NEWCREST MINING LIMITED

CADIA

Blast Monitoring Program

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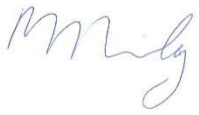
4	16/7/2020	
		Merrilyn Tinsley

[1] Subject to minor amendment

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1. INTRODUCTION AND BACKGROUND

Project Approval for the Cadia East Project was granted by the NSW Minister for Planning under Part 3A of the Environmental Planning and Assessment Act, 1979 (EP&A Act) on 6 January 2010. The Cadia East Project is described in Schedule 1 of the Project Approval as including the Cadia East underground mine, the Cadia Hill open cut mine (now used for tailings deposition), the Ridgeway underground mine (currently in 'care and maintenance'), the Blayney and Cadia Dewatering Facilities, and ancillary infrastructure. These components are together known as Cadia Valley Operations (Cadia).

This Blast Monitoring Program (BMP) outlines blast over-pressure and vibration monitoring that is undertaken at Cadia. The BMP addresses the requirements contained in the Cadia East Project Approval (PA-06_0295) and Environmental Protection Licence (EPL) 5590 and has been prepared in accordance with Schedule 3, Condition 16 of the project approval. Table 1-1 provides the requirements of Condition 16, and an indication of which sections of the BMP address these requirements.

Table 1-1: Cadia East Project Approval - Condition 16 Requirements

Project Approval Requirement	Relevant Section of Plan
Blast Monitoring Program	
16. The Proponent shall prepare and implement a Blast Monitoring Program for the project to the satisfaction of the Secretary. This program must:	
(a) be prepared in consultation with EPA, and be submitted to the Secretary for approval within 3 months of the date of this approval; and	Section 1.1
(b) include a protocol for evaluating blast-related impacts (including blast-induced seismic activity) on, and demonstrating compliance with the blasting criteria in this approval for:	Section 4.1
➢ privately-owned residences and structures; ➢ items of Aboriginal and non-indigenous cultural heritage significance (including the Cadia Engine House and Surrounds); and ➢ publicly owned infrastructure.	Section 4

In addition to the above requirements, Cadia received notification from the Department of Planning, Industry and Environment on 9 June 2010 following consideration of Version 1 of the BMP requiring:

> *"that the calculation of the allowable vibration exceedances must include a combination of caving induced vibration (as noted in section 2.1 of the Vibration Monitoring Program) and blast induced vibration."*

Section 2.3.3, Section 2.4.1 and Section 4 of the BMP demonstrates how Cadia will address this requirement.

1.1 Consultation

CHPL consulted with the Bathurst regional office of the Environment Protection Authority (formerly Department of Environment, Climate Change and Water) in March 2010 during the development of Version 1 of the BMP.

CHPL consulted with directly affected stakeholders and the Cadia Community Consultative Committee during development of Version 1 and Version 2 of the BMP.

The EPA was consulted through the Annual Environmental Management Review (AEMR) process in November 2013 on changes associated with Version 3 of the BMP.

2. COMPLIANCE CONDITIONS AND COMMITMENTS

2.1 Cadia East Project Approval

Conditions imposed by the Cadia East Project Approval (PA_0295), as they relate to blasting and blast management Conditions 10-16, Schedule 3) are replicated below:

BLASTING AND VIBRATION

Blasting Impact Assessment Criteria

10 The Proponent shall ensure that blasting at the project does not exceed the criteria in Table 7.

Table 7: Blasting impact assessment criteria

Location	***Time of Blasting***	***Airblast overpressure (dB(Lin Peak))***	***Ground vibration (mm/s)***	***Allowable exceedance***
Residence on privately owned land	Any time	120	10	0%
	Day	115	5	5% of the total number of blasts over a period of 12 months
	Evening	105	2	
	Night, and all day on ays and Public holidays	95	1	
Heritage sites, including Cadia Engine House and Surrounds (but excluding Little Cadia Copper Mine)	Any time	-	15	0%

Note: The impact assessment criteria for Cadia Engine House and Surrounds apply in the absence of any anti-vibration strengthening. Alternative criteria may be approved under the Historical Heritage Management Plan (see condition 43) if anti-vibration strengthening works are implemented.

Operating Conditions

11 During mining operations on site, the Proponent shall implement best blasting practice to:

(a) protect the safety of people, property, public infrastructure, and livestock;

(b) protect items of Aboriginal and non-indigenous cultural heritage significance; and

(c) minimise the dust and fume emissions from blasting at the project, to the satisfaction of the Secretary.

