

# **Noise and Vibration Impact Assessment**

Detailed State Significant Development Application  
**Site C, Crows Nest over station development**

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## Glossary

The following terms are defined for clarity; this table will be included in the overarching Environmental Impact Statement and as such does not require inclusion in the appended statements. Consistent terms and abbreviations should be used where possible.

Term	Definition
<b>'A' Weighted</b>	Frequency filter applied to a noise spectrum that adjusts ('weights') each frequency differently. The 'A' weighting very roughly corresponds with subjective assessments of noise levels.
<b>Ambient Sound</b>	The overall noise level associated with an environment or space. It is usually a composite of sounds from many sources, both near and far. Usually taken to mean the LAeq value.
<b>Background Noise Level</b>	The average of the lowest measured noise levels in an affected area, in the absence of noise from occupants and/or unwanted external noise sources. Usually taken to mean the LA90 value.
<b>Concept SSD Application</b>	A concept development application as defined in section 4.22 of the EP&A Act. It is a development application that sets out the concept for the development of a site, and for which detailed proposals for the site or for separate parts of the site are to be the subject of a subsequent development application or applications.
<b>Council</b>	North Sydney Council, unless otherwise indicated
<b>Crows Nest Station precinct</b>	<p>The Crows Nest Station precinct comprises the land between the Pacific Highway and Clarke Street (eastern side of the Pacific Highway) and Oxley Street and south of Hume Street, Crows Nest. The precinct is divided into three (3) sites:</p> <ul style="list-style-type: none"> <li>• Site A: The block bound by the Pacific Highway, Hume Street, Oxley Street, and Clarke Lane (497-521 Pacific Highway, Crows Nest)</li> <li>• Site B: The block on the southern corner of Hume Street and the Pacific Highway (477-495 Pacific Highway, Crows Nest)</li> <li>• Site C: One lot on the north-western corner of Hume Street and Clarke Street (14 Clarke Street, Crows Nest)</li> </ul>
<b>CSSI</b>	Critical State Significant Infrastructure
<b>CSSI Approval</b>	The approval under the EP&A Act for the construction of the Sydney Metro City & Southwest Chatswood to Sydenham project, as amended by subsequent modification applications. The CSSI project (application number SSI 15_7400) was approved by the (then) Minister for Planning on 9 January 2017 and has been amended on 6 previous occasions.
<b>dB(A)</b>	The overall 'A' Weighted sound pressure level.
<b>Decibel, dB</b>	Unit of acoustic measurement. Measurements of power, pressure and intensity may be expressed in dB relative to standard reference levels.

<b>Term</b>	<b>Definition</b>
<b>Detailed SSD Application</b>	The SSD Application(s) made after the concept SSD Application that seek consent for the use, design and to physically construct stages of the development.
<b>DPIE</b>	Department of Planning, Industry and Environment
<b>EIS</b>	Environmental Impact Statement
<b>ENL</b>	Existing Noise Level, LAeq dB
<b>EP&amp;A Act</b>	Environmental Planning and Assessment Act 1979 (NSW)
<b>EP&amp;A Regulation</b>	Environmental Planning and Assessment Regulation 2000 (NSW)
<b>Heritage item</b>	An item of environmental heritage that is listed in Schedule 5 of North Sydney Local Environmental Plan 2013 or on the State Heritage Register under the Heritage Act 1977
<b>IAP</b>	Interchange Access Plan required under Condition E92 of the CSSI Approval. The IAP complements the SDPP and informs the final design of transport and access facilities and services, including footpaths, cycleways, passenger facilities, parking, traffic and road changes, and the integration of public domain and transport initiatives around and at each station.
<b>INP</b>	Industrial Noise Policy
<b>ISD</b>	Integrated station development – combined station, OSD and public domain works
<b>L90, L10, etc</b>	A statistical measurement giving the sound pressure level which is exceeded for the given percentile over a measurement period, ie L90 is the level which is exceeded for 90% of the measurement period. Likewise, the L10 level is the noise level exceeded for 10% of the measurement time. The LA90, LA10 (etc) levels are the A-weighted noise levels exceeded for the respective percentile.
<b>LAeq, T</b>	Equivalent continuous A-weighted sound pressure level. The equivalent continuous A-weighted sound that, within a measurement time interval T, has the same A-weighted sound energy as a time-varying sound.
<b>Minister</b>	The Minister for Planning and Public Spaces
<b>Noise Reduction</b>	The difference in sound pressure level between any two areas. The term 'noise reduction' does not specify any grade or performance quality unless accompanied by a specification of the units and conditions under which the units apply.
<b>NR,</b>	Noise Rating
<b>NSDCP 2013</b>	North Sydney Development Control Plan 2013
<b>NSLEP 2013</b>	North Sydney Local Environmental Plan 2013

<b>Term</b>	<b>Definition</b>
<b>OSD</b>	Over station development as defined in the CSSI Approval – includes non-rail related development that may occupy land or airspace above, within or in the immediate vicinity of the Sydney Metro CSSI but excluding spaces and interface works such as structural elements that may be constructed as part of the CSSI Approval to make provision for future developments
<b>PIR</b>	The Submissions and Preferred Infrastructure Report submitted as part of Sydney Metro City & Southwest Chatswood to Sydenham project, application no. SSI 15_7400
<b>POEO</b>	Protection of the Environment Operations (Noise Control) Regulation 2017. This Regulation controls noise from motor vehicles and marine vessels and sets community standards on acceptable noise intrusion in homes from such appliances as intruder alarms, music amplifiers, air conditioners and powered garden tools.
<b>Rating Background Level (RBL)</b>	A single figure noise level that represents the background noise level for assessment purposes
<b>RW</b>	Weighted Sound Reduction Index. A single number value of the acoustic performance of a partition or building element. Calculation procedures for RW are defined in ISO 140-2:1991 “Measurement of Sound Insulation in Buildings and of Building Elements Part 2”. The RW is function of the level difference between two spaces separated by the building partition or element, surface area of the building partition or element, room volume and area of absorption in the receiver room (generally measured by the reverberation time).
<b>SDPP</b>	Station Design and Precinct Plan required under Condition E101 of the CSSI Approval. The SDPP resolves the public domain areas for the Crows Nest Station precinct as part of the CSSI Approval and addresses (among other things): <ul style="list-style-type: none"> <li>• Opportunities for public art</li> <li>• Landscaping and building design opportunities to mitigate the visual impacts of rail infrastructure and operational fixed facilities</li> <li>• Any salvaged historic and artistic elements</li> <li>• Location of existing vegetation and proposed landscaping</li> <li>• Location and design of operational lighting and measures to minimise lighting impacts</li> <li>• Timing for the implementation of access, landscaping and public realm initiatives</li> </ul>
<b>SEARs</b>	The Secretary’s environmental assessment requirements, which informs the content of an EIS
<b>Secretary</b>	Secretary of the NSW Department of Planning, Industry and Environment, or their delegate

