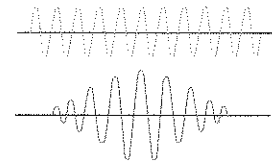


Pasminco Cockle Creek Smelter Pty Ltd

PCCS Site Remediation Project

Noise & Vibration Management Plan



Report No. 29N-05-2957-TRP-150253-0 -

Vipac Engineers & Scientists Ltd

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EXECUTIVE SUMMARY

Vipac Engineers & Scientists Ltd. (VIPAC) has been commissioned by the Fitzwalter Group Pty Ltd on behalf of Pasminco Cockle Creek Smelter Pty Ltd (PCCS) to create a Noise and Vibration Management Plan for the proposed PCCS Remediation Works Outline.

Construction Noise

Impacts of air-borne construction (remediation) noise have been assessed in Section 7.3. Daytime exceedances of up to 20dB are predicted for residential receivers and up to 15dB for industrial receivers. To bring upper noise levels to the more acceptable levels it is recommended that noise attenuation may be required in certain areas and at certain times (e.g. closest to residential areas) and that temporary noise walls are effective means of achieving the desired noise reductions. These noise control devices need to be placed on boundaries of the remediation work areas in close proximity to nearby residential areas to achieve maximum noise control. Work area #5 proximity to Boolaroo residential district, located in a relatively quiet neighbourhood, is an example of the distance from noise source to noise sensitive receiver.

Notwithstanding the above VIPAC understands that PCCS are to noise monitor field trials in the construction work areas in mid 2006 to confirm the theoretical predictions in this report and to improve the management of noise for the balance of the works.

Ground-borne Vibration

Ground-borne vibration levels due to construction are assessed in Section 7.4 and limiting distances from construction activities are recommended. Where limiting distances are breached then vibration monitoring is recommended, and where levels are determined to exceed, then it is recommended that alternative construction methods be investigated.



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1. INTRODUCTION

Vipac Engineers & Scientists Ltd. (VIPAC) has been commissioned by the Fitzwalter Group Pty Ltd on behalf of Pasminco Cockle Creek Smelter Pty Ltd (PCCS) to create a Noise and Vibration Management Plan for the proposed PCCS Remediation Works Outline.

The purpose of the plan was to predict airborne noise and ground vibration impacts, if any, that the activities and operations of the proposed remediation works would have upon the surrounding area.

The remediation area extends from Boolaroo in the south, to Main Road in the west, the rail line and Cardiff Industrial Estate in the north and Munibung Hill to the east as shown in Figure 1.



Figure 1 – Aerial Photograph of the PCCS Site divided into numerical Work Areas

The management plan is substantially associated with the requirements set out in the NSW Environmental Protection Agency's (EPA)¹ Industrial Noise Policy (INP), Noise Guide for Local Government and other regulatory requirements such as Lake Macquarie City Council DCP No.1

¹ Note that the Environment Protection Authority (EPA) is a statutory body with specific powers under environmental protection legislation. In September 2003, the EPA became part of the Department of Environment and Conservation (DEC).



1.1. PROJECT DESCRIPTION

The entire project consists of staged remediation (6 months per work area) of the entire site over a five (5) year period, which includes the following activities:

- Excavation of contaminated soils;
- Construction of a containment cell;
- Treatment of excavated materials as required;
- Emplacement of excavated materials into the containment cell;
- Capping of the containment cell; and
- Installation of temporary and permanent environmental controls.

The remediation work areas noted in Figure 1 are identified below as:

1. Cardiff West Estate;
2. Triangular Paddock South;
3. Railway Employment Zone;
4. Triangular Paddock North & Main Entry Precinct;
5. Boolaroo Heights;
6. Munibung Hill Residential;
7. Munibung Hill Industrial;
8. Boolaroo North;
9. Cell Surrounds;
10. Mixed Use Zone;
11. Containment Cell.

The remediation activities are broken into three (3) connected phases of operation being:

- Excavation of material and transport to the cell area;
- Temporary storage of material adjacent to the cell where some treatment (e.g. drying & mixing) will occur before placement; and
- Compaction into the cell plus capping of the cell with material imported to the site by trucks.

1.2. SOURCE OF NOISE

Plant and equipment proposed for the three (3) phases of operation, which have the potential to create noise impacts include:

Excavation Logistics

- One (1) Excavator with capacity to excavate approximately 800m³ per day;
- One (1) Loader to load trucks;
- Three (3) 25m³ Rigid Dump Trucks.



In addition to the earthmoving plant mentioned above the following *support plant and equipment* will be made available throughout the phases of operation to be utilised on a site needs basis.

- One (1) Water Cart for dust suppression;
- One (1) Rock-Breaker (Silenced) for removal of existing concrete foundation;
- One (1) Grader for site haul road maintenance;
- One (1) Refuelling/Maintenance Vehicle.

Mixing and Treatment Areas Logistics

- One (1) Front End Loader with Backhoe with capacity to load/carry 600m³ per day;
- One (1) Water Cart for dust suppression.

Refuelling/maintenance duties will be undertaken by the cell construction team, which will be operating adjacent to the mixing and treatment area.

The Dump Trucks will deliver contaminated material to the mixing area directly from each of the excavation sites.

Cell Construction Logistics

- One (1) Loader used to transport material between the mixing area and the tipping face of the cell;
- One (1) Track Dozer or Grader used to distribute material at the tipping face;
- Two (2) Pad-foot Compactors/Rollers required to compact loose materials.

