CONSTRUCTION MANAGEMENT PLAN FRAMEWORK

UTS BROADWAY BUILDING (BB)
SYDNEY

FOR THE UNIVERSITY OF TECHNOLOGY, SYDNEY

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Introduction

This Construction Management Plan (CMP) Framework summarises the strategies proposed to conduct the construction works for the new building for the Faculty of Engineering and Information Technology for the University of Technology, Sydney (UTS). It supports the Environmental Assessment Report for MP 09-0212. The CMP addresses all items as outlined in the Director General Requirements, Key Assessment Requirements, Section12, Excavation and Construction Management. This report is to be understood as a set of general management principles that will be further defined once the Main Works Contractor is appointed. A separate Construction Management Plan was prepared for the Excavation Works and was submitted as part of the Application to Modify the Concept Plan.

In the report following, construction management areas such as site management, health and safety, traffic management, noise and vibration, waste management, dust mitigation measures and flora and fauna management will be discussed.

Background to the Project

The proposed 'Broadway Building' will house the Faculty of Engineering and Information Technology. The site, of an approximately size of 3540 m^2, is located within UTS's Broadway precinct, bounded to the South by Broadway, to the West by Wattle Street and to the East by Jones Street. The existing Campus Building 10 defines the site to the North.

The building will comprises twelve levels of classrooms, offices and lecture theatres above ground with four basement floors, accommodating further teaching spaces, car parking and plant equipment. Additional plant will be located at roof level.

The current design concept comprises a multi storey reinforced concrete frame with post tensioned beams and traditional reinforced floor slabs. Lateral restraint will be provided by central cores.

Seven lifts, escalators, stairs and internal bridge links connect the various floors of the building.

Air supply is proposed by an underfloor ducted system to all levels above ground.

The building envelope is designed as a double glazed curtain wall facade which will be screened by a full-height perforated aluminium screen to the South, East, West and partly to the North. The screen will be supported off the curtain wall mullions.

Nine bridge links will connect the Broadway Building with the adjacent campus Building 10.

A glazed canopy between Broadway Building and CB10 will cover the laneway.

Dilapidation Report
Prior to commencement of any works on site a dilapidation report will be prepared by the Head Contractor. The report will include a survey which will give an exact record of the conditions of the site inclusive of all areas handed to the Head Contractor including adjoining buildings, infrastructure and roads. The appropriate parties will be issued with a copy of the Dilapidation report before any construction works commence. The report will include photographs and site plans with location reference for ease of use.

This report will form the basis for comparison with the dilapidation report that will be prepared after all construction works are completed.

Site Working Hours
Working hours are subject to Authority Approval and have been confirmed in the Conditions of Approval for the Concept Plan to be restricted to within the hours of 7.00am to 7.00pm Monday to Friday, and within the hours of 7.00am to 5.00pm Saturday, with no work on Sundays and Public Holidays.

Outside these hours, works, such as delivery of materials may be undertaken where it is required by authorities or for safety reasons. Further, in an emergency, to avoid loss of lives, property and/or harm to the environment, works outside those hours may become necessary.

Any alterations to the times specified must be approved by the Director, Strategic Assessment of the Department of Planning.

Contact Details
Site Superintendent – Denton Corker Marshall Pty Ltd, phone +61 3 90123600.

Head Contractor - TBC

Parking
No on-site parking will be available for visitors, tradesmen or site personnel. There are a number of paid parking areas available in the local vicinity.

Security
Site security measures will be in place at all times when the site is not in operation. Measures may include but not be limited to perimeter hoarding, locked gates, surveillance cameras, security lighting and motion detectors.

Unauthorised access to the site and adjoining buildings will be prevented by providing adequate security measures.

Site security will be managed by physical means of separation and monitoring. Site personnel and visitors will gain access to the site via the main entrance off Jones Street where the Head Contractor will provide turnstiles or similar methods to ensure no unauthorised access is gained during the works or out of hours. The security of materials and equipment will be provided by standard measures of site monitoring. Vehicular access to site will be limited and monitored by site personnel. A detailed site management plan will be developed to ensure site security is established and maintained as necessary to prevent unauthorised access to the site during all construction times.

Further consideration to public access and safety will be given during the development of the detailed site management plan which will be prepared by the Head Contractor. Access of site amenities and facilities such as offices, toilets, lunch rooms, first aid rooms and change rooms will be provided.

Site Amenities

The location of the site facilities during construction will be via a high level gantry over footpaths adjoining the site. As site occupancy levels increase during the basement construction additional facilities will be located on the gantry. As construction progresses above ground level, amenities will be sited on a public protection type gantry. Additional gantries will be provided to Broadway. In order to provide sufficient public protection and supervision of site visitors, it is intended to locate the main pedestrian entrance to Wattle Street.

Further consideration to public access and safety will be given during the development of the detailed site management plan, which will be prepared by the Head Contractor. Access of site amenities and facilities such as offices, toilets, lunch rooms, first aid rooms and change rooms will be provided.

Hoardings

The site will be appropriately secured by fences, hoardings and gates during the entire duration of the construction work. Class B hoarding will be provided to all three street frontages. Gates will be installed to control access to the site. Egress paths from CB10 will be secured by fences and overhead protection. Hoardings, gates and fences will be suitably lined in order to limit public viewing and ensure safe pedestrian flow. Attention will be paid to the effects of hoarding on pedestrian travel paths. If required, ramps or tactile indicators may need to be installed. Relevant approvals will be provided.

Approval to extend the period for the retention of perimeter hoardings used during the Early Works stage of the project will be sought through Sydney City Council by the Main Works Head Contractor.

Architectural, construction and structural details of the design of the hoarding will be in accordance with relevant policies and guidelines as specified by The City of Sydney's – Policy for the Design of Construction Hoardings.

Structural certification for the hoarding will be prepared and signed by an appropriately qualified practicing Structural Engineer.

Safety and Protection

Safety signage, lighting and traffic controls to the site will be provided during the duration of the construction.

Any temporary or permanent changes to street lighting will first need to be approved by the relevant authorities.

All personnel, sub contractors and visitors must undertake the UTS Occupational Health and Safety (OH&S) 'ELMO' online induction training. 'ELMO' is a UTS-wide construction worker site safety induction process that is conducted online to cover UTS-specific issues.

The Head Contractor and all sub contractors must induct their employees into their safe work procedures and submit a copy of their induction register and safe work method statements. These safe work method statements are to be kept on site.

An OH&S meeting will be held weekly to deal with issues that may arise on site. This meeting will be attended by a representative of each sub contractor and chaired by the Superintendent.

An OH&S information board will be erected and a copy of the UTS OH&S policy will be prominently displayed on the board.

Sub contractors will be required to submit an OH&S Plan to the Superintendent for review prior to commencement of work on site. The sub contractor is to incorporate any feedback from the superintendent into the OH&S Plan.

In accordance with the Construction Traffic Management Plan, the loading zone is proposed in Wattle Street. Details of the logistics methodology during construction will be further detailed by the Head Contractor.

Number and location of cranes will also be subject to the Head Contractor's site establishment strategy.

Due to the proximity of the structure to the building boundary it will be necessary to make use of all available storage on the surrounding gantries. A just in time delivery approach for materials deliveries will be adopted whereby vehicles wait off site and are contacted via two way communication when loading bay availability is established, thus reducing any banking of vehicles and unnecessary impact on local area traffic conditions.

First Aid Facilities
First aid facilities are to be provided as per OH&S legislative requirements.

The Head Contractor and all sub contractors shall provide the name of a designated First Aid Officer to the Superintendent.

Approved Plans to be on Site
A copy of the approved and certified plans, specifications and documents incorporating conditions of approval and certification shall be kept on site at all times.

Signage and Site Notice
A site notice is to be prominently displayed at the boundary to each frontage of the site for the purpose of informing the public of appropriate project details and relevant approvals.

A sign that displays key contact names, phone numbers and security measures will be provided.

Signs, road markings, street furniture, parking meters etc, that might be affected by the construction works will either be relocated or suitably protected during the duration of the construction. Appropriate authority approval will be sought as required.

Public Domain
Footpaths and bicycle paths adjacent to the site will be kept unobstructed from tripping hazards from hoarding or fences. All services extending over footpaths will be covered and fitted with a ramp to facilitate safe pedestrian access and access for persons with disabilities.

Ingress & Egress of Vehicles to the Site
All ingress and egress of vehicles on and around the site will be in accordance with the methods outlined in the Construction Traffic Management Plan.