Public Notice

12 During mining operations on site, the Proponent shall:

(a) notify the landowner/occupier of any residence within 2 kilometres of blasting operations who registers an interest in being notified about the blasting schedule at the mine, or any other landowner nominated by the Secretary;

(b) operate a Blasting Hotline, or alternate system agreed to by the Secretary, to enable the public to get up-to-date information on the blasting schedule at the project;

(c) publish an up-to-date blasting schedule on its website (for open pit and major underground blasting operations); and

(d) advertise the blasting hotline number and website information in the mine's regular newsletter, to the satisfaction of the Secretary.

Property Inspections

13 The Proponent shall advise the owners of privately-owned land that they are entitled to a structural property inspection to establish the baseline condition of buildings and other structures on the property:

(a) within 2 months of the date of this approval, for properties within 2 kilometres of blasting operations occurring at the date of this approval; and

(b) at least 2 months prior to blasting within 2 kilometres of additional properties.

14 If the Proponent receives a written request for a structural property inspection from any such landowner, the Proponent shall:

(a) within 2 months of receiving this request commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to inspect the condition of any building or structure on the land (prior to blasting taking place within 2 kilometres of the property, if possible), and recommend measures to mitigate any potential blasting impacts; and

(b) give the landowner a copy of the property inspection report.

Property Investigations

15 If any landowner of privately-owned land within 2 kilometres of blasting operations, or any other landowner nominated by the Secretary, claims that buildings and/or structures on his/her land have been damaged as a result of blasting at the project, the Proponent shall within 3 months of receiving this request:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to investigate the claim; and

(b) give the landowner a copy of the property investigation report.

If this independent property investigation confirms the landowner's claim, and both parties agree with these findings, then the Proponent shall repair the damages to the satisfaction of the Secretary.

If the Proponent or landowner disagrees with the findings of the independent property investigation, then either party may refer the matter to the Secretary for resolution.

If the matter cannot be resolved within 21 days, the Secretary shall refer the matter to an Independent Dispute Resolution Process (see Appendix 8).

Blast Monitoring Program

16 The Proponent shall prepare and implement a Blast Monitoring Program for the project to the satisfaction of the Secretary. This program must:

(a) be prepared in consultation with EPA, and be submitted to the Secretary for approval within 3 months of the date of this approval; and

(b) include a protocol for evaluating blast-related impacts (including blast-induced seismic activity) on, and demonstrating compliance with the blasting criteria in this approval for:

- privately-owned residences and structures;
- items of Aboriginal and non-indigenous cultural heritage significance (including the Cadia Engine House and Surrounds); and
- publicly-owned infrastructure.

2.2 Environment Protection Licence 5590

Conditions imposed by the Cadia Environment Protection Licence 5590 are replicated below:

L5 Blasting

L5.1 The licensee must ensure that blasting at the premises does not exceed the criteria specified in the Table below:

Location	Time of Blasting	Airblast overpressure (dB(Lin Peak))	Ground vibration (mm/s)	Allowable exceedance
Residence on privately owned land	Any time	120	10	must not be exceeded.
	Daytime (7am - 6pm) Monday - Saturday	115	5	may be exceeded by no more than 5% of the total number of blasts over each licence reporting period
	Evening (6pm - 10pm)	105	2	may be exceeded by no more than 5% of the total number of blasts over each licence reporting period
	Night (10pm - 7am) and all day on Sunday and public holidays	95	1	may be exceeded by no more than 5% of the total number of blasts over each licence reporting period

L5.2 Error margins associated with any monitoring equipment used to measure airblast overpressure and ground vibration are not taken into account in determining whether or not the limit has been exceeded.

Blast monitoring

M4.5 The licensee must monitor all blasts carried out in connection with the premises (in line with the reporting period) at or near the nearest residence or noise sensitive location (such as a school or hospital) that is not owned by the licensee or subject of a private agreement between the licensee and owner of the residence or noise sensitive location relating to alternative blasting limits, to adequately determine compliance with the blast limits stipulated by condition L5.1.

M4.6 The results of the blast monitoring required by condition M4.5, and an interpretation of these results, must be provided as an attachment to each corresponding years Annual Return.

2.3 Cadia East Environmental Assessment

The Cadia East Project Environmental Assessment (CHPL, 2009) describes the potential blasting effects associated with Cadia. A summary of the blasting assessment is provided below to provide some overall context to this BMP.

Appendix J of The Australian Standard Explosives – Storage and Use – Part 2 Use of Explosives (AS 2187.2-2006) advises that vibration and air blast levels at which people become annoyed are well below levels at which damage occurs (s J4.2 and J5.1). The Cadia East EA predicted that vibration and air blast overpressure levels for the Cadia East project would occur below the 5mm/s vibration and 120dBL blast overpressure annoyance criteria.

Blasting criteria are provided for structural damage, protection of amenity and for European heritage sites. The blasting assessment undertaken in the Cadia East Environmental Assessment indicated that the structural damage criteria would be met at all receivers and blasting emissions at the Cadia Engine House would be below the relevant criteria.