As mentioned above the additional earthmoving plant will be utilised at the cell location on a site needs basis.

2. SENSITIVE NOISE RECEIVERS

The potentially worst affected *Sensitive Noise Receivers* around the perimeter of the proposed PCCS remediation site are as follows:

- *Argenton Residential District (ARD)* – These are the nearest potentially affected residential premises to the North of the site, situated on the opposite side of the railway corridor.
- *Cardiff Industrial Estate (CIE)* – These are the nearest potentially affected industrial premises to the Northeast of the site, adjacent to the Cardiff West Estate (1) remediation area.
- *Macquarie Hills District (MHD)* – These are the nearest potentially affected residential premises to the East of the site, adjacent to the Munibung Hill Residential (6) remediation area.
- *Boolaroo Residential District (BRD)* – These are the nearest potentially affected residential and/or commercial premises to the South of the site, adjacent to Triangular Paddock South (2), Boolaroo Heights (5) and Boolaroo North (8) remediation areas.
- *Argenton Industrial Area (AIA)* – These are the nearest potentially affected industrial premises to the North of the site.



3. NOISE SURVEY

VIPAC personnel have conducted a noise monitoring survey around the perimeter of the proposed PCCS Remediation Site in accordance with the NSW Industrial Noise Policy to determine the current ambient noise levels at the residences adjacent to the proposed site for use in determination of construction noise assessment criteria noise levels.

The results of our noise monitoring are presented in detail in the VIPAC reports **291448_TRP_001577_01 & 29N-05-2959-TRP-150194-2**, pertaining to site related *Construction (Remediation) Noise*.

In order to assess the existing local noise climate noise logging was conducted at the following three (3) locations around the perimeter of the proposed remediation site:

- *Logger location for Argenton residential area* – On public reserve, facing 26 Elizabeth Street, Argenton, to the North of the remediation site, situated on the opposite side of the railway corridor.
- *Logger location for Macquarie Hills residential area* – Three (3) noise loggers were installed within the subdivision. Two loggers were positioned along the northern boundary of the site in order to capture any potential influence of the adjoining industrial park. The third logger was located at the western boundary in order to measure noise from the Pasminco site.
- *Logger location for Boolaroo residential area* – 17 Third Street, Boolaroo.

3.1 EXISTING BACKGROUND NOISE LEVELS

The INP specifies the times of the day as being:

Day - 7:00am to 6:00pm Monday to Saturday; or,

8:00 am to 6:00 pm on Sundays and public holidays

Evening - 6:00pm to 10:00pm

Night - the remaining periods.

The **Table 3.1** below presents a summary of the measured background (L_{A90}) noise levels.

Table 3.1: Summary of Existing Ambient and Background Noise Levels

All Values in dB(A)

Location	Period	L_{Aeq}	RBL ²
Argenton Residential Area	Day	58.5	39.0
	Evening	58.5	37.5
	Night	59.0	37.0

² Note: RBL is the median of the overall assessment background noise level calculated using DEC Industrial Noise Policy methodology.



Location	Period	L _{Aeq}	RBL ³
Macquarie Hills Residential Area	Day	46.0	40.0
	Evening	46.0	41.0
	Night	44.0	38.0
Boolaroo Residential Area	Day	52.0	38.5
	Evening	51.0	38.0
	Night	46.5	38.0

Summary of Existing Background Noise Levels at Logging Locations [All values in dB(A)].

Receiver Location	Construction Period ¹	Day period background noise level [L _{A90} dB(A)]
Argenton Area	Monday to Friday (7 am to 6 pm)	39
	Saturday (8 am to 1pm)	
Macquarie Hills Area	Monday to Friday (7 am to 6 pm)	40
	Saturday (8 am to 1pm)	
Boolaroo Area	Monday to Friday (7 am to 6 pm)	38.5
	Saturday (8 am to 1pm)	

¹ Note: The 'Construction Period' falls within the Day period as specified by the INP.

4 ASSESSMENT OF CONSTRUCTION NOISE

4.1 NOISE GUIDE FOR LOCAL GOVERNMENT

Table 4.1 presents a summary of the *Noise Guide for Local Government* aims, to provide practical guidance to council officers in the management of Construction noise problems.

Table 4.1 – Excerpt of 'Table A1: A quick reference guide' from the EPA's *Noise Guide for Local Government*

The noise problem	Construction
How to assess it	Some noise from a construction site is expected. However, additional and avoidable noise may be (<i>sic</i>) result of work practices not in accordance with consent conditions from development application approval.
How to manage it	Work practices need to conform to consent conditions, which can stipulate particular times of day for noisy activities and particular work practices to avoid additional noise.
How to regulate it	The consent conditions and the planning legislation act to regulate the activity. Noise Control Notices and Prevention Notices can also be used consistent with the consent conditions.

³ Note: RBL is the median of the overall assessment background noise level calculated using DEC Industrial Noise Policy methodology.



