12 NOISE AND VIBRATION

12.1 Introduction

12.1.1 This Chapter reports the likely significant effects of the Proposed Development in terms of Noise and Vibration in the context of the Site and surrounding area. In particular it considers the likely significant effects of the Proposed Development upon existing sensitive receptors and proposed sensitive receptors in the vicinity of the development.

12.1.2 This Chapter (and its associated figures and appendices) is not intended to be read as a standalone assessment and reference should be made to the front end of this ES (Chapters 1 – 6), as well as the final chapters, 'Summary of Residual and Cumulative Effects' and 'Conclusions' (Chapters 21 - 22).

12.2 Legislation, Policy and Guidance

12.2.1 The relevant legislation, policy and guidance are listed below, with details provided in Appendix 12.1.

Legislative Framework

12.2.2 The applicable legislative framework is summarised as follows:

- Control of Pollution Act (COPA) 1974

Planning Policy

12.2.3 The applicable planning policy is summarised as follows:

- Future Wales: The National Plan 2040
- Planning Policy Wales, 2021
- Cardiff Local Development Plan 2006 – 2026 (adopted January 2016)
- Technical Advice Note 11 (TAN 11): Noise, 1997

Guidance

12.2.4 The applicable guidance is summarised as follows:

- British Standard 8233: 2014 Guidance on Sound Insulation and Noise Reduction for Buildings
- Department of Transport's Memorandum: Calculation of Road Traffic Noise, 1988 (CRTN)

- IEMA Guidelines for Environmental Noise Impact Assessment, 2014
- British Standard 4142:2014+A1:2019, Methods for Rating and Assessing Industrial Noise and Commercial Sound (BS4142)
- British Standard 5228: 2009:+A1:2014 Code of Practice for Noise and Vibration on Construction and Open Sites – Part 1: Noise (BS5228-1), and Part 2: Vibration (BS5228-2)
- Noise Council 'Code of Practice on Environmental Noise Control at Concerts', 2011
- Institute of Acoustics (IOA) 'Good Practice on Control of Noise from Pubs and Clubs', 2003

12.3 Assessment Methodology and Significance Criteria

Scope of the Assessment

12.3.1 The scope of this assessment comprises a consideration of noise and vibration at existing sensitive receptor locations located in the vicinity of the Proposed Development and at proposed sensitive receptors within the development itself. These existing and proposed sensitive receptors are described in Table 12.7 in Section 12.4.

12.3.2 The assessment will consider the potential noise and vibration impacts during the demolition, construction and operation of the Proposed Development as follows:

- the impact of the demolition and construction phase noise and vibration of the Proposed Development on existing sensitive receptors;
- the impact of development led road traffic on existing and proposed sensitive receptors;
- the impact of any existing noise sources on proposed sensitive receptors; and
- the operational noise impact of the Proposed Development on existing and proposed sensitive receptors. Proposed sources of noise include:
    - Entertainment Noise – The assessment will consider low frequency noise at 63hz and 125hz and aim to achieve 3dB below background noise levels. Overall entertainment noise will be assessed to aim for 10dB below background noise levels.

- Plant – The assessment will consider the noise impact from plant throughout the development at existing and proposed sensitive receptors, during the daytime and night-time.
- Service Yard – The assessment will consider the potential impact from noise within the arena service yard. This will include potential noise during the daytime and night-time following events.
- Heavy Goods Vehicle (HGV) Movements – The assessment will consider noise from HGVs associated with the Proposed Development such as deliveries and setup and closure of events during the daytime and night-time.
- Pedestrian Noise – The assessment will consider the potential impact at existing and proposed sensitive receptors from pedestrian noise associated with events at the Proposed Development. This will include noise generated by pedestrians walking on main routes and to/from public transport stations when attending events. In addition, noise from pedestrians will be assessed from queuing points, taxi ranks and amenity areas such as smoking areas. Noise from pedestrians will be assessed during the daytime and night-time.
- Noise from future traffic noise associated with the Proposed Development

12.3.3 The intrusive nature of entertainment noise will be considered, particularly the potential noise impact from low frequency noise.

12.3.4 All sources of an industrial / commercial nature will be assessed in accordance with BS4142, and where required, mitigation will be suggested to reduce any significant impacts.

Effects Not Considered within the Scope

12.3.5 No issues relating to noise have been scoped-out of this assessment.

12.3.6 Due to the likely activities and land use at the Proposed Development, i.e. entertainment events, commercial properties and residential, vibration during the operational phase is not considered significant. Vibration during the operational phase of the development has therefore been scoped out of the assessment.

Extent of the Study Area

12.3.7 The noise assessment considers an area up to 1 kilometre (km) from the Proposed Development.

Consultation Undertaken to Date

12.3.8 Table 12.1 provides a summary of the consultation activities undertaken in support of the preparation of this Chapter. Copies of relevant correspondence are provided in Appendix 12.2.

Table 12.1: Summary of Consultation Undertaken to Date

Organisation	Individual(s)	Meeting Date and other forms of Consultation	Summary of Outcome of Discussion
Shared Regulatory Services for Cardiff, Bridgend and the Vale of Glamorgan Councils	Tomos Jenkins	e-mail sent on 29th June 2021	Outlining Wardell Armstrong's survey and assessment methodology.
Shared Regulatory Services for Cardiff, Bridgend and the Vale of Glamorgan Councils	Tomos Jenkins	e-mail received on 1st July 2021	Outlining noise limits for arena and plant noise. Highlighting assessment requirements – pedestrian noise, development led traffic noise.
Shared Regulatory Services for Cardiff, Bridgend and the Vale of Glamorgan Councils	Tomos Jenkins	Meeting on 1st July 2021	WA survey and assessment methodology agreed in principle.

Assessment Methodology

12.3.9 The method of baseline data collection and assessment has been agreed with the Shared Regulatory Services for Cardiff, Bridgend and the Vale of Glamorgan Councils (Appendix 12.2) and is in accordance with current guidance and industry best practice.

12.3.10 A baseline noise survey was undertaken by ARUP, which informed the noise limit targets for the Arena and Hotel design. A summary of the ARUP noise survey and Vanguardia noise limit targets are included as Appendix 12.3.

12.3.11 Additional survey data has been collected by Mott MacDonald on behalf of Cardiff Council in relation to the Proposed Development. Full details of this survey data are included as Appendix 12.4.

Significance Criteria

12.3.12 The potential noise effects associated with the Proposed Development have been assessed in accordance with the guidance detailed above to determine whether statutory objectives are exceeded or whether undesirable/desirable consequences may occur on the receiving environment. Where potential adverse impacts are identified, appropriate mitigation measures are proposed to avoid, reduce or compensate for the adverse effects. The significance of an environmental impact will be determined not only by the magnitude of the impact but also by the sensitivity of the receptor as shown in Tables 12.2 – 12.5 respectively.

Table 12.2: Magnitude of Operational Noise Impact	
Sensitivity	**Description**
Large	Impact resulting in a considerable change in baseline environmental conditions predicted either to cause statutory objectives to be significantly exceeded or to result in severe undesirable/desirable consequences on the receiving environment.
Medium	Impact resulting in a discernible change in baseline environmental conditions predicted either to cause statutory objectives to be marginally exceeded or to result in undesirable/desirable consequences on the receiving environment.
Small	Impact resulting in a discernible change in baseline environmental conditions with undesirable/desirable conditions that can be tolerated.
Negligible	No discernible change in the baseline environmental conditions, within margins of error of measurement.