Blasting at night-time, on Sundays and Public Holidays will be conducted using reduced maximum instantaneous charge (MIC) to ensure that the criterion is met.

Caving induced vibration (seismic) events occur at Cadia. Presented below is a background discussion on these events.

2.3.1 Background

Underground mining at Cadia is undertaken using caving methods. Ridgeway utilises a block caving method while Cadia East utilises panel caving.

The panel caving mining method results in the gradual downward subsidence of fractured rock and the upward fracturing of overlaying host rock in the caving zone. This movement of rock results in localised vibrations as broken rock subsides downward in the caving zone. Localised vibration also occurs through the upward fracturing as stresses are redistributed in the rock mass above the caving zone.

During the operation of the caving mining method the draw from the base of the mine is carefully managed to control the gap between the top of the caved rock and the in-situ rock above. Draw rate and locations are managed to control the size of the rock fragments that are released from the cave back, which minimises the size of the associated vibration. The management of the caving process is a critical operational safety issue as large rock falls within the caving zone have the potential to cause damaging air-blast events within the mine.

Seismic activity is a feature of the region with Geoscience Australia recording regular seismic events since monitoring commenced in 1961 with magnitudes as high as 4.1 on the Richter scale. Seismic activity at Cadia is monitored and assessed on a case by case basis to determine whether the seismicity is mining related (cave or blast induced) or if activity is a regional event. Australian Geoscience Monitoring station at Young NSW, regularly liaise with Cadia regarding seismicity and provide information on regional earthquakes.

Historical regional events can be found on the Australian Geoscience website at http://www.ga.gov.au/earthquakes/.

2.3.2 Vibration Monitoring

Vibration monitoring at Cadia is conducted using two methods and for two separate purposes.

Monitoring of caving-induced vibrations from the Cadia East mine is conducted for operational mine safety and caving management purposes using a comprehensive network of sensitive geophones and accelerometers which have been installed underground and, on the surface, surrounding the mine. This equipment is capable of measuring vibration in the order of 0.001 millimetres per second (mm/sec) and locating the area where the vibration activity occurs. The main function of this monitoring is to measure the propagation of the cave zone and inform management decisions. The caving-induced vibrations ('seismic events') are measured on a local scale similar to the Richter scale.

The second type of monitoring is conducted for amenity and structural purposes and is designed to measure vibrations on privately owned land surrounding the mining operations. Blasting is routinely conducted within the Cadia East underground mine. No blasting is currently planned within Ridgeway / Ridgeway Deeps (currently in 'care and maintenance'). Blast vibration monitoring is conducted with a network of seven vibration monitors within the mining lease and at nearby privately-owned properties. These monitors continually monitor vibration and record events that exceed 0.1 mm/s. The monitoring programme is designed to assess whether the relevant amenity criteria (i.e. human comfort) and structural damage criteria are being complied with at the nominated monitoring sites and on privately owned land. These criteria are specified in the Environmental Performance conditions of the Cadia East Project Approval and EPL 5590 (blasting only).

2.3.3 Management of Blasting and Caving-induced Vibration at the Cadia East Mine

The measures that are implemented to manage vibration at the Cadia East Project include pre-conditioning of the ore body, limiting the size of blasts and management of the cave.

As described in Section 2.5.7 of the Cadia East Project EA, pre-conditioning of the ore body would be undertaken using a combination of hydraulic fracturing and blasting. These techniques create fractures in the cave zone, changing the overall properties of the rock mass.

At Cadia East, pre-conditioning is planned to cover the entire production cave area of the proposed Cadia East mine. The intensity of pre-conditioning is planned to be more extensive than the programme completed for the Ridgeway Deeps mine and this would be achieved by incorporating closer crack spacing of hydraulic fracturing in addition to using pre-conditioning blasts. Data collected to date has shown increased rate of cave propagation through the preconditioned horizon, allowing increased caving rate and release of seismic energy over a shorter period of time.

Development and operation of the mine would be managed to reduce the magnitude of vibrations by management of blast events and caving. During the development of the mine, blasting would be designed and managed to ensure that maximum instantaneous charge (MIC) of blasting events do not result in exceedances of vibration criteria (as described in Section 4.7.3 of the EA and EPL5590).

During the operation of the cave, the extraction of ore from the base of the mine would be managed to control the gap between the top of the caved rock and the in-situ rock above. Management practices target specific cave draw/cave production sequences to control the size and geometry of the broken ore in the cave zone. This is intended to control the size of the rock released by the cave and, therefore, the size of any corresponding caving-induced vibration event.

2.4 Other Commitments, Standards and Guidelines

The following standards have been referenced in the BMP and would be used during the implementation of the BMP, where applicable.