Term	Definition
<b>Sound Isolation</b>	A reference to the degree of acoustical separation between any two areas. Sound isolation may refer to sound transmission loss of a partition or to noise reduction from any unwanted noise source. The term 'sound isolation' does not specify any grade or performance quality and requires the units and measurement conditions to be specified.
<b>Lp, dB</b>	A measurement obtained directly using a microphone and sound level meter. Sound pressure level depends on the distance from a source and on the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms. sound pressure to the reference sound pressure of 20 microPascals - $20\log_{10}(\text{measured rms pressure}/2 \times 10^{-6})$
<b>SSD</b>	State significant development as defined by Section 4.36 of the EP&A Act
<b>Station box</b>	The volumetric area of the Crows Nest Station development approved under the CSSI Approval – includes below and above ground elements up to the 'transfer slab' level, within and above which would sit each OSD
<b>Sydney Metro</b>	The applicant for this detailed SSD Application
<b>Sydney Metro City &amp; Southwest – Chatswood to Sydenham project</b>	<p>The Chatswood to Sydenham component of Sydney Metro City &amp; Southwest involves the construction and operation of a 16.5-kilometre metro line from Chatswood, under Sydney Harbour and through Sydney's CBD out to Sydenham.</p> <p>This section of the Sydney Metro City &amp; Southwest will deliver new metro stations at:</p> <ul style="list-style-type: none"> <li>• Crows Nest</li> <li>• Victoria Cross</li> <li>• Barangaroo</li> <li>• Martin Place</li> <li>• Pitt Street</li> <li>• Central (new underground platforms)</li> <li>• Waterloo</li> <li>• Sydenham</li> </ul> <p>This part of the project will operate between Chatswood and Sydenham Stations</p>
<b>Sydney Metro City &amp; Southwest –Sydenham to Bankstown Upgrade</b>	<p>Upgrading of the T3 Bankstown Line to Sydney Metro standards between Sydenham and Bankstown, including the upgrade of all 10 stations.</p> <p>These works are the subject of a separate Critical State Significant Infrastructure project (reference SSI 17_8256), which was granted consent in December 2018.</p>
<b>Sydney Metro CSSI</b>	Sydney Metro City & Southwest – Chatswood to Sydenham project

# 1 Introduction

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## 1.1 Purpose of this report

This report supports a State Significant Development (SSD) Application for the detailed design, construction and use of Over Station Development (OSD) on Site C of the Crows Nest Station precinct. It is submitted to the Department of Planning, Industry and Environment (DPIE) pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

On 9 January 2017, the Minister for Planning (the Minister) approved the Sydney Metro City & Southwest - Chatswood to Sydenham application lodged by Transport for NSW (TfNSW) as a Critical State Significant Infrastructure project (reference SSI 15\_7400), hereafter referred to as the CSSI Approval. The CSSI Approval includes all physical work required to construct the CSSI, including the demolition of existing buildings and structures on each site. Importantly, the CSSI Approval also includes provision for the construction of below and above ground structures and other components of the future OSD (including building infrastructure and space for future lift cores, plant rooms, access, parking and building services, as relevant to each site). The rationale for this delivery approach, as identified within the CSSI application is to enable the OSD to be more efficiently built and appropriately integrated into the metro station structure.

Sydney Metro is seeking to develop an OSD commercial building located above and integrated with the Clarke Street entrance to the Crows Nest Station. It represents the next phase in the realisation of the Crows Nest Station precinct. It follows and is pursuant to the Concept SSD Application (SSD 9579), granted consent on 23 December 2020, which established the planning and assessment framework for all OSD within the Crows Nest Station precinct. This detailed SSD Application has been prepared to be consistent with the Concept SSD Application in accordance with Division 4.4 of the EP&A Act.

The Concept SSD Application established the building envelopes (i.e. volumetric parameters), maximum gross floor area (GFA), minimum non-residential GFA, land uses, future subdivision (if required) and general development strategies to inform the future detailed design of the OSD. It is consistent with the strategic planning work undertaken by DPIE, including the finalisation of the St Leonards and Crows Nest 2036 Plan (2036 Plan) and the Crows Nest Sydney Metro Site Rezoning Proposal (Rezoning Proposal).

The Concept SSD Application approved the following key parameters with regard to Site C:

- Maximum building height – RL 127 metres or 9 storeys (includes two station levels and conceptual OSD space approved under the CSSI Approval)
- Maximum building services zone – RL 132 or 5 metres to accommodate lift overruns, rooftop plant and services
- Gross floor area – maximum of 3,100 square metres
- Land uses – commercial office premises (of which two floors could be provided as social infrastructure), including the use of approximate conceptual areas associated with the OSD which have been provisioned for in the Crows Nest station box (CSSI Approval) including areas above ground level (i.e. OSD lobbies and associated spaces)
- Strategies – for modulation and expression of built forms, loading, vehicular and pedestrian access arrangements, utilities and services provision, managing stormwater and drainage, achievement of ecological sustainable



development, providing public art, signage zones, and a design excellence framework

This detailed SSD Application for the Site C OSD is classified as SSD in accordance with Clause 12 of *State Environmental Planning Policy (State and Regional Developments) 2011* (SEPP SRD). Under Clause 12 of the SEPP, any development application pursuant to a Concept SSD Application is also classified as SSD whether or not that part of the development exceeds the minimum value specified in the relevant schedule of the SEPP. Accordingly, while the estimated capital investment value of this application does not exceed \$30 million in accordance with clause 19(2) of Schedule 1 of the SEPP, it is pursuant to the approved Concept SSD Application and has not been delegated to Council under Section 4.37 of the EP&A Act. The proposed development is, therefore, classified as SSD and is submitted to DPIE for assessment and determination.