4.2 LMCC DCP NO.1 PART 2.1 SECTION 15 - NOISE AND VIBRATION

Lake Macquarie City Council (LMCC) Development Control Plan No. 1, Part 2.1 (Environmental Responsibility and Land Capability), Section 2.1.15 (Noise and Vibration) – adopted by LMCC on 22nd March 2004 outlines key Performance Criteria, with relevant excerpts presented in **Table 4.2**:

Table 4.2 - Extract from LMCC DCP No.1 Part 2.1.15 Noise and Vibration

Performance Criteria	Acceptable Solutions
P2. "The construction of development is carried out so that no intrusive or offensive impacts from noise are caused to the surrounding population, now or in the future."	A2. The operating noise level of machinery, plant and equipment complies with NSW EPA ENCM or equivalent; and A Noise Management Plan has been prepared and lodged for construction periods in excess of 26 weeks duration and includes specifications for stringent hours of construction.
<i>For road(s):</i> P5. "Noise generated by vehicles either on the road system or within a development site is not of an intrusive or offensive impact upon the surrounding population."	A5. Vehicle noise generated on the road complies with the NSW EPA publication ECRTN; and/or Vehicle noise generated within a development site complies with the amenity and intrusiveness criteria in the NSW EPA INP.

4.3 CRITERIA FOR CONSTRUCTION NOISE

Noise nuisance caused by construction (**remediation activities**) noise is normally of short duration. If a noisy activity (e.g. rock breaking or piling) has to take place that could affect the neighbouring properties, the occupants should be warned in advance, particularly in regard to the duration and type of activity.

In order to assess the impact that construction noise may have on residential receivers the EPA sets out noise level restriction guidelines within Chapter 171-1 of the Environmental Noise Control Manual (ENCM), the criteria are dependent upon the duration of construction.

(i) *Construction Period of 4 weeks and under,*

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20dB(A).

(ii) *Construction Period greater than 4 weeks and not exceeding 26 weeks,*

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10dB(A).

If construction work occurs for more than 26 weeks, it is recommended that L_{10} levels measured over 15 minutes do not exceed the background level by more than 5dB(A).

These criteria for 'Noise Control Guidelines - Construction Site Noise' (ENCM) are summarised in **Table 4.3**:



Table 4.3: Construction Site Noise Level Restriction

Construction Period	Noise Level Restriction
Less than 4 weeks	Construction Noise $L_{A10, 15 \text{ minutes}} < \text{Background} + 20\text{dB}$
Greater than 4 weeks and not exceeding 26 weeks	Construction Noise $L_{A10, 15 \text{ minutes}} < \text{Background} + 10\text{dB}$
26 weeks or more	Construction Noise $L_{A10, 15 \text{ minutes}} < \text{Background} + 5\text{dB}$

The time periods for construction site noise are provided in Chapter 171 of the NSW EPA ENCM. The construction criteria are only applicable within the following hours:

- Monday to Friday: 7 am to 6 pm
- Saturday: 7 am to 1pm, if inaudible from the adjacent residences
8 am to 1pm, if audible from the adjacent residences
- No construction work to take place on Sundays or Public Holidays.

4.3.1 Performance criteria

The performance criteria seek to minimise the negative impacts from the remediation activities on the PCCS site, Boolaroo. From the ambient noise monitoring previously conducted and the construction noise criteria based on EPA ENCM, **Table 4.4** summarises the appropriate construction noise level restrictions at each receiver type. The proposed works have an *expected duration of no more than 26 weeks in each work area*.

Table 4.4: Summary of project specific Construction Noise Limits at Sensitive Locations

Receiver	Daytime RBL [L_{90} dB(A)]	Noise Level Limit L_{10} dB(A)
		#Wks 4 to 26 [Construction Noise $L_{A10, 15 \text{ minutes}} < \text{Background} + 10\text{dB}$]
Residential Receivers		
Argenton Area	39	49
Macquarie Hills Area	40	50
Boolaroo Area	38.5	48.5
Commercial / Industrial Receivers⁴		
Argenton		59
Cardiff		60
Boolaroo		58.5

⁴ It is generally acceptable that commercial receivers will tolerate noise levels due to construction operation up to 5-10 dB(A) higher than residential receivers. Ref. ENCM Chapter 20.



5. TRAFFIC NOISE

5.1 ADDITIONAL TRAFFIC NOISE ON PUBLIC ROADS

As a consequence of the existing traffic volumes on the surroundings roads, we believe that truck traffic associated with the site during remediation activities will not significantly affect existing traffic noise levels upon residential dwellings on Main Road and Frith Avenue, Boolaroo and is therefore not an issue.

Utilizing data from the Roads & Traffic Authority of N.S.W 'Traffic Volumes for Hunter Region 2001', the nearest monitoring conducted to the site was in 1988 at Station 05.498 on Lake Road with an Average Annual Daily Traffic (AADT) of 23476.

5.2 SITE GENERATED TRAFFIC NOISE

Truck movements associated with the proposed operations and activities on site is expected to be minor over the extent of the five (5) year remediation period. We expect that truck movements would be associated with the supply of raw fill material from outside to the cell construction area and from material haulage from Work Areas # 2 and 4 to the stockpile area, plus occasional rubble haulage of spoil etc. Other expected deliveries would encompass fuel trucks etc. and those vehicles accessing Incitec.

Both entry and egress for the site is currently via the existing access road to PCCS and Incitec. This concrete/bitumen road has a speed limit of less than 50Km/Hr and opens onto the site from Frith Avenue, Boolaroo.