Table 12.3: Construction Noise Assessment Significance Criteria	
Magnitude of Impact	**Criteria for assessing Construction Noise Impact**
Large	Noise levels exceed the Assessment Category threshold level for the duration of the construction works.
Medium	Noise levels exceed the Assessment Category threshold level for periods of more than one month, but for significantly less than the whole duration of the construction works.
Small	Noise levels exceed the Assessment Category threshold level for periods of less than one month.

Negligible	Noise levels do not exceed the Assessment Category threshold level during any period.

Table 12.4: Construction Vibration Assessment Significance Criteria	
Magnitude of Impact	**Criteria for Assessing Construction Vibration impact**
Large	> 10mm per second. Vibration likely to be intolerable for more than brief exposure. Approaching the level at which cosmetic damage may occur in light structures.
Medium	5mm - 10mm per second. Tolerance less likely even with prior warning and explanation.
Small	1mm – 5mm per second. Complaints are likely, but can be tolerated if prior warning and explanation given.
Negligible	<1mm per second. Below level at which complaints are likely.

Table 12.5: Sensitivity of Receptor	
Sensitivity	**Receptor Type**
High	Receptor/resource has little ability to absorb change without fundamentally altering its present character, or is of international or national importance. For example hospitals, residential care homes, and internationally and nationally designated nature conservation Sites which are also known to contain noise sensitive species (i.e. noise may change breeding habits or threaten species in some other way).
Moderate	Receptors/resource has moderate capacity to absorb change without significantly altering its present character. For example residential dwellings, offices, schools, and play areas. Locally designated nature conservation Sites which are also known to contain noise sensitive species (i.e. noise may change breeding habits or threaten species in some other way).
Low	Receptor/resource is tolerant of change without detriment to its character or is of low or local importance. For example industrial estates.
Negligible	Receptor/ resource is not sensitive to noise.

12.3.13 The significance of an environmental effect for road traffic noise, and on-site operational noise and vibration, is determined by the interaction of magnitude and sensitivity. The Effect Significance Matrix used in this assessment is shown in Table 12.6.

Table 12.6: Effect Significance Matrix				
Magnitude	**Sensitivity**			
	High	**Moderate**	**Low**	**Negligible**
Large	Very Substantial	Substantial	Moderate	None
Medium	Substantial	Substantial	Moderate	None
Small	Moderate	Moderate	Slight	None
Negligible	None	None	None	None

12.4 Baseline Conditions

Sensitive Receptors

12.4.1 Table 12.7 shows the existing sensitive receptors (ESRs) and proposed sensitive receptors (PSRs) that have been assessed. The ESRs and PSRs are representative of those residential properties that are closest to the Proposed Development. These receptors are illustrated on Figure 12.1, Appendix 12.8 and are represented, respectively, by the noise monitoring locations shown in Figure 12.2, Appendix 12.8. Other existing sensitive receptors may be affected by the Proposed Development, although the effect is likely to be equal to or less than those described in Table 12.7.

Table 12.7: Existing and Proposed Noise Sensitive Receptor Locations Closest to the Proposed Development						
Existing Receptors	**Location**	**Receptor Type**	**Grid Reference**		**Bearing from the Site**	**Approx. Distance to Site Boundary**
			Easting	**Northing**		
ESR1	Halliard Court & Schooner Drive	Residential	319309	175238	North	0m
ESR2	Schooner Way / Lloyd George Avenue	Residential	319114	175056	West	0m
ESR3	Galleon Way	Residential	319420	175118	East	15m
PSR1	Proposed residential development east of the proposed arena	Residential	319299	175161	Within site boundary	0m

Noise Survey

12.4.2 Wardell Armstrong (WA) carried out a noise survey at the Site on the 19th and 22nd July 2021.

12.4.3 Attended noise measurements were taken at four monitoring locations (shown on Figure 12.2), which were considered to be representative of the existing residential receptors most exposed to the likely dominant noise sources from the Proposed Development. The monitoring locations were as follows:

- Monitoring Location 1: North of the Site, adjacent to properties on Schooner Drive, approximately 175m from the A4234 and 95m from Schooner Way.
- Monitoring Location 2: West of the Site, adjacent to properties on Schooner Way / Lloyd George Avenue, approximately 10m from Schooner Way.
- Monitoring Location 3: East of the Site, adjacent to properties on Galleon Way, approximately 140m from the A4234.
- Monitoring Location 4: Adjacent to proposed dwellings in the south of the Site. Approximately 20m from the A4232.

12.4.4 Un-attended noise monitoring was carried out at each location for approximately 24 hours. These measurements were taken during these times in order to capture background noise levels at existing and proposed noise sensitive receptors throughout the daytime and night-time.

12.4.5 The noise measurements were made using two Class 1, integrating sound level meters (DUO Serial number 10151 and DUO Serial number 10517). The sound level meter was mounted vertically on a tripod 1.5m above the ground and more than 3.5m from any other reflecting surfaces. The sound level meters were calibrated to a reference level of 94dB at 1kHz both before, and on completion of, the noise survey. No significant drift in calibration over 0.5dB was measured during the survey.

12.4.6 Noise monitoring took place during dry and calm weather conditions. The daily weather conditions are described in Table 8.

Table 12.8: Survey Weather Conditions

Date	Daytime	Night-time
19/07/21	Partial cloud, dry, 18-29°C, wind 2m/s	Partial cloud, dry, 18-20°C, wind 2m/s
20/07/21	Partial cloud, dry, 17-28°C, wind 2-3m/s	Partial cloud, dry, 17-18°C, wind 2m/s

Table 12.8: Survey Weather Conditions		
Date	**Daytime**	**Night-time**
21/07/21	Partial cloud, dry, 17-28°C, wind 2-3m/s	Partial cloud, dry, 17-18°C, wind 2m/s
22/07/21	Partial cloud, dry, 20-29°C, wind 3-4m/s	Partial cloud, dry, 20-22°C, wind 3m/s

12.4.7 For the purpose of this assessment daytime hours are taken to be 0700 to 2300 hours and night-time hours to be 2300 to 0700 hours.

12.4.8 A-weighted[1] L_{eq}[2] maximum and L_{90}[3] noise levels were measured to comply with the requirements of BS8233 and BS4142. The L_{10}[4] and minimum sound pressure levels were also measured to provide additional information. The measured noise levels are set out in full in Appendix 12.5.

12.4.9 During the survey, observations were made of the significant noise sources which contribute to the noise levels at the sensitive receptors. The observations identified the following:

- ***Road Traffic Noise:*** Road traffic was the dominant noise source at all monitoring locations.
- ***Other Sources:*** Birdsong was audible at each monitoring location.

Existing Noise Levels

12.4.10 The measured octave band and broadband L_{Aeq}, L_{A90} and L_{Amax} noise levels for the monitoring locations have been divided into daytime (0700-2300 hours) and night-time (2300-0700 hours) categories.

12.4.11 The overall levels measured during each daytime and night-time period have then been averaged and then rounded to give a single daytime and night-time level for each monitoring location.

12.4.12 The measured broadband L_{Aeq} and L_{A90} noise levels for the daytime and night-time have been rounded to give a single background noise level for each monitoring

[1] A' Weighting — An electronic filter in a sound level meter which mimics the human ear's response to sounds at different frequencies under defined conditions

[2] L_{eqs} — Equivalent continuous noise level; the steady sound pressure which contains an equivalent quantity of sound energy as the time-varying sound pressure levels.

[3] L_{90} — The noise level which is exceeded for 90% of the measurement period.

[4] L_{10} — The noise level which is exceeded for 10% of the measurement period.

location during the daytime and night-time. The summary results for the monitoring locations are presented in Table 12.9.

