

12.0 VIBRATION

12.1 Introduction

This chapter considers potential vibration impacts associated with future operation of the Proposed Development. The assessment identifies appropriate evaluation criteria, considers potential sources of vibration and specifies mitigation measures to control vibration at sensitive receptors.

While the Proposed Development includes both mining and non-mining related activities, consideration has only been given within this chapter to the mining activities and vibration associated with blasting underground. No blasting is required as part of the construction of the proposed GRPWS wells and associated infrastructure, and so potential vibration impacts have been scoped out for the non-mining activities.

12.2 Vibration Terminology

Ground vibration at sensitive receptors is measured as peak particle velocity (ppv) in mm / sec while the air-over pressure is measured in dB (Lin). The ppv is the maximum instantaneous velocity of a particle at a point during a given time interval. Air overpressure is energy transmitted from the blast site within the atmosphere in the form of pressure waves and is generally perceived as a loud bang.

In the case of traffic, vibration is perceptible at around 0.5 mm/s and may become disturbing or annoying at higher magnitudes. However, higher levels of vibration are typically tolerated for single events or events of short duration like blasting.

BS7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15Hz and 50 mm/s at 40Hz and above.

Because air overpressure is transmitted through the atmosphere, meteorological conditions such as wind speed and direction, temperature, cloud cover and humidity will all affect the intensity of the air overpressure experienced at a distance from the blast site. Minimising air overpressure at source, such that, even under unfavourable weather conditions, all such energy is within acceptable criteria at distance, remains the best practicable approach.

Much of the concern in relation to vibration relates to a lack of understanding of vibration energy. Table 12.1 below, taken from the EPA's guide on the extractive industry, explains how very normal everyday events can result in vibrations above the levels that will be expected to be generated at the Garrylaun Project.

Table 12.1: EPA's – Guide to Vibration Levels

Vibration level	Description of activity
1.0–2.5 mm/s	Walking measured on a wooden floor
2.0–5.0 mm/s	Door slam, measured on a wooden floor
12–35 mm/s	Door slam, measured over doorway
5–50 mm/s	Footstamp, measured on wooden floor
30–70 mm/s	Daily changes in temperature and humidity
120 dB	Constant wind of 5 m/s: Beaufort Scale 3, Gentle Breeze
130 dB	Constant wind of 8 m/s: Beaufort Scale 4, Moderate Breeze

Source: DETR (1998).

As people understand the risks associated with a slamming door a vibration of 5 mm/sec from such an event will not cause alarm. In a similar manner; a truck driving into a pot-hole outside a house can set up a significant vibration wave within a property, but again; as the resident is aware of what is happening, and it is an everyday event it will generally not cause alarm. In this instance the resident has also subconsciously heard the truck approaching and is 'ready for' the vibration when it arrives at the house. Blasting from a mine or a quarry will generally happen instantaneously, and this can result in a 'startle effect'.

It is worth noting that the most of the residences near Garrylaun will have become accustomed to blast vibrations over the years and as such it is expected that there will be good understanding and tolerance of vibration. Shanoon will ensure that good communication is in place to explain the process to all residences (new and old) and ensure there is no worry caused due to lack of understanding. Communication will include an 'open-door' policy where the Environmental Manager for the mine will act as community liaison officer and will provide a contact number and email address to concerned neighbours.

12.3 Ground Vibration

Ground vibration is caused by the imperfect utilisation of the explosive energy released during blasting operations. The energy that is unused in the fragmentation of rock propagates as an elastic disturbance away from the shot area as seismic waves. These waves, which radiate in a complex manner, diminish in strength with distance from the source. The theory relative to this motion is based on an idealised (sinusoidal) vibratory motion. When these waves come into contact with a free face, physical motion results as the energy induces oscillation in the ground surface. Blasting vibration is a surface wave type, which incorporates components of both body and surface motion.

Ground vibration itself is inaudible, however air vibrations both audible and sub-audible usually accompany it. The resulting impacts of blasting vibration are often characterised as being impulsive and of short duration, usually less than 3 seconds. It is difficult for the average lay person to differentiate between the various types of vibrations (ground and air), humans commonly associate the level of vibration with the 'loudness' of a blast.

12.3.1 Ground Vibration Control

Ground vibration from blasting at any receptor is influenced mainly by:

- The characteristics of the rock mass;
- The maximum instantaneous charge of explosives;
- The medium between blast source and receptor point; and
- The distance between the receptor point and the blast source.

Ground Vibration Control is based on reducing the weight of explosives detonated per delay (reducing the maximum instantaneous charge (MIC)). In any given situation, large amounts of explosives can be detonated using time delay intervals between each specific charges within the overall blast. The level of ground vibration is related to the maximum charge weight per delay and numerous studies have shown that peak particle velocity is closely related to the maximum charge weight per delay.

In terms of predicting ground vibration, each location is 'site specific'. Monitoring stations will be positioned at locations representative of sensitive residences nearest the orebodies or at alternative locations by agreement with the regulatory authorities.

