



Heidelberg Materials

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# **TYTHERINGTON QUARRY: 6 MILLION TONNES ADDITIONAL RESERVES**

Environmental Statement: Chapter 8 Vibration





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Environmental Statement: Chapter 8 Vibration

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## 8 BLASTING VIBRATION

### 8.1 INTRODUCTION

8.1.1 This ES chapter reports the outcome of the assessment of likely significant blasting vibration effects arising from the Proposed Scheme. This chapter is intended to be read as part of the wider ES with particular reference to **Chapter 3: Description of Proposed Scheme** and with respect to relevant parts of **Chapter 7: Noise**, where common receptors have been considered and where there is an overlap or relationship between the assessment of effects.

### 8.2 LIMITATIONS AND ASSUMPTIONS

8.2.1 With the Proposed Scheme, there will be no changes to extant mineral extraction and blasting methods, there will be no change to the current operating hours, and no intensification of mineral extraction activities.

### 8.3 POLICY AND LEGISLATIVE CONTEXT

8.3.1 This section identifies the legislation, planning policy and technical guidance that has informed the assessment of effects with respect to blasting vibration. Further information on policies relevant to the Proposed Scheme is provided in **Chapter 5: Planning policy overview** as well as the accompanying Planning Statement.

8.3.2 The only significant source of vibration that could be perceptible outside of the site boundary is groundborne vibration from blasting activities. The proposed blasting activities are for the purposes of mineral extraction and therefore the relevant mineral extraction, blasting, and vibration related policy and guidance applies, in addition to any conditions set out within the extant planning consents.

#### LEGISLATIVE FRAMEWORK

8.3.3 A summary of the relevant legislation is provided in **Table 8-1**.

- The Town and Country Planning (Environmental Impact Assessment) Regulations 2011 (as amended);
- The Control of Pollution Act 1974 (particularly Sections 60 and 61); and
- The Quarries Regulations 1999.

**Table 8-1 – Legislation relevant to the blasting vibration assessment**

Legislation	Legislative context
<b>The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (SI 2017 No. 571)</b>	Defines the requirements and process to undertake EIA for development meeting specific criteria which have the potential to give rise to significant effects on the environment.

Legislation	Legislative context
<b>The Control of Pollution Act 1974<sup>1</sup> (CoPA)</b> (particularly Sections 60 and 61)	Defines the legislative basis for the control of noise and vibration from construction activities, including codes of practice and Best Practicable Means (BPM).
<b>The Quarries Regulations 1999</b>	The Regulations aim to protect those working at a quarry and others who may be affected by quarrying activities, e.g. those living, passing or working nearby, or visitors to the site.

## PLANNING POLICY

- 8.3.4 A summary of the relevant national and local planning policy is given in **Table 8-2**. The Planning Statement will cover the detail of actual policies.

**Table 8-2 - Planning policy relevant to the blasting vibration assessment**

Policy	Policy context
<b>National Policy:</b>	
National Planning Practice Guidance (Minerals), 2014	Blast vibration is referred to as one of “the principal issues that planning authorities should address” (Paragraph: 013). No further detail is provided.
<b>Local Policy:</b>	
Gloucestershire County Council Minerals Local Plan (adopted March 2020)	Policy DM01 Amenity states that mineral development proposals will be permitted only where it can be demonstrated adverse impacts on the amenity of local communities within Gloucestershire and those of neighbouring administrative areas will be avoided, strictly controlled or mitigated so as to ensure unacceptable impacts will not arise in respect of noise, vibration, air pollution and visual intrusion.
South Gloucestershire Local Plan: Policies, Sites and Places Plan (adopted November 2017)	Policy PSP21 Environmental Pollution and Impacts supports proposals where they demonstrate that development has been designed to prevent unacceptable risks and avoids unacceptable levels of pollution including vibration. Criteria B of this policy supports proposals that are sensitive to vibration where they do not threat operational constraints for reasons of safeguarding, economic or wider social needs.
	Policy PSP23 Mineral Working and Restoration requires new mineral workings to demonstrate that permitted operations will not have unacceptable adverse impacts on the natural and historic environment, human health, or local amenity. Proposals will be expected to comply with other development plan policies and provide consideration with respect to blasting and vibration.

<sup>1</sup> HMSO (1974). *Control of Pollution Act 1974*.

8.3.5 In addition, this Chapter has been prepared in accordance with the Government's National Planning Practice Guidance (2020).