## 1.2 Site description

The Crows Nest Station precinct is located between the Pacific Highway and Clarke Street (eastern side of the Pacific Highway) and Oxley Street and south of Hume Street, Crows Nest. It is wholly located within the North Sydney Local Government Area, however, it is also near the boundary of both the Willoughby and Lane Cove Local Government Areas.

The approved Concept SSD Application encompasses three sites that make up the Crows Nest Station precinct. Of relevance to this application is Site C that comprises one lot on the north-western corner of Hume Street and Clarke Street (14 Clarke Street, Crows Nest). Site C has a site area of 608 square metres.

Separate and future application/s will be undertaken for OSD in relation to Sites A and B.



 Crows Nest Station precinct  Site C OSD (subject of this application)  NOT TO SCALE

**Figure 1 Aerial photograph of Site C within the greater Crows Nest Station precinct**

### 1.3 Overview of the proposed development

This application seeks approval for the following:

- The design, construction and operation of a new nine storey (plus rooftop plant) commercial OSD tower consistent with the building envelope for Site C established under the approved Concept SSD Application
- The detailed design and delivery of interface areas within the approved station box that contain OSD exclusive elements including the entry lobby, bicycle parking and end of trip facilities, and plant not associated with the rail infrastructure
- Works related to the provision of services, management of drainage and flooding, and the mitigation of construction noise and vibration
- Provision of rooftop building identification signage zones

The development is located entirely within the approved Concept SSD Application building envelope and has a maximum height of RL 132m and a GFA of 3,100m<sup>2</sup> (attributed to the OSD, excluding CSSI areas).



**Figure 2 Proposed Site C OSD contained within the approved building envelope (view from Clarke St)**

## 1.4 Assessment requirements

DPIE has issued the Secretary's Environmental Assessment Requirements (SEARs) for the preparation of an Environmental Impact Statement for the proposed development. This report has been prepared having regard to the SEARs as follows:

SEARs Requirement	Where addressed
<b>Row 17. Noise and vibration (operation and construction)</b> <ul style="list-style-type: none"><li><i>Provide a noise and vibration assessment in accordance with the EPA guidelines. This assessment must detail construction and operation noise and vibration impacts on nearby sensitive receivers and outline the proposed management and mitigation measures that would be implemented</i></li></ul>	Subject of this report

## 1.5 Revision History

Rev	Date Issued	Comment
1	14 <sup>th</sup> April 2021	SSDA Submission

## 2 Existing Noise Environment

### 2.1 Affected receivers

We have identified the following noise sensitive receivers, to which we have assessed noise and vibration levels:

- Crows Nest Site A (operational noise and vibration only) – residential
- 20 Clarke Street – commercial
- 22 Clarke Street – residential

These are displayed in Figure 3.

### 2.2 Unattended noise monitoring

Noise monitoring of the Crows Nest Metro Station was undertaken from December 5 until December 15, 2019. Unattended noise measurements were undertaken at the most affected receiver, 20 Clarke Street directly adjacent to Site C, using ARL EL316 Type 1 environmental noise loggers. These instruments were calibrated using a BK4231 94dB Type 1 Calibrator before and after use, with no significant drift occurring (+/- 0.5 dB).

Measurement results, provided in Appendix B, were used to determine the Rating Background Level (RBL), described in Section 3.

### 2.3 Attended noise monitoring

In addition, attended measurements were conducted at 4 locations using NPI Type 1 sound level meter to derive relevant site related noise spectra for the project. Measurements were conducted on 16 December 2019 and 5 February 2020, to determine relative noise levels and suitable design spectra for the project. Noise measurements were conducted using an NPi Type 1 instrument calibrated using a BK4231 94dB Type 1 Calibrator before and after use, with no significant drift occurring (+/- 0.5 dB). Measurements were conducted at 4 locations for Crows Nest Site C, as shown in Table 1, Figure 3 and Figure 4.

**Table 1 Attended noise measurement results (dB)**

Location	Time/Date	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	dBA
1: 20 Clarke Street – Ground	4.30am-4.45am 5/2/20	66	61	55	50	47	43	37	30	53
2: Corner Hume/Clarke Lane - Ground	4.00am-4.15am 5/2/20	67	60	51	48	45	43	39	33	52
3: 20 Clarke Street – L1	12.45pm-13.00pm 16/12/19	71	69	69	63	62	58	51	41	67
4: 20 Clarke Street-L1	12.00pm-12.15pm 16/12/20	73	69	66	64	65	61	55	50	68





**Figure 3 20 Clarke Street unattended noise monitoring location and noise sensitive receivers**



**Figure 4 20 Clarke Street attended measurement location**

## 3 Noise and Vibration Emission Criteria

### 3.1 Operational noise criteria

Under the POEO, the Environment Protection Authority, now incorporated within the NSW Office of Environment and Heritage (OEH), has the responsibility to issue policy statements to set out criteria and methods of management for noise within the state.

It should be noted that this has been adopted for the main Crows Nest Station precinct for the design of the main train station and over station development, under planning consent conditions for the Crows Nest Metro project, of which Site C is a part. We have applied the Noise Policy for Industry (NPfI) to this project.

#### 3.1.1 NSW Noise Policy for Industry

For the purpose of the assessment, the measured noise data was processed into the following time periods:

- Daytime: 0700 to 1800 hrs.
- Evening: 1800 to 2200 hrs.
- Night-time: 2200 to 0700 hrs.