All building contractors shall be notified of the truck routes and will be required to adhere to the nominated routes as outlined in the Construction Traffic Management Plan for the Main Works.

Ingress to and egress from the site is generally provided from Wattle Street. During the early stages of the construction limited access is available from Jones Street onto a temporary loading platform at the East end of the site. The loading platform will eventually be removed as the building works progress.

Loading and Unloading
Loading and unloading of materials on site is restricted. Vehicles will only be able to access the temporary loading platform during the early stages of the construction works, when the construction of the lower basement levels is undertaken. Beyond this stage, all loading and unloading will take place in the allocated loading sections as described in the Construction Traffic Management Plan for Main Works. All construction vehicles will stand in the allocated sections to deliver, load and unload materials during the majority of the construction period.

Driveway access will be controlled by qualified personnel and pedestrian warning signs and flashing lights will be installed.

A delivery/removal register will be located on site for completion by all sub contractors and will be reviewed by the Superintendent.

Only construction vehicles will be allowed on site.

Marshalling of Trucks
The nominated marshalling area for trucks will adhere to the location specified in the Construction Traffic Management Plan for Main Works.

Traffic Management Methods
All vehicles are to be directed by a representative of the Head Contractor to a nominated loading or work areas.

All vehicles prior to leaving the site must be checked by a Head Contractor's representative for cleanliness and must be washed down if required.

Construction vehicles are not permitted on site without approval from the Head Contractor's site manager.

The maintenance and cleaning of vehicles and construction plant will not be undertaken in areas where oil or runoff may be discharged into a watercourse, street gutter or stormwater drainage system. Waste from these activities will be collected, stored and then disposed of in a manner that is approved by the Department of Environment, Climate Change and Water.

To reduce traffic and noise impacts, trucks transporting materials or equipment to or from site will be confined to the main road network to avoid local roads as much as practicable.

Pedestrian Management Methods

Pedestrian thoroughfares around the site are to be maintained and clearly marked. Access to the footpaths around the site will not be restricted. The footpaths will be protected by B Class hoarding with overhead protection. The proposed laneway between CB10 and the proposed Broadway Building will remain inaccessible until the Main Construction Works are completed.

Usage of the footpath along Wattle Street as well as along Jones Street may be temporarily restricted when construction or delivery vehicles approach the site. Also, loading and unloading of construction materials and equipment may impact the pedestrian flow along these footpaths. The footpath to the West of Jones Street immediately adjacent to the site will be closed during the duration of the construction works in order to avoid pedestrians crossing the driveway to the site. A traffic supervisor will assist in the safe conduct of construction traffic and pedestrians as per the Construction Traffic Management Plan for Main Works. Alternatively pedestrians can resort to the footpath on the West side of Wattle Street and the East side of Jones Street respectively.

Visitors to the Site

All visitors to the site will report to the Site Office to sign the Visitor's Register.

All visitors must sign out when leaving the site.

All visitors must wear suitable attire before entering the site. This includes helmets, steel capped boots and high visibility vest/jacket.

An inducted person must accompany visitors on site at all times.

No private parking will be available within the site. Visitors must find parking in surrounding streets or public car parks.

The construction area will be suitably cordoned off from public and adjoining building pedestrian areas.

Pedestrian access to, from and around the site is to be via designated access routes to be clearly identified as part of the induction process.

Construction Noise Objectives
Reasonable measures will be undertaken to manage noise from construction activities.

For details on expected noise levels and appropriate mitigation measures refer to the Construction Noise and Vibration Management Plan for main works, attached to this Construction Management Plan as Appendix A.

Working hours will be in accordance with the conditions of consent. All works will take place within these allotted times and follow the conditions in which works may be undertaken outside these hours.

Proposed Mitigation Treatments, Managed Methods and Procedures
The following mitigation treatments, management methods and procedures are proposed:

Construction work will only be given permission to commence once the Head Contractor has submitted and received approval for a schedule of equipment which describes the equipment types to be used, noise levels, expected time and duration of use, and any measures required to ensure the noise levels are acceptable.

Loading and unloading of construction vehicles will only take place on site in the allocated loading areas.

Personal safety measures, such as ear muffs and ear plugs shall be enforced wherever noise exceeds 85db.

Operating noise limits are to be implemented to achieve the construction noise objectives.

The Head Contractor and all sub contractors will be requested to use silenced equipment where applicable.

The Head Contractor, as part of the site safety plan is to ensure ear and eye protection is available for all site personnel and visitors and should be enforced on a daily basis.

Bored piles will be used in lieu of driven piles.

Construction work that exceeds agreed noise limits, but cannot be avoided, will be proposed to be scheduled during times such as semester breaks or exam-free times to reduce the impact on the university's users and other residents.

Windows in CB10 facing the site will be specifically treated in order to protect occupants from noise impacts.

The relocation of UTS personnel in buildings adjacent to the site will be considered.

Vibration emission levels for equipment used on site will be established prior to the commencement of works. Site specific buffer distances will be determined on the basis of this.

Notification Period
Occupants of adjoining buildings will be notified of activities that are likely to cause disturbance through noise and vibration prior to commencement of works.

Waste Management

The objective of the waste management strategy is to carry out all construction activities so that waste production can be avoided or significantly reduced. Landfill will be minimised with the reuse and recycling of construction materials.

All construction waste and packaging is to be removed in accordance with the requirements of relevant legislation, codes, standards and guidelines.

A more specific Waste Management Plan will be further developed by the Head Contractor.

A Waste Storage and Handling Plan will be developed and will be displayed on site to identify details of waste storage and waste transport during the duration of the construction.

As a general waste management mitigation measure it will be encouraged to only use dedicated skips or bins which will be removed from site for emptying and cleanout to an approved waste depot.

All domestic waste including litter will be managed via a similar bin system that will be provided in the vicinity of designated eating areas. Materials collected for recycling should include:

– Construction and demolition waste bins and domestic waste bins will be located in separate designated areas on the site to ensure appropriately safe storage and collection of waste.

– Waste areas will be clearly signposted and colour coordinated to define acceptable waste types suited for each bin and secured where required.

– The location of the waste bins and recycling areas will be marked on the site waste management plans located on site.

The Head Contractor and all sub contractors will be responsible for cleaning their respective work areas on a daily basis.

Separation of waste will be encouraged and monitored by the Head Contractor.

If a particular bin is found to be "contaminated" by waste material from a subcontractor, that particular Subcontractor will be liable for all measures and costs associated with removing, sorting and tipping of the waste.

Washout processes and facilities for paint and/or finishing trades on site will be minimised and water recycling for these activities will be encouraged.

Finishing trades washout facilities will not be connected to any building services but of a stand-alone nature. The maintenance of these facilities will be the respective contractor's responsibility and will need to comply with all appropriate Environmental Legislation and local authority guidelines.

All suppliers of building materials will be encouraged to nominate packaging minimisation and reuse initiatives. Bulk handling and the application of reusable transport containers will be encouraged.

Suppliers will be encouraged to nominate products that include a recycled component and ability/opportunity for recycling of unused components in accordance with the specified 80% waste reduction target as outlined in the ESD and Energy Efficiency Report.

Preventive Measures

All adequate measures are to be taken to prevent erosion affecting the neighbouring buildings, sites or the public domain during construction. These measures are further explained in the Geotechnical Investigation and Hydrogeological Assessment.

Drainage of the site will occur to a legal point of discharge. Stormwater will be captured and filtered before entering the point of discharge.

Measures will be applied to prevent stormwater from entering adjoining properties or the sewage system.

Grated drains at stormwater exit points from the site will be provided to prevent uncontrolled runoff.

Existing on-site storm water drainage pits will be cleaned of rubbish and silt. All drainage grates will be covered with suitable geotextile fabric securely fixed in position.

Natural rainwater run-off will be controlled to prevent sediment draining into the stormwater system.

Waste material, including liquid wastes will be prevented from discharge into the stormwater system.

Sediment barriers to storage areas of loose materials such as soil, sand or gravel will be provided.

Potential groundwater inflows and seepage into the site, if occurring, will be monitored. Pump facilities will be designed and installed as required.

Silt fencing will be installed at the base of the site hoarding in order to catch any silt laden runoff and prevent it from leaving the site. The silt fencing is to be anchored at the base by either embedment or weighed down with sand bags.

Preventive Measures

Air quality in and around the site will be maintained at an acceptable level throughout the duration of the construction.

Dumping of loose materials on the site will be minimised. If dumping of loose materials is unavoidable, detailed measures for preventing dust and other airborne matter impacting on the surrounding area will be applied.