## TECHNICAL GUIDANCE

8.3.6 A summary of the main technical standards and guidance for blasting vibration is given in **Table 8-3**.

**Table 8-3 — Technical standards and guidance relevant to the blasting vibration assessment**

Technical guidance/standard document	Description
<b>Quarries Regulations 1999: Approved Code of Practice and Guidance<sup>2</sup></b>	Is the approved Code of Practice (CoP) and guidance which provides practical advice on the Quarries Regulations 1999. Appendix 2 of this CoP provides useful guidance on blasting specifications which are relevant to any type of blasting activity.
<b>Planning Advice Note (PAN) 50: Controlling the Environmental Effects of Surface Mineral Workings<sup>3</sup></b>	Provides general advice on the more significant environmental effects arising from mineral workings operations.
<b>Planning Advice Note (PAN) 50 Annex D: Controlling the Environmental Effects of Surface Mineral Workings<sup>4</sup></b>	Provides advice on how to keep the effects of blasting from surface mineral workings within environmentally acceptable limits.
<b>BS 5228-2: 2009 + A1: 2014: Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration<sup>5</sup></b>	This part of BS 5228 gives recommendations for basic methods of vibration control relating to construction and open sites where work activities / operations generate significant levels of vibration.
<b>BS 6472-2: 2008: Guide to Evaluation of Human Exposure to Vibration in Buildings – Part 2: Blast Induced Vibration<sup>6</sup></b>	This part of BS 6472 gives guidance on human exposure to blast induced vibration in buildings. It is primarily applicable to blasting associated with minerals extraction.
<b>BS 7385-2: 1993: Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration<sup>7</sup></b>	This part of BS 7385 gives guidance on the levels of vibration above which building structures could be damaged. It identifies the factors which influence the vibration response of buildings and describes the basic procedure for carrying out measurements. Vibrations of both transient and continuous character are considered.

<sup>2</sup> Health and Safety Executive (2013) *Quarries Regulations 1999 Approved Code of Practice and Guidance*.

<sup>3</sup> Local Government and Communities Directorate (1996) *Planning Advice Note 50: Controlling the Environmental Effects of Surface Minerals Workings*.

<sup>4</sup> Local Government and Communities Directorate (2000) *PAN 50 Annex D: The Control of Blasting at Surface Minerals Workings*.

<sup>5</sup> British Standards Institution (BSI, 2014) *British Standard BS 5228-2: 2009 + A1: 2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration*. London, BSI.

<sup>6</sup> British Standards Institution (BSI, 2008) *British Standard BS 6472-2: 2008 Guide to Evaluation of Human Exposure to Vibration in Buildings – Part 2: Blast-induced Vibration*. London, BSI.

<sup>7</sup> British Standards Institution (BSI, 1993) *British Standard BS 7385-2: 1993 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration*. London, BSI.

8.3.7 Those guidance documents (British Standard) that suggest appropriate limits to control the effects of blast vibration are described in more detail below.

**BS 5228-2: 2009+A1 2014: Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration**

8.3.8 BS 5228-2 provides recommendations for basic methods of vibration control relating to construction and open sites. The legislative background is described, and guidance is provided on methods of measuring vibration and assessing its effects on the environment.

8.3.9 Guidance criteria are suggested for the assessment of vibration effects. Such criteria are provided in terms of Peak Particle Velocities (PPV) and are concerned with both human and structural responses to vibration. The criteria set out in **Table 8-4** below are presented as being applicable in the assessment of human exposure to construction vibration.

**Table 8-4 - Guidance Criteria for the Assessment of Vibration (BS 5228-2) – Human Response, PPV (mm/s)**

Vibration PPV (mm/s)	Effect
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Vibration might be just perceptible in residential environments.
1.0	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10.0	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.
<p>A. The magnitudes of the values presented apply to a measurement position that is representative of the point of entry into the recipient.</p> <p>B. A transfer function (which relates an external level to an internal level) needs to be applied if only external measurements are available.</p> <p>C. Single or infrequent occurrences of these levels do not necessarily correspond to the stated effect in every case. The values are provided to give an initial indication of potential effects, and where these values are routinely measured or expected then an assessment in accordance with BS 6472-1 or -2, and/or other available guidance, might be appropriate to determine whether the time varying exposure is likely to give rise to any degree of adverse comment.</p>	

8.3.10 With regard to Note C in the above table, it is noted that, for infrequent occurrences (which would be the case for blasting at Tytherington), BS 5228-2 suggests that BS 6472-2 might be a more appropriate standard for the assessment of human exposure to vibration. For the purposes of this assessment, the guidance contained within BS 6472-2 is assumed to carry more weight than that that contained within BS 5228-2.

## BS 6472-2: 2008: Guide to Evaluation of Human Exposure to Vibration in Buildings – Part 2: Blast Induced Vibration

- 8.3.11 This standard gives guidance on human exposure to blast-induced vibration in buildings.
- 8.3.12 The provided guidance, as duplicated in **Table 8-5**, is based on human response criteria and is stated to be appropriate for “long term blasting such as that from surface mineral extraction sites”.
- 8.3.13 It is also stated that for blasting undertaken outside normal working hours (defined as 08:00 to 18:00 hours Monday to Friday and 08:00 to 13:00 on a Saturday), the specified limits “may be relaxed in special circumstances by prior negotiation with interested parties including the occupiers”.
- 8.3.14 When more than three blast vibration events occur in a working day, it advises that the following relationship can be used to determine a multiplying factor which can be applied to the satisfactory magnitudes detailed in the table above:

$$F = 1.7 N^{0.5} T^{-d}$$

where:

F is the multiplying factor

N is the number of blast events per day (and is greater than 3)

T is the blast vibration event duration typical for the site (in seconds)

d is zero where T is less than 1s, otherwise 0.32 for wooden floors and 1.22 for concrete floors.

- 8.3.15 For Tytherington Quarry, it is not expected that there will be more than 3 blasts on any one day.