12.4 Air Blast (Air-Overpressure) Noise

An explosion causes a diverging shock-wave front that quickly reduces to the speed of sound, and an air blast is then propagated through the atmosphere as sound waves. 'Air Blast' or 'Air Overpressure' is the term used to describe the low frequency, high energy air vibrations generated by blasting detonation. Air blasts are characterised by containing a larger proportion of its energy in the sub-audible spectrum, below 20Hz. Because the waves associated with air blasts are essentially outside the audible spectrum (below 20Hz), a separate unit of measure, pressure is reported.

The pressure is recorded using an air-blast transducer and the linear device must measure accurately in the structurally critical range, 2 to 20Hz. Air blast (sound waves) can be reported in two distinct units of measurements, pressure (psi / kPa) or decibels (dB).

Sound waves in the form of the sub-audible sound waves (air overpressure/air blast waves), and noise (the audible waves) are sometimes linked inextricable. It is difficult sometimes for humans to differentiate between the characteristics of air blasts and noise.

For quarries or other operations where air pressure is a concern; in general the sub-audible waves are of greatest concern. The sub-audible sound waves, if high enough can excite structures to produce audible rattle inside structures and may in the extreme, break glass and crack wall coverings. There are no known cases of foundation cracks from air blasts at values anywhere near the glass breakage threshold of 140dB, (Siskind et al. 1993). The cracking of glass (the weakest component of a structure) is likely to be probabilistic in nature. In other words, not all windows will crack at above 140dB.

A wind speed of 9 m/sec produces a pressure equal to 133.7dB (0.014 psi). Although such wind is comparable in amplitude to a strong air blast, its effects are not as noticeable because of the relatively slow rate of wind change and the corresponding minor or non-existent rattling, compared with the rapid rise time (impulsive) of an air blast transient.

Air blast waves are attenuated over distance in much the same way as sound waves. However, there are some differences due to the lower frequency of the sub-audible air blast waves.

12.4.1 Control of Air Blasts (Air Overpressure)

The principal factors governing air blasts are as follows:

- a) The type and quantity of explosives;
- b) The degree of confinement (plaster shooting, overcharging and poor stemming);
- c) The method of initiation (exposed detonating fuse etc.);
- d) Local geology and topography;
- e) Atmospheric conditions; and
- f) Distance and condition of structures.

Factors a), b) and c) are variables within the control of the site operator whereas d), e) and f) are essentially uncontrollable at any particular site. However by varying the timing of a blast, the quantities of explosives, the degree of confinement and the method of initiation (non-use of detonating chord) the quarry operator, in effect, achieves partial control over the influence of atmospheric conditions and hence over the blast emissions.

12.4.2 Scope of Assessment

The scope of this assessment has included the following:

- Consultation with Environmental Health departments of the local authorities;
- Analysis of historical blast vibration data;

- Review of applicable vibration criteria;
- Review of previously measured ground-borne vibration levels associated with underground blasting at representative locations;
- Evaluation of predicted blast vibration levels against agreed criteria; and
- Specification of appropriate mitigation, if required.

Given the separation distances between proposed plant operational areas and roads accessing the Site from sensitive receptors, continuous vibration from sources other than blasting is anticipated to be negligible and has been scoped out of this assessment.

12.4.3 Site Location and Setting

The Site is located in the townlands of Garrylaun, Castletown, Rathreagh, Rathpatrick, Whiteswall, Moneynamuck, Rathbane and Waterland in Co. Kilkenny and in the townland of Kyle, Co. Laois. The Site is accessed via the regional road R435 and is situated approximately 7 km north of Johnstown, Co. Kilkenny and approximately 7 km south of Rathdowney, Co Laois. The village of Galmoy is situated approximately 3.5 km to the south-east of the Site.

The former mine Plant Site is currently operated by an industrial, environmental and drainage services provider which has based its administrative and logistics centre on the Site.

12.4.4 Study Area and Vibration Sensitive Receptors

The study area considered in this assessment comprises a buffer of 500 m beyond the extent of the underground mine area. This area includes representative Vibration Sensitive Receptors (VSRs) identified to be potentially impacted by blast vibration from mining operations. The VSRs considered are shown in Figure 12.1 **Error! Reference source not found.** There is 1 existing VSR within the underground mine area, 14 existing VSRs within 250 m of the underground mine areas, 19 existing VSRs within 500 m of the underground mine areas and 1 potential VSR within 500 m of the underground mining areas (a residential planning application has been lodged but decision is pending at the time of writing this EIAR). All VSRs are residential dwellings, or proposed dwellings, with the exception of a receptor to the south of G Orebody which is representative of both a residential dwelling (Erke House) and adjacent church ruins (Erke Church).