Table 12.9: Average ambient and background noise levels during the daytime and night-time (Figures in dB)

Monitoring Location	Time	Average Measured Noise Level L_{Aeq}	Maximum Measured Noise Level L_{AMax}	Average Measured Noise Level L_{A90}
ML1	0700-2300 2300-0700	53.3 51.2	- 59.1	50.9 50.1
ML2	0700-2300 2300-0700	51.3 46.4	- 57.1	42.1 40.5
ML3	0700-2300 2300-0700	59.8 58.0	- 65.5	57.8 56.5
ML4	0700-2300 2300-0700	75.1 68.9	- 78.2	68.6 52.9

Noise from Demolition and Construction Phase

12.4.13 For the purposes of this Chapter it is possible to estimate the degree of impact from the site works (earthworks and demolition and construction), according to the suggested standards detailed in Appendix 12.1, by reference to the time periods during which noise levels may occur in excess of the quoted values. These levels can be seen in Table 12.10.

12.4.14 The noise assessment for the demolition and construction phase, details baseline daytime noise levels measured at similar locations to the sensitive receptor locations identified in the main noise and vibration chapter. It also sets out details of 'best practice' management and control measures to ensure that impacts are minimised as far as possible.

12.4.15 The demolition and construction phase has only been considered for existing sensitive receptors close to the site boundary the site boundary. Details of the noise survey carried out at the sensitive receptors are set out in section 12.4 of this chapter.

12.4.16 Based on the ambient noise levels measured during the daytime period, the appropriate category value has been determined for each of the sensitive receptors, as detailed in Table 12.10.

Table 12.10: Construction Noise Assessment Significance Criteria					
Receptor	**Representative Monitoring Location**	**Average Measured Noise Levels (dB L_{Aeq})**	**Ambient Noise Level Rounded to the nearest 5dB(A) (dB L_{Aeq})**	**Appropriate Category Value A, B or C in accordance with BS5228-1**	**Noise Level above which activities of the Construction Phase may cause a significant impact at the Receptor (dB L_{Aeq})**
ESR1	ML1	53	55	A	65
ESR2	ML2	51	50	A	65
ESR3	ML3	60	60	A	65

Noise from Demolition and Construction Vehicles

12.4.17 In addition to the demolition and construction activities, vehicle movements to and from the Proposed Development have the potential to generate noise at existing sensitive receptors, in the immediate vicinity of the local road network.

12.4.18 At this stage, detailed traffic data relating to the likely numbers of demolition and construction vehicles is not available. However, the number of demolition and construction vehicles is not considered to be significant relative to the existing flows on the major road links surrounding the development site, and will be less than the proposed development flows. It is therefore considered that the level of road traffic noise at sensitive receptor locations will not change significantly, due to demolition and construction vehicles during the demolition and construction phases of the development, and this impact has not therefore been considered further.

Vibration from the Demolition and Construction Phase

12.4.19 Work involving heavy plant on an open site is likely to generate vibration, which may, in certain circumstances, propagate beyond the boundary of the site. In situations where particularly heavy plant, vibrating compaction equipment or piling rigs are being used close to the site boundary, nearby properties may experience ground-borne vibration.

12.4.20 The existing sensitive receptors most likely to be affected by vibration generated by the demolition, earthworks and construction phase works of the development are detailed in Table 12.7 of this noise and vibration chapter.

12.4.21 Guidance on the assessment of vibration from development sites is given in British Standard 5228 -2:2009 + A1:2014 "Code of Practice for noise and vibration control on demolition and construction and open sites – Part 2: Vibration" (BS5228-2). BS5228-2 indicates that vibration can have disturbing effects on the surrounding neighbourhood; especially where particularly sensitive operations may be taking place. The significance of vibration levels which may be experienced adjacent to a site is dependent upon the nature of the source.

12.4.22 It is not possible to mitigate vibration emissions from an open site. It is important therefore to examine the proposed working method to ascertain what, if any, operations would be likely to cause unacceptable levels of vibration at nearby sensitive locations. It is possible that these operations could be modified to reduce their vibration impacts.

12.4.23 BS5228-2 indicates that the threshold of perception is generally accepted to be between a peak particle velocity (PPV) of 0.14 and 0.3mm/sec. In an urban situation it is unlikely that such vibration levels would be noticed. BS5228 also indicates that it is likely that vibration of 1.0 mm/s in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents. The standard also indicates that 10 mm/s is likely to be intolerable for any more than a very brief exposure to this level.

12.4.24 The Highways Agency Research Report No. 53 "Ground Vibration caused by Civil Engineering Works" 1986 suggests that, when vibration levels from an unusual source exceed the human threshold of perception, complaints may occur. The onset of complaints due to continuous vibration is probable when the PPV exceeds 3mm/sec.

12.4.25 British Standard BS6472: 2008 "Guide to Evaluation of human exposure to vibration in buildings. Part 1: Vibration sources other than blasting" (BS6472-1) suggests that adverse comments or complaints due to continuous vibration are rare in residential situations below a PPV of 0.8mm/sec. Continuous vibration is defined as "vibration which continues uninterrupted for either a daytime period of 16 hours or a night-time period of 8 hours". The proposed demolition, earthworks and construction works at the site will not cause continuous vibration as defined in BS6472-1.

12.4.26 Human perception of vibration is extremely sensitive. People can detect and be annoyed by vibration before there is any risk of structural damage. Cases where damage to a building has been attributed to the effects of vibration alone are extremely rare; even when vibration has been considered to be intolerable by the occupants.

12.4.27 It is not possible to establish exact vibration damage thresholds that may be applied in all situations. The likelihood of vibration induced damage or nuisance will depend upon the nature of the source, the characteristics of the intervening solid and drift geology and the response pattern of the structures around the site. Most of these variables are too complex to quantify accurately and thresholds of damage, or nuisance, are therefore conservative estimates based on a knowledge of engineering.

12.4.28 Where ground vibration is of a relatively continuous nature, there is a greater likelihood of structural damage occurring, compared to transient vibration; for example that caused by transiting vehicles.

12.4.29 BS5228-2 2009 suggests that the onset of cosmetic damage is 15mm/sec (15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz for residential or light commercial type buildings).

Road Traffic Noise

12.4.30 The operational phases of the Proposed Development will generate additional traffic movements on the existing road network. Additional vehicle movements have the potential to increase road traffic noise levels at existing receptors located adjacent to the main routes to and from the Proposed Development.

12.4.31 *'The Calculation of Road Traffic Noise'*, Department of Transport, 1988 was used to calculate the increase in road traffic noise from 2019 (baseline) and future years 2025 (Phase 1) and 2032 (Phase 2) with and without the development. The existing receptor locations have been chosen along those routes most likely to be affected by traffic associated with the proposed Development. Calculations were undertaken for the above mentioned years for both 'with' and 'without' the development in place and impacts predicted for the sensitive receptors described in Table 12.7.

12.4.32 The traffic noise for the roads surrounding the Proposed Development has been derived from the work undertaken by WSP and has been provided as 18hour Annual Average Weekday Traffic (AAWT) flows as shown within Appendix 12.6. The traffic

data has been used to calculate the traffic along the road links detailed within Appendix 12.6.

Arena and Hotel Plant, Service Yard and Red Dragon Centre

12.4.33 Any noise associated with plant and vehicles movements related to the Arena and Hotel Plant, Arena Service Yard and Red Dragon Centre will be assessed with reference to BS4142 and consultation undertaken with the SRS.

Arena Entertainment Noise, crowd noise and Atlantic Square Entertainment Noise

12.4.34 Noise associated with the Arena entertainment, crowds and Atlantic Square entertainment will be assessed with reference to the Code of Practice on Environmental Noise Control at Concerts and WHO guidelines and consultation undertaken with the SRS. The assessment will also consider the predicted ambient noise levels of the proposed noise sources in relation to residual and existing background noise levels.