- Australian Standard 2187.2-2006 Explosives – Storage and use Part 2: Use of explosives, Australia
- Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (Australian and New Zealand Environment and Conservation Council [ANZECC], 1990).

2.4.1 Seismic Events

In addition to all blasts, seismic events caused by Cadia's mining activities (cave-induced vibration and blast-induced vibration) that trigger blast monitors (i.e. vibration > 0.1mm/s) are assessed against the above blast criteria for compliance. Individual seismic events are assessed against the maximum criteria, while events that fall within the 5% allowance are included in the calculation for allowable vibration exceedances.

2.4.2 Heritage Structure Protection Criteria

In accordance with the Exemption from Section 60 of the NSW Heritage Act (re-issued 1/11/2007) the ground vibration criteria that applies to the Cadia Engine House and Surrounds (Chimney) where anti-vibration strengthening has been implemented are 25 mm/s (5% allowable exceedance), 30 mm/s (1% allowable exceedance) and 55 mm/s (0% allowable exceedance) over any one calendar month. When blasting, should blast-induced seismicity and non-mining related seismicity events generate ground vibration that exceeds 15mm/s at the Cadia Engine House and Surrounds, an inspection of the Cadia Engine House and Surrounds will occur.

3. MONITORING

3.1 Monitoring Overview

Monitoring will be conducted using blast monitoring units which measure ground vibration and air overpressure. The locations of these are shown in Table 3-1 and Table 3-1.

Table 3-1: Monitoring Locations

Location	Easting	Northing
Coorabin	688,091	6,300,432
Meribah	687,519	6,287,535
Chimney	684,513	6,297,184
Chesterfield	688,942	6,298,540
Rosebank	681,773	6,298,569
Mayburies	681,901	6,291,348
Warrengong	689,988	6,294,775

3.2 Assessment periods

The vibration and air blast assessment periods that are mentioned in this program are shown in the following Table 3-2. Prior to 2010 vibration and air blast monitors were only operational during the designated blast times. To enable capture of vibration from seismic events, the monitors have been upgraded to monitor 24 hours a day.

Table 3-2: Vibration assessment periods

Period	Start	Finish
Day	7AM	6PM
Evening	6PM	10PM
Night	10PM	7AM

Figure 3-1: Blast and Vibration Sites

3.3 Ground vibration monitoring

Ground vibration monitoring will be conducted to assess the ground vibration from blasting and mining induced seismic events. The details of the monitoring are as follows;

- Monitoring will be conducted using a geophone set to trigger during ground vibration events greater than 0.10mm/s
- Monitoring will be conducted continuously
- Monitoring will record peak vector sum (PVS – mm/s) waveforms

3.4 Airblast over pressure monitoring

Airblast overpressure monitoring will be conducted to assess the air pressure or air vibration generated from blasting. The details of the monitoring are as follows;

- Monitoring will be conducted using a sound level meter or microphone as part of the blast monitor unit and set to trigger on ground vibration events
- Monitoring will be conducted continuously
- Monitoring will record air overpressure peak (dB(Linear)) waveforms

3.5 Vibration Parameters

The equipment used for vibration monitoring will be programmed to measure the following parameters.

Table 3-3: Vibration parameters

Parameter	Measurement	Units
Ground Vibration	Peak vector sum (PVS)	mm/s
Airblast Overpressure	Air overpressure peak	dB(Linear)

3.6 Public Infrastructure

No definitive criteria have been determined in AS 2187.2-2006 for recommended limits to impact on public infrastructure. Tables J4.5(B) and J5.4(B) in Appendix J of AS 2187.2-2006 recommend that vibration and air blast limits for service structures such as pipelines, power lines and cables be determined by structural design methodology.

In the absence of defined limits on structural damage from blasting on public infrastructure this program establishes a procedure in response to concerns raised by infrastructure owners on damage from blasting. Where concerns are expressed that damage has or may potentially be caused to public infrastructure the vibration air blast overpressure data results shall be evaluated against the structural design limits relevant to the specific infrastructure.

3.7 Meteorological Monitoring

Meteorological monitoring is used to assist in the analysis of blast monitoring data. The weather stations details are shown in the following Table 3-4.

Table 3-4: Meteorological Monitoring

Station	Easting	Northing	Parameters
Ridgeway	684,193	6,298,081	Temperature, barometric pressure, rainfall, wind direction, wind speed, sigma-theta, relative humidity and solar radiation
Southern Lease Boundary	684,247	6,291,467	Temperature, barometric pressure, relative humidity, solar radiation, evaporation, wind direction, wind speed & sigma-theta.

3.8 Aboriginal Heritage

There are no identified Aboriginal heritage sites that will be impacted by blast and vibration events at Cadia.