Dust arising from construction vehicles entering and leaving the site or loading and unloading adjacent to the site, will be controlled by watering down driveways and vehicles in a considered and efficient manner.

The provision of vehicle entry/exit points including truck cleaning facilities will be allowed for. These points will be managed by a gate controller. Gates shall be closed between vehicle movements and shall be fitted with geotextile fabric.

Cleaning of footpaths and driveways shall be carried out periodically.

Perimeter hoarding and fencing will minimise dust impacting on the public domain.

Materials will be stored on site or on gantries and will be covered so that exposure to the weather elements is minimised.

Exhausts and ductwork from equipment used on site will be located away from air intakes of surrounding buildings, and public areas.

Construction materials will only be cut in designated areas away from the site boundary and the public domain. Dust and noise suppression measures will be utilised.

Air intake vents on adjacent campus buildings that might be exposed to excessive dust or otherwise affected air quality will be fitted with filters. Documentation of these preventive measures by the consultant team will ensue.

Protection of Existing Street Trees

An Aboricultural Implications Plan has been prepared to evaluate the impact of the construction activities on existing trees around the site.

All street trees shall be protected as required at all times during construction. Any tree on the footpath which is damaged or removed during construction shall be replaced.

Street trees are required to be protected by means of tree guards, barriers and other measures as necessary in order to protect the canopy, roots, trunk and branches during construction.

An Arborist Report has been prepared in order recommend detailed measures that need to be applied in order to protect the trees around the site from potential damage. In particular those trees that are listed in the city of Sydney's Register of Significant Trees will require careful assessment of implications during the construction works.

A site Arborist has been appointed to consult directly with the main contractor.

A dilapidation tree schedule will be prepared prior to commencement of construction works.

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APPENDIX A

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UTS BROADWAY BUILDING

CONSTRUCTION NOISE & VIBRATION MANAGEMENT PLAN

TE914-01F01 (REV 3) CNVMP.DOC

21 FEBRUARY 2011

Prepared for:

University of Technology, Sydney

City Campus

Level 6, Building 10

235 Jones Street

Broadway NSW 2007

Attention: MR IAN FERGUSON

25 1982-2007 ACOUSTIC ENGINEERING EXCELLENCE

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DOCUMENT CONTROL

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21/02/2011	Finalise report	-	3	MCH	-	MCH

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This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

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1 INTRODUCTION

Renzo Tonin & Associates were engaged to prepare a Construction Noise and Vibration Management Plan (CNVMP) for the proposed University of Technology, Sydney (UTS) Broadway Building development on the corners of Jones Street, Broadway and Wattle Street, Ultimo. This management plan will provide guidelines to reduce noise and vibration impacts to nearby affected receivers during construction works.

Furthermore, this management plan has been prepared in response to the key assessment requirements of Condition 12 of the Director General's Requirements (DGRs).

In accordance with relevant guidelines, this document:

- Identifies the potential sources of noise and vibration during the proposed works;
- Specifies the noise and vibration criteria for the proposed works;
- Describes in detail what actions and measures could be implemented to enable these works to comply with the relevant noise and vibration criteria;
- Describes how the effectiveness of these actions and measures would be monitored during the proposed works, clearly indicating who would conduct the monitoring, how often this monitoring would be conducted, how the results of this monitoring would be recorded; and, if any non-compliance is detected; and
- Describes procedures to handle complaints.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on the Australian Standard / NZS ISO 9001.

2 PROJECT DESCRIPTION

2.1 Location

The construction site is located on the corners of Jones Street, Broadway and Wattle Street, Ultimo and is bound by Jones Street to the east, Broadway to the south and Wattle Street to the west. UTS building CB10 bounds the site to the north and shares a common boundary with the site. Other UTS buildings to the east, commercial properties to the west and residential apartments to the northwest surround the site.

The nearest and potentially worst affected sensitive receivers were identified during a site inspection. These sensitive receivers are as follows:

- **Receiver R1** – **UTS Building CB10**
  Building with teaching spaces, offices and commercial spaces located directly adjacent to the north of the construction site and sharing a common boundary.

- **Receiver R2 – 129-133 Broadway, Ultimo**
  Commercial development located approximately 45m across Wattle Street to the west of the construction site.

- **Receiver R3** – **513-519 Wattle Street, Ultimo**
  Mixed use development with commercial premises on the ground level and residential apartment units on the upper levels located approximately 50m across Wattle Street to the northwest of the construction site.

Figure 1 is a locality map showing the site and its surrounding area.

In addition to the above receiver locations and given that UTS Building CB10 is a multi-level building, each floor level of the UTS Building CB10 was also assessed for construction noise impacts.

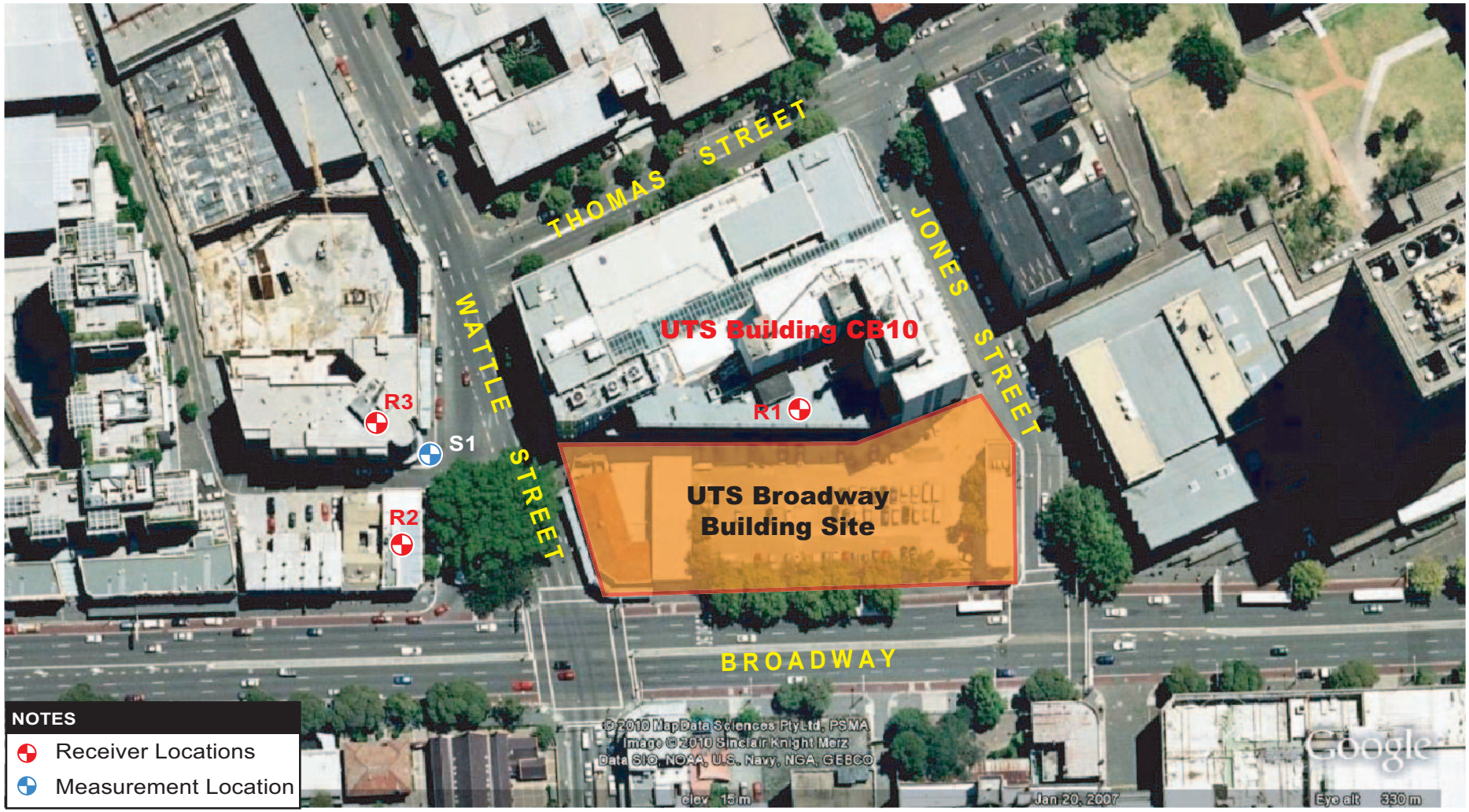
2.2 Proposed Construction

2.2.1 Summary of Construction Activities

The proposal includes three phases of construction which consists of demolition, excavation and construction of the UTS Broadway Building development. However, this management plan will only address the construction phase of the development.