Limitations

12.4.35 To reduce the level of uncertainty within the assessment the following steps have been taken:

- The background noise measurement locations were selected to be representative of the background noise level at the closest point of the receptors to the proposed new operations at the Site;
- In accordance with guidance, the sound level meter was mounted vertically on a tripod 1.5m above the ground. Monitoring locations were also more than 3.5m from any other reflecting surfaces;
- The distance between the source and nearest receptors has been measured from scale plans showing the locations of each building;
- The background noise measurements were undertaken during suitable weather conditions;
- The results of each measurement period were reported to the nearest 0.1dB; and
- Noise measurements were made using a Class 1, integrating sound level meter.

12.4.36 At this stage, detailed information regarding the nature and timescales of activities likely to take place during the earthworks and construction phase are not known.

Activities on the Site, which could give rise to construction noise impacts include (but are not limited to):

- Site preparation i.e. existing building demolition, ground excavation, levelling of ground, trenching, trench filling, unloading and levelling of hardcore and compacting filling; and
- Construction of the Proposed Development including piling, construction of access roads, fabrication processes e.g. planing, sanding, routing, cutting, drilling and laying foundations.

12.4.37 The contractor undertaking the demolition, enabling and construction works has not yet been appointed. However, it is considered that the enabling and building construction works are likely to be restricted to daytime hours, i.e. between 08:00 and 18:00 hours Monday to Friday and 08:00 to 13:00 hours on a Saturday, with no work on Sunday and Bank Holidays.

12.4.38 During the plant installation, commissioning and testing phase, it is likely that the contractor will need to work seven days a week; however, in this case the works would largely be undertaken within the completed building structure with wall and roof cladding in place.

12.4.39 Many of these unknown details will be resolved in due course once a contractor has been appointed. The information would be provided through the development of a Construction Environmental Management Plan (CEMP) that would be agreed with Cardiff Council prior to the demolition and construction phase.

12.5 Assessment of Effects

Design Solutions and Assumptions

12.5.1 This assessment has been based upon the following information:

- Site Location Plan (Appendix 1.1);
- Illustrative Masterplan (Appendix 3.3);
- Likely activities to be undertaken during the operational phase of the development;
- Traffic flow data provided by WSP;
- Predicted arena noise levels provided by Vanguardia;

- Sandy Brown Consulting undertook a noise survey of crowds at 5m from the crowd route following a music event at a London stadium on the 22nd June 2018. The survey measures levels between 63 and 67dB during any 15 minute measurement period. In order to provide a robust assessment and A-weighted sound pressure level for a crowd has been estimated at of 70dB L_{Aeq} nearest to the arena for this assessment.
- Crowd noise has been modelled as areas noise sources, covering the immediate external areas and walkways of the arena;
- It has been assumed external crowd noise would happen prior and post any event noise and therefore arena noise and external crowd noise have been assessed separately;
- It has been assumed that during an arena event, there would not be a music event within the event square (Atlantic Square);
- There are no plant details currently available for the proposed Red Dragon Centre (RDC2), therefore the assessment considers noise limits for this based upon existing background sound levels; and
- There is no detailed delivery information currently available for the arena service yard therefore the assessment considers noise limits for this based upon existing background sound levels.

Assessment of Effects

Demolition and Construction Phase

Noise from, Demolition, Earthworks and Construction Phase Activities

12.5.2 The activities associated with the demolition, earthworks and construction phase of the Proposed Development will have the potential to generate noise and create an impact on the surrounding area.

12.5.3 Demolition and construction noise can have disturbing effects on the surrounding neighbourhood. The effects are varied and are complicated further by the nature of the Site works, which will be characterised by mobile noise sources that will change location throughout the demolition and construction period. The duration of demolition and construction works is also an important consideration. Higher noise levels may be acceptable if it is known that the levels will occur for a limited period.

12.5.4 For the purposes of this assessment, the occupants of residential properties in the vicinity of the Site are considered to be the receptors most likely to be affected by the demolition and construction phases of the Proposed Development. Details of the receptors are set out in Table 12.7.

12.5.5 During the demolition, earthworks and construction phase, any work carried out at the Site is likely to generate noise that may propagate beyond the Site's boundary.

12.5.6 As stated in the limitations and assumptions sections above, detailed information regarding the nature and timescales of activities (i.e. types of vehicles and equipment and the times and length of use) likely to take place during the earthworks and construction phase are not known. Activities on the Site, which could give rise to construction related noise impacts include (but are not limited to):

- Site preparation i.e. demolition of buildings, ground excavation, levelling of ground, trenching, trench filling, unloading and levelling of hardcore and compacting filling; and
- Construction of the Proposed Development including piling, construction of access roads, fabrication processes e.g. planing, sanding, routing, cutting, drilling and laying foundations.

12.5.7 The contractor undertaking the demolition, enabling and construction works has not yet been appointed. However, for the purposes of this assessment it is assumed that the demolition, enabling and construction works will be restricted to daytime hours, i.e. between 08:00 and 18:00 hours Monday to Friday and 08:00 to 13:00 hours on a Saturday, with no work on Sunday and Bank Holidays. Based on the expected ambient noise levels during the daytime period, the appropriate category value has been determined for each of the sensitive receptors, as detailed in Table 12.10.

12.5.8 The demolition, earthworks and construction phase activities have the potential to generate short term increases in noise levels, above those recommended in BS5228-1. The levels of noise received at the receptors closest to the Proposed Development would depend on the sound power levels of the machines used, the distance to the properties, the presence of screening or reflecting surfaces and the ability of the intervening ground to absorb the propagating noise.

12.5.9 The nearest existing noise sensitive receptors to the Proposed Development, as detailed in Table 12.7, will vary depending on the phase of the Proposed Development

under demolition or construction. Given the distances between the demolition and construction activities and residential dwellings, noise levels at the existing noise sensitive receptors may at times occur above those detailed in Table 12.10.

12.5.10 Therefore, noise arising from the demolition and construction phase is likely to have a direct, temporary, medium-term effect on existing residential properties of moderate to substantial adverse significance prior to the implementation of mitigation measures. Mitigation measures are discussed within section 12.6 of this Chapter.

Vibration from Demolition, Earthworks and Construction

12.5.11 WA's archives contain field trial measurements of ground vibration associated with types of machinery likely to be used during the demolition and construction of the Proposed Development. The representative, measured levels, made by WA using a Vibrock B801 Digital Seismograph, are set out in Table 12.11.

Table 12.11: Measured Vibration Levels of Plant Under normal Operating Conditions

Plant Type	Distance from Source		
	10m (mm/s)	20m (mm/s)	30m (mm/s)
25-30 tonne excavator	0.175	0.075	Background
25 tonne dumptruck (Volvo A25)			
Loaded	1.000	0.150	Background
Empty	0.225	0.050	Background
Dozer	1.050	0.400	Background
Vibrating roller Drum			
Vibrator on	4.470	3.270	2.350
Vibrator off	0.500	0.150	0.050
Loading shovel	1.025	0.150	Background

12.5.12 The nearest sensitive receptors to the proposed demolition and construction works, as detailed in Table 12.7, will vary depending on the part of the Proposed Development under demolition or construction. As a worst-case scenario, demolition, earthworks and construction works may potentially take place at a distance of approximately 150m from existing residential properties.

12.5.13 At this distance, it is considered unlikely that vibration due to the operation of demolition or construction machinery will be above the threshold of complaint.