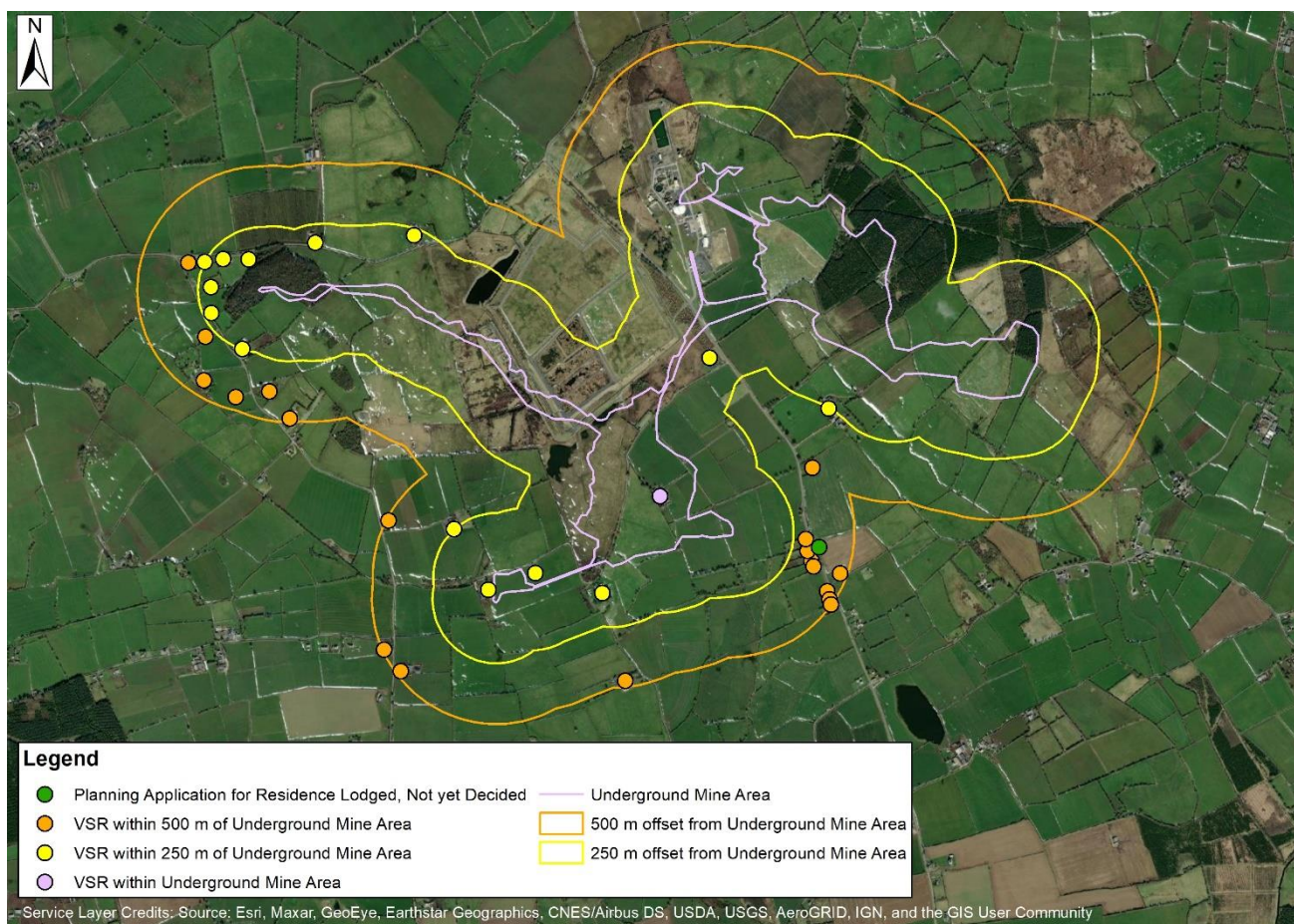


Figure 12.1: Study Area and VSRs

12.5 Legislative and Policy Context

12.5.1 Relevant Legislation

There is no specific Irish legislation relating to environmental vibration. This assessment has therefore been undertaken in accordance with appropriate guidance as detailed below.

12.5.2 Relevant Guidance

This assessment has been made with guidance from the ‘Guidelines on the information to be contained in environmental impact assessment reports’, published in ‘draft’ by the EPA in August 2017. Guidance related specifically to noise and vibration has been identified below.

12.5.2.1 *British Standard BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites, Part 2 - Vibration*

BS5228 (BSI, 2014) provides a procedure for the estimation of construction noise and vibration levels and for the assessment of the significance of the predicted effects at the nearest sensitive receptors.

Part 2 of the Standard provides threshold levels at which vibration may be perceptible to people, through to becoming intolerable, and frequency-weighted thresholds at which vibration may cause cosmetic damage to structures.

The thresholds are dependent on frequency and the type of building, however, in the worst-case, residential or light commercial structures may see the onset of damage at 15 mm/s peak particle velocity (PPV) at 4 Hz, increasing to 20 mm/s PPV at 15 Hz and above.

12.5.2.2 **BS6472-2:2008 Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration**

BS 6472 provides 'satisfactory magnitudes' of vibration for the daytime and night-time period, expressed as PPV mm/s. The standard notes that the probability of 'adverse comment' (i.e. complaints) is low where the criteria are met.