Construction activities will involve the construction of the UTS Broadway Building on the site and other associated works, such as the provision for vehicular access through the adjacent UTS CB10 Building.

Construction works are anticipated to begin in January 2012 and will continue for a period of approximately 22 months.



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Title : Figure 1 - Site, Surrounds, Receivers & Measurement Location

Date : 15/07/10

Scale: NTS

Project: UTS Broadway Building

Ref : TE914-01P01 (rev 0)

3 EXISTING ACOUSTIC ENVIRONMENT

Appropriately secure locations were unable to be found for long term, unattended noise monitoring. Instead, several short term attended background noise measurements were conducted during different periods of the day, corresponding to the construction hours, on Tuesday 15th June 2010 and Wednesday 16th June 2010. Measurements were conducted in the 'free field', away from any reflective surfaces.

The following noise monitoring locations were selected for the purpose of this assessment.

- **Location S1 – 513-519 Wattle Street, Ultimo**
  Eastern side of building on the footpath facing Wattle Street. The noise environment at this location was dominated by traffic noise from Wattle Street and distance traffic from Broadway. The background noise levels at this location are considered to be representative of Receiver R3.

3.1 Noise Monitoring Results

The results of the short term measurements are shown below.

Table 3.1 – Measured Existing Background (L_{90}) & Ambient (L_{eq}) Noise Levels, dB(A)

Location	L_{90} Background Noise Level	L_{eq} Ambient Noise Level
Location S1 – 513-519 Wattle Street	66	72

4 NOISE MANAGEMENT PLAN

4.1 Purpose

This section provides an assessment of construction noise emissions from the site and recommends noise mitigation measures and management measures that can be used to minimise noise impacts at receivers surrounding the site.

4.2 Noise Criteria

4.2.1 Interim Construction Noise Guideline

Chapter 171 of the NSW *Environmental Noise Control Manual* (ENCM, Environment Protection Authority 1994) provides guidelines for assessing noise generated during the construction phase. However, the Department of Environment, Climate Change and Water (DECCW – formerly DECC) has recently released its *NSW Interim Construction Noise Guideline* (ICNG). This document is the DECCW's standard policy for assessing construction noise. This new guideline supersedes Chapter 171 of the ENCM.

The key components of the guideline that could be incorporated into this assessment include:

1. Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.

   In recent years NSW noise policies including DECCW's NSW Industrial Noise Policy (INP) and the NSW Environmental Criteria for Road Traffic Noise (ECRTN) have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

   Consistent with the ICNG we recommend the use of L_{Aeq} as the key descriptor for measuring and assessing construction noise.

2. Application of reasonable and feasible noise mitigation measures

   As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

   Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

3. Quantitative and qualitative assessment

   The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment.

   A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria.

A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the significant scale of the construction works proposed for the UTS Broadway Building, a quantitative assessment is carried out herein, consistent with the ICNG's requirements.

Management Levels

Table 4.1 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied for residential receivers. The guidelines intend to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

In Table 4.1 below, the rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

Table 4.1 – Noise at Residences Using Quantitative Assessment

Time of Day	Management Level $L_{Aeq\ (15\ min)}$*	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(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 or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. 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) 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB(A)	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 of the *NSW Interim Construction Noise Guideline*.

Time of Day	Management Level $L_{Aeq\ (15\ min)}$*	How to Apply

** Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.*

The background noise level measured at the measurement location was considered to be representative of the RBL for the residential apartment on Wattle Street affected by construction noise from the site. Therefore, the measured background noise level is suitable for setting construction noise criteria for residential receivers, consistent with a conservative assessment. Based on the background noise level measured and the construction works proposed for the day time period only, the construction noise criteria for the residential receivers during the day period are summarised below.

Table 4.2 – Summary of Construction Noise Management Levels, dB(A)

Time of Day	Management Level $L_{Aeq(15min)}$	Base Management Level $L_{Aeq(15min)}$
During recommended standard hours (day)	RBL + 10dB(A)	66 + 10 = **76**

Given that the base management level is higher than the 'highly noise affected' level of 75dB(A), as stipulated in the ICNG and presented in Table 4.1 above, the applicable noise management level to be used for the assessment of construction noise at the residential receiver will be **75dB(A)**.

Sensitive Land Uses

Table 4.3 below (reproduced from Table 3 of the ICNG) sets out the noise management levels for sensitive land uses. Given that Receiver R1 (UTS Building CB10) includes teaching spaces, the management levels for school classrooms would be applicable.

Table 4.3 – Noise at Other Sensitive Land Uses Using Quantitative Assessment

Land use	Management level, $L_{Aeq\ (15\ min)}$
Classrooms at Schools and other educational institutions[1]	Internal noise level = 45 dB(A)

Notes: 1. Applicable for the internal teaching spaces in UTS Building CB10 directly affected by construction noise

As a general rule, masonry / brick type building structures would typically provide a 15dB(A) reduction from external noise levels to internal noise levels. Therefore, the equivalent external management noise level for classrooms is **60dB(A)**.

Commercial Premises

Commercial premises are located near the proposed UTS Broadway Building construction site and in accordance with Section 4.1.3 of the ICNG, commercial properties should be assessed for construction noise impacts. The noise management levels presented in the ICNG for commercial premises are reproduced in Table 4.4 below.

Table 4.4 – Noise at Commercial Premises Using Quantitative Assessment

Type of Premises	Management level, $L_{Aeq\ (15\ min)}$
Commercial (such as offices and retail outlets)	External noise level = 70 dB(A)

4.2.2 Australian Standard 2107:2000

In addition to the DECCW's ICNG, recommended internal noise levels for different types of occupancies are provided in Australian Standard 2107:2000 'Acoustics – Recommended design sound levels and reverberation times for building interiors'. Table 1 of the standard provides recommended design sound levels within internal areas which would be applicable to affected internal areas of UTS Building CB10. The recommended internal noise levels are presented below and are for internal areas not addressed by the ICNG.

Table 4.5 – AS2107:2000 Recommended Internal Design Sound Levels

Type of Occupancy	Recommended Design Sound Level, L_{Aeq}, dB(A)	
	Satisfactory	Maximum
Office areas	40	45
Retail stores	45	50

4.2.3 Time Restrictions

In accordance with the ICNG, the standard work hours are:

- Monday to Friday, 7am to 6pm.
- Saturday, 7am to 1pm if inaudible on residential premises, otherwise 8am to 1pm.
- No construction work to take place on Sundays or Public Holidays.

4.3 Proposed Construction Noise Sources

The construction of the proposed UTS Broadway Building will be conducted in three main phases. Phase 1 of the construction relates to demolition of the existing buildings on the proposed site. Phase 2 of the construction consist mainly of excavation works which involves excavating through class 1 and 2 sandstone and fill on the site. The final phase of the construction is the construction of the proposed UTS Broadway Building. However, as part of this management plan, only the construction phase will be addressed.

Actual construction plant and equipment to be used during the construction phase of the development are not yet known. Therefore, typical plant and equipment likely to be used during the construction works are provided in Table 4.6 below.

Table 4.6 – Typical Construction Equipment & Sound Power Levels, dB(A)

Plant Item	Plant Description	L_{Aeq} Sound Power Levels
1	Rock Breaker	117
2	Concrete Floating Machine	112
3	Pneumatic Hand Tools (general)	110
4	Tower Crane	110
5	Excavator	107
6	Concrete Truck	106
7	Delivery Truck	105
8	Concrete Pump	102
9	Welder	102
10	Concrete Vibrator	100
11	Silenced Air Compressor	95
12	Hoists	92
13	Forklift	90

The sound power levels for the majority of activities presented in the above table are based on maximum levels given in Table D2 of Australian Standard 2436 - 1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites", information from past projects and information held in our library files.

4.4 Estimated Noise Levels

The estimated noise levels at the nearest affected receiver locations due to construction activities were calculated and are shown in Table 4.7 below. It must be noted that for a conservative assessment the predicted noise levels based on a 'worst case' scenario where all the construction plant and equipment are operating concurrently are also presented.