6 ASSESSMENT OF GROUND VIBRATION

A summary of ground-borne vibration criteria for the PCCS Remediation Works Outline is provided in Table 6.1:

Table 6.1: Summary of Construction (Remediation) Vibration Criteria

Criterion	Comments
Vibration in relation to structural damage: DIN 4150 and BS 7385 Part 2 - 1993	Typically 5mm/s Peak Particle Velocity (PPV) for continuous sources such as rock breakers and vibratory rollers. For short term or transient events the criteria are frequency dependent, ranging from 5 mm/s to 20 mm/s for dwellings and from 20 mm/s to 50 mm/s for commercial buildings.
Vibration in relation to human comfort: BS 6472-1992 (low probability of adverse comment)	Except as approved by the Director General/DEC via the Construction Noise and Vibration Sub Plan.
Vibration at heritage buildings <= 3 mm/s	Except as approved by the Director General/DEC.



7 ASSESSMENT OF CONSTRUCTION NOISE

In this section, the impact of construction (remediation activities) noise on receivers during the full duration of the project is assessed. The guidelines for assessment are those established by the EPA in the ENCM and the criteria are set out in **Table 4.4**.

7.1 ASSESSMENT METHODOLOGY

Predictions of construction noise at local receivers take into account the following factors:

- Expected maximum sound power levels of each noise source (plant usage and duration is indicative at this stage);
- Distance between source and receiver;
- Ground relief between source and receiver (especially important for determining noise shielding effects, if any, of existing and proposed barrier structures);
- Shielding effects of existing constructions.

Effects of air absorption between source and receivers have not been taken into account. Effects of ground absorption between source and receivers have been modelled with all ground absorption between source and receiver assumed to be totally reflective.

7.2 REMEDIATION EQUIPMENT NOISE LEVELS

Table 7.1 below presents a summary of maximum sound power levels (L_w) typical of mobile plant and fixed equipment used during construction activities. The noise sources detailed in Section 2.1 of the report proposed for the remediation works were used in our noise model to predict their impact on nearby receivers. Noise data levels have been gathered from previous onsite measurements conducted by VIPAC, equipment suppliers and sound power levels given in Appendix D of AS2435:1981 – *Guide to Noise Control on Construction, Maintenance and Demolition Sites*.

Table 7.1 Typical Maximum Sound Power Levels from Construction Plant

Construction Activity	L_w .dB(A)	Construction Activity	L_w .dB(A)
Excavator	116	Loaders	115
Semi-Trailer	112	Tip Truck	108
Graders	111	Track Dozer (D10)	120
Roller	114	Backhoe	110
Rock-Breaker (Silenced)	113	Pad Foot Roller	111
Ballast Tamper	116	Excavator (small)	108
Generator	104		

7.3 PREDICTED CONSTRUCTION NOISE LEVELS

The noise generated by construction activities is difficult to predict with a high degree of accuracy for any given location and point in time, as activities vary from hour to hour, day to day and in location. It should be noted that some exceedances are inevitable during construction in built up areas.

Typical noise sources (**Table 7.1**) have been used to predict the noise level at the sensitive receivers.



Where applicable the following assumptions have been made to determine the sound pressure level at the affected receivers:

- Duration of the Remediation works should not exceed 26 weeks in each excavated work area;
- Simultaneous operations of plant items in each work area were included in calculation. However, barrier effects, such as from buildings and topography were excluded. This provides a measure of conservatism;
- All sound pressure levels predicted at affected receivers are based on a L_{A10} for a 15-minute period.

Noise Sensitive Receivers

The following tables present the predicted noise levels at the potentially affected *noise sensitive receivers* surrounding the site. Note that simultaneous operations of plant items have the potential to result in an increased emitted sound power level.

In each case the expected range of L_{A10} construction noise levels are presented for each receiver as applicable. The upper limit of the range is effectively a maximum L_{A10} noise level and is based on a worst-case 15-minute period as required by the NSW EPA ENCM with the plant items unshielded and positioned at the closest boundary of the site to the receivers of the particular work area. The lower limit of the expected range is based on reduced plant usage and/or operations occurring at areas of the site that are remotely located from the receiver at the limits of the site boundaries and/or significantly shielded. Actual noise levels during operations will generally fall somewhere within this given range.

Table 7.2 predicts the received noise levels associated with work area excavation activities, detailed in Section 2.1 Excavation Logistics, on the noise sensitive receivers surrounding the PCCS site.

Table 7.2: Predicted Received Noise Levels from Work Area Excavation Activities

Work Areas	Predicted noise level range [$L_{10, 15min}$ dB(A)]				
	ARD	CIE	MHD	BRD	AIA
Area 1	56-70	72-76	53-61	-	-
Area 2	-	-	-	65-79	-
Area 3	58-63	-	-	-	63-68
Area 4	-	-	-	56-64	-
Area 5	-	-	-	60-79	-
Area 6	-	-	57-60	-	-
Area 7	63-70	-	-	-	-
Area 8	-	-	-	59-76	-
Area 9	55-60	-	-	-	-
Area 10	-	-	-	53-56	-
Area 11	53-58	-	52-54	49-53	-
Noise Criterion	49	60	50	48.5	59

* Argenton Residential District (ARD), Cardiff Industrial Estate (CIE), Macquarie Hills District (MHD), Boolaroo Residential District (BRD), Argenton Industrial Area (AIA).

Table 7.3 predicts the received noise levels associated with work area excavation activities, additional support plant and equipment including rock breaking of existing concrete foundations, on the noise sensitive receivers surrounding the PCCS site.