The measured background ( $L_{A90}$ ) and equivalent continuous ( $L_{Aeq}$ ) noise levels during these defined time periods. The  $L_{A90}$  noise levels presented are Rating Background Levels (RBLs), being the median of the background  $L_{A90}$  (i.e. of the lowest 10th percentile of samples) in each daytime, evening and night-time measurement period, for each 24-hour period during the noise survey.

##### 3.1.1.1 Amenity and Intrusiveness Criteria

The NSW NPfI provides assessment methodologies, criteria and detailed information on the assessment of environmental noise emissions in NSW. The NSW NPfI criteria for noise sources consider two (2) components:

- Controlling **intrusive** noise impacts for residential receivers. Assessing intrusiveness generally requires noise measurements to quantify background ( $L_{A90}$ ) noise levels at a location considered representative of the most potentially affected residential receiver(s). The intrusiveness criterion essentially means that the equivalent continuous noise level ( $L_{Aeq}$ ) of the source(s) under consideration should be controlled to not exceed background noise levels by more than 5 dBA.
- Maintaining noise **amenity** for various categories of land use (including residential receivers and other sensitive receivers). The amenity criterion is based on the sensitivity of a particular land use to industrial-type noise. The recommended amenity noise levels detailed in Table 2.2 of NSW NPfI represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location. This is to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area. The project amenity criteria for each new source of industrial noise is equal to recommended amenity noise level minus 5 dBA.

A +3 dBA to be added to project amenity noise level for conversion from a period level to a 15-minutes level. Where the resultant project amenity noise level is 10 dB or more below the existing industrial noise level, the project amenity noise levels can be set at 10 dB below existing industrial noise levels

if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

The NPfI recommends “Intrusive noise levels are only applied to residential receivers (residences).”

**Table 2 NSW NPfI Amenity Criteria**

Type of receiver	Indicative noise amenity area	Time of day	Recommended Leq noise level, dB	
			Acceptable	Maximum
Residence	Urban	Day 7:00 to 18:00	60	65
		Evening 18:00 to 22:00	50	55
		Night 22:00 to 7:00	45	50
Commercial	All	When in use	65	65

### 3.1.1.2 NSW NPfI Project Specific Criteria

Following the determination of the intrusiveness and amenity criteria, the following project specific criteria were determined for the project, which is summarized below in Table 3. It should be noted that the criteria were derived from the existing noise level (ENL) – 10 dB, with the amenity criteria as the most stringent.

**Table 3 NSW NPfI Project specific noise levels, dB**

Period	RBL (L <sub>A90</sub> , dB)	Intrusive Criterion (RBL + 5)	Existing Noise Level (ENL) (L <sub>Aeq</sub> , dB)	Urban Amenity Criteria (L <sub>Aeq</sub> , dB)	Project Specific Criteria (L <sub>Aeq</sub> , dB)
<b>Site A, Crows Nest (Residential)</b>					
Day (7:00 to 18:00)	61	66	68	(60-5)+3 = 58 dBA	(ENL-10) = 58
Evening (18:00 to 22:00)	56	61	63	(50-5)+3 = 48	(ENL-10) = 53
Night (22:00 to 7:00)	53	59	62	(45-5)+3 = 43	(ENL-10) = 52
<b>20 Clarke Street, Crows Nest (Commercial)</b>					
When in use	-	-	-	65 dB L <sub>Aeq</sub> , 15min	65 dB L <sub>Aeq</sub> , 15min

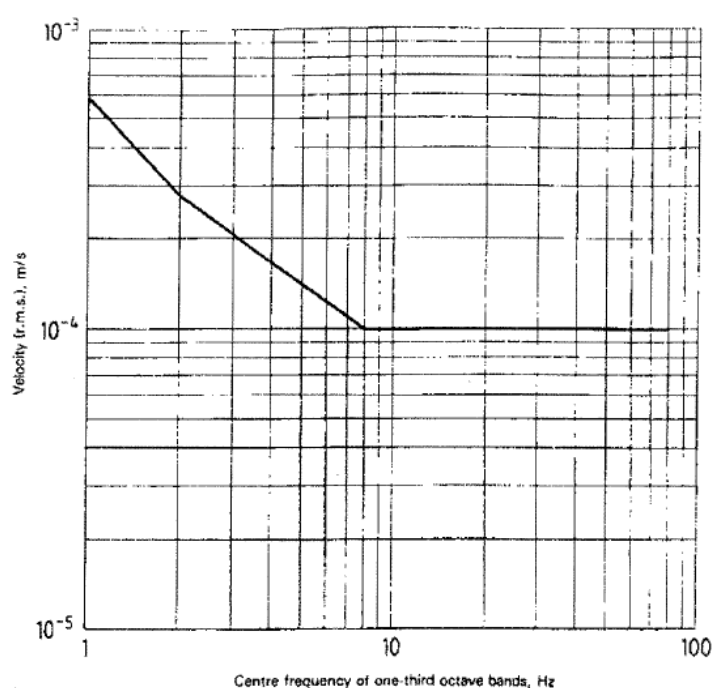
## 3.2 Operational Vibration Criteria

While the Environment Protection Authority does not prescribe operational vibration emission limits for developments, this project has adopted the vibration criteria stated within AS 2670.2-1990 — Evaluation of human exposure to whole-body vibration - Part 2: Continuous and shock-induced vibration in buildings (1 to 80Hz).

Table 4 outlines the recommended vibration levels within affected buildings. Annex A of the standard lists multiplication factors to be applied to a base curve for various spaces. Note that these criteria only apply to vibration from building services and exclude footfall and vehicular induced vibration, as building services are expected to be the main source of vibration emission.