12.5.14 In addition to the demolition, earthworks and construction works described, it is possible that piling will be required. At this time, the type(s) of piling which would be

used at various locations across the Site is not known and it is likely that the contractor responsible for undertaking construction works at the Site would decide the method of piling.

12.5.15 BS5228-2 recognises that the most common form of vibration associated with piling is the intermittent type derived from conventional driven piling. The intensity of vibration disturbance, which may be registered at a receptor, will be a function of many factors. These are set out in BS5228-2 and include:

- Energy per blow or cycle;
- Distance between source and receptor;
- Soil structure interaction i.e. nature of connection between soil and structure being monitored; and
- Construction of structure and location of measuring points e.g. soil surface, building foundation and internal structural element.

12.5.16 As the responsible contractor has not yet been appointed, detailed information regarding the above is not known. It is not therefore possible to assess the potential impacts of vibration generated by piling.

12.5.17 Therefore, vibrations arising from the demolition and construction phase is likely to have a direct, temporary, medium-term effect on existing and proposed residential properties of moderate adverse significance prior to the implementation of mitigation measures.

12.5.18 The receptors likely to be affected by piling will vary depending on the phase of the Proposed Development under demolition and construction. Once the precise building locations, ground conditions for each location and type(s) of piling are confirmed, vibration levels could be estimated and recommendations for control made as appropriate. Mitigation measures are discussed within section 12.6 of this Chapter.

Operational Phase

Proposed Noise Sources

12.5.19 The operational phase of the development includes the following potential noise sources:

- Arena events
- External crowd noise related to the arena
- Arena and hotel associated plant
- Service yard
- Use of the public event square as an entertainment area including music events
- New Red Dragon Centre plant noise
- Plant associated with any buildings within the Proposed Development including hotels, residential and office space.

12.5.20 As there are not currently detailed information available regarding use of the service yard, events at the Atlantic Square, plant associated with the Red Dragon Centre and plant associated with other proposed buildings within the development noise limits will be proposed to consider these sources of noise.

Future Industrial/Commercial Noise from the Proposed Arena and Hotel Plant – BS4142 Assessment

Introduction

12.5.21 The arena and hotel proposed within the development will include plant with noise emissions which may be audible at the nearest residential receptors. Therefore, an industrial and commercial noise assessment has been carried out in accordance with BS4142 to assess the likely impact of noise from the development on the nearest existing and proposed residential receptors, which are ESR1-3 and PSR1. As there will be some sources of noise that continue throughout the night-time hours, a daytime and night-time assessment has been carried out.

12.5.22 Noise from the plant will likely be lower at night-time due to some plant not being utilised during this time, however this has not been specified therefore the worst-case scenario has been considered for this assessment.

Identification of the Specific Noise

12.5.23 Vanguardia have designed the arena and hotel acoustics and provided specific noise levels from the plant. The noise model provided by Vanguardia is included as Appendix 12.7. As noise from the plant will be constant, the specific noise level will be the same for daytime and night-time. The noise levels provided for each ESR are detailed in Table 12.12.

Table 12.12: Specific Noise Levels at each Receptor	
Receptor	**Daytime dB $L_{Aeq,1hour}$ / dB Night-time $L_{Aeq,15minute}$**
ESR1	40
ESR2	35
ESR3	27
PSR1	35

Application of Acoustic Feature Penalties

BS4142 discusses the application of penalties for noise sources that are tonal, intermittent and/or impulsive. Due to the low levels of the plant noise, it is considered that no acoustic features would be noticeable at the receptors and therefore none have been included within the assessment.

Identification of the Background Sound

12.5.24 Section 8 of BS4142 provides guidance on the selection of the background sound to be used in the assessment. BS4142 states that the background sound levels used for the assessment should be representative of the period being assessed (i.e. daytime or night-time periods), and that there is no "single" background sound level.

12.5.25 Monitoring was undertaken over a 24-hour period. It was therefore considered most representative to use the background noise levels throughout the daytime and night-time periods, as the plant noise will be active 24 hours a day. The background noise levels measured during each daytime and night-time period have been averaged for each ML as shown in Appendix 12.5 and summarised in Table 12.13.

Table 12.13: Background Noise Levels at Existing Sensitive Receptors		
Receptor	**Background Noise Level**	
	Daytime $L_{A90,1hr}$	**Night-time $L_{A90,15min}$**
ESR1 (ML1)	51	50
ESR2 (ML2)	42	41
ESR3 (ML3)	58	57
PSR1 (ML2)	42	41

BS4142 Assessment - Daytime

12.5.26 In accordance with BS4142, the noise rating levels for the noise sources associated with the Proposed Development, as received at the existing sensitive receptors, have been compared with the corresponding measured background sound levels during the daytime, as shown in Table 12.14.

Table 12.14: BS4142 Assessment of the Noise at Receptors in the vicinity of the Arena and Hotel Plant during the Daytime – (Figures in dB(A))

Description	Existing Residential Receptor Locations			
	ESR1	ESR2	ESR3	PSR1
Specific Sound Level i.e. noise level of the operational activities (including distance correction), dB L_{Aeq}	40	35	37	35
Acoustic feature	0	0	0	0
Rating Level, dB	40	35	37	35
Background Sound level Range for Period	51	42	58	42
Excess of rating over Background level	**-11**	**-7**	**-21**	**-7**

12.5.27 The results of the BS4142 assessment indicate that the exceedance of the noise from the arena and hotel plant is likely to be between -21 and -7dB at the receptors during the daytime. This would indicate a low impact at the ESRs that is not likely to be significant during the daytime, depending on the BS4142 context guidelines.

BS4142 Assessment – Night-time

12.5.28 In accordance with BS4142, the noise rating levels for the noise sources associated with the Proposed Development, as received at the existing sensitive receptors, have been compared with the corresponding measured background sound levels during the night-time, as shown in Table 12.15.

Table 12.15: BS4142 Assessment of the Noise at Receptors in the vicinity of the Arena and Hotel Plant during the Night-time – (Figures in dB(A))

Description	Existing Residential Receptor Locations			
	ESR1	ESR2	ESR3	PSR1
Specific Sound Level i.e. noise level of the operational activities (including distance correction), dB L_{Aeq}	40	35	37	35
Acoustic feature	+0	+0	+0	+0
Rating Level, dB	40	35	37	35
Background Sound level Range for Period	50	41	57	41
Excess of rating over Background level	**-10**	**-6**	**-20**	**-6**

12.5.29 The results of the BS4142 assessment indicate that the exceedance of the noise from the Proposed Development is likely to be between -19 and -5dB at the ESRs. This would indicate a low impact at the ESRs that is not likely to be significant during the night-time, depending on context.

BS4142 Context Assessment

12.5.30 BS4142:2014 states; *"The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound sources exceeds the background sound level and the context in which the sound occurs".*

12.5.31 The first requirement of this statement has been determined within the noise impact assessment section above. To determine the context in which the proposed industrial sound will reside, three factors must be considered, these are;

- The absolute level of sound;
- The character and level of the residual sound compared to the character and level of the specific sound; and
- The sensitivity of the receptor.

Absolute Level of Sound

12.5.32 The impact of a given difference between rating level and background noise level will depend upon whether the residual sound level is low or high. The assessment has demonstrated that the residual sound is moderate, and the rating levels are low, therefore the margin by which the rating level exceeds the background sound is considered most relevant.

12.5.33 Given that plant from the Arena and Hotel are, for the most part, likely to be inaudible at the existing sensitive receptors, it is considered likely that the noise impact would be less than shown in Tables 12.14 and 12.15 for the day and night-time respectively.