*Table 7.3: Predicted Received Noise Levels from Work Area Additional Plant Operations*

Work Areas	Predicted noise level range [L _{10, 15min} dB(A)]				
	ARD	CIE	MHD	BRD	AIA
Area 1	49-63	55-69	46-54	-	-
Area 2	-	-	-	58-72	-
Area 3	51-56	-	-	-	57-61
Area 4	-	-	-	49-57	-
Area 5	-	-	-	53-72	-
Area 6	-	-	53-50	-	-
Area 7	57-63	-	-	-	-
Area 8	-	-	-	53-69	-
Area 9	49-53	-	-	-	-
Area 10	-	-	-	46-49	-
Area 11	46-51	-	45-47	42-46	-
Noise Criterion	49	60	50	48.5	59

* Argenton Residential District (ARD), Cardiff Industrial Estate (CIE), Macquarie Hills District (MHD), Boolaroo Residential District (BRD), Argenton Industrial Area (AIA).

Table 7.4 provides the expected range of L_{A10} construction noise levels due to activities undertaken in Area 11, associated with the mixing and treatment activities on the residential receivers surrounding the PCCS site.

Table 7.4: Predicted Received Noise Levels from Mixing & Treatment Operations

Work Areas	Predicted noise level range [L _{10, 15min} dB(A)]				
	ARD	CIE	MHD	BRD	AIA
Area 11	49-54	-	48-51	45-50	-
Noise Criterion	49	60	50	48.5	59

* Argenton Residential District (ARD), Cardiff Industrial Estate (CIE), Macquarie Hills District (MHD), Boolaroo Residential District (BRD), Argenton Industrial Area (AIA).

Table 7.5 provides the expected range of L_{A10} construction noise levels due to activities undertaken in Area 11, associated with the cell construction, on the residential receivers surrounding the PCCS site.

Table 7.5: Predicted Received Noise Levels from Cell Construction

Work Areas	Predicted noise level range [L _{10, 15min} dB(A)]				
	ARD	CIE	MHD	BRD	AIA
Area 11	51-56	-	50-53	47-52	-
Noise Criterion	49	60	50	48.5	59

* Argenton Residential District (ARD), Cardiff Industrial Estate (CIE), Macquarie Hills District (MHD), Boolaroo Residential District (BRD), Argenton Industrial Area (AIA).

7.3.1 Notes on Exceedances

The assessments are for the worst-case conditions for each work area. This worst-case condition includes no shielding or minimal shielding for low-rise noise sensitive receivers.



Low-level receivers (single storey dwellings) are generally predicted to meet the noise level requirements due to the formation of temporary noise walls (earth bunds and/or closed board fences) around the work sites.

It is noted that exceedances of the construction noise criteria are predicted in the abovementioned tables.

7.3.1-1 Residential Noise Receivers

During most stages of the proposed remediation works exceedances of up to 15-20dB of the noise level requirements are predicted for the upper limit of the expected noise range of operations. However, the upper limits are based on maximum sound power levels of plant occurring continuously at the site boundaries, which is likely to be a rare occurrence but highlights the need to minimise noise generation as much as possible. Construction noise management sub-plans are to be put in place to achieve this goal (see section 8). Mid-range operations would be expected to give 5-10dB exceedance, which is a more acceptable situation.

7.3.1-2 Industrial Noise Receivers

During some stages (activities in Work Areas 1 & 3) of the proposed remediation works exceedances of up to 10-15dB of the noise level requirements are predicted for the upper limit of the expected noise range of operations. Again the construction noise management sub-plans should be in place to achieve this goal (see section 8). However, mid-range operations are not expected to exceed the noise criterion.

7.3.1-3 Notes on Noise Mitigation

To achieve noise levels as presented in Tables 7.2 to 7.5 an efficient management of construction (remediation) noise will be required. A similar construction noise sub-plan to that noted in Section 8 should be implemented to ensure that efficient management of remediation operations and activity noise is achieved.

7.4 GROUND-BORNE VIBRATION DUE TO CONSTRUCTION

It is normal to consider vibration in respect of potential damage to buildings and potential annoyance to residents. In many cases, it is the residents' fear of building damage that enhances the potential annoyance. The most common form of measurement for ground vibration with respect to gauging limiting vibration levels at and around structures is the peak particle velocity (ppv) in mm/s. With respect to human vibration, a root mean square (rms) value is normally used, this being somewhat lower than peak particle velocity (by up to a factor of 5 for impulsive events).

The German Standard DIN 4150, Part 3, 1986, "*Structural vibrations in buildings*" is generally accepted world-wide as the being foremost authority on limiting ground vibration at building structures to achieve zero expectation of damage. DIN 4150 recommends maximum peak particle velocity (ppv) vibration limits in mm/s for different frequency ranges to be associated with vibration sources. The NSW DEC ENCM gives generally accepted criteria levels for limiting vibration within building occupancies while maintaining human comfort.

Vibration levels due to construction activities are very difficult to predict due to vibration in ground conditions, etc. However, past experience has shown that in general the recommendations in the following sections should be adhered to.



7.4.1 Vibratory Rollers

Research suggests that the use of vibrating rollers is the construction activity that has the most potential to cause damage to buildings in close proximity. Suggested minimum operating distances from buildings and residences, both to minimise damage and to reduce complaints and claims to an acceptable level are given in Table 7. below. The distances given are compiled from a limited amount of literature and are intended to give a guide to practice. Care must be taken to consider the adjacent structures and field conditions. It is recommended that vibration monitoring be undertaken where premises are within these distances from roller works.

Standards note that special attention should be paid to buildings that are already visibly damaged or cracked.