**Table 8-5 - Maximum Satisfactory Magnitude of Vibration with Respect to Human Response for Up to Three Vibration Events per Day**

Place	Time	Satisfactory magnitude <sup>A</sup> PPV mm/s
Residential	Day <sup>D</sup>	6.0 to 10.0 <sup>C</sup>
	Night <sup>D</sup>	2.0
	Other times <sup>D</sup>	4.5
Offices <sup>B</sup>	Any time	14.0
Workshops <sup>B</sup>	Any time	14.0
<p>Note 1 This table recommends magnitudes of vibration below which the probability of adverse comment is low (noise caused by any structural vibration is not considered).</p> <p>Note 2 Doubling the suggested vibration magnitudes could result in adverse comment and will increase significantly if the magnitudes are quadrupled.</p> <p>Note 3 For more than three occurrences of vibrations per day see the further multiplication factor in Section 5.2 (of the standard - duplicated in this chapter in the text above this table, see paragraph 8.3.14).</p>		

- A. The satisfactory magnitudes are the same for the working day and the rest of the day unless stated otherwise.
- B. Critical working areas where delicate tasks impose more stringent criteria than human comfort are outside the scope of this standard.
- C. With residential properties people exhibit a wide variation of tolerance to vibration. Specific values are dependent upon social and cultural factors, psychological attitudes and the expected degree of intrusion. In practice the lower satisfactory magnitude should be used with the higher magnitude being justified on a case-by-case basis.
- D. For the purpose of blasting, daytime is considered to be 08:00 to 18:00 Monday to Friday and 08:00 to 13:00 Saturday. Routine blasting would not normally be considered on Sundays or Public Holidays. Other times cover the period outside the working day but exclude night-time, which is defined as 23:00 to 07:00.

8.3.16 With regard to Note D in the above table, these are the hours specified in BS 6472-2. For Tytherington Quarry, permitted hours for blasting operations will be further constrained by the hours specified in the extant planning condition.

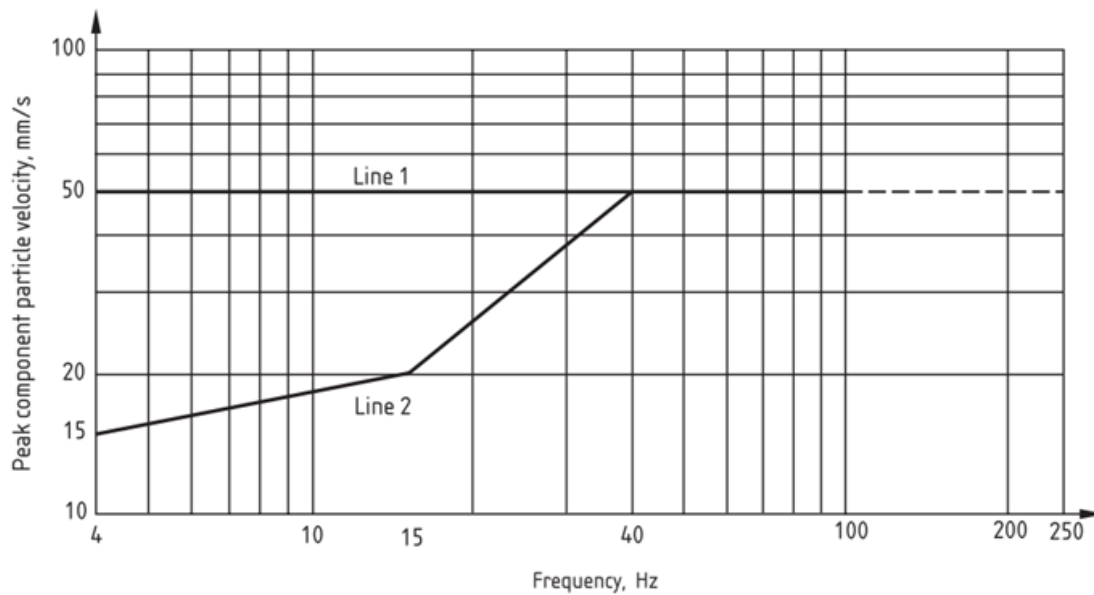
**BS 7385-2: 1993: Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration**

8.3.17 With regard to structural response to vibration and the potential for building damage, BS 5228-2 refers to the damage threshold criteria presented in BS 7385-2, which provides limits in terms of the component PPV for transient vibration above which cosmetic damage could occur. These limits are summarised in **Table 8-6** and **Figure 8-1** below.

**Table 8-6 - Transient Vibration Guide Values for Cosmetic Damage**

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	50mm/s at 4 Hz and above
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above
Note 1: Values referred to are at the base on the building.		
Note 2: At frequencies below 4 Hz, a maximum displacement of 0.6mm (zero to peak) is not to be exceeded.		

**Figure 8-1 - BS 7385-2 Guidance on Damage Levels for Groundborne Vibration**



- 8.3.18 It should be noted that the values presented within the above table are applicable to cosmetic damage only. It is stated within BS 5228-2 and BS 7385-2 that minor structural damage is possible at vibration magnitudes which are greater than twice those given in the table. BS ISO 4866<sup>8</sup> (which replaced part 1 of BS 7385) defines cosmetic damage as “the formation of hairline cracks on drywall surfaces or the growth of existing cracks in plaster or drywall surfaces...”. Minor structural damage is defined as “the formation of large cracks or loosening and falling of plaster or drywall surfaces, or cracks through bricks or concrete blocks”.
- 8.3.19 The above guidance relates to “impulsive” vibration, which is typical of blasting vibration.
- 8.3.20 Note that, in the above figures, different criteria apply to “reinforced or framed structures” and “unreinforced or lightweight structures”. For the purposes of this assessment, it is assumed as a worst case that all sensitive receptors are unreinforced structures and that the more stringent criteria should apply.
- 8.3.21 It should also be noted that the lower limits set out in **Table 8-4** and **Figure 8-1** are frequency dependent. As a worst case, it is assumed that the lowest PPV limits (at a frequency of 4 Hz) should apply.