Character and Level of Residual Sound compared to the Character and Level of the Specific Sound

12.5.34 The character of the noise from plant at the hotel and arena is likely to be broadband in nature. Therefore, given that the surrounding acoustic environment is dominated by road traffic noise, which is also a broadband source, the plant could be considered similar to the existing noise character of the area. Also, as the residual noise levels at

each receptor are significantly higher than the predicted specific noise levels from the plant. This would suggest that it is unlikely that noise from the plant would be distinguishable against existing noise.

Sensitivity of Receptor and Existing Acoustic Conditions

12.5.35 Due to the existing noise levels at each receptor, existing sensitive receptors are already exposed to noise levels that are significantly higher than the specific sound from plant at the Arena or Hotel. Furthermore, the ambient noise levels would not increase due to the introduction of the plant. Therefore, the sensitivity of the existing sensitive receptors remains unchanged as does their acoustics conditions.

12.5.36 Proposed sensitive receptors would be designed to achieve suitable noise levels incorporating glazing, acoustic ventilation and barriers where necessary and would therefore have a low sensitivity.

Summary of the BS4142 Assessment

12.5.37 When considering the Site context, and in accordance with BS4142, noise from the plant at the arena and hotel could cause a **low impact** at each receptor during the daytime and night-time with no additional mitigation in place.

12.5.38 In addition to the above the rating levels all fall 5dB below background noise levels as agreed with the Shared Regulatory Services (SRS) proposed noise limits.

12.5.39 The impact of the proposed arena and hotel plant noise would therefore have no significant effect with no further mitigation measures in place.

Future Plant Noise from deliveries associated with the Service Yard – BS4142 Assessment

Introduction

12.5.40 The proposed arena will include a service yard with noise emissions which may be audible at the nearest residential receptors. Therefore, an industrial and commercial noise assessment has been carried out in accordance with BS4142 to assess the likely impact of noise from the service yard on the nearest existing and proposed residential receptors.

12.5.41 The service yard will only accept 6 lorries/buses at any one time. Any remaining vehicles will wait off site until there is space to access the service yard. At the busiest

times, 6 vehicles will access the service yard at once. The vehicles will then be loaded/unloaded and leave the service yard.

12.5.42 The BS4142 assessment will consider the impact of noise from the vehicles and relating activities whilst they are in the service yard.

12.5.43 As there will be some activities continuing throughout the night-time hours, a daytime and night-time assessment has been carried out.

12.5.44 Noise levels from the proposed activities within the service yard are not known. Noise limits will therefore be proposed based on existing background noise levels. It is assumed that the noise limits of 5dB below background noise as proposed for the hotel arena plant, will also be acceptable for the service yard.

Application of Acoustic Feature Penalties

12.5.45 The service yard is roofed reducing noise emissions from the area. It is considered that impulsivity may be just noticeable due to bangs relating to loading/unloading at times, therefore a +3dB correction has been applied to account for this.

Identification of the Background Noise

12.5.46 As the service yard could be active 24 hours a day, it was considered most representative to use the background noise levels throughout the daytime and night-time periods. The background noise levels measured during each daytime and night-time period have been averaged for each ML as shown in Appendix 12.5.

12.5.47 The nearest receptors to the proposed delivery area are ESR2 and PSR1. The daytime and night-time background noise levels used for the assessment are summarised in Table 12.16.

Table 12.16: Background Noise Levels at Existing Sensitive Receptors

Receptor	Background Noise Level L_{A90}	
	Daytime	Night-time
ESR2 – ML2 monitoring data	42	41
PSR1 – ML2 monitoring data	42	41

BS4142 Assessment

12.5.48 In accordance with BS4142, the background noise levels have been used to determine noise limits at each receptor as detailed in Table 12.17.

Table 12.17: BS4142 Assessment of the Noise at Receptors in the vicinity of the Arena Service Yard – (Figures in dB(A))				
Description	**Existing Residential Receptor Locations**			
	ESR2		**PSR1**	
	Daytime	**Night-time**	**Daytime**	**Night-time**
Background Noise level	42	41	42	41
Acoustic Feature Correction	-3	-3	-3	-3
SRS requirement below	-5	-5	-5	-5
Proposed Noise limit	**34**	**33**	**34**	**33**

12.5.49 The results of the BS4142 assessment indicate any delivery noise should not exceed 34dB $L_{Aeq,\ 1hr}$ during the daytime and 33dB $L_{Aeq,\ 15\ minutes}$ during the night-time at the nearest receptors. Standard measures can be followed in order to achieve the proposed noise limit such as:

- Close doors to delivery yard during deliveries;
- No idling engines;
- Stagger deliveries to avoid multiple deliveries at one time; and
- Minimise night-time deliveries.

12.5.50 If delivery noise does not exceed the proposed noise limits, deliveries would have a **Low Impact** on the nearest receptors.

12.5.51 The impact of the proposed service yard noise would therefore have no significant effect with no further mitigation measures in place.

Future Plant Noise from the Proposed Red Dragon Centre – BS4142 Assessment

Introduction

12.5.52 The new Red Dragon Centre (RDC2) proposed within the development will include plant with noise emissions which may be audible at the nearest residential receptors. Therefore, an industrial and commercial noise assessment has been carried out in accordance with BS4142 to assess the likely impact of noise from the development on the nearest existing and proposed residential receptors. As there will be some activities continuing throughout the night-time hours, a daytime and night-time assessment will be carried out.

12.5.53 There is currently no noise source data available for proposed plant associated with the Red Dragon Centre. Noise limits will therefore be proposed based on existing

background noise levels. It is assumed that the noise limits of 5dB below background noise as proposed for the hotel arena plant, will also be acceptable for the Red Dragon Centre.

Application of Acoustic Feature Penalties

12.5.54 As there is no noise source data available for the proposed plant at this stage, it is not yet known if there will be any acoustic features. However, as it is plant noise it is assumed that it would not be intermittent or impulsive. Due to the proximity of the new Red Dragon Centre to receptors it is also considered unlikely that any tonal feature would be more than slightly noticeable. Therefore, to provide a robust assessment a +3dB penalty will be included.

Identification of the Background Noise

12.5.55 As the plant noise will be active 24 hours a day, it was considered most representative to use the background noise levels throughout the daytime and night-time periods. The background noise levels measured during each daytime and night-time period have been averaged for each ML as shown in Appendix 12.5.

12.5.56 The nearest receptors to the proposed Red Dragon Centre are ESR3 and PSR1. The daytime and night-time background noise levels used for the assessment are summarised in Table 12.18.

Table 12.18: Background Noise Levels at Existing Sensitive Receptors

Receptor	Background Noise Level L_{A90}	
	Daytime	Night-time
ESR3 – ML3 monitoring data	58	57
PSR1 – ML2 monitoring data	42	41

Distance Correction

12.5.57 The nearest receptors will be at least 90m from any proposed plant associated with the new Red Dragon Centre. Therefore, a point source distance correction of 20dB has been applied to the proposed noise limit.

BS4142 Assessment

12.5.58 In accordance with BS4142, the background noise levels have been used to determine noise limits at each receptor as detailed in Table 12.19.

Table 12.19: BS4142 Assessment of the Noise at Receptors in the vicinity of the Red Dragon Centre Plant– (Figures in dB(A))				
Description	**Existing Residential Receptor Locations**			
	ESR3		**PSR1**	
	Daytime	**Night-time**	**Daytime**	**Night-time**
Background Noise level	58	56	42	40
Acoustic Feature Correction	-3	-3	-3	-3
SRS requirement below	-5	-5	-5	-5
Point Source correction	+20	+20	+20	+20
Proposed Noise limit	**70**	**68**	**54**	**52**

12.5.59 The results of the BS4142 assessment indicate any plant associated with the new Red Dragon Centre that is placed at the closest point to receptors should not exceed 52dB at 1m. Plant that is placed further away and/or screened from the receptors could have a higher noise level.