Table 7.6: Suggested Proximity Limits for the Use of Vibrating Rollers to Prevent Damage to Buildings and Reduce Complaints and Claims to an Acceptable Level

Roller Class	Example-Weight Range and Centrifugal Force (CF)	Restriction: Distance to Nearest Building
I. Very Light	Maintenance and patching rollers, less than 1.25 t (CF 1-2 t)	Generally not restricted for normal road use. (10 ft, 3 m)*
II. Light	1-2 t (CF 2-5 t)	Generally not restricted for normal road use. (15 ft, 5 m)*
III. Light-Medium	2-4 t (CF 5-10 t)	15 ft, 5 m**, (30 ft, 10 m)*
IV. Medium Heavy	4-6t (CF 10-20 t)	Not advised for city and suburban streets. 30 ft, 10m **, (65 ft, 20 m)*
V. Heavy	7-11 t (CF 20-30 t)	Restricted. Not advised for built up areas. 65 ft, 20m **, (130 ft, 40 m)*
VI. Very Heavy	12 t and over (CF over 30 t)	Restricted, major construction, rural area, away from structures and buildings.

* Values in brackets are those suggested to keep claims and complaints to an acceptably low level. For complaints to be stopped completely in residential areas, these distances would possibly need to be increased still further.

** To prevent damage to buildings.

Table 7.7 provides indicative construction vibration levels that could potentially be generated during the fill and compaction works within the cell work area. The likely vibration levels from earthworks have been estimated at the nearest sensitive receivers using average literature values (*Hiller and Crabb 2000*) for vibratory rollers.

Table 7.7: Indicative Vibration Levels during Construction

Residence	Earthworks, Filling and Compacting Works [#]
20 m	2 – 6
50 m	0.05 – 3
100 m	0.01 – 0.6

[#] range of literature measured and theoretical values for vibratory roller

Source: Hiller & Crabb 2000

The actual vibration levels experienced during the operation of vibratory roller will depend upon the soil type (mix of sand, clay, rock etc.) and the ground structure between the work site and receivers.



Assuming that the nearest potential residential receiver to the site is in excess of 150 m to the cell construction works, no vibration impacts are likely to be experienced during the operations at the cell area of the remediation site.

7.4.2 Rock-Breakers

Where rock breaking takes place it is recommended that vibration monitoring be undertaken where premises are within the following distances from the works:

Table 7.8: Recommended Limiting Distances for Rock Breaking at Adjacent Premises

Activity	Limiting Distance	Reference Criteria
Heavy Rock Breaking (1500 kg)	20 m	Appendix A, Table A-1
Light Rock Breaking (600 kg)	5 m	Appendix A, Table A-1

8 DRAFT CONSTRUCTION NOISE AND GROUND-BORNE VIBRATION MANAGEMENT PLAN

It is recommended that either the following Draft Noise and Vibration Management Plan or other suitable Noise and Vibration Management Plan be applied during construction.

8.1 NOISE

8.1.1 Summary of Impacts

The remediation works of the PCCS may have the potential to create noise impacts if poor noise management is implemented.

8.1.2 Objective

The objective of this plan is to ensure that any noise emissions during remediation, are of a reasonable level and any exceedances are dealt with quickly and effectively.

General noise mitigation should be implemented using strategies set out in Australian Standard 2436-1981. Examples of such strategies are listed including:

- ⇒ Adherence to the DEC recommended preferred hours of construction.
- ⇒ Fitting of higher-grade silencers or exhausts to mobile plant than standard.
- ⇒ Regular compliance checks on plant noise emissions and noise monitoring at receiver locations.
- ⇒ Pro-active management on a daily basis to reduce the coincidence of operation of noisy equipment.



- ⇒ Use of acoustic enclosures or partial enclosures for stationary plant. This recommendation is especially pertinent in the case of any plant, which will be operating continuously 24 hours a day.
- ⇒ Maximising separation distance between noisy plant and sensitive receivers.
- ⇒ Development and maintenance of a positive relationship with local residents and building owners to inform of progress and alleviate concerns thereby minimising complaints. This may take the form of leafletting and/or personal calls from a responsible person where unusually high levels of noise are expected.
- ⇒ Use of potentially noisy non-standard equipment that could cause significant increases in noise emissions will require prior approval of the DEC.
- ⇒ No queuing of heavy vehicles to occur outside day-time hours except as required for essential night-time works.

8.1.3 Noise Mitigation Implementation

Initial predictions of construction noise with no additional mitigation treatments highlight exceedances will occur in a number of instances. As such noise mitigation is recommended to reduce the effects to an acceptable level.

- Install temporary noise barriers adjacent to the excavation work areas which are located in close proximity to residential receivers to avoid line of sight between PCCS machinery and the sensitive noise receivers;
- Ensuring that all pieces of plant on site that require it have silencing treatments applied with the aim of limiting emitted Sound Power Levels (L_w) to comply for both weekday and weekend usage;

In addition to the above noise mitigation implementations, the strategies stipulated in Section 8.1.2 of the construction noise management plan should be implemented to ensure all practical measures are undertaken at all times to reduce noise from operations as much as is feasible.

Table 8.1 below is an excerpt from Appendix E ‘Noise Sources, remedies and their effectiveness’ from Australian Standard 2436:1981, presenting possible noise reductions from various control mechanisms.