4. DATA REVIEW

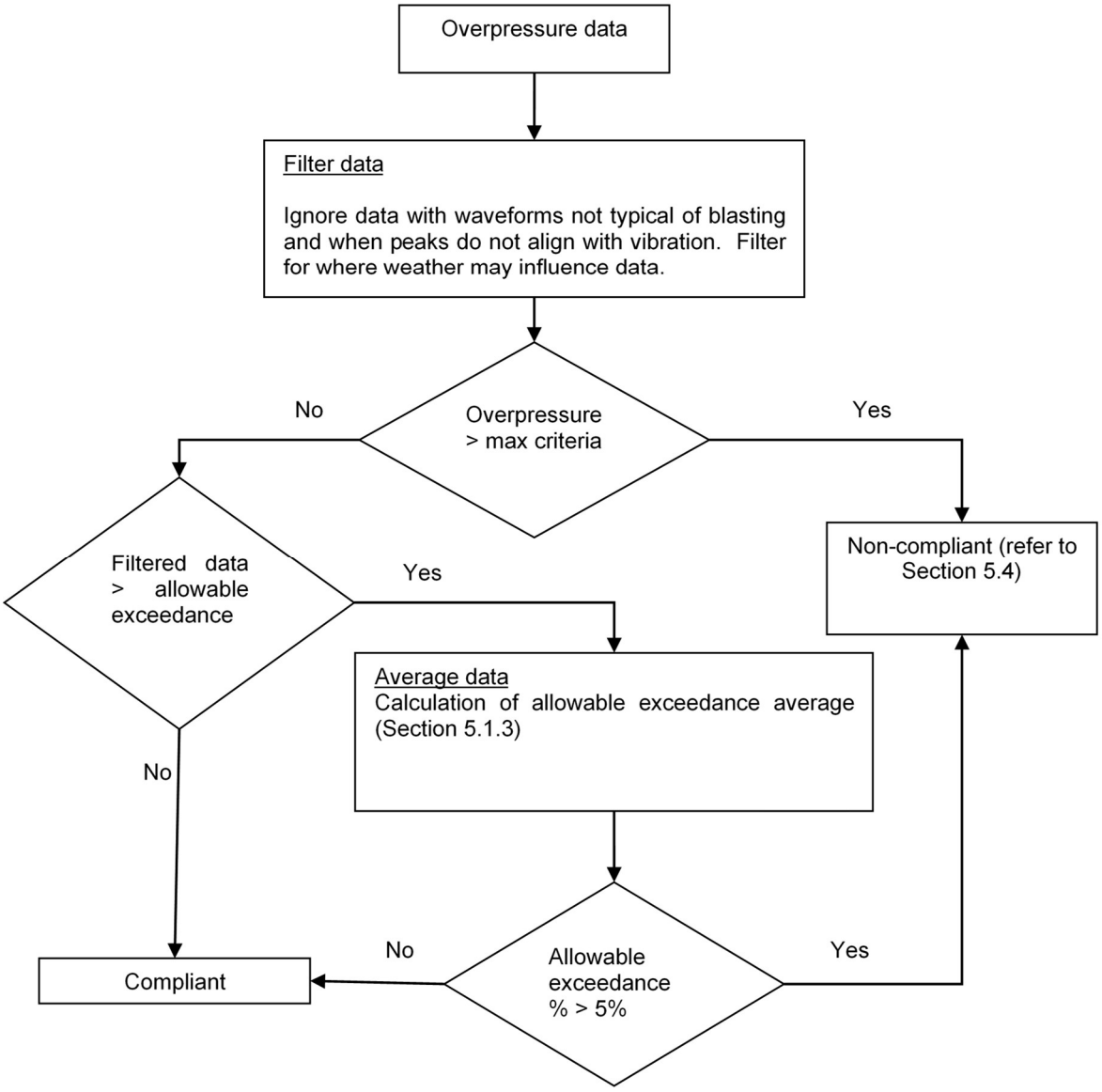
Results from the monitoring program will be reviewed to assess compliance and in response to complaints. The process for assessing compliance and the types of reports that are generated are detailed in the following sections.

4.1 Protocols for Evaluating Compliance

4.1.1 Blast overpressure

Assessment of overpressure data from the blast monitors will be conducted daily. There are different criteria depending on the day and time of the blast. Overpressure data will be assessed as shown in Figure 4-1. Assessment will be undertaken on a monthly basis by an independent consultant.