**Table 4 Criteria for continuous or intermittent vibration**

Place	Type of Occupancy	Curve Multiplier (applied to Base Curve, Figure 5)
Residential	Day	2
	Night	1.4
Office	Day	4
	Night	4
Workshop	Day	8
	Night	8



**Figure 4b — Building vibration combined direction (x-, y-, z-axis) velocity base curve** (this figure shall be used when the direction of the human occupants varies or is unknown with respect to the most interfering or annoying vibration. See 4.2.3)

**Figure 5 AS 2670.2 Base curve for whole body vibration**

### 3.3 Construction Noise Criteria

The NSW Interim Construction Noise Guideline was developed by the NSW-Department of Environment & Climate Change DECC, NSW which incorporates the EPA. The Guideline contains detailed procedures for the assessment and management of construction noise impacts.

The guideline presents two ways of assessing construction noise impacts – the quantitative method, which is generally suited to longer term construction works and the qualitative method, which is generally suited to short term works (usually not more than 3 weeks) such as infrastructure maintenance.

It is expected that the length of the construction works associated with the development would be more than 3 weeks and therefore a quantitative method has been used for this assessment.



Table 5 and Table 6 set out the management levels for noise at residence and sensitive land uses, respectively. Restrictions to the hours of construction may apply to activities that generate noise at residences above the 'highly noise affected management level' which is >75dBA. Affected properties above 75 dBA will require community consultation and a Construction Noise & Vibration Management Plan (CNVMP).

**Table 5 NSW construction noise criteria (residences)**

Time of Day	Management Level, LAeq (15min)	How to apply
Recommended Standard Hours: <b>Monday to Friday</b> 7am to 6pm <b>Saturday</b> 8am to 1pm No work on <b>Sundays</b> or public holidays	Noise affected $RBL + 10dB(A) = 71$ dBA	The noise affected level represents the point above which there may be some community reaction to noise. <ul style="list-style-type: none"> <li>Where the predicted or measured LAeq (15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level;</li> <li>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.</li> </ul>
	Highly noise affected (75 dBA)	The highly noise affected level represents the point above which there may be strong community reaction to noise. <ul style="list-style-type: none"> <li>Where noise is above this level, the relevant authority (consent, determining, regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ul style="list-style-type: none"> <li>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);</li> <li>If the community is prepared to accept longer period of construction in exchange for restrictions on construction times.</li> </ul> </li> </ul>
Outside recommended standard hours	Noise affected $RBL + 5dB$	<ul style="list-style-type: none"> <li>A strong justification would typically be required for work outside the recommended standard hours;</li> <li>The proponent should apply all feasible and reasonable work practices to meet the noise affected level;</li> <li>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;</li> <li>For guidance on negotiating agreements see Section 7.2.2 of NSW Interim Construction Noise Guideline.</li> </ul>

**Table 6 Noise at sensitive land use (other than residence)**

Land Use	External management level, $L_{eq,15min}$ (dBA) (applies when properties are being used)
Commercial premises	70

### **3.4 Construction Vibration Criteria**

#### **3.4.1 Structural Response to Vibration - German Standard DIN 4150-3:1999**

The German Standard DIN 4150-3 Structural Vibration Part 3: Effects on building and structures is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading.

The response of a building to vibration is affected by several factors that include its type of foundation, the underlying ground conditions, its construction and the state of the building. Please note the construction vibration limits are designed to ensure the structural integrity of nearby buildings and are not for human comfort.

According to DIN 4150 short term vibration refers to vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated. Long-term vibration refers to all types of vibration not covered by the definition of 'short-term vibration'. The criteria for short-term and long-term vibration are listed in the following. We expect the long-term vibration limits to be applicable to the site.

##### **3.4.1.1 Guideline values for evaluation of short-term vibration - DIN 4150-3:1999**

The vibration limits of Table 1 in DIN 4150-3:1999 (replicated in Table 7 below) refer to the evaluation of the effects of short-term vibration on structures.

The criteria are the peak particle velocities (PPV) measured on any foundation or uppermost full storey of any building not related to the site and are listed in the Table 7.

It should however be noted that compliance with the vibration limits to avoid structural damage of buildings, cannot provide certainty. If damage occurs despite compliance with the standard, it is to be assumed that other causes are responsible, however, further investigations are necessary. And on the other hand, exceeding the limits does not necessarily lead to damage.

**Table 7 DIN 4150-3 Construction vibration limits - short term**

Type of Structures	Guideline values for vibration velocity (mm/s)			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1 to 10 Hz	10 to 50 Hz	50 to 100Hz	
Buildings for commercial purposes, Industrial building and building of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

#### 3.4.1.2 Guideline Values for evaluation of long-term vibration - DIN 4150-3:1999

The vibration limits of Table 3 in DIN 4150-3:1999 refer to the evaluation of the effects of long-term vibration on structures.

The criteria are the peak particle velocities measured on the uppermost full storey of any building not related to the site and are listed in Table 8. According to the standard, exceeding the values listed below does not necessarily lead to damage.

If a building is subject to harmonic vibration, then maximum values can occur in floors other than the top floor, or in the foundation. The values given also apply in these cases.

**Table 8 DIN 4150-3 Construction vibration limits - long term**

Type of Structures	Guideline values for velocity, $v_i$ , in mm/s of vibration in horizontal plane of highest floor, at all frequencies
Buildings for commercial purposes, Industrial building and building of similar design	10
Dwellings and buildings of similar design and/or occupancy	5
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	2.5

## 4 Operational Noise Assessment

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The main sources of operational noise emission for the development are expected to be building services equipment and, to a lesser degree, loading noise. These are addressed in the following sections.