Table 8.1 - Excerpt 'Table E3' Relative effectiveness of various forms of noise control, AS2436-1981

Control by	Noise reduction possible in practice, dB(A)
Distance	Approximately 6 for each doubling of distance
Screening	Maximum 15, normally 7 to 10
Enclosure	Maximum 50, normally 15 to 30
Silencing	Maximum 20, normally 5 to 10
Substitution by alternative process	Maximum 60, normally 15 to 25

8.1.4 Legislative Basis

Ensure that noise from construction complies with the requirements of DEC ENCM.



8.1.5 Performance Criteria

The performance criteria seek to minimise the negative impacts of construction. The noise limits in Section 4.3.1 have been determined using the DEC noise criteria specified in this report and the measured background noise levels.

8.1.6 Community Liaison

The following work practices may be adhered to reduce impacts of construction noise:

- ⇒ Road closures, following approval, would be advertised in the daily press, the local newspapers and prominently displayed at various locations throughout the commercial district prior to implementation.
- ⇒ In addition a 24-hour 7-days/week free telephone service provided to assist in keeping the public informed, as well as register complaints.
- ⇒ Letterbox drops carried out in areas adjacent to the closure prior to roadwork.
- ⇒ Traffic controllers provided for the duration of the closures to roads.
- ⇒ All complaints will be addressed within 48 hours with spot-check noise measurement and implementation of noise reduction strategies where required. Reporting to stakeholders to occur within 3 working days of complaint.

8.1.7 Monitoring

Best practice procedure dictates that the administering body would carry out or delegate the following monitoring activities:-

- ⇒ Noise measurements should be conducted at nearby sensitive receivers to ensure that the above noise limits are being adhered to. Results should consist of a combination of manned and unmanned measurements. Noise measurements should be conducted every 3 months and exceedances should be noted and directed to the responsible parties.
- ⇒ Noise measurements may also be required if a noise complaint is received.

8.1.8 Reporting

The reporting requirements for the Noise Management Plan during the operation of the facility are as follows:

- ⇒ Reporting of the noise measurement results every 3 months.
- ⇒ Additional noise reports may arise if complaints are received.

8.1.9 Corrective Actions

Recorded exceedances of the noise emission limits shall instigate the following actions:



- ⇒ Manned measurement of noise levels to determine activity causing excessive noise emission levels;
- ⇒ If necessary, specialist consultants will be employed to determine adequate amelioration strategies.
- ⇒ Meetings between the complainant and proponent.

8.2 VIBRATION

In general the recommendations set out in Section 7.4 should be adhered to.

9 CONCLUSIONS & RECOMMENDATIONS

Vipac Engineers & Scientists Ltd. (VIPAC) has been commissioned by the Fitzwalter Group Pty Ltd on behalf of Pasminco Cockle Creek Smelter Pty Ltd (PCCS) to create a Noise and Vibration Management Plan for the proposed PCCS Remediation Works Outline.

Construction Noise

Impacts of air-borne construction (remediation) noise have been assessed in Section 7.3. Daytime exceedances of up to 20dB are predicted for residential receivers and up to 15dB for industrial receivers. To bring upper noise levels to the more acceptable levels it is recommended that noise attenuation may be required in certain areas and at certain times (e.g. closest to residential areas) and that temporary noise walls are effective means of achieving the desired noise reductions. These noise control devices need to be placed on boundaries of the remediation work areas in close proximity to nearby residential areas to achieve maximum noise control. Work area #5 proximity to Boolaroo residential district, located in a relatively quiet neighbourhood, is an example of the proximity from noise source to noise sensitive receiver.

Notwithstanding the above VIPAC understands that PCCS are to noise monitor field trials in the construction work areas in mid 2006 to confirm the theoretical predictions in this report and to improve the management of noise for the balance of the works.

Ground-borne Vibration

Ground-borne vibration levels due to construction are assessed in Section 7.4 and limiting distances from construction activities are recommended. Where limiting distances are breached then vibration monitoring is recommended, and where levels are determined to exceed, then it is recommended that alternative construction methods be investigated.



10 APPENDIX A: GENERAL NOTES ON VIBRATION

VIBRATION DUE TO CONSTRUCTION

Vibration Criteria

Human Comfort – Limits for “Low Expectation of Adverse Comment”.

Recommendations presented in Table A-1 are based on Standards Association of Australia (SAA), AS2670.2 – 1990, Evaluation of human exposure to whole body vibration. Part 2: Continuous and shock -induced vibration in buildings (1 to 80 Hz) and Chapter 174 of the ECM referencing the standard. Recommended levels have been calculated for vibration sources with dominant frequencies of 15 Hz and above (our estimations of dominant frequencies of operation of proposed construction plant). As the majority of cases will be associated with continuous or intermittent vibration then the more stringent values in columns 3 and 4 should generally be adhered to.

Table A-1: Recommended Satisfactory Magnitudes Of Building Vibration With Respect To Human Response.