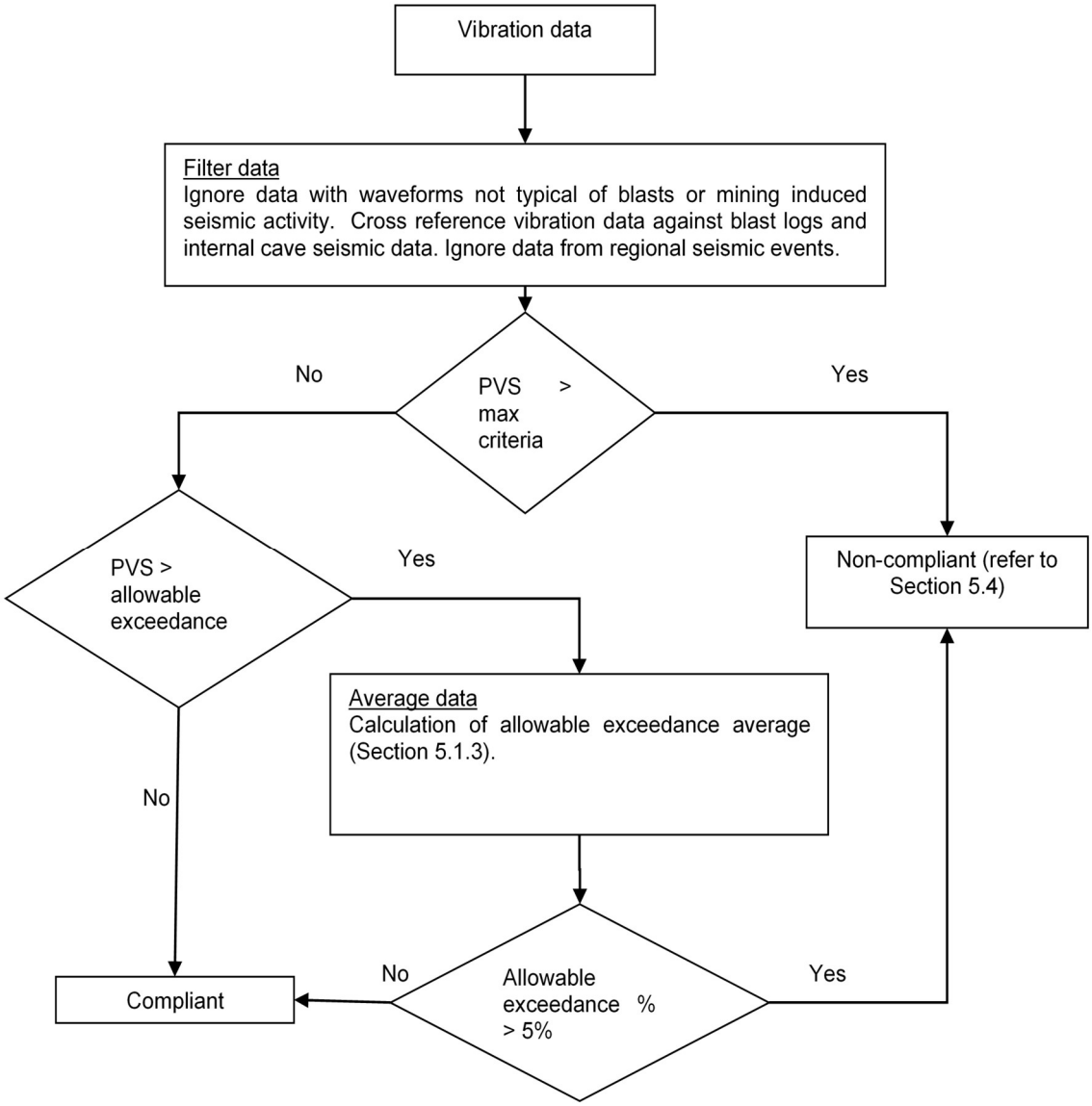
Figure 4-1: Overpressure Assessment Process



4.1.2 Project Induced Vibration

There are different criteria depending on the day and time of the blast and/or mining induced seismic activity. Vibration data will be assessed as shown in Figure 4-2 There are no accepted criteria to assess vibration impacts on public infrastructure. In the case where the owner of the public infrastructure expresses concerns of impacts from vibration events, an investigation will be undertaken in accordance with Sections 5.4 and 5.5. Assessment will be undertaken on a monthly basis by an independent consultant.

Figure 4-2: Vibration Assessment Process



4.1.3 Calculation of annual rolling average exceedance percentage.

The Annual Rolling Average Exceedance percentage will be calculated using the following methodology. The annual (rolling) exceedance rate will be determined on a monthly basis.

$$\text{Exceedance rate} = \frac{\text{Number of Blast exceedances recorded over the past 12 months (rolling) + number of 'blast or mining induced' seismic exceedance events}}{\text{Total number of blasts over the past 12 months + Number of 'blast or mining induced' seismic exceedance events}}$$