12.5.2.3 **BS7385: Evaluation and measurement for vibration in buildings, Part1 1990 Guide for measurement of vibrations and evaluation of their effects on buildings and Part 2 1993 Guide to damage levels arising from ground borne vibration**

BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15Hz and 50 mm/s at 40 Hz and above.

BS7385 also provides further context with regards to air overpressure:

"Windows are generally the weakest parts of a structure exposed to air overpressure. Research by the United States Bureau of Mines has shown that a poorly mounted window that is pre-stressed can crack at around 150 dB(lin), with most windows cracking at around 170 dB(lin). Structural damage would not be expected at air overpressure levels below 180 dB(lin).

12.5.2.4 **Other Guidance**

Other guidance reviewed as part of the assessment process include:

- The EPA's Environmental Management Guidelines: Environmental Management in the Extractive Industry (Non-Scheduled Minerals; April 2006);
- The EPA is in the process of updating the existing guidance documents relating to EIAs and the preparation of EIARs. 'Guidelines on the information to be contained in environmental impact assessment reports', published in 'draft' by the EPA in August 2017, and 'Advice notes for preparing Environmental Impact Statements', (Draft, 2015);
- BS 7385-1:1990 - Evaluation and measurement for vibrations in buildings;
- Environmental Code (2005) Irish Concrete Federation; and
- EPA guidelines in relation to blasting activities outlining the methodology and limits to be used for vibration measurement.

12.5.2.5 **Former Site Operating Licences**

During previous operation of the mine, vibration was controlled in accordance with the requirements of an Integrated Pollution Prevention and Control (IPPC) licence (now referred to as an Industrial Pollution Control Licence or IPC Licence), referenced P0517-01 (October 2002) and P0517-02 (August 2013). The blast vibration conditions specified in the most recent IPC licence (P0517-02) are provided below:

"5.5.3 No blast, or combination of simultaneous blasts shall give rise to a vibration level at any noise sensitive location which exceeds the following limits:

a) Daytime 8 mm/second;

b) Night-time 4 mm/second.

(expressed as maximum peak particle velocity, in any plane, measured at foundation level).

5.5.4 No blast or combination of simultaneous blasts shall give rise to an air overpressure level at any noise sensitive location which exceeds the following limits:

- a) Daytime 125 dB (lin). Max. Peak,
- b) Night-time 105 dB (lin). Max. Peak.

6.15 *The licensee shall provide and maintain facilities for periodic monitoring of noise, vibration and air overpressure emissions from the activity at such locations as may be specified and agreed by the Agency.*"

The former IPC licence defined the daytime period as 08:00 – 22:00 and the night-time period as 22:00 – 08:00. Consideration has also been given to the Industrial Emissions Licence (IEL) for an existing mine in Ireland; Boliden's Tara Mines which operates under licence Reg. Ref. P0516-04 which was granted on 7th September 2018. Similarly to an IPC Licence, the IEL defines the environmental limits for the mine operations. In the case of Reg. Ref. P06516-07, the vibration limits are the same as the historical Galmoy Mine. Reg. Ref. P06516-04 specifies the following:

"5.7 No blast, or combination of simultaneous blasts shall give rise to a vibration level at any noise sensitive location which exceeds the following limits:

- a) 0800hrs to 2200hrs 8 mm/ second,
- b) 2200hrs to 0800hrs 4 mml second.

(expressed as maximum peak particle velocity, in any plane, measured at foundation level).

5.8 No blast or combination of simultaneous blasts shall give rise to an air-overpressure level at any noise sensitive location which exceeds the following limits:

- a) 0800hrs to 2200hrs 125 dB (lin). max. Peak,
- b) 2200hrs to 0800hrs 105 dB (lin). max. Peak."

12.6 Assessment Methodology and Significance Criteria

12.6.1 Overview of Vibration Sources

The most significant potential sources of ground borne vibrations that could be generated by the proposed operations at the mine is the extraction of ore by blasting or development blasting (e.g. blasting to create an access drive) from the underground workings. Underground mining requires cyclical drilling, blasting, loading and hauling. Of these processes, underground blasting may result in vibration felt at surface level.

To characterise potential vibration impacts at the closest receptors, historical monitoring undertaken by the former operators of the mine during blasting activities has been considered in this assessment as the Proposed Development is not proposing a deviation from historical mining methods.

Potential vibration levels have been assessed according to *British Standard BS 7385: Evaluation and measurement for vibration in buildings, Part1 1990 Guide for measurement of vibrations and evaluation of their effects on buildings and Part 2 1993 Guide to damage levels arising from ground borne vibration* and by comparison with the site's former vibration limits according to IPC licence P0517-02, which this assessment assumes will be appropriate for the control of future blast vibration as it is the same as the existing IEL P0516-04 for Tara Mines.