Vibration sources with dominant frequencies of 15 Hz and above (See Reference 0). All values in mm/s

Occupancy Type	Time	Continuous or Intermittent Vibration		Transient Vibration excitation with several occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Critical Working Areas (for example some hospital operating theatres, some precision laboratories etc.)	Day Night	0.1	0.27	0.1	0.27
Residential	Day	0.2	0.54	3 to 6	8.1 to 16.2
	Night	0.14	0.4	0.14 to 2	0.4 to 5.4
Offices	Day	0.4	1.08	6 to 12.8	16.2 to 34.6
	Night				
Workshops	Day	0.8	2.2	9 to 12.8	24.3 to 34.6
	Night				

Notes:

- The above figures are based on the RMS (root mean square) vibration levels. For peak allowable vibration levels the levels should be multiplied by the appropriate crest factor (ratio of peak level to RMS level). Crest factors vary from 1.4 for construction activities of a sinusoidal nature (eg vibratory rolling and rotating plant) to up to 4 or more for intermittent activities such as rock breaking or ripping.
- Where a range has been given upper levels generally relate to upper limits recommended by the NSW EPA and lower levels generally relate to lower limits recommended by both the NSW EPA and AS2187 or AS2187 alone.
- Transient vibration may be defined as a rapid build up to a peak and then a damped decay.
- Intermittent vibration may be described as a string of vibration incidences with much lower levels in between e.g. impulse sources (e.g. pile drivers, punch presses), repetitive sources (e.g. pavement breakers) or sources which operate intermittently but would produce continuous vibration if operated continuously (e.g. intermittent machinery, lifts, road traffic, railway trains).
- Continuous vibration may be defined as vibration, which remains uninterrupted over a time period under consideration.



- AS2187 notes that adjustments and variations may be allowed for short term engineering works (for example foundation excavation and tunnelling) where good public relation practices are followed and prior warnings are given.
- AS2187 also notes that within residential areas there are wide variations in tolerance to vibration and that specific values are dependent on social and cultural factors, psychological attitudes and expected interference with privacy.
- Single high magnitude events such as blasting are a special case and should be limited to night-time use and limited to a small number of events.
- In hard rock excavation, where underground disturbances cause higher frequency vibration, higher factors than those given above have been found to be satisfactory for residential properties in some countries.
- Where NSW EPA guidelines have been incorporated then acceleration levels given in the criteria have been converted into velocity levels for continuity with AS2187.
- AS2187 notes that acceleration (or velocity) levels of vibration generated on construction sites should be less than those listed under “intermittent or impulsive “ vibrations. Therefore a “Continuous” condition should be assumed.
- When measured levels exceed those permitted for “continuous” vibration then the following time restrictions will be imposed:
 - 7am to 6pm Mon-Fri.
 - 7am to 1 pm Saturdays
 - None on Sundays or Bank Holidays.



11 APPENDIX A: GLOSSARY OF ACOUSTIC TERMS

Decibel, dB(A):

Unit of acoustic measurement. Measurements of power, pressure and intensity. Expressed in dB relative to standard reference levels.

dB(A):

Unit of acoustic measurement weighted to approximate the sensitivity of human hearing to sound frequency.

Sound Pressure Level, L_p (dB), of a sound:

20 times the logarithm to the base 10 of the ratio of the r.m.s. sound pressure to the reference sound pressure of 20 micro Pascals. Sound pressure level is measured using a microphone and a sound level meter, and varies with distance from the source and the environment.

Sound Power Level, L_w (dB), of a source:

10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 Pico Watt. Sound power level cannot be directly measured using a microphone. Sound power level does not change with distance. The sound power level of a machine may vary depending on the actual operating load.

Ambient Sound:

Of an environment: the all-encompassing sound associated with that environment, being a composite of sounds from many sources, near and far.

Percentile Level - L_{90} , L_{10} , etc:

A statistical measurement giving the sound pressure level that is exceeded for the given percentile of an observation period, e.g. L_{90} is the level that is exceeded for 90% of a measurement period. L_{90} is commonly referred to as the "**background**" sound level.

Average Maximum A-weighted sound pressure level - $L_{AMAX,T}$:

The A-weighted sound pressure level obtained by using time weighting Fast and arithmetically averaging the maximum levels measured during the time interval considered - $L_{A10,T}$ is commonly taken to be an approximation for $L_{AMAX,T}$.

Average Background A-weighted sound pressure level - $L_{ABG,T}$:

The A-weighted sound pressure level obtained by using time weighting Fast and arithmetically averaging the lowest levels of the ambient sound pressure levels measured in the absence of the noise source(s) under investigation, during the time interval considered - $L_{A90,T}$ is commonly taken to be an approximation of $L_{ABG,T}$.

Rating Background Level – RBL:

Method for determining the existing background noise level that involves calculating the tenth percentile from the L_{A90} measurements. This value gives the Assessment Background Noise Level (ABL). Rating Background Level is the median of the overall ABL.

$L_{AEQ,T}$:

Equivalent continuous A-weighted sound pressure level. The value of the A-weighted sound pressure level of a continuous steady sound that, within a measurement time interval T, has the same A-weighted sound energy as the actual time-varying sound.



STC - Sound Transmission Class:

Of a partition separating two enclosed spaces: a single number evaluation of its ability to attenuate sound passing between the two spaces. STC takes into account the sound transmission loss in each band of a specified set of one-third octave bands.

R_w – Weighted Sound Reduction Index:

A new single number quantity for airborne sound insulation rating which replaces STC. STC has been traditionally used for the classification of partitions and to define acoustical requirements in the Building Code of Australia.

For majority of partitions, the value for R_w will be similar to the value for STC. Partitions with particularly poor performance at 100Hz may have lower values for R_w than for STC. Conversely, partitions with poor performance at 4kHz may have higher values for R_w than for STC.

Subjective Response to changes in noise levels:

The subjective response or reaction to changes in noise levels can be described as follows:

A 3 dB (A) change in sound pressure level is just noticeable or perceptible to the average human ear; a 5 dB (A) increase is quite noticeable and a 10 dB (A) increase is typically perceived as a doubling in loudness.