5. REPORTING

5.1 Cadia website

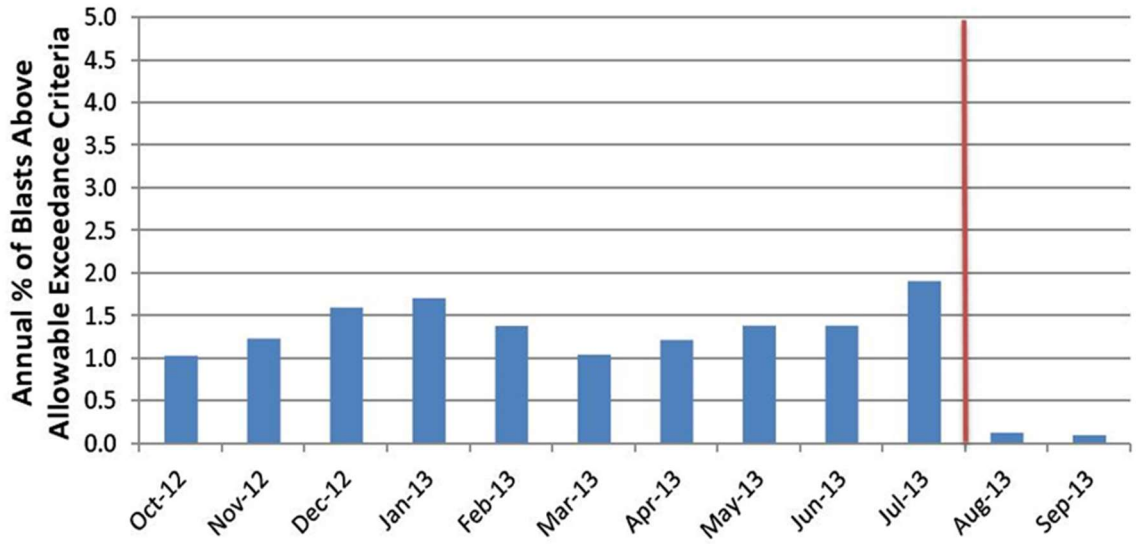
A summary of the monitoring data will be updated on a monthly basis on the Cadia website (www.cadiavalley.com.au). This will include;

- Sites monitored
- Period that have been included in the analysis
- Blast vibration and overpressure data
- Independent assessment of compliance with vibration and overpressure (monthly report)

5.2 Stakeholder Review

A summary of the monitoring data will be reported to direct stakeholders through quarterly Community Consultative Committee meetings and six-monthly Cadia District Residents meetings. An example of presented data is shown in Figure 5-1.

Figure 5-1: Example of Monitoring Results Displayed on the Newcrest Website



Combined rolling 5% vibration and overpressure exceedance average

5.3 Annual review

An annual review will be completed for the financial year. The annual review will be published on the Newcrest website and will include:

- Summary of all monitoring conducted during the year, including additional complaints-based monitoring
- Discussion of the monitoring results against the appropriate criteria
- Discussion of the ground vibration and overpressure contributing to vibration above the criteria
- Recommendations for addition and/or removal of monitoring sites

5.4 Vibration complaints

Complaints are managed and recorded according to the protocol in Figure 5-2. Additional monitoring may be conducted if it is determined there is insufficient information to respond adequately to a vibration complaint. Structural inspections will be carried out on residences and public structures where the landowner or infrastructure owner claims that buildings and/or structures have been damaged as a result of blasting and/or blast induced seismic activity. The structural inspections will be completed in accordance with Condition 15, Schedule 3 of the Project Approval.

5.5 Management of Non-compliances

If the results of monitoring are greater than the relevant impact assessment criteria, except where a negotiated agreement has been entered into in relation to that impact, then Cadia, within 2 weeks of obtaining the monitoring results, will notify the Secretary (DPIE), the affected landowners and tenants (including tenants of mine-owned properties) accordingly, and provide quarterly monitoring results to each of these parties until the results show that the project is complying with the criteria. Landowners that believe that their property has been damaged as a result of blasting can request a Property Inspection (as detailed in Condition 13, Schedule 3 of the Cadia East Project Approval (Reproduced in Section 2.1 of the BMP).

The following steps will be undertaken in the event of a non-compliance:

The exceedance will be registered within Cadia's Incident Management System (CHESS) and investigated in accordance with Newcrest Standards and Procedures. The incident investigation and development of corrective actions will broadly include the following considerations:

Step 1: Management Strategy

The management strategy component facilitates determining the blast control and management measures that will be adopted, based on the results of the blast/vibration monitoring. This stage will be conducted in consultation with the relevant mining operations personnel.

Blasting control and management measures will be selected with consideration of:

- location of blasting operations relative to receivers;
- magnitude of the exceedances of criteria;
- mining method being used; and
- feasibility of alternative blasting activities with the potential to reduce blasting effects.

In relation to seismic events, a review of Cadia mining methods would be undertaken to identify measures to reduce the likelihood of future seismic events and/or their magnitude, where practicable.