Table 4.7 – Predicted Construction L_{Aeq} Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Receiver R1	Receiver R2	Receiver R3
1	Rock Breaker	92	76	75
2	Concrete Floating Machine	87	71	70
3	Pneumatic Hand Tools (general)	85	68	68
4	Tower Crane	85	68	68
5	Excavator	82	66	65
6	Concrete Truck	81	65	64
7	Delivery Truck	80	63	63
8	Concrete Pump	77	60	60
9	Welder	77	61	60
10	Concrete Vibrator	75	59	58
11	Silenced Air Compressor	70	53	53
12	Hoists	67	51	50

Plant Item	Plant Description	Receiver R1	Receiver R2	Receiver R3
13	Forklift	65	49	48
All Equipment Operating Concurrently		**95**	**79**	**78**

The predicted noise levels above are based on construction plant and equipment generally operating in the areas closest to the corresponding nearby critical receivers. Calculations take into consideration attenuation due to distance between the receiver and the construction activity only and does not consider shielding provided by intervening structures. Furthermore, the predicted noise levels are based on no noise mitigation treatment applied to plant and equipment on site.

In addition to the nominated receiver locations, predicted construction noise levels for each floor level of UTS Building CB10 were also predicted and are presented in the table below.

Table 4.8 – Predicted Construction L_{Aeq} Noise Levels at CB10 Floor Levels, dB(A)

Plant Item	Plant Description	UTS Building CB10 Floor Level												
		L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14
1	Rock Breaker	92	91	90	88	86	85	83	82	81	80	79	78	78
2	Concrete Floating Machine	87	86	85	83	81	80	78	77	76	75	74	73	73
3	Pneumatic Hand Tools (general)	85	84	82	80	79	77	76	75	74	73	72	71	70
4	Tower Crane	85	84	82	80	79	77	76	75	74	73	72	71	70
5	Excavator	82	81	80	78	76	75	73	72	71	70	69	68	68
6	Concrete Truck	81	80	79	77	75	74	72	71	70	69	68	67	67
7	Delivery Truck	80	79	77	75	74	72	71	70	69	68	67	66	65
8	Concrete Pump	77	76	74	72	71	69	68	67	66	65	64	63	62
9	Welder	77	76	75	73	71	70	68	67	66	65	64	63	63
10	Concrete Vibrator	75	74	73	71	69	68	66	65	64	63	62	61	61
11	Silenced Air Compressor	70	69	67	65	64	62	61	60	59	58	57	56	55
12	Hoists	67	66	65	63	61	60	58	57	56	55	54	53	53
13	Forklift	65	64	63	61	59	58	56	55	54	53	52	51	51
All Equipment Operating Concurrently		**95**	**94**	**93**	**91**	**89**	**88**	**86**	**85**	**84**	**83**	**82**	**81**	**81**

Based on Table 4.7 and Table 4.8 above, noise emission from construction activities will generally exceed the set noise criteria for all locations. Noise mitigation measures should therefore be considered to minimise noise impact during construction activities.

4.5 Noise Mitigation Measures

4.5.1 General Engineering Noise Controls

Implementation of noise control measures, such as those suggested in Australian Standard 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-1981, Appendix E, Table E1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table E2 in Appendix E presents typical examples of noise reductions achievable after treatment of various noise sources. Table E3 in Appendix E presents the relative effectiveness of various forms of noise control treatment.

Table 4.9 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 4.9 – Relative Effectiveness of Various Forms of Noise Control, dB(A)

Noise Control Method	Practical Examples	Typical noise reduction possible in practice		Maximum noise reduction possible in practice	
		AS 2436	Renzo Tonin & Assoc.	AS 2436	Renzo Tonin & Assoc.
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	7 to 10	5 to 10	15	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 30	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	15 to 25	15 to 25	60	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436.

To ensure efficient noise attenuation performances are achieved using any of the methods listed above, it is recommended acoustic engineers work closely with the construction contractors and carry out noise testing of works.

Typical noise treatment options that may be considered for the construction activities on the site are summarised below. Note that the ability to implement these measures is subject to site practicality.

1. ***Noise Control Kits*** Where possible, 'noise control kits' could be fitted to plant engines to reduce noise level emissions. Such 'noise control kits' comprise:
   - high performance 'residential-grade' exhaust mufflers,
   - additional engine cowling / enclosure lined inside with sound

absorbent industrial-grade foam, and

- air intake and discharge silencers / louvres.

2. Partial Acoustic Enclosures

Where noise exceedance occurs, partial acoustic enclosures may be constructed around noisy plant and equipment, for example air compressors. A partial enclosure can be constructed from 10mm plywood, located on site as close as practical to the plant. The inner face of the plywood enclosure should be lined with 50mm acoustic insulation (eg. Tontine AcoustiSorb2 or TBL 32/50, hydrophobic mineral wool, or equivalent).

Acoustic enclosures should be checked by a suitable acoustic engineer once they are constructed.

3. Hoarding

Where stationary equipment (ie. non-transient activities) is used on site, temporary hoarding between the source and receiver may be erected. The hoarding should be constructed from any durable material with sufficient mass to prevent direct noise transmission eg. steel, aluminium, fibrous-cement, timber, polycarbonate, or any combination of such materials, provided they withstand the weather elements.

Hoarding should be checked by a suitable acoustic engineer once erected.

4. Truck Movement

Potential noise impact from truck movement will be limited by managing the movement of trucks around the site. The number of trucks around the site should be kept to a minimum, where possible.

4.5.2 Specific Noise Mitigation Measures to UTS Building CB10

Noise sensitive areas within UTS Building CB10 generally consist of teaching spaces, offices and commercial spaces. Some of these noise sensitive areas have windows that overlook the construction site and are directly exposed to noise impacts from construction activities proposed for the site. Therefore, to reduce airborne noise through the existing windows on the southern façade of the CB10 building, acoustic treatment to the windows would be required. The noise mitigation measures required to reduce airborne noise to internal areas on the southern side of the CB10 building are as follows:

Table 4.10 – Noise Mitigation Measures to Southern Windows of Building CB10

Floor Level	Type of Mitigation Measure to Windows
Levels 2 to 8	2 layers of 12mm thick Compressed Fibre Cement (CFC) / 100mm air gap / 50mm acoustic insulation with min. density of 25kg/m^3
Levels 9 to 11	1 layer of 10mm thick glass / 100mm air gap
Levels 12 to 14	1 layer of 15mm thick Perspex / 10mm air gap

The CFC, glass and Perspex sheets should be fixed to a metal frame, which in turn should be fixed to the internal window recess. The frame should be sealed air tight to the recess and the CFC, glass and Perspex sheets should be sealed air tight to the frame with mastic sealant. Furthermore, the CFC and Perspex sheets should overlap a minimum of 50mm above, below and either side of the window recess and sealed air tight with mastic sealant.

4.5.3 Noise Management Measures

In addition to physical and engineering mitigation measures described above, the following noise management measures shall be considered to minimise adverse noise impacts to nearby receivers.

1. Time Management

Where noise level exceedance cannot be avoided or where physical noise control measures are not reasonable or feasible, then consideration should be given to implementing time restrictions and/or providing periods of repose for neighbours. That is, daily periods of respite from noisy activities may be scheduled for building occupants in UTS Building CB10 during business hours.

Some items of plant may exceed noise limits even after noise treatment is applied. To reduce the overall noise impact, the use of noisy plant should be restricted to within certain time periods, to be negotiated with stakeholders.

2. Relocation of Affected People

Given that some of the areas in the CB10 building potentially affected by noise impacts from the construction activities are teaching spaces, relocation of classes to quieter areas of the building or to a different building altogether may be considered as an option.

Office areas impacted by the construction activities may also be considered for relocation if deemed necessary after consultation with affected stakeholders.

3. General

- Plant and equipment should be properly maintained.
- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel.
- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods should be switched off.

- Good relations with people living and working in the vicinity of the construction site should be established at the beginning of the works and be maintained throughout the works, as this is of paramount importance.
- Keep stakeholders informed of progress.
- Take complaints seriously and deal with them expeditiously. The person selected to liaise with the stakeholders should be adequately trained and experienced in such matters.

4. Regular Periodic Noise Monitoring

Noise monitoring should be undertaken at the commencement of works and regular periods at all affected receiver locations identified in this study to provide feedback to management on any noise exceedances, so necessary actions can be taken. Noise monitoring should be undertaken in accordance with Appendix C.

5. Complaints Handling Procedure

A complaint handling procedure should be put in place to deal with noise complaints that may arise from construction activities. A contact number for complaints to be made on should be established for affected stakeholders to inform the site of unsatisfactorily high noise levels. This number should be displayed clearly on signage at the site perimeter. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits. See Appendix D for an example of a complaint handling procedure and form.