## EXTANT PLANNING CONSENTS

- 8.3.22 The extant principal planning consent for Tytherington Quarry, ref: NA/IDO/002/A, includes a condition (Condition 15) which places restrictions on the maximum peak particle velocity of 9 mm/s at a 95% confidence level. This is consistent with the guidance set out within BS 6472-2 as

<sup>8</sup> The British Standards Institution. (2010). BS ISO 4866: Mechanical Vibration and Shock. Vibration of Fixed Structures. Guidelines for the Measurement of Vibrations and Evaluation of their Effects on Structures. London: BSI Standards Ltd. Note that this supersedes Part 1 of BS 7385; however, Part 2 of BS 7385 remains current.

described above. Note that a method for determining the ‘confidence level’ is set out within Annex E of BS 5228-2.

## 8.4 DATA GATHERING METHODOLOGY

### STUDY AREA

- 8.4.1 The study area is an area approximately 1km from the quarry boundary, which encompasses all the nearest receptors to the quarry. The receptors to be considered in the assessment are the same as those identified for the noise assessment (**ES Chapter 7**).

### DESK STUDY

- 8.4.2 A desktop study, based on review of aerial imagery, was undertaken to identify receptors that could potentially be affected by blasting vibration arising from the Proposed Scheme. A summary of the desktop data used is provided in **Table 8-7** below.

**Table 8-7 – Desktop data for blasting vibration assessment**

Desktop data	Source of desktop data	Details of the information
Aerial imagery from Google Earth Pro	Google Earth Pro	Aerial views of the study area described above in paragraph 8.4.1, and surrounding environs, to establish potential noise sensitive receptors.

### DATA SOURCES

- 8.4.3 The assessment has been based upon the results of a desk study and professional judgement based on knowledge of the site and surrounding area. The desk study has involved reviewing Ordnance Survey mapping and Google Earth imagery of the site and surrounding.
- 8.4.4 As the relevant assessment criteria, as set out in the technical standards and guidance detailed above, are based on the absolute level of vibration and not via a comparison to background levels of vibration, no baseline vibration surveys have been undertaken.

## 8.5 OVERALL BASELINE

### CURRENT BASELINE

- 8.5.1 There is no information available to quantify the blasting vibration environment at locations surrounding the quarry. Review of Google Earth imagery indicates that the main source of vibration would be from the operation of the existing Tytherington Quarry and that there are no other significant sources of blast vibration in the vicinity.

### PREDICTED FUTURE BASELINE

- 8.5.2 It is envisaged that the only activity that could potentially increase the magnitudes and frequency of occurrence of blasting vibration would be due to increased activities at the consented Tytherington Quarry in terms of either frequency of blasting or the closer proximity of blasting operations to existing receptors. However, this is not considered likely as the soil store area is located further from residential properties than anywhere else quarried within Tytherington and the deepening of the quarry is unlikely to have an effect on vibration levels above those existing.

## 8.6 CONSULTATION

- 8.6.1 The assessment has been informed by consultation responses and ongoing stakeholder engagement. An overview of the approach to consultation is provided in **Section 2.4 of Chapter 2: Approach to Environment Impact Assessment**.

### SCOPING

- 8.6.2 A Scoping Opinion was issued by South Gloucestershire Council (SGC) on 18 January 2024. No comments in relation to blasting vibration were included in the Scoping Opinion.

## 8.7 ENVIRONMENTAL MEASURES INCOPORATED INTO THE PROPOSED DEVELOPMENT

- 8.7.1 A range of environmental measures have been embedded into the development proposals as outlined in **Chapter 3 (Section 3.3)**. The Proposed Scheme design includes for a number of vibration mitigation measures included from the outset, based on the mitigation and control measures implemented as part of the extant planning consent for Tytherington. These measures include:
- Compliance with all statutory regulations and good practice guidelines relating to good blast design and minimisation of environmental effects, including those guidelines identified in **Table 8-3** and especially the Operator's Good Practice Guide, outlined in the DETR report *The Environmental Effects of Production Blasting from Surface Mineral Working*<sup>9</sup>;
  - Adoption of the vibration control limit set out in the extant planning consent for Tytherington Quarry, namely that the maximum peak particle velocity must not exceed 9 mm/s at a 95% confidence level at any sensitive receptor;
  - Procedures for the routine monitoring of blast vibration, including the maintenance of records and reporting of monitoring results;
  - Procedures for investigating any exceedance of the adopted vibration limits and procedures for investigating and handling complaints from local residents;
  - Procedures for communicating with the local community, particularly with regards to expected blast activities; and
  - Auditing of monitoring results and investigations and reporting such results to the relevant planning authorities.

## 8.8 SCOPE OF THE ASSESSMENT

- 8.8.1 The scope of the assessment is limited to the effects of groundborne vibration and specifically excludes the assessment of air overpressures (energy transmitted from the blast site in the form of pressure waves). The reasons for excluding an assessment of air overpressures are:
- Practical difficulties associated with the prediction and measurement of air overpressure during conditions where there is even the slightest wind. This is because wind itself is a pressure variation which may mask the blast induced pressure wave, even when using proprietary

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<sup>9</sup> Department of the Environment, Transport and the Regions (DETR, 1998). *Environmental Effects of Production Blasting from Surface Mineral Working*. Rotherham, DETR.

windshields on the microphone. Hence, demonstration of compliance with an air overpressure limit is not considered a practicable possibility. Compliance with an air overpressure limit is also not considered necessary due to the extremely high levels that would need to occur to cause any structural damage to buildings, which is a vanishingly small possibility for production blasting associated with minerals extraction. These practical difficulties are recognised in PAN 50 which advises against the use of planning conditions relating to air overpressure.