12.5.60 If noise from any proposed plant does not exceed the proposed noise limit, it will have a **low impact**.

12.5.61 The impact of the proposed Red Dragon Centre plant noise would therefore have no significant effect with no further mitigation measures in place.

Future Plant Noise from the Proposed Hotels, Residential Buildings and Office Space – BS4142 Assessment

Introduction

12.5.62 The Proposed Development will include hotel buildings, residential buildings and office space which may include plant with noise emissions which may be audible at the nearest residential receptors. Therefore, an industrial and commercial noise assessment has been carried out in accordance with BS4142 to assess the likely impact of noise from the development on the nearest existing and proposed residential receptors. As there may be some activities continuing throughout the night-time hours, a daytime and night-time assessment will be carried out.

12.5.63 There is currently no noise source data available for proposed plant associated with proposed buildings within the development. Noise limits will therefore be proposed based on existing background noise levels. It is assumed that the noise limits of 5dB below background noise as proposed for the hotel arena plant, will also be acceptable for other proposed plant.

Application of Acoustic Feature Penalties

12.5.64 As there is no noise source data available for the proposed plant at this stage, it is not yet known if there will be any acoustic features. However, as it is plant noise it is assumed that it would not be intermittent or impulsive. Due to the proximity of the new Red Dragon Centre to receptors it is also considered unlikely that any tonal feature would be more than slightly noticeable. Therefore, to provide a robust assessment a +3dB penalty will be included.

Identification of the Background Noise

12.5.65 As the plant noise will be active 24 hours a day, it was considered most representative to use the background noise levels throughout the daytime and night-time periods. The background noise levels measured during each daytime and night-time period have been averaged for each ML as shown in Appendix 12.3.

12.5.66 The nearest receptors to the proposed buildings within the development which may include plant are ESR3 and PSR1. The daytime and night-time background noise levels used for the assessment are summarised in Table 12.20.

Table 12.20: Background Noise Levels at Existing Sensitive Receptors

Receptor	Background Noise Level L_{A90}	
	Daytime	Night-time
ESR3 – ML3 monitoring data	58	57
PSR1 – ML2 monitoring data	42	41

BS4142 Assessment

12.5.67 In accordance with BS4142, the background noise levels have been used to determine noise limits at each receptor as detailed in Table 12.21.

Table 12.21: BS4142 Assessment of the Noise at Receptors in the vicinity of the Red Dragon Centre Plant– (Figures in dB(A))

Description	Existing Residential Receptor Locations			
	ESR3		PSR1	
	Daytime	Night-time	Daytime	Night-time
Background Noise level	58	57	42	41
Acoustic Feature Correction	-3	-3	-3	-3
SRS requirement below	-5	-5	-5	-5
Proposed Noise limit at Receptors	**50**	**49**	**34**	**33**

12.5.68 The results of the BS4142 assessment indicate any plant associated with any proposed buildings within the Proposed Development should not exceed those limits identified in Table 12.21.

12.5.69 If noise from any proposed plant does not exceed the proposed noise limit, it will have a **low impact**.

12.5.70 The impact of the plant noise associated with any buildings within the Proposed Development would therefore have no significant effect with no further mitigation measures in place.

Future Noise from the Proposed Arena Events – Assessment

Introduction

12.5.71 The arena proposed within the development will hold events which may be audible at the nearest residential receptors. Therefore, a noise assessment has been carried out in accordance with relevant guidelines to assess the likely impact of noise from the development on the nearest existing and proposed residential receptors, which are ESR1-3 and PSR1. The events will only occur during daytime hours, therefore only a daytime assessment has been undertaken for the entertainment noise.

12.5.72 The Code of Practice on Entertainment Noise Control at Concerts suggests noise guideline levels for concert noise, however the guidelines only consider venues that will hold up to 30 events per calendar year. The guidelines suggest that venues that hold up to 30 events per year should not exceed the background noise level by more than 5dB at receptors. In order not to inhibit the use of the arena to a certain number of events, it has been agreed with SRS to achieve a noise level at the nearest receptors of no more than 10dB below L_{A90} at receptors.

12.5.73 The guidelines also suggest that low frequency noise should be considered for certain types of events. It is likely that the arena will hold some events that have relatively high, low frequency noise levels. It has therefore been agreed with SRS to achieve noise limits of no more than 3dB below background noise levels for 63Hz and 125Hz. It has also been agreed that where background noise levels are very low, the noise levels will not be required to achieve levels lower than 57dB and 51dB for 63Hz and 125Hz respectively based on NANR as described in Appendix 12.3.

Identification of the Arena Entertainment Noise Emissions

12.5.74 Vanguardia has designed the arena and provided the predicted noise levels from the arena during an event at each receptor. The noise model for this is also shown in Appendix 12.7. As the SRS have requested noise limits for frequencies of 63Hz and 125Hz, specific noise levels have been provided for these also. The noise levels provided for each receptor are detailed in Table 12.22.

Table 12.22: Operational Noise Levels at each Receptor during the Daytime dB(A)

Receptor	L_{eq}	L_{eq} 63Hz	L_{eq} 125Hz
ESR1	29	53	37
ESR2	32	57	41
ESR3	25	49	33
PSR1	29	53	37

Identification of the Background Noise

12.5.75 In order not to restrict the potential hours of use of the arena, it was considered most robust to use the background noise levels throughout the daytime. The average background noise levels for each ML are shown in Appendix 12.5 and are summarised in Table 12.23.

Table 12.23: Background Noise Levels at Sensitive Receptors during the Daytime dB(A)

Receptor	L_{A90}	L_{90} 63Hz	L_{90} 125Hz
ESR1 – ML1 monitoring data	51	53	53
ESR2 – ML2 monitoring data	42	57	48
ESR3 – ML3 monitoring data	58	66	62
PSR1 – ML2 monitoring data	42	57	48

Assessment

12.5.76 The L_{A90s} for the noise sources associated with the arena, as received at the existing sensitive receptors, have been compared with the corresponding background noise levels and proposed limits during the daytime, as shown in Table 12.24.

Table 12.24: Assessment of the Noise at Receptors in the vicinity of the Arena during the Daytime – (Figures in dB(A))

Description	Existing Residential Receptor Locations			
	ESR1	ESR2	ESR3	PSR1
Predicted Noise Level dB L_{Aeq}	29	32	25	29
Background Noise level L_{A90}	51	42	58	42
Proposed Noise Limit	41	32	48	32

Excess of precited noise level over proposed noise limit	**-12**	**0**	**-23**	**-3**

12.5.77 The arena at 63Hz and 125Hz, as received at the existing sensitive receptors, have been compared with the proposed noise limits during the daytime, as shown in Table 12.25.

Table 12.25: Assessment of the 63Hz and 125Hz Noise at Receptors in the vicinity of the Arena during the Daytime – (Figures in dB(A))

Description	**Existing Residential Receptor Locations**							
	ESR1		**ESR2**		**ESR3**		**PSR1**	
	63Hz	**125Hz**	**63Hz**	**125Hz**	**63Hz**	**125Hz**	**63 Hz**	**125Hz**
Predicted Noise Level dB L_{Aeq}	53	37	57	41	49	33	53	37
Background Noise Level L_{A90}	53	53	57	48	66	62	57	48
Proposed noise limit	57	51	57	51	63	59	57	51
Excess of rating over noise limit	**-4**	**-14**	**0**	**-10**	**-14**	**-18**	**-4**	**-14**

12.5.78 The results of the Table 12.24 and Table 12.25 indicate that the arena noise will not exceed the proposed noise limits at the receptors during the daytime. This would indicate that the impact at the receptors is not likely to be significant during the daytime.