5 VIBRATION MANAGEMENT PLAN

5.1 Vibration Sources

Typical vibration levels from construction plant and equipment most likely to cause significant vibration are summarised below. The information was sourced from a variety of reference materials available in the Renzo Tonin & Associates library.

Table 5.1 – Typical Ground Vibration Generated by Construction Plant

Plant	Typical ground vibration
Excavator	Typical ground vibration levels from excavators are similar to those from jackhammers. They range from 1 mm/s to 2 mm/s at distances of approximately 5 m and at distances greater than 20m, vibration levels are usually below 0.2 mm/s.
Rock Breaker	Typical ground vibration levels from rock breakers hammering hard rock and sandstone range from 1 mm/s to 5 mm/s at distances of approximately 5m depending on the size of the breaker. At distances greater than 20m, vibration levels are usually below 0.5 mm/s. Use of smaller machines can reduce levels of vibration significantly.
Truck traffic	Typical vibration from heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels in the range of 0.01 - 0.2mm/s at the footings of buildings located 10 - 20m from a roadway. Very large surface irregularities can cause levels up to five to ten times higher. In general, ground vibration from trucks is usually imperceptible in nearby buildings. The rattling of windows and other loose fittings that is sometimes reported is more likely to be caused by airborne acoustic excitation from very low frequency (infrasonic) noise radiated by truck exhausts and truck bodies. While this may cause concern to the occupants, the phenomenon is no different from the rattling caused by wind or people walking or jumping on the floor and fears of structural damage or even accelerated ageing are usually unfounded.

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

5.2 Vibration Criteria

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 for the UTS Broadway Building site.

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 ensure that compliance is also achieved for the other two categories.

Category 1 – Disturbance to Buildings Occupants

For disturbance to human occupants of buildings, we refer to the DECCW'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 Table 2.2 of the guideline and are reproduced below.

Table 5.2 – Preferred and Maximum Weighted rms Values for Continuous and Impulsive Vibration Acceleration (m/s^2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z axis	x & y axis	z axis	x & y axis
Continuous vibration					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010

Location	Assessment period[1]	Preferred values		Maximum values	
		z axis	x & y axis	z axis	x & y axis
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes: 1. *Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am*

2. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992*

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 2.4 of the guideline and are reproduced below.

Table 5.3 – Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime [1]		Night-time [1]	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1. *Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am*

2. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992*

Based on Table 5.2 and Table 5.3 above, UTS Building CB10 (Receiver R1) and the commercial building across Wattle Street (Receiver R2), will be assessed against the criteria for 'Offices, schools, educational institutions and places of worship'. For the occupants of the residential apartments on Wattle Street (Receiver R3) the assessment of vibration will be against the criteria for 'Residences'.

Category 2 – Effects on building contents

The typical frequency range of construction induced ground vibration is approximately 8 Hz to 100 Hz. Over this range the threshold of visible movement of building contents such as plants, pictures, blinds etc is approximately 0.5 mm/s. At vibration levels higher than 0.9 mm/s, audible rattling of loose objects such as crockery can be expected.

Category 3 – Structural Damage to Buildings

Currently there exists no Australian Standard for assessment of structural building damage caused by vibrational energy. Therefore, reference is made to both the British and German standards below which are relevant to the assessment of structural damage.

British Standard

British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings", can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

BS7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage criteria for frequencies within the range 4Hz to 250Hz, which is the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The levels from the standard are given below in Table 5.4.

Table 5.4 – BS 7385 Structural Damage Criteria

Group	Type of Structure	Peak component particle velocity, mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

The peak vibration limits set for minimal risk of 'cosmetic' damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (Line 2; increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (Line 1; constant across all frequencies). 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

These values relate to transient vibrations and to low rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.

The levels set by this standard are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular types of buildings. Damage comprises

minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls.

This standard states that it considers sources of vibration including blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery.

As stated in the standard, it sets guide values for building vibration based on the lowest levels above which damage has been credibly demonstrated. That is, it gives guidance on the levels of vibration above which building structures could be damaged.

German Standard

The German standard DIN 4150 - Part 3 - "Structural vibration in buildings - Effects on Structures", also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings it is 5mm/s and for particularly sensitive structures (eg historical with preservation orders etc), it is 3mm/s. These limits increase as the frequency content of the vibration increases. These values are presented in Table 5.5 below and are generally recognised to be conservative.

Table 5.5 – DIN 4150-3 Structural Damage Criteria

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation at Frequency of			Plane of Floor Uppermost Storey
		< 10Hz	10Hz - 50Hz	50Hz - 100Hz	All Frequencies
1	Buildings used for 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 Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

5.3 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 (eg 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. The buffer distances below are applicable to residential type receivers only and for commercial type receivers, for which UTS Building CB10 is considered to be, buffer distances will be lower and less stringent due to the higher limits applicable to these types of occupancies.

It is noted that since the human comfort criteria is more stringent than the structural damage criteria, if compliance is achieved for the assessment of human comfort, then compliance will also be achieved for the assessment of structural damage to buildings.

Table 5.6 – Recommended Minimum Buffer Distances for Construction Plant

Plant Item	Recommended Minimum Buffer Distance (m)
Excavators	5
Rock breaker - small	5
Rock breaker - medium	7
Rock breaker - large	15
Truck movements	10

Note: Above buffer distances are applicable to residential buildings only.

It is noted that these are indicative distances only, relevant to residential type receiver; and more detailed site specific buffer distances should be determined once vibration emission levels are measured from each plant item prior to the commencement of their regular use on site.

Furthermore, periodic vibration monitoring should be conducted at all critical or sensitive areas and the vibration levels are to be tested for compliance with the set vibration limits. This monitoring shall be undertaken in accordance with the vibration monitoring methods described in Appendix D of this report.

5.4 Vibration Management Measures

Further to buffer distances, to ensure vibration impacts are minimised during the construction period, the following vibration management control measures are provided:

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 contractor.

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. An example of a vibration complaint management procedure and complaint form is presented in Appendix E of this report.

3. Carry out vibration testing of actual equipment on site prior to the construction works to determine acceptable buffer distances to the sensitive receivers.

4. Carry out additional vibration monitoring as specified in Appendix D when construction activities are at the nearest point to the nominated occupancies. This monitoring may signal to the contractor by way of a buzzer or flashing light etc, when levels approach/exceed the recommended limits in nearby occupancies.

5. Carry out periodic vibration monitoring at all critical or sensitive areas and assess the vibration levels for compliance with the set vibration limits. This monitoring shall be undertaken in accordance with the vibration monitoring program described in Appendix D.

6. 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 construction plant, 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.

7. Before, during and after the construction works, preparation of a dilapidation report on the state of the existing buildings surrounding the construction site is recommended.

6 COMPLAINTS MANAGEMENT

Noise and vibration levels generated by construction activities associated with the construction of the UTS Broadway Building should aim to comply with the noise and vibration goals set by the relevant regulations and guidelines.

The building contractor is responsible for implementing this Noise and Vibration Management Plan and ensuring that all reasonable measures are implemented such as the provision of a Noise / Vibration Complaints Program, to minimise the generation of excessive noise and vibration levels from the site to nearby sensitive areas.

Occupants of nearby affected properties shall be informed by direct mail of a direct 24-hour telephone line where any noise and / or vibration complaints related to the construction activities will be recorded. Additionally, occupants will be notified of any periods of noisy construction activities at least 24 hours prior to their commencement.

All noise and vibration complaints shall be investigated by the site in accordance with the Noise / Vibration Complaint Management Procedure identified in Appendix E of this report.

7 CONCLUSION

A Construction Noise and Vibration Management Plan (CNVMP) has been prepared for the UTS Broadway Building construction site on the corners of Jones Street, Broadway and Wattle Street, Ultimo. Specifically, this report aims to manage noise and vibration impact during the construction of the UTS Broadway Building through noise and vibration management measures, to achieve compliance with relevant guidelines and standards.

In-principle recommendations are provided in Section 4.5 and Section 5.4 to limit the potential impact of noise and vibration generated by construction activities to acceptable levels. In addition, buffer distances for vibration compliance have been provided as guidance; however, should be determined in more detail prior to the start of construction works through on-site measurements of vibration.

Procedures to manage complaints are also provided in Section 6 and Appendix E to ensure complaints are dealt with accordingly.

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse Weather — Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).

Ambient Noise — The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.

Assessment Period — The period in a day over which assessments are made.

Assessment Point — A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.