- BS 6472-2 indicates that the prediction of air overpressure is “almost impossible” and goes on to state that “control of air overpressure should always be by its minimisation at source through appropriate blast design”.
- No limits relating to air overpressure arising from the blast operations have been specified in the extant planning consents for the site.

8.8.2 For the above reasons, no predictions or assessment of air overpressure have been undertaken.

### **SPATIAL SCOPE**

8.8.3 The spatial scope of the assessment of blasting vibration covers the area of the Proposed Scheme contained within the red line boundary, together with the Zones of Influence (Zols) that have formed the basis of the study area described in **Section 8.4**.

8.8.4 The study area was determined on the basis of including all nearby receptors that could potentially be affected by noise from the Proposed Scheme. Based on professional experience of similar schemes, it would be unlikely that receptors further than 1km would experience significant noise effects from quarry activities.

### **TEMPORAL SCOPE**

8.8.5 The temporal scope of the assessment of blasting vibration is consistent with the period over which the Proposed Scheme would be carried out and therefore covers the currently consented period of operation. The Proposed Scheme will be undertaken within 3 development phases, which in total will last a period of circa 6 to 7.5 years subject to market conditions, but not extend beyond the extant 2042 end date of the principal planning consent.

### **POTENTIAL RECEPTORS**

8.8.6 The desk study identified a number of potential receptors that could be affected by the Proposed Scheme. All potential receptors identified in the desk study are dwellings and are considered to be of high sensitivity to blasting vibration effects. These are the same sensitive receptors as those identified in **Chapter 7: Noise** and detailed in **Table 7-9** and shown on **Figure 7.1**.

### **POTENTIALLY SIGNIFICANT EFFECTS**

#### **Effects scoped-in to the assessment**

8.8.7 The potential blasting effects that have been taken forward for further assessment are those arising from mineral extraction activities and preparation of the proposed mineral extraction area, at the key receptor locations identified above.

#### **Effects scoped-out of the assessment**

8.8.8 As detailed in **paragraphs 8.8.1** and **8.8.2** above, the scope of the assessment is limited to the effects of groundborne vibration and specifically excludes the assessment of air overpressures (energy transmitted from the blast site in the form of pressure waves).

## 8.9 ASSESSMENT METHODOLOGY

8.9.1 The generic project-wide approach to the assessment methodology is set out in **Chapter 4**, and specifically in **Sections 4.5 to 4.7**. However, whilst this has informed the approach that has been used in this blasting vibration assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of this blasting vibration assessment.

### METHODOLOGY FOR PREDICTION OF EFFECTS

8.9.2 The proposal to extract an additional 6 million tonnes of reserves at Tytherington is essentially, in terms of blast vibration, an extension of the current operations at Tytherington. Vibration control measures, achieved via appropriate blast design, will be adopted to comply with the vibration limits set out in Condition 15 of the extant principal planning consent (ref: NA/IDO/002/A) which states:

*“Ground vibration as a result of blasting operations ... shall be designed not to exceed a peak particle velocity of 9 millimetres per second in 95 per cent of all blasts as measures over any period of 12 months and no individual blast shall exceed a peak particle velocity of 12 millimetres per second as measures at the nearest residential property. Ground and airborne vibration from blasting shall be regularly monitored with monitoring recording the maximum of three mutually perpendicular directions taken at the ground surface. The results of the blast monitoring shall be incorporated, as necessary, into the modification of future blast design so as to reduce environmental emissions.”*

8.9.3 The accepted, and industry standard, method for blast design to achieve such limits is set out in Annex E of BS 5228-2, and this method has been adopted for the assessment.

8.9.4 The method is to plot measured peak particle velocities against a scaled distance value for each measurement location. When a number of such values are plotted on logarithmic axes a straight-line relationship is observed. This is the so-called blasting regression line. In almost all cases, a certain amount of data scatter would be evident, and so statistical confidence levels are also calculated by least squares regression analysis techniques and the best fit or mean (50%) line as well as the upper 95% confidence level are plotted. The latter forms the basis of most vibration regulations (and is used in Condition 15 of the extant principal planning consent).

8.9.5 The blasting regression line can then be used to calculate appropriate charge weights (Maximum Instantaneous Charge) for use in the blast design to ensure that the appropriate vibration limit would not be exceeded within the stated confidence level.

8.9.6 The magnitude of change criteria, provided in **Table 8-8** below, has been determined based on both the vibration limit set in extant Condition 15 as well as the guidance and criteria in Annex E of BS 5228-2.

**Table 8-8 - Magnitude of change criteria**

Predicted blasting vibration level	Magnitude of change
Not exceeding blasting vibration limit of 9 mm/s PPV at a 95% confidence level	<b>Small to negligible</b> , depending on how far the predicted vibration levels fall below the criteria. For example, if vibration levels are below 1 mm/s, this could indicate a negligible magnitude of change.
Exceeding blasting vibration limit of 9 mm/s PPV at a 95% confidence level	<b>Large to medium</b> , depending on how far the predicted vibration levels exceeds the criteria. For example, if vibration levels are above 12.5 mm/s, this would indicate a large magnitude of change.