### 4.1 Mechanical Services

#### 4.1.1 System Description

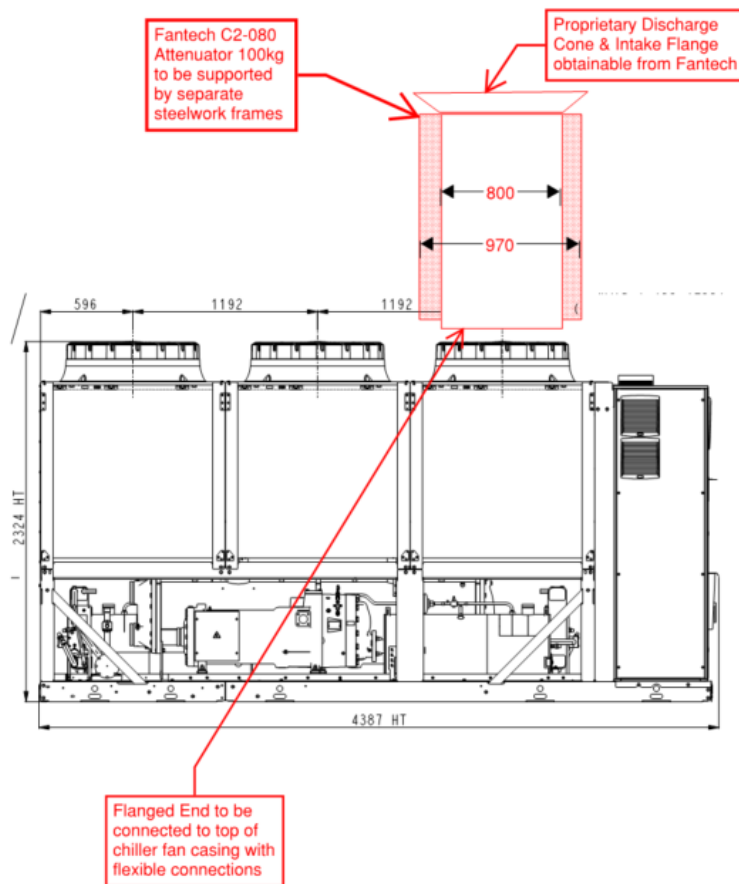
Fresh air is provided by air handling units and outside air fans, located on Level 9, via on-floor fan coil units. Stair pressure fans are located in the Level 10 plant enclosure on the western side of the rooftop. Smoke spill fans serving the lift lobbies and office floors are located at the top of the smoke spill plenums at the southern corner of the rooftop. Cooling is achieved through an air-cooled chiller on the eastern side of the rooftop.

#### 4.1.2 Acoustic Treatment

Preliminary analysis of base building plant has been undertaken for costing purposes. It should be noted that the plant is approximately 6m distance from the nearest commercial receiver on the western boundary. The following allowances have been made for in the design:

- Intake and Discharge (up to attenuators) ductwork of SPF-10.1 and SPF-10.2 shall be internally lined with 50mm thick acoustic insulation.
- Intake ductwork of AHU-9.1 shall be internally lined with 50mm thick acoustic insulation.
- All penetrations to the plant rooms should be properly dimensioned, packed and sealed;
- Main services ducts and pipes to have their own individual penetrations, with suitable spacing to allow good sealing;
- Allowance for acoustic attenuation treatments e.g., internal lining to air inlets and discharges to meet Council/INP criteria;
- Allowance for 50mm thick heavy density (35-48kg/m<sup>3</sup>) mineral wool/polyester insulation with perforated metal facing (>20% perforation) should be made to the entire plant room walls;
- For major equipment such as chillers, allow for local stiffening of the plant room floor;
- All intakes and discharges from the plant room are to be internally lined with 75mm perforated faced insulation;
- Speed controllers, if used, should be of good quality and compatible with the motor model. Poor quality controllers can result in significant increase in motor noise, typically 10 dB(A) or greater, with an offensive high frequency tone;
- Selection of low noise fans, allowance for smooth airflow conditions in ductwork, use of attenuators and lined duct work while minimising regenerated noise at bends, take-offs and transitions;
- All return air duct work should as a minimum consist of at least 1 50mm internally lined bend, 1 50mm internally lined plenum and 1 meter of 50mm internally lined ductwork past the bend;

- Select a low noise chiller, typically 10-15 dB(A) quieter than the standard Carrier unit. Make an allowance for fan discharge attenuators, as per Figure 6.



**Figure 6 Large chiller treatment for rooftop platform**

## 4.2 Fire Protection Services

Two fire pumps are located on the Level 9 plant floor. The detailed design of the fire pump room and selection of the plant is yet to be finalised, however it is expected to require the following acoustic treatment to achieve boundary noise compliance:

- Heavy construction to acoustic enclosure walls and ceiling
- Acoustic attenuators to intake, outlet and exhaust

Detailed design and selection of the fire pump and plantroom will ensure that fire pump noise emissions from the development will be designed to satisfy the boundary noise requirements.

## 4.3 Hydraulic Services

We do not anticipate any significant sources of noise emission from hydraulics services equipment.

## 4.4 Electrical Services

We do not anticipate any significant sources of noise emission from electrical services equipment.

## 4.5 Loading Noise

There is no formal loading dock area proposed for Site C as loading is proposed to occur on-street. We also note the following:

- Upon completion of Crows Nest Station and the OSD projects it is expected that service vehicle numbers will decrease slightly from current use (from 32 to 26)
- The pre-existing usage of Clarke Lane and associated access roads was predominantly utes, trucks in loading docks and waste removal. Most of the pre-existing developments used Clarke Lane for waste removal.
- The shift in land use to predominantly residential is likely to change the mix of vehicles to a higher proportion of private light vehicles which benefits the acoustic environment.

Based on the above we do not expect a net increase to the ambient acoustic environment from noise associated from loading activities.

## 5 Operational Vibration Assessment

### 5.1 Plant Vibration Isolation

With regards to continuous vibration, all plant and equipment are to be reviewed for determining factors rotational speeds, weights and structural requirements to select suitable vibration isolation for the project in accordance with ASHRAE Chapter 47 and relevant review of manufacturer data. Installation of mounts which are manufactured by a supplier who can demonstrate a proven record of successful installations and that will provide appropriate warranty and technical support. All rotating plant and associated pipes shall be with compatible vibration isolation mountings with the aim to achieve minimum 90% isolation efficiency. Mount types which provide the minimum deflection under operating load have been recommended as per below.

With building services plant equipment isolated as per Table 9, the development will readily comply with the nominated operational vibration emission criteria.