No above ground blasting is proposed; therefore, no significant air overpressure is anticipated. It is possible that, under specific atmospheric conditions, air overpressure effects transmitted via vent shafts may occur at VSRs, however, given the proposed design of the shafts and the proposed baffle mounds, this is considered highly unlikely. This assessment therefore considers only ground-borne vibration, however, the mine operator also commits to meeting the air-overpressure limits provided in the IPC licence.

12.6.2 Vibration Measurement Parameters

- Ground vibration at sensitive receptors is measured as Peak Particle Velocity (PPV) in mm/s. The PPV is the maximum instantaneous velocity of a particle at a point during a given time interval; and
- Air blast (air overpressure) noise is measured in linear decibels dB(Lin). Air overpressure is energy transmitted from the blast site within the atmosphere in the form of pressure waves and is generally perceived as a loud bang.

12.6.3 Receptor Sensitivity

This assessment considers that human receptors, including residential dwellings, have a high sensitivity to vibration. Commercial and industrial receptors, comprising buildings and businesses, are considered to have a low sensitivity to vibration and have been scoped out of further assessment. It has been noted within the assessment that a protected structure (a building; Erke Church) is within 250 m of the underground workings, however, it is immediately adjacent to a residential receptor, which has 'High' sensitivity as it is a residential dwelling. The assumed sensitivity of all identified representative VSRs is 'High'.

12.6.4 Evaluation Criteria

Table 1 in BS6472 (reproduced here as Table 12.2) provides magnitudes of vibration that are acceptable with respect to human response for up to three blast vibrations events per day.

Table 12.2: BS6472 Satisfactory Magnitude Criteria – Blast Vibration

Receptor Type	Time	Satisfactory Magnitude, PPV (mm/s)
Residential	Day – 07:00 to 18:00 Mon-Fri, 08:00 to 13:00 Saturdays	6.0 to 12.0
	Night – 23:00 to 07:00	2.0
	Other times	4.5
Offices	Any time	14.0
Workshops	Any time	14.0

The table provides recommended magnitudes of vibration below which the probability of adverse comment is low.

In the context of BS6472 satisfactory magnitude criteria, the mine's IPC daytime vibration limit of 8 mm/s lies within the range at which the probability of adverse comment is low. The night-time vibration limit of 4 mm/s is 2 mm/s above the range at which the probability of adverse comment is low.

This assessment adopts the limits provided in the former IPC permit as evaluation criteria. It is assumed that the night-time vibration limits previously provided in the permit did not result in adverse comment, and that the history of mining within the area may contribute towards an acceptance of higher vibration magnitudes than those recommended in BS6472.

Derived impact magnitude criteria drawing on the mine's former IPC vibration limits and BS6472 criteria are provided in Table 12.3.

Table 12.3: Derived Impact Magnitude Criteria

Measured vibration level, PPV mm/s	Impact magnitude
Daytime period (08:00 to 22:00 Mon-Fri, 08:00 to 13:00 Saturdays)	
>12	High
>8, ≤12	Medium
>6, ≤8	Low
<6	No change / None
Night-time period (22:00 – 08:00)	
>4	High / Medium
>2, ≤4	Low
<2	No change / None

Drawing on the above impact magnitude criteria, a significance matrix is provided in Table 12.4, showing the significance of vibration effects for different magnitudes of impact, based on receptor sensitivity.

Table 12.4: Effect Significance as a Product of Impact Magnitude and Receptor Sensitivity

Impact Magnitude	Level of Significance, Relative of Receptor Sensitivity		
	Low Sensitivity	Medium Sensitivity	High Sensitivity
High	Moderate	Moderate/Large	Large
Medium	Slight	Moderate	Moderate
Low	Neutral	Slight	Slight
No change / negligible	Neutral	Neutral	Neutral

This assessment considers that effects with a significance of Moderate or Large are significant and effects with a significance of Slight or Neutral are not significant.

12.7 Baseline Conditions

The Site comprises lands previously held by Galmoy Mines for the underground extraction of zinc and lead. The former Plant Site is currently operated by AQS Composting Ltd. The lands surrounding the Site are predominantly used for agricultural purposes, the dominant agricultural use is livestock grazing, either by cattle or sheep. There is some sparse residential housing in the area, however this is primarily concentrated to linear ribbon settlements along local roads. As such, current baseline conditions are not anticipated to comprise any significant sources of vibration.

Human beings are extremely sensitive to vibration, the threshold of perception is typically in the PPV range of 0.14 mm/s to 0.3 mm/s. BS6472-2 sets out vibration levels from blasting activities at which minimal adverse comment is likely to be provoked (Table 12.2). If vibration levels from blasting exceed these values, then the

chance of adverse comment increases significantly. Potential annoyance from blasting activities does not correlate to baseline vibration levels.

Vibration monitoring was undertaken at the Site between 1996 and 2012 when the former mine was in operation, however, no active mines or quarries operate within the area at present.