## SIGNIFICANCE EVALUATION METHDOLOGY

- 8.9.7 The significance level attributed to each effect has been assessed based on the sensitivity/value of the affected receptor(s) and the magnitude of change arising from the Proposed Scheme, as well as a number of other factors that are outlined in more detail in **Chapter 5: Approach to EIA**. The sensitivity of the affected receptor is assessed on a scale of high, medium, low and negligible, and the magnitude of change is assessed on a scale of large, medium, small, negligible and no change, as set out in **Chapter 5: Approach to EIA**.

### Effect Significance

- 8.9.8 The following terms have been used to define the significance of the effects identified and apply to both beneficial and adverse effects:
- **Major effect:** where the Proposed Scheme could be expected to have a substantial improvement or deterioration on receptors;
  - **Moderate effect:** where the Proposed Scheme could be expected to have a noticeable improvement or deterioration on receptors;
  - **Minor effect:** where the Proposed Scheme could be expected to result in a perceptible improvement or deterioration on receptors; and
  - **Negligible:** where no discernible improvement or deterioration is expected as a result of the Proposed Scheme on receptors, including instances where no change is confirmed.
- 8.9.9 As set out in **Chapter 5: Approach to EIA**, effects that are classified as **minor or above** are considered to be **significant**. Effects classified as below minor are considered to be **not significant**.
- 8.9.10 The significance matrix provided in **Table 8-9** below is based on that provided in **Chapter 4: Approach to EIA**. However, the matrix used to determine significance of potential noise effects provided in **Table 8-9** has been modified to be appropriate for the blasting vibration assessment. Only receptors of high sensitivity need to be considered, as only dwellings are assessed, and these are all considered to be of high sensitivity. Therefore, receptors of lower sensitivity have been removed from the matrix. As the magnitude of change criteria provided in **Table 8-8** are based on absolute limits as defined in both the extant Condition 15 and national guidance (Annex E of BS 5228-2), the significance outcomes have been modified to reflect this. Therefore, for a small magnitude of change, where blasting vibration from the Proposed Scheme is predicted not to exceed the permitted limits, the resulting effects would be not significant, and hence would only be of minor significance.

**Table 8-9 - Matrix for determining Significance of Effect**

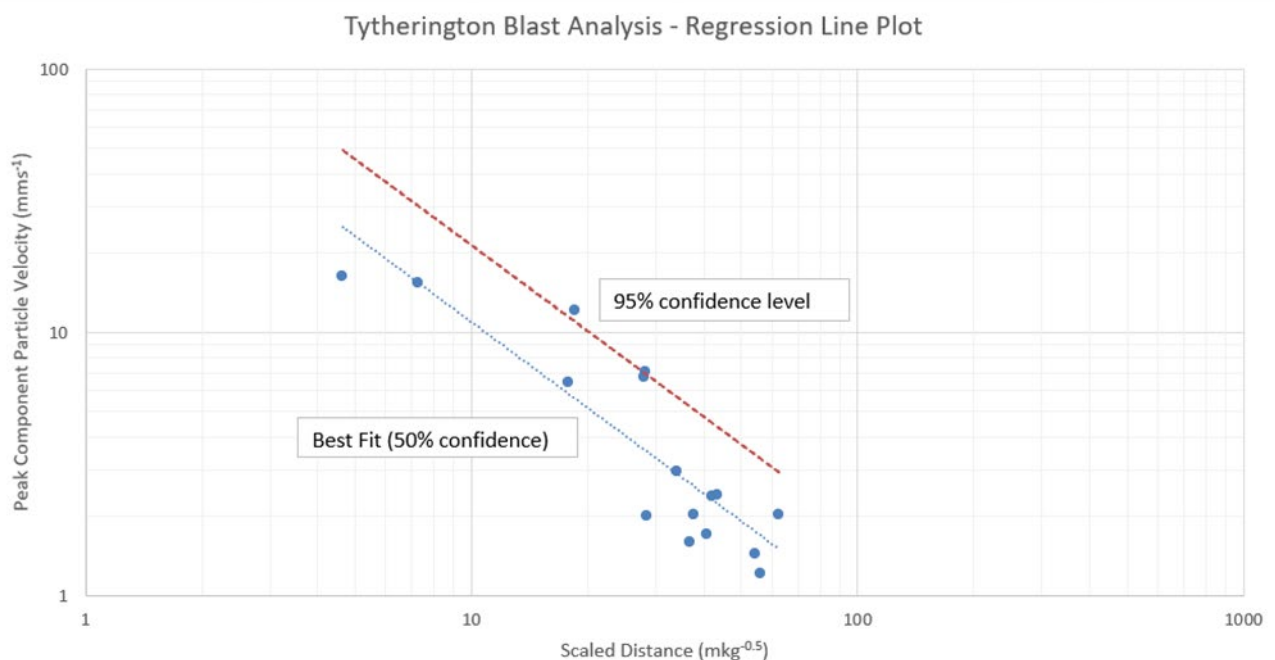
		Sensitivity (Value / Importance)
		High
Magnitude of Change	Large	Major
	Medium	Moderate
	Small	Minor
	Negligible	Negligible

Note: Significant effects are those identified as 'Major'. 'Moderate' effects would normally be deemed to be significant. However, there may be some exceptions, depending on the environmental topic and the application of professional judgment.