**Table 9 Vibration isolation mounts for plant and equipment**

Equipment Type	Shaft Power (kW) and Other	RPM	Equipment Location											
			Slab on grade			Floor span								
						Up to 6m			6 to 9m			9 to 12m		
			Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)
Chillers														
Centrifugal, screw, scroll, Absorption	All	All	A	1	8	A	4	25	A	4	50	A	4	
Air compressors and vacuum pumps														
All	All	All	C	3	25	C	3	25	C	3	50	C	3	
Pumps														
Close-coupled	≤5.6	All	B	2	8	C	3	25	C	3	25	C	3	
	≥7.5	All	C	3	25	C	3	25	C	3	50	C	3	
Large in-line	3.7 to 19	All	A	3	25	A	3	50	A	3	50	A	3	
	≥22	All	A	3	50	A	3	50	A	3	50	A	3	
End suction and split case	≤30	All	C	3	25	C	3	25	C	3	50	C	3	
	37 to 93	All	C	3	25	C	3	25	C	3	50	C	3	
	≥110	All	C	3	25	C	3	50	C	3	75	C	3	
Cooling towers														
All	All	Up to 300	A	1	8	A	4	100	A	4	100	A	4	
		301 to 500	A	1	8	A	4	75	A	4	75	A	4	
		500 and up	A	1	8	A	4	25	A	4	25	A	4	

Equipment Type	Shaft Power (kW) and Other	RPM	Equipment Location												
			Slab on grade			Floor span									
						Up to 6m			6 to 9m			9 to 12m			
			Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)	
Boilers															
All	All	All	A	1	8	B	4	25	B	4	50	B	4		
Axial fans															
< 560mm diameter	All	All	A	2	8	A	3	25	A	3	25	C	3		
> 610mm diameter	≤500 Pa SP	Up to 300	B	3	75	C	3	100	C	3	100	C	3		
		300 to 500	B	3	25	B	3	50	C	3	75	C	3		
		500 and up	B	3	25	B	3	50	B	3	50	B	3		
	≥500 Pa SP	Up to 300	C	3	75	C	3	100	C	3	100	C	3		
		300 to 500	C	3	50	C	3	50	C	3	75	C	3		
		500 and up	C	3	25	C	3	50	C	3	50	C	3		
	Centrifugal fans														
	< 560mm diameter	All	All	B	2	8	B	3	25	B	3	25	C	3	
	> 610mm diameter	≤30	Up to 300	B	3	75	B	3	100	B	3	100	B	3	
300 to 500			B	3	50	B	3	50	B	3	75	B	3		
500 and up			B	3	25	B	3	25	B	3	25	B	3		
≥37		Up to 300	C	3	75	C	3	100	C	3	100	C	3		
		300 to 500	C	3	50	C	3	50	C	3	75	C	3		
		500 and up	C	3	50	C	3	50	C	3	50	C	3		
		Heat pumps													
All	All	All	A	3	25	A	3	25	A	3	25	A/D	3		
Condensing units															
All	All	All	A	1	8	A	4	25	A	4	50	A/D	4		
PAC units															



Equipment Type	Shaft Power (kW) and Other	RPM	Equipment Location											
			Slab on grade			Floor span								
						Up to 6m			6 to 9m			9 to 12m		
			Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)	Base Type	Isolator Type	Min. Defl. (mm)
All	≤7.5	All	A	3	25	A	3	25	A	3	25	A	3	
	≤11, ≤1kPA SP	Up to 300	A	3	25	A	3	100	A	3	100	C	3	
		300 to 500	A	3	25	A	3	75	A	3	75	A	3	
		500 and up	A	3	25	A	3	50	A	3	50	A	3	
	≥11, ≥1kPA SP	Up to 300	B	3	25	C	3	100	C	3	100	C	3	
		300 to 500	B	3	25	C	3	50	C	3	75	C	3	
		500 and 3up	B	3	25	C	3	50	C	3	50	C	3	
	PAC rooftop equipment													
All	All	All	A/D	1	8	D	3	25	-	-	-	-	-	
Engine-driven generators														
All	All	All	A	3	25	C	3	50	C	5	75	C	5	
Base Type:						Isolator Type:								
A. No base, isolators attached directly to equipment						1. Rubber pads								
B. Structural steel rails or base						2. Rubber floor isolator or hanger								
C. Concrete inertia base						3. Spring floor isolator or hanger								
D. Curb-mounted base						4. Restrained spring isolator								
						5. Air mount								

## 6 Construction Noise Assessment

This section provides a preliminary construction noise assessment for the site. Further investigation is likely to be required once the construction methodology has been developed.

### 6.1 Preliminary Construction Noise Assessment

The following has been assumed in regards to noise intensive equipment/activities:

- Construction will be undertaken in standard construction hours
- Excavation will be undertaken as part of the Station works and therefore have not been included in this assessment
- Rotary piling will be implemented
- Main structural works and building erection.

For the assessment reference sound levels for representative equipment have been taken from the BS5228 databases. The documents include extensive databases of sound data covering trucks, excavators, hand tools and all manner of other construction equipment and activities. The ratings listed are for individual pieces of equipment at constant operation.

**Table 10 Typical external noise levels of demolition and construction machinery/activity**

Item #	Activity /Machinery	BS 5228 – 1:2009 reference number	Leq Sound Pressure Level at 10m (dBA)
<b>Structural / Piling Works</b>			
1	Tracked excavator, 30 t, 170kW	Table C2 Ref 16	75
2	Articulated dump truck 23 t, 187 kW	Table C4 Ref 2	78
3	Large Piling rig 110 t / 20 m deep / 1.2 m diameter	Table C3 Ref 14	84
4	Concrete mixer discharging with concrete Pump 26 Ton / 7 m3 + 22m boom	Table C4 Ref 28	75
<b>Building Fabric and Interior Works</b>			
5	Handheld cordless nail gun (15 to 50 mm nails)	Table C4 Ref 95	73
6	Tower crane 88Kw/22t	Table C4 Ref 48	76
7	Diesel scissor lift 24 kW / 6 t	Table C4 Ref 59	78
8	Handheld circular saw	Table C4 Ref 73	84

### 6.2 Predicted Construction Noise & Treatment

Based upon the above plant sound pressure levels, an acoustic barrier is likely to be required surrounding the site. The barrier is to be constructed with a solid material of minimum 8.5 kg/m<sup>2</sup> surface weight and is to extend minimum 3.5m from ground level. All joints between panels are to be sealed. In addition to the noise barrier, localised treatment is also likely to be required in order to protect the opening windows on the southeastern façade of 20 Clarke St that directly overlook the site. This may take the

form of localised moveable barriers surrounding noisy equipment/activities or a physical barrier covering the windows themselves.