12.8 Characteristics of the Proposed Development

12.8.1 Blasting Methods

Blasting has not been conducted at the Site since 2012 when mining operations ceased. It is proposed that material will once again be extracted at the Site by means of blasting underground. The proposed production blasts will follow best practice and involve the detonation of charges in a number of working faces within the mine. The ignition pattern at each face will be controlled, blast hole by blast hole by means of ignition delay timer of different time settings. The ignition delay timers will allow for a designed blast pattern around the Maximum Instantaneous Charge (MIC) which is detonated at any point. The MIC is the principal parameter that dictates the maximum vibration level experienced at the surface arising from the blast.

Material will be extracted by blasting and it is expected that the maximum vibration limit will not exceed previous blasting records at the Site which were in compliance with the regulations. Production blasts will take place at the end of each shift; with development blasting taking place throughout each shift, Monday to Saturdays as was previously the case at Galmoy. No blasting will take place on Sundays or Bank Holidays.

The proposed blasting will not exceed 4 mm/sec during the night time and 8 mm/sec during daytime.

12.8.2 Historical Blast Results

Historical blasting during previous mining operations is considered as a good representation of future predicted blast events as the general site setting remains the same and blasts will be designed in line with historical blasts.

Three permanent vibration monitoring stations were previously located in the vicinity of the Site. The location of these monitoring stations was chosen based on their proximity to sensitive residences. A fourth station was added to monitor blasts above R Zone when that was permitted in 2003. Additional vibration monitoring was undertaken at third party houses, records were made available from a station located at Erke House (a current VSR) which monitored blasting in the G Orebody in 2007 and 2012.

In relation to the historical licensed vibration monitoring locations, it was stated in the 2000 EIS by Arcon Mines Ltd. that the vibration level measured at the three permanent monitoring locations seldom exceeded 1 mm/sec PPV, Figure 12.2, refers to the former locations. In further support of this, the 2003 EIS by Arcon Mines Ltd. again noted that the highest recorded blast event since calibration of the monitors in October 2003 gave a PPV of 1.64 mm/s.

Monitoring results for Ground Vibration and Air Blast (Air Overpressure) for blasting events carried out in August 2007 and between January 2012 and August 2012 are presented in Table 12.5. There was no exceedance in resultant peak particle velocity or air overpressure during the period of monitoring. Under the impact magnitude criteria shown in Table 12.3, the impact magnitude would be '**no change/none**' and the level of Significance to the nearest VSR would be **Neutral**.

The monitoring result in August 2007 of 1.06 mm/sec (rppv) was the highest recorded event that year. It was recorded at a residence (Erke House) within a distance of 120 m from the G Orebody and was significantly lower than the corresponding night time limit value of 4 mm/sec. The air overpressure was recorded as 98.84 dB against a limit of 105 dB.

The 2012 data shown in Table 12.5 shows that the highest recorded vibration level was measured on the 14 February 2012 (15:34:15) at 7.5 mm/sec rppv with an air overpressure of 81.94 dB. Monitoring results taken at

15:34:15 (1.14 mm/sec rppv) and 15:34:27 (1.97 mm/sec rppv) show much lower values than the peak of 7.5 mm/sec rppv which occurred during the very brief intervening 11 seconds. It is not known why the peak of 7.5 mm/sec rppv occurred from the data available and contributory factors are unknown, however, it is noted to be within the licence limit. In comparison, the average rppv for the monitoring results from 2012 was 1.28 mm/sec which is significantly lower than both the daytime limits (8 mm/sec rppv) and the night time limits (4 mm/sec rppv). The corresponding average air overpressure for 2012 at Erke House was 89.03 dB.

With the exception of the vibration level measured on the 14 February 2012 at Erke House, the significance of previous blasts is considered to be **Neutral**, the Erke House 7.5 mm/sec rppv value would be considered **Moderate** under the assessment criteria presented here.



Figure 12.2: Former vibration monitoring locations at the Site

Table 12.5: Vibration Monitoring Data on 18/08/2007 and between 14/02/2012 to 20/09/2012 (Blasting ceased at the site following Q3 2012).