## 8.10 ASSESSMENT OF VIBRATION EFFECTS

- 8.10.1 The blasting regression line, calculated in accordance with the methodology set out within Annex E of BS 5228-2 and taking into account available monitoring data from the Tytherington Quarry, is presented in **Figure 8-2**.

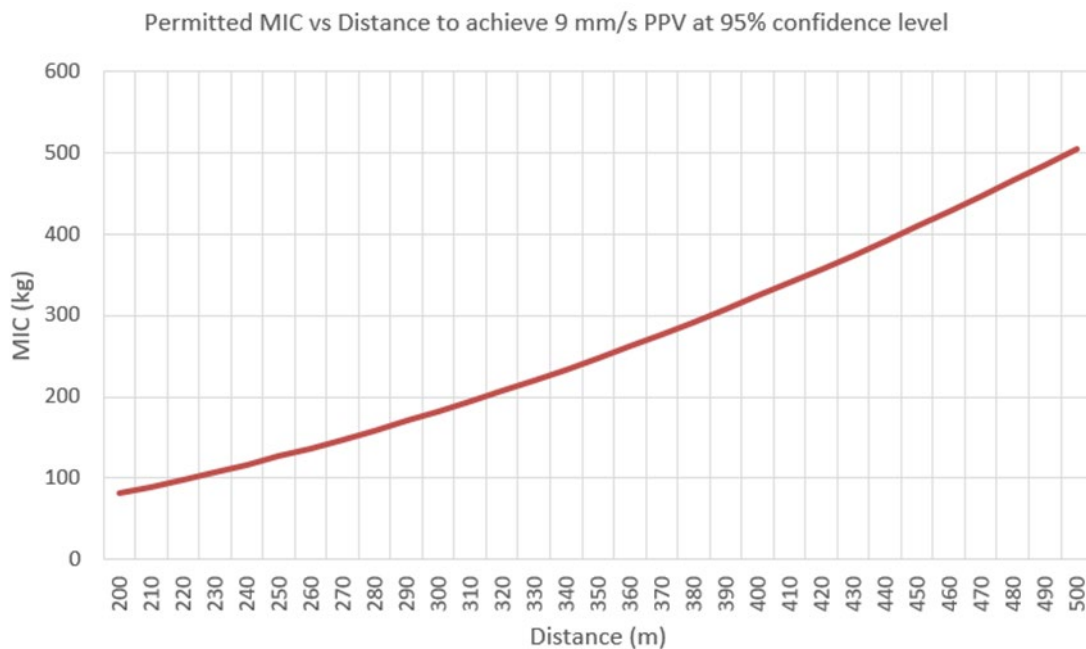
**Figure 8-2 - Vibration Regression Line Plot**



Note to **Figure 8-2**: The graph indicates some measurement points where the PPV exceeded the limit of 9 mm/s as set out within Condition 34 of the extant planning permission. It should be noted that these data were not recorded at sensitive receptor locations but were measured at locations closer to the blasting operations (and within the site boundary) to provide data for the purposes of conducting a vibration regression analysis. Further details can be found within the report from EPC Groupe: *Hanson Tytherington Quarry – Vibration Regression Model* (doc ref: DR0122, dated 25 May 2022).

- 8.10.2 It can be seen from the results presented in **Figure 8-2** that in order to achieve a limit of 9 mm/s PPV at a 95% confidence level, the scaled distance must not exceed 22.24 mkg<sup>-0.5</sup> (this being the point on the 95% confidence regression line for which the PPV is 9 mm/s).
- 8.10.3 The scaled distance can be used to calculate the permitted MIC for any blast event given the distance of the blast site from the nearest sensitive receptor location, as shown in **Figure 8-3**.

**Figure 8-3 - Plot of MIC versus Distance to Achieve 9 mm/s PPV at 95% Confidence**



- 8.10.4 The range of blast weights shown in **Figure 8-3** are within the same range as those used for previous and current blasting activities at Tytherington. Adhering to these limits is therefore not expected to result in higher levels of groundborne vibration than is the case for operations undertaken within the extant principal planning consent for Tytherington Quarry.
- 8.10.5 Furthermore, the existing soil store area from which additional minerals is to be extracted is located further from residential receptors than anywhere else quarried within Tytherington, and the deepening of the existing quarried areas is unlikely to require higher blast weights compared to the existing situation.

## SUMMARY OF EFFECTS

- 8.10.6 In summary, the exploitation of the 6 million tonne additional reserves at Tytherington Quarry is not expected to result in a worsening of the existing vibration climate as experienced under the currently consented operations. The exploitation of the additional reserves will, though, extend the operational life of the quarry.
- 8.10.7 In terms of significance of effects associated with blast vibration:
- The sensitivity of nearby residential receptors is considered to be high.
  - The magnitude of change is considered to be very low.
  - The overall effect is considered to be minor (not significant).

## 8.11 ASSESSMENT OF CUMULATIVE EFFECTS

- 8.11.1 Cumulative impacts for blasting vibration have been considered and not significant. Considerations for a noise and vibration management plan would seek to address any such effects.
- 8.11.2 Consented and proposed schemes set out in **Chapter 15: Cumulative Effects** were reviewed to identify any proposals that could have the potential to result in cumulative effects, noting that only those schemes that could have the potential to generate blasting vibration from site activities alone (i.e. extraction and blasting methods).
- 8.11.3 Review of the consented and proposed schemes identified no quarry works that could have the potential to give rise to cumulative effects, as these are all at least 5 km away.
- 8.11.4 Based on the above, cumulative blasting vibration effects are considered to result in minor to negligible effects and are **not significant**.