Predicted construction noise levels for the various works phases, incorporating the required hoarding, are presented in Table 11. As shown construction noise levels during all phases are predicted to be compliant with the construction noise criteria.

Construction noise has been assessed to 20 Clarke Street, being the most affected commercial receiver, and to 22 Clarke Street, being the most affected residential receiver (as Site A and Site B will be constructed after Site C).

**Table 11 Predicted construction noise  $L_{eq,15min}$**

Receivers	Recommended Hours	Period	Predicted Construction Noise Level*	Construction Noise Criteria
<b>Structural Works Phase</b>				
20 Clarke Street	<b>Monday-Friday</b> 7am to 6pm <b>Saturday</b> 8am to 1pm No work on <b>Sundays</b> or Public Holidays	Day	69 dBA	70 dBA commercial properties
22 Clarke Street	<b>Monday-Friday</b> 7am to 6pm <b>Saturday</b> 8am to 1pm No work on <b>Sundays</b> or Public Holidays	Day	65 dBA	71 dBA (Noise affected) 75 dBA (Highly noise affected)
<b>Building Fabric and Interior Works</b>				
20 Clarke Street	<b>Monday-Friday</b> 7am to 6pm <b>Saturday</b> 8am to 1pm No work on <b>Sundays</b> or Public Holidays	Day	69 dBA	70 dBA commercial properties
22 Clarke Street	<b>Monday-Friday</b> 7am to 6pm <b>Saturday</b> 8am to 1pm No work on <b>Sundays</b> or Public Holidays	Day	65 dBA	71 dBA (Noise affected) 75 dBA (Highly noise affected)

NB: 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.

*\*Incorporating 3.5m tall hoarding surrounding the site*

The following assumptions were made in the construction noise predictions:

- Activities presented in Table 11 occur simultaneously per phase
- Activities occur centrally within the site.
- No shielding has been applied to the tower crane
- All equipment is operating for the entire assessment period, with the exception of the tower crane which operates for 50% of the assessment

## 7 Construction Vibration Assessment

This section provides a preliminary construction vibration assessment for the site. Further investigation is likely to be required once the construction methodology has been developed.

### 7.1 Preliminary Vibration Assessment

Based on the information available at this stage, the construction activities expected to occur on the site may have a vibration impact 20 Clarke Street, the closest sensitive receiver. Careful selection of equipment will be required in order to ensure compliance with the construction vibration criteria.

It is important to note that construction vibration levels depend on several factors. These include the activity, the machine, the geology of the ground and the distance between the building and the source. Surface works are expected to have a lower vibration impact than ground compacting/breaking works.

NSW RMS provides safe operating distances as per the CNVG for cosmetic damage to the building and for human response to vibration which has been used as a guideline at this stage. Table 12 lists minimum safe working distances for critical equipment. Based upon current work distance to the nearest affected receivers, with Clarke Street being directly adjacent the site, it is recommended that the use smaller hydraulic hammers is used at these working distances.

In addition to the above, an additional source of vibration may be piling. If rotary piling is utilised we do not expect vibration levels at 20 Clarke Street to exceed construction vibration criteria. If methods such as percussive piling or vibratory piling are employed, however, a detailed construction vibration prediction should be carried out. At this stage we recommend implementing rotary piling if practical.

**Table 12 RMS safe operating distances - construction noise and vibration guideline 2016**

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration Guideline - AVaTG)
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Jackhammer	Hand-held	1 m (nominal)	2 m

## 8 Conclusion

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A commercial development is proposed at 14 Clarke Street, Crows Nest. This report addresses operational and construction noise and vibration emissions as received at the most affected receivers, being Crows Nest Site A, 20 Clarke Street, and 22 Clarke Street.

### 8.1 Operational Noise

- Operational noise criteria have been set in accordance with NSW NPfI as Existing Noise Level – 10 dB
- The main contributors of operational noise emission are expected to be building services equipment
- Building services equipment will be attenuated through the use of typical acoustic treatment items such as internally lined ductwork, attenuators, acoustic louvres, etc., as required.

### 8.2 Operational Vibration

- Operational vibration criteria have been set as per AS 2670
- The main contributors of operational vibration emission are expected to be building services equipment
- Building services equipment will incorporate vibration isolators according to the equipment operating parameters and the characteristics of the supporting structure.

### 8.3 Construction Noise

- Construction noise criteria have been set in accordance with NSW Interim Construction Noise Guideline
- A preliminary construction noise assessment indicates that hoarding to 3.5m in height is likely to be required surrounding the perimeter of the site in order to comply with construction noise limits.
- Further investigation is likely to be required once the construction methodology has been developed.

### 8.4 Construction Vibration

- Construction vibration has been assessed against “Assessing Vibration: a technical guideline” issued by the Department of Environment and Conservation NSW for measurement and assessment of vibration, and German Standard DIN 4150-3 Structural Vibration Part 3: Effects on building and structures
- The main sources of construction vibration emission from the site are expected to be handheld jackhammers, rock breakers and piling.
- Further investigation is likely to be required once the construction methodology has been developed.

## **APPENDIX A – ACOUSTIC TERMINOLOGY**

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No longer used (incorporated into Glossary)

## APPENDIX B – NOISE SURVEY RESULTS