Step 2: Implementation

This stage involves the implementation of the blast control and management measures selected in the management strategy process. The relevant mining operations personnel will be responsible for the timely implementation of the selected measures. For example, if the review finds that the MIC in a particular underground blast has caused high levels of vibration, in future the MIC could be limited in this type of blasting.

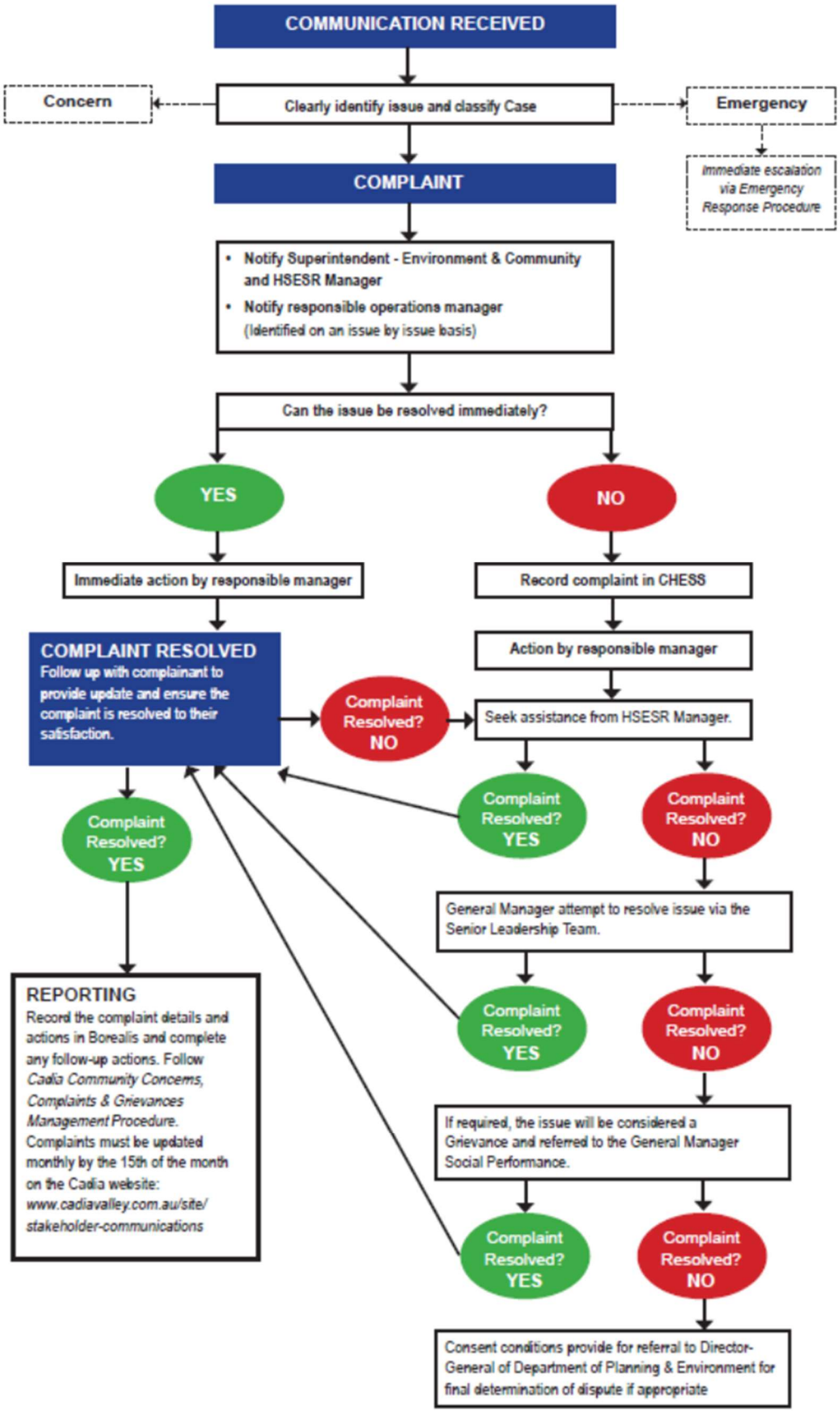
Step 3: Review

The effectiveness of the adopted measures will be assessed against the relevant criteria identified in Section 2.1 and Section 2.2. The management strategy phase of the protocol will be revisited as required if the blast/vibration criteria continue to be exceeded.

Step 4: Reporting

Non-compliance with the criteria will be reported based on the analysis completed in the monthly reports. These would be reported to the Office of Environment and Heritage (OEH) Department of Planning, Industry and Environment (DPIE) and the landholder. Landholder notification would be undertaken in accordance with Schedule 4, Condition 2 (which is provided in full below).

Figure 5-2: Complaints Management and Reporting Protocol



6. REFERENCES

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