## 8.12 ASSESSMENT OF IN-COMBINATION CLIMATE IMPACTS

- 8.12.1 The In-combination Climate Change Impacts (ICCI) assessment considers the extent to which climate change exacerbates or ameliorates the potential effects identified for blasting vibration.
- 8.12.2 The ICCI assessment presented has been informed by the future baseline presented within **Chapter 13: Climate Resilience**. The ICCI uses the topic specific assessment methodologies and professional judgement to assess likelihood and magnitude of the impacts, with the combined consideration of future climate trends and impacts.

**Table 8-10 - In-Combination Climate Change Impacts (ICCI) related to blating vibration**

EIA topic	Climate Hazard	Potential impacts of Climate Change	Mitigation
Chapter 8: Blasting vibration	<ul style="list-style-type: none"> <li>■ Extreme temperature events</li> </ul>	Higher temperatures could lead to more time when windows are open, leading to greater exposure blasting vibration.	No additional mitigation is required beyond those measures set out in <b>Chapter 8: Blasting Vibration</b> , which are considered sufficient to address risks from increased blasting vibration exposure.

## 8.13 MITIGATION AND ENHANCEMENT MEASURES

- 8.13.1 Opportunities to mitigate potential adverse effects have already been incorporated within the development or are imposed through a number of existing mitigation, monitoring and regulatory control measures (see **Section 8.7** above). Implementation of these measures should continue throughout the extraction of the additional 6mt of mineral reserves. The Proposed Scheme with these measures and controls in place has been subject to the assessment. No other measures are proposed as mitigation in relation to the effects that are identified in this chapter.
- 8.13.2 Vibration monitoring data from all future blasting activities should be collated and used to continually update the blast vibration regression analysis. This will enable the blast design and selection of appropriate charge weights to be undertaken with increasing accuracy as the works progress.

## 8.14 CONCLUSIONS OF SIGNIFICANCE EVALUATION

8.14.1 The following table provides a summary of the conclusions about the significance of the predicted blasting vibration effects that have been subject to assessment in this ES.

**Table 8-11 - Summary of significance of predicted blasting vibration effects**

Receptor and effects	Magnitude <sup>1</sup>	Sensitivity <sup>2</sup>	Significance	
			Level	Rationale
Operational Phase				
Operational blasting vibration effects at residential receptors	Slight adverse effect	High	NS	Use of Noise and Vibration Management Plan expected to control blasting vibration to below criterion in Condition 15 of the extant principal planning consent (ref. NA/IDO/002/A) and below best practice guidance criterion in Annex E of BS 522-5.
Key	Magnitude <sup>1</sup>	Sensitivity <sup>2</sup>	Significance	
	Substantial adverse effect Moderate adverse effect Slight adverse effect Negligible effect	High Medium Low Negligible	S = Significant NS = Not Significant	

## 8.15 IMPLEMENTATION OF ENVIRONMENTAL MEASURES

8.15.1 **Table 8-12** describes the environmental measures embedded within the Proposed Scheme and the means by which they will be implemented, i.e. they will have been secured through the planning conditions.

**Table 8-12 - Implementation of environmental measures**

Environmental measure / mitigation	Responsibility for implementation	Compliance mechanism	ES section reference
Vibration mitigation and control measures	Heidelberg Materials	By extant Planning Condition and monitored by South Gloucestershire Council.	8.7

## 8.16 REFERENCES [UPDATE AS REQUIRED]

8.16.1 [Reference numbering to be pre-fixed by chapter number].

- Reference 8.1: HMSO (1974). *Control of Pollution Act 1974*.
- Reference 8.2: Health and Safety Executive (2013) *Quarries Regulations 1999 Approved Code of Practice and Guidance*
- Reference 8.3: Local Government and Communities Directorate (1996) *Planning Advice Note 50: Controlling the Environmental Effects of Surface Minerals Workings*.
- Reference 8.4: Local Government and Communities Directorate (2000) *PAN 50 Annex D: The Control of Blasting at Surface Minerals Workings*.
- Reference 8.5: British Standards Institution (BSI, 2014) *British Standard BS 5228-2: 2009 + A1: 2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration*. London, BSI.
- Reference 8.6: British Standards Institution (BSI, 2008) *British Standard BS 6472-2: 2008 Guide to Evaluation of Human Exposure to Vibration in Buildings – Part 2: Blast-induced Vibration*. London, BSI.
- Reference 8.7: British Standards Institution (BSI, 1993) *British Standard BS 7385-2: 1993 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration*. London, BSI.
- Reference 8.8: The British Standards Institution. (2010). *BS ISO 4866: Mechanical Vibration and Shock. Vibration of Fixed Structures. Guidelines for the Measurement of Vibrations and Evaluation of their Effects on Structures*. London: BSI Standards Ltd. Note that this supersedes Part 1 of BS 7385; however, Part 2 of BS 7385 remains current.
- Reference 8.9: Department of the Environment, Transport and the Regions (DETR, 1998). *Environmental Effects of Production Blasting from Surface Mineral Working*. Rotherham, DETR.



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