Background Noise — Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the $\mathbf{L_{90}}$ noise level (see below).

Decibel [dB] — The units that sound is measured in. The following are examples of the decibel readings of every day sounds:

0dB The faintest sound we can hear

30dB A quiet library or in a quiet location in the country

45dB Typical office space. Ambience in the city at night

60dB Martin Place at lunch time

70dB The sound of a car passing on the street

80dB Loud music played at home

	90dB The sound of a truck passing on the street
	100dB The sound of a rock band
	115dB Limit of sound permitted in industry
	120dB Deafening
dB(A):	A-weighted decibels The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{max}	The maximum sound pressure level measured over a given period.
L_{min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).

L_{eq}	The “equivalent noise level” is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound Absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B - SPECIFICATION FOR DETERMINING THE SOUND POWER LEVELS OF CONSTRUCTION PLANT

B1. SCOPE

This document specifies methods for determination of sound power levels for construction plant including earthmoving equipment and other ancillary plant and equipment used during construction.

B2. REFERENCED STANDARDS

- Australian Standard 1259 – 1990: "Acoustics - Sound Level Meters",
- Australian Standard 2012.1-1990: "Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - stationary test condition - Part 1: Determination of compliance with limits for exterior noise"
- ISO 6395: "Acoustics & Measurement of airborne noise emitted by earthmoving machinery - Dynamic test conditions"
- AS1217.5-1985: "Acoustics – Determination of sound power levels of noise sources – Part 5 – Engineering methods for free-field conditions over a reflecting plane"
- AS1217.7-1985: "Acoustics – Determination of sound power levels of noise sources – Part 5 – Survey method"

B3. TESTING PROCEDURES – EARTHMOVING MACHINERY

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

Each significant plant item shall be tested in terms of both the 'stationary' and the 'dynamic' testing procedures detailed below.

All sound level meters used must be Type 1 instruments as described in Australian Standard 1259.2-1990 "Acoustics - Sound Level Meters" and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the meters shall be checked in the field before and after the noise measurement period.

B3.1 STATIONARY TESTING

Stationary measurements shall be performed on all earthmoving plant according to the method of AS2012.1-1990.

In addition to measuring overall A-weighted noise levels, octave band frequency $L_{Aeq,T}$ noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and

corrections to measured octave-band noise levels shall be applied as described in Table 1 of AS2012.1-1990.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band $L_{Aeq,T}$ noise levels shall also be processed as described in Section 8 of that Standard to establish octave-band sound power levels.

The overall A-weighted sound power levels to be determined shall be in terms of both the $L_{Aeq,T}$ and $L_{A10,T}$ noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

All measured noise level data and determined sound power levels shall be included in the test reports.

B3.2 DYNAMIC TESTING

Details of equipment operation during testing will vary depending on the equipment type. Dynamic measurements shall be performed on all earthmoving plant according to the method in International Standard ISO 6395.

In addition to measuring overall A-weighted noise levels, octave band frequency $L_{Aeq,T}$ noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in International Standard ISO 6395.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band $L_{Aeq,T}$ noise levels shall also be processed to establish octave-band sound power levels.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

The overall A-weighted sound power levels to be determined shall be in terms of both the $L_{Aeq,T}$ and $L_{A10,T}$ noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

All measured noise level data and determined sound power levels shall be included in the test reports.

B4. TESTING PROCEDURES – OTHER CONSTRUCTION PLANT

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All sound level meters used must be Type 1 instruments as described in Australian Standard 1259.2-1990 “Acoustics - Sound Level Meters”. The calibration of the meters shall be checked in the field before and after the noise measurement period.

Noise measurements shall be performed on all non-earthmoving construction plant according to the methods of either AS1217.5-1985 or AS1217.7-1985, whichever is applicable to the items of plant being tested.

Machinery shall be operated at high idle speed. In the case of drilling, boring and rock-breaking machines, the testing location shall allow for these machines to be operated in rock of characteristics that are typical for the project site.

In addition to measuring overall A-weighted noise levels, octave band frequency $L_{Aeq,T}$ noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in Table 1 of AS2012.1-1990.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band $L_{Aeq,T}$ noise levels shall also be processed as described in Section 8 of that Standard to establish octave-band sound power levels.

The overall A-weighted sound power levels to be determined shall be in terms of both the $L_{Aeq,T}$ and $L_{A10,T}$ noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

All measured noise level data and determined sound power levels shall be included in the test reports.

APPENDIX C - SPECIFICATION FOR CONSTRUCTION NOISE MONITORING

C1. SCOPE

This document specifies methods for undertaking noise monitoring during the construction phase of the project.

C2. REFERENCED STANDARDS & GUIDELINES

- Australian Standard 1259–1990: "Acoustics - Sound Level Meters",
- Australian Standard 1055-1989 "Acoustics - Description and Measurement of Environmental Noise",
- NSW Environment Protection Authority's "Environmental Noise Control Manual", and
- NSW Environment Protection Authority's "Industrial Noise Policy".

C3. TESTING PROCEDURES

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All noise monitoring equipment used must be at least Type 2 instruments as described in Australian Standard 1259.2-1990 "Acoustics - Sound Level Meters" and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the monitoring equipment shall also be checked in the field before and after the noise measurement period, and in the case of long-term noise monitoring, calibration levels shall be checked at minimum weekly intervals.

Long-term noise monitoring equipment or Noise Loggers, consist of sound level meters and computers housed in weather resistant enclosures. The operator may either retrieve the data at the conclusion of each monitoring period either in person or via a telephone modem if the logger is fitted with a mobile phone option. The nominated long-term environmental noise level monitors are to be of the RTA Technology Pty Ltd [phone (02) 8218 0500] type or equivalent.

All environmental noise measurements shall be taken with the following meter settings:

- Time Constant – FAST (ie 125 milliseconds)
- Frequency Weightings – A-weighting
- Sample Period – 15 minutes

All outdoor noise measurements shall be undertaken with a windscreen over the microphone. Windscreens reduce wind noise at the microphones.

Measurements of noise should be disregarded when it is raining and the wind speed is greater than 5 m/s (18 km/hr).

C3.1 LONG-TERM (UNATTENDED) MONITORING

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

Noise monitoring equipment shall be placed at positions which have unobstructed views of general site activities, whilst shielded as much as possible from non-construction site noise (eg. road traffic, rail noise and other surrounding noise).

Noise levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory for later retrieval is the following A-weighted noise levels: L_{min}, L_{90}, L_{eq}, L_{10}, L_1 and L_{max}.

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Meteorological conditions such as wind velocity, wind direction and rainfall shall also be either monitored on site or recorded from the nearest weather station to the project site, over the entire noise monitoring period.

C3.2 SHORT-TERM (ATTENDED) MONITORING

Attended short-term noise monitoring shall be conducted at noise receiver locations with closest proximity to the construction activities.

Short-term noise monitoring shall be conducted within the first month of commencement of construction works, and then every 1 to 2 months thereafter, dependent on the level of complaint from construction activities.

All attended short-term noise monitoring shall be recorded over 15 minute sample intervals. Noise levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory and reported are the following A-weighted noise levels: L_{min}, L_{90}, L_{eq}, L_{10}, L_1 and L_{max}.

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Outdoor noise monitoring is to be undertaken with the microphone at a height of 1.2 – 1.5m from the ground, unless noise measurements are taken from a balcony or verandah, in which case the same microphone height shall apply off the floor.

Conditions such as wind velocity, wind direction, temperature, relative humidity and cloud cover shall also be recorded during short-term noise monitoring.

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

The following information shall be recorded:

- Date and time of measurements
- Type and model number of instrumentation
- Results of field calibration checks before and after measurements
- Description of the time aspects of each measurement (ie sample times, measurement time intervals and time of day)
- Sketch map of area
- Measurement location details and number of measurements at each location
- Weather conditions during measurements
- Operation and load conditions of the noise sources under investigation
- Any adjustment made for presence or absence of nearby reflecting surfaces
- Noise due to other sources (eg traffic, aircraft, trains, dogs barking, insects etc)

APPENDIX D - SPECIFICATION FOR CONSTRUCTION VIBRATION MONITORING

D1. SCOPE

This document specifies methods for undertaking vibration monitoring during the construction phase of the project.