Year Q	Date & Time	IPC (P0517-02) Limits					ERKE HOUSE				
		L mm/s	T mm/s	V mm/s	PPV (rppv) (mm/sec)	AOP dB	L mm/s	T mm/s	V mm/s	PPV (rppv) (mm/sec)	AOP dB
2007 Q3	18/08/2007 02:24:03	4	4	4	4	105	0.476	0.286	1.05	1.06	98.84
2012 Q1	14/02/2012 15:29:25	8	8	8	8	125	0.762	0.762	0.762	1.14	87.96
2012 Q1	14/02/2012 15:34:15	8	8	8	8	125	3.94	4.57	6.10	7.50	81.94
2012 Q1	14/02/2012 15:34:22	8	8	8	8	125	0.508	1.14	1.52	1.97	81.94
2012 Q1	14/02/2012 15:34:27	8	8	8	8	125	0.635	1.27	1.14	1.49	87.96
2012 Q1	23/02/2012 15:30:25	8	8	8	8	125	0.635	0.635	0.762	0.852	81.94
2012 Q1	01/03/2012 15:32:45	8	8	8	8	125	0.381	0.508	0.508	0.648	81.94
2012 Q1	06/03/2012 14:54:38	8	8	8	8	125	0.508	0.635	0.381	0.783	81.94
2012 Q1	06/03/2012 15:14:06	8	8	8	8	125	***	***	5.84	***	113.06
2012 Q1	06/03/2012 15:14:18	8	8	8	8	125	1.40	0.508	0.508	1.57	98.80
2012 Q1	08/03/2012 15:31:16	8	8	8	8	125	0.635	0.381	0.381	0.660	81.94
2012 Q1	13/03/2012 16:43:51	8	8	8	8	125	0.508	0.381	0.381	0.539	81.94
2012 Q1	20/03/2012 15:18:28	8	8	8	8	125	0.762	0.635	0.381	0.933	81.94
2012 Q3	24/07/2012 15:41:39	8	8	8	8	125	0.889	0.889	0.762	1.09	-3
2012 Q3	26/07/2012 23:01:01	4	4	4	4	105	0.492	0.810	0.730	0.966	
2012 Q3	14/08/2012 18:39:13	8	8	8	8	125	1.65	1.40	1.02	1.73	98.80
2012 Q3	23/08/2012 15:20:35	8	8	8	8	125	0.810	0.778	0.476	1.02	-3

Year Q	Date & Time	IPC (P0517-02) Limits					ERKE HOUSE				
		L mm/s	T mm/s	V mm/s	PPV (rppv) (mm/sec)	AOP dB	L mm/s	T mm/s	V mm/s	PPV (rppv) (mm/sec)	AOP dB
2012 Q3	28/08/2012 15:23:46	8	8	8	8	125	0.397	0.540	0.587	0.706	98.80
2012 Q3	30/08/2012 18:34:29	8	8	8	8	125	0.317	0.476	0.667	0.681	81.94
2012 Q3	06/09/2018 15:30:25	8	8	8	8	125	0.476	0.492	0.619	0.655	98.90
2012 Q3	06/09/2012 20:06:51	8	8	8	8	125	0.397	0.540	0.460	0.655	-3
2012 Q3	20/09/2012 16:55:351	8	8	8	8	125	0.429	0.254	0.524	0.593	81.94
2012 Q3	20/09/2012 17:44:092	8	8	8	8	125	0.254	0.413	0.619	0.663	98.90
Average 2012							0.799	0.858	1.14	1.28	89.03

Note 1: The monitor was placed on the front step of Erke House.

Note 2: The monitor was placed at the back door of Erke House.

Note 3: AOP reading not included on report.

***: Out of range

12.8.3 Embedded Mitigation

Material will be extracted by blasting and it is expected that the maximum vibration limit will not exceed previous blasting records at the Site, which were in compliance with the regulations. Blasting will be undertaken by the Blast Design Team (BDT). The BDT will use the site-specific regression curve to determine the maximum MIC which can be used such that resultant predicted vibration levels at the closest VSRs do not exceed 75% of the adopted limits. While localised ground conditions may result in actual/measured vibration levels exceeding 75% of the limits, it is not anticipated that the limits will be breached if this approach is followed.

The BDT will update the regression curve periodically with measured results to improve its accuracy. If measured levels exceed 95% of the limit value the blasting strategy will be revised to further reduce the likelihood of the limit value being exceeded.

The ventilation shafts will be designed to minimise any likelihood of significant air overpressure resulting from underground blasts.

The proposed blasting schedule has yet to be finalised, however, no blasting will occur on Sundays.

12.9 Potential Effects

12.9.1 Construction Impacts

No significant off-site vibration is anticipated associated with surface works during the construction phase. Any blasting required during the construction phase will be mitigated by appropriate blast design such that vibration limits are met. Vibration impacts during the construction phase will therefore be not significant.

12.9.2 Operational Impacts

A quantitative assessment has been carried out of the potential impact upon nearby receptors using historical blast details as these are the same as proposed for the development. As can be seen from Table 12.5, above, the Ground Vibration and Air Blast (Air Overpressure) monitoring results were generally significantly lower than the limit values which were in place at the former mine and under the assessment criteria presented here, blasts were largely considered to have had a **Neutral** significance with the exception of a **Moderate** significance at Erke House for one event on 14 February 2007. The Proposed Development should achieve the same low value results as similar blasting practices as were previously used will be undertaken. Given that the isolated high recording that occurred at Erke House in 2007 was anomalous, it is assessed that the embedded mitigation measures employed by the Blast Design Team are sufficient to justify a conclusion that the potential vibration impacts from the Proposed Development are '**Slight**' overall.