D2. REFERENCED STANDARDS & GUIDELINES

- AS 2775 Mechanical Mounting of Accelerometers
- AS 2670.2 Part 2: Evaluation of human exposure to whole body vibration
- EPA ENCM Chapter 174 – Vibration in Buildings
- DIN 4150.3 Structural Vibration in Buildings – Effects on Structures
- BS 7385:1 Evaluation and Measurement for Vibration in Buildings – Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings
- BS 7385:2 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration
- ISO 4866 Mechanical Vibration & Shock – Vibration of Buildings – Guidelines for the Management of the Vibrations and Evaluation of their Effects on Buildings

D3. TESTING PROCEDURES

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking vibration measurements.

All vibration monitoring equipment used must be calibrated at least once every two years to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The monitoring system should also have a measurement frequency range down to 1Hz.

Long-term vibration monitoring equipment or Vibration Loggers consist of a computer unit connected by cable to a triaxial vibration transducer which senses vertical, axial and horizontal vibration. Vibration levels are continuously monitored, and the data is processed statistically and stored in the computer memory. The operator may either retrieve the data at the conclusion of each monitoring period either in person or via a telephone modem if the logger is fitted with a mobile phone option. The nominated long-term Vibration Loggers are to be of the RTA Technology Pty Ltd [phone (02) 8218 0570] type or equivalent.

D3.1 LONG-TERM (UNATTENDED) MONITORING

Vibration monitoring shall be undertaken at vibration sensitive locations determined to fall within the 'buffer distances' established for each item of plant during the commencement of use of each plant on site.

Vibration monitoring shall be undertaken over the following period(s):

- Continuously whilst the vibrating plant is operational within the pre-determined 'buffer distances' from the potentially affected building.

  Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant.

  Vibration levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of vibration metrics to be stored in memory for later retrieval is the following:

- Vector-sum root-mean-square (rms) – maximums and statistical metrics
- Vector-sum peak-particle velocity (ppv) – maximums and statistical metrics.

  Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

- Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant.
- The surface should be solid and rigid in order to best represent the vibration levels entering the structure of the building under investigation
- The vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces
- The vibration sensor or transducer shall be directly mounted to the vibrating surface using bees wax or a magnetic mounting plate onto a steel plate or bracket either fastened or glued to the surface of interest
- Where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest and the vibration sensor or transducer shall be mounted on that.

D3.2 SHORT-TERM (ATTENDED) MONITORING

Where vibration complaints or requests from relevant authorities are received, attended short-term vibration monitoring shall also be conducted at the requested location and at any other relevant vibration receiver location with closest proximity to the construction activities.

Short-term vibration monitoring shall be used to supplement long-term vibration monitoring undertaken at nearby locations, and to check whether or not the vibration levels measured by the long-term vibration monitors are caused by construction activities carried out on site.

All attended short-term vibration monitoring shall be recorded over 15 minute sample intervals. Vibration levels are to be recorded at a minimum rate of 10 samples per second. The minimum range of vibration metrics to be stored in memory and reported are the following:

- root-mean-square (rms) – maximums and statistical levels
- peak-particle velocity (ppv) – maximums and statistical levels.

In addition to measuring and reporting overall vibration levels, statistical vibration levels shall also be measured and reported in third-octave band frequencies from 1Hz to 250Hz.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

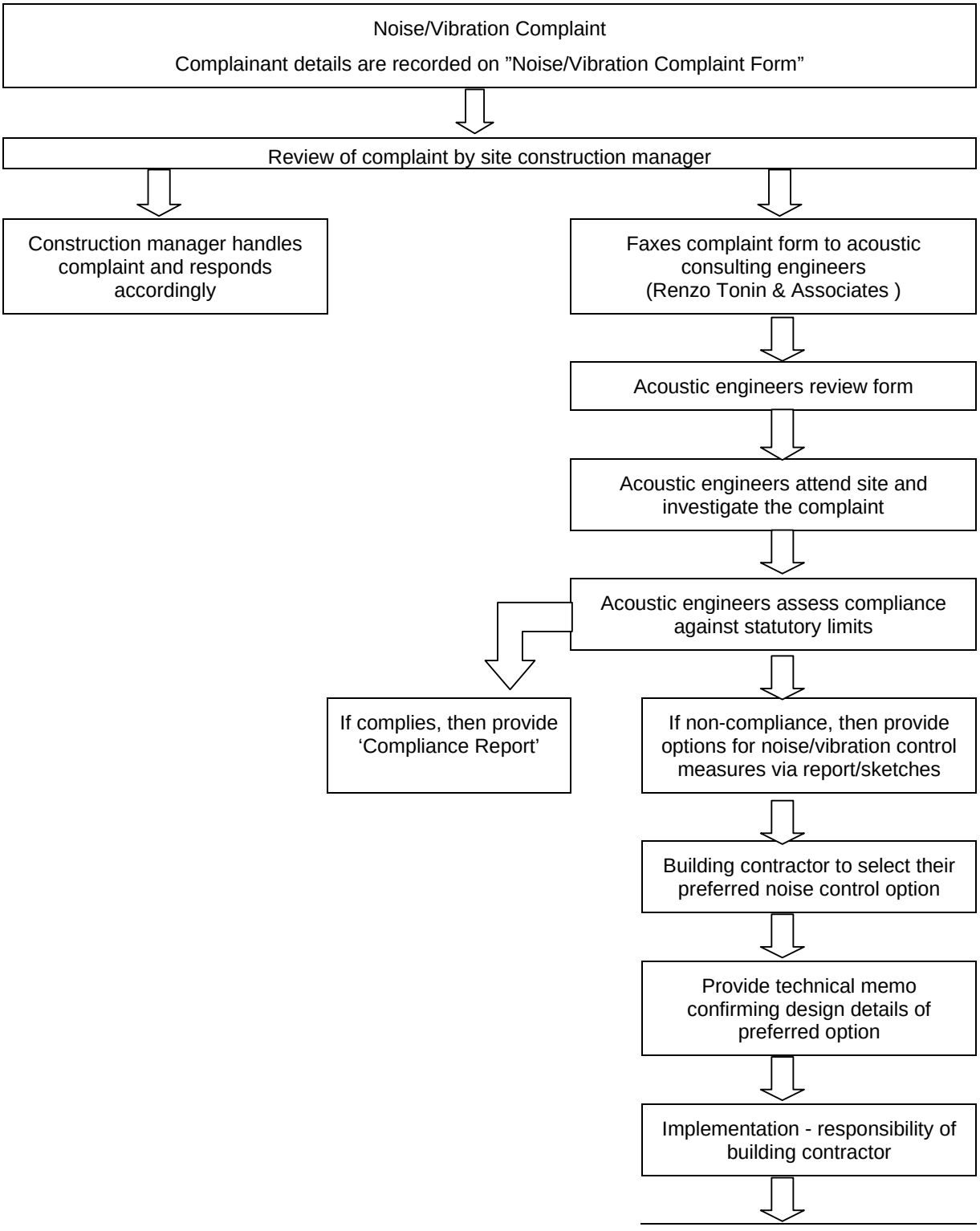
- vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant.
- the surface should be solid and rigid in order to best represent the vibration levels entering the structure of the building under investigation
- the vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces
- the vibration sensor or transducer shall be directly mounted to the vibrating surface using either bees wax or a magnetic mounting plate onto a steel washer, plate or bracket which shall be either fastened or glued to the surface of interest
- where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that.

The following information shall be recorded:

- Date and time of measurements
- Type and model number of instrumentation
- Description of the time aspects of each measurement (ie sample times, measurement time intervals and time of day)
- Sketch map of area
- Measurement location details and number of measurements at each location

- Operation and load conditions of the vibrating plant under investigation
- Possible vibration influences from other sources (eg domestic vibrations, other mechanical plant, traffic, etc)

APPENDIX E - NOISE / VIBRATION COMPLAINT MANAGEMENT PROCEDURE



Building contractor notifies complainant of action taken

NOISE/VIBRATION COMPLAINT FORM

COMPLAINANT'S DETAILS

Date :		**Received by** (tick a box) **:**	**Phone** ☐	**Written in** ☐	**Person** ☐		
Complaint Received By:			**Complainant's Name:**				
Complainant's Address:							
Complainant's Contact Numbers:	**Home:**		**Work:**		**Mob:**		

COMPLAINT DETAILS

Describe when the problem occurred (date and time), what equipment caused the complaint (if known) and where person was standing when he/she experienced the noise/vibration:

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INVESTIGATION

Question foreman responsible on site and obtain information on what equipment or processes would most likely have caused the complaint:

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Please fax this form to Renzo Tonin & Associates Pty Ltd for processing after obtaining approval from the Project Manager - Fax: (02) 8218 0501