As all blasts at Garrylaun will be underground, air overpressure is not a major concern, as it might be in an open cast mine or quarry. Air pressure will exit the mine via the vent raises and the decline (Portal) but much of the sound wave will travel throughout the mine workings which will in fact have the effect of acting like a muffler, as the air wave travels between chambers in the mine it will be reflected and attenuated

G West, K2 and M Orebodies are additional orebodies where blasting has not previously taken place. However, development blasting will take place to first allow access to be gained to the orebodies, with this blasting being peripheral to the orebodies. In the case of G West and M orebodies, ca. 250 m long access drives will be blasted out before the orebodies are reached and blasting commences within the orebodies. As the access drives are being developed (by blasting), vibration monitoring will be undertaken which will allow blast parameters to be further tailored before production blasting commences within these orebodies and proximal to receptors.

12.9.3 Do Nothing Scenario

In the Do Nothing scenario no further mining will occur and vibration levels will remain at current baseline levels. This assessment notes that following cessation of the proposed mining activity, vibration at all VSRs will return to baseline levels.

12.10 Mitigation and Management

The following blast mitigation procedures will be employed during each blast event:

- Blast events will be conducted by experienced trained mine personnel in accordance with best practice, and potential impacts associated with the activity will therefore be minimised;
- The use of delayed blasting techniques whereby each blast event takes place in a series of timed small blasts rather than a single large blast will assist in the minimisation of vibrations in the rock body;
- All shot holes will be drilled to exact specifications by specialist mining operatives. Any features encountered during drilling such as cavities or soft material will be recorded by the driller and this information will be subsequently passed on to the shot-firer so that the correct charge will be used. This will ensure safe and efficient blasting of the rock face;
- In addition to implementing the necessary blast specifications, the mine operator will undertake required vibration monitoring;
- In advance of development into new ground (K2, M, G West), vibration monitoring will be undertaken during development blasting and future blasts within the orebodies will be refined to reflect conditions locally at the new orebodies (e.g. MIC required may be reduced);
- A dedicated point of contact for residents will be appointed and a method for reporting complaints will be publicised; and
- Where possible, blasts will be restricted to the end of shifts.

12.10.1 Monitoring

Vibration monitoring stations will be set up prior to the recommencement of mining at the Proposed Development. The proposed monitoring stations will be positioned at locations representative of sensitive residences nearest the orebodies or at alternative locations by agreement with the regulatory authorities.

The following monitoring programme will be put in place during operation of the mine:

- Vibration blast monitoring will be undertaken during blast activities at the closest VSRs to blasting locations;
- Monitoring of vibration levels at VSRs will be conducted in agreement and with the consent of local residents. The Mine Manager / Environmental Manager will give at least 24-hours' notice to the residents at whose homes vibration monitoring will occur; and
- Vibration blast monitoring will record PPV, air overpressure, distance to each blast and maximum instantaneous charge levels (MIC).

12.11 Mine Closure

Following mine closure there will be no sources of vibration at the Application Site.

12.12 Cumulative Impacts

A review of extractive and other industrial activities nearby has determined that there are no other industrial/commercial facilities operating in close proximity to the mine which produce vibration, and cumulative effects are therefore not anticipated.

Potentially cumulative vibration effects have therefore been assessed as 'not significant'.

12.13 Residual Effects

Following implementation of appropriate mitigation, vibration effects will remain Slight and are therefore **Not Significant**.

12.14 Difficulties Encountered

Historical blasting data is considered to represent an accurate record of ground conditions with regard to transmission of vibration. There is a small chance when blasting in previously un-worked areas that ground conditions may be different, due to localised fracturing of rock. Appropriate precautions will be taken when designing blasts in previously un-worked areas to ensure that the limits are met at VSRs.

12.15 References

- Arcon Mines Limited (2000) Galmoy Mine Extension, Environmental Impact Statement
- Arcon Mines Limited (2003) Galmoy Mine Underground Extension: R Zone
- BS7385: Evaluation and measurement for vibration in buildings, Part1 1990 Guide for measurement of vibrations and evaluation of their effects on buildings and Part 2 1993 Guide to damage levels arising from ground borne vibration. British Standards Institution, 1990 & 1993
- BS6472-2:2008 - The Evaluation of Human Exposure to vibration in buildings. Blast-induced vibration. British Standards Institution, 2008
- BS5288: 2009+A1:2014 Code of practice for noise and vibration control on open sites: Part 1 Noise and Part 2 Vibration. British Standards Institution, 2014
- BS7385: Evaluation and measurement for vibration in buildings, Part1 1990 Guide for measurement of vibrations and evaluation of their effects on buildings and Part 2 1993 Guide to damage levels arising from ground borne vibration. British Standards Institution, 1990 & 1993
- Department of the Environment, Heritage and Local Government (2004) – Quarries and Ancillary Activities: Guidelines for Planning Authorities, 2004
- EPA (2006) Environmental Management Guidelines-Environmental Management in Extractive Industry (Non-Scheduled Minerals)
- EPA (2017) 'Guidelines on the Information to be Contained in Environmental Impact Assessment Reports'
- Galmoy Mines Limited (2008) Underground Extension; K2 Orebody, Environmental Impact Statement.
- InstanTel (2007 & 2012) Blast Monitoring Event Reports
- Irish Concrete Federation (2005) Environmental Code