12.5.79 The impact of the proposed arena would therefore have no significant effect with no further mitigation measures in place.

Future Noise from the Proposed Crowds Associated with Arena Events

Introduction

12.5.80 The arena proposed within the development will hold events which could involve external crowd noise of up to 15,000 people. Therefore, a noise assessment has been carried out to assess the likely impact of noise from the crowds on the nearest existing and proposed residential receptors. The assessment considers the worst effected receptors which are ESR2 and PSR1. The crowd noise may occur during daytime and night-time hours, therefore a daytime and night-time assessment has been undertaken for the crowd noise.

12.5.81 The predicted crowd noise will be assessed in comparison to the existing background noise levels and residual noise levels

Precited Crowd Noise Levels at Receptors

12.5.82 Crowd noise had been assumed to be approximately 70dB as established in Section 12.5 of this Chapter, and has been modelled as an area source as shown in Figure 12.3, Appendix 12.8. The crowd noise is predicted to be the same during daytime and night-time, therefore only one figure has been calculated. The noise levels have been calculated at each receptor as detailed in Table 12.26.

Table 12.26: Specific Noise Levels $L_{Aeq,15min}$ at each Receptor during the Daytime and Night-time dB(A)

Receptor	Daytime and Night-time
ESR2	61
PSR1	61

Identification of the Background Noise

12.5.83 Monitoring was undertaken over a 24-hour period. It was therefore considered most representative to use the background noise levels throughout the daytime and night-time periods. The background noise levels used for the assessment are summarised in Table 12.27.

Table 12.27: Background Noise Levels at Sensitive Receptors during the daytime and night-time

Receptor	Daytime L_{A90}	Night-time L_{A90}
ESR2 – ML2 monitoring data	42	41
PSR1 – ML2 monitoring data	42	41
Note – $L_{Aeq\ levels}$ are considered representative for the assessment of the short period in which crowds would leave the area.		

Identification of the Residual Noise Level

12.5.84 The residual noise levels are shown in Table 12.9 and summarised for ESR2 and PSR1 in Table 12.28.

Table 12.28: Residual Noise Levels at Sensitive Receptors during the daytime and night-time

Receptor	Daytime $L_{Aeq,15min}$	Night-time $L_{Aeq,15min}$
ESR2 – ML2 monitoring data	51	46
PSR1 – ML2 monitoring data	51	46

Assessment

12.5.85 The noise levels associated with the crowds as received at the sensitive receptors, have been compared with the corresponding measured background noise levels and residual noise level during the daytime, as shown in Table 12.29.

Table 12.29: Assessment of the Noise at Receptors in the vicinity of the crowds during the Daytime– (Figures in dB(A))				
Description	**Existing Residential Receptor Locations**			
	Daytime		**Night-time**	
	ESR2	**PSR1**	**ESR1**	**PSR1**
Predicted Noise Level at Receptor dB L_{Aeq}	61	61	61	61
Background Noise level L_{A90}	42	42	40	40
Residual Noise Level L_{Aeq}	51	51	46	46
Excess of rating over Background level	**+19**	**+19**	**+21**	**+21**
Excess of Crowd Noise over Residual level	**+10**	**+10**	**+15**	**+15**

12.5.86 The results of the Table 12.29 indicate that the exceedance of the noise from the arena is likely to be between 19dB above background noise level at the receptors during the daytime and 21dB during the night-time. The Table also indicates that the excess of crowd noise could be 10dB above residual during the daytime and 15dB above residual during the night-time.

12.5.87 The residual and background noise levels at the receptors are relatively low. It should also be noted that these locations will already be subject to some crowd noise due to the existing land uses in this area. However, as the predicted noise level is significantly higher than the background and residual noise level it is likely that with no mitigation in place, the crowd noise could have a substantial effect on receptors.

12.5.88 Mitigation measures are discussed further in section 12.6

Future Noise from events at the public square during events – BS4142 Assessment

Introduction

12.5.89 The proposed Atlantic Square within the development will hold events which may be audible at the nearest residential receptors. Therefore, a noise assessment has been carried out in accordance with relevant guidelines to assess the likely impact of noise from the development on the nearest existing and proposed residential receptors, which are ESR2 and PSR1. The events will only occur during daytime hours, therefore only a daytime assessment has been undertaken for the entertainment noise.

12.5.90 It is unknown at this stage what the full range of events would be and how they would be carried out, therefore there is no noise source data available for the events. Noise limits will therefore be proposed based on existing background noise levels.

12.5.91 The Code of Practice on Entertainment Noise Control at Concerts suggests noise guideline levels for concert noise that depend on the number of events held per year. The guidelines suggest noise limits for numbers of events between 1 and 3, 4 and 12 and up to 30 events. It is considered unlikely that the area will hold less than 4 or more, therefore this has not been considered further.

12.5.92 The proposed limits for 4 to 12 events per year is no more than 15dB above background noise for more than a 15 minute period at receptors. The proposed limit for up to 30 events per year is no more than 5dB above background noise for more than a 15 minute period at receptors. Both of these noise limits will be considered.

12.5.93 It is likely that the area will hold some events that have relatively high, low frequency noise levels. It is therefore considered that the noise limits as agreed with SRS for the arena noise should be implemented here. These noise limits are no more than 3dB below background noise levels for 63Hz and 125Hz or no more than 57dB and 51dB for 63Hz and 125Hz respectively.

Identification of the Background Noise

12.5.94 In order not to restrict the potential hours of use of the area, it was considered most robust to use the background noise levels throughout the daytime. The average background noise levels for each ML are shown in Appendix 12.5 and are summarised in Table 12.30.

Table 12.30: Background Noise Levels at Sensitive Receptors during the Daytime dB(A)

Receptor	L_{A90}	L_{90} 63Hz	L_{90} 125Hz
ESR1 – ML1 monitoring data	51	53	53
ESR2 – ML2 monitoring data	42	57	48
ESR3 – ML3 monitoring data	58	66	62
PSR1 – ML2 monitoring data	42	57	48

Assessment

12.5.95 In accordance with guidance, the background noise levels have been used to determine noise limits at each receptor as detailed in Table 12.31.

Table 12.31: Assessment of the 63Hz and 125Hz Noise at Receptors in the vicinity of the Arena during the Daytime – (Figures in dB(A))						
Description	**Existing Residential Receptor Locations**					
	ESR2			**PSR1**		
	A weighted	**63Hz**	**125Hz**	**A Weighted**	**63 Hz**	**125Hz**
Background Noise Level L_{90}	42	57	48	42	57	48
Proposed L_{Aeq} Noise Limit 4-12 events per year	57	57	51	57	57	51
Proposed L_{Aeq} Noise Limit up to 30 events per year	47	57	51	57	57	51

12.5.96 The results in Table 12.31 indicate that depending on the number of events, noise from events within the public event square should not exceed an L_{Aeq} of 57dB or 47dB at ESR2 and PSR1 for 4 to 12 events or up to 30 events respectively. Low frequency noise levels should not exceed 57dB and 51dB at 63Hz and 125Hz respectively. There is potential that during a music event these noise levels could therefore have a substantial effect on receptors with no mitigation in place.

12.5.97 Mitigation could therefore be required during events. Outline mitigation measures will be discussed further in section 12.6.

Future Traffic Noise at Existing Sensitive Properties

12.5.98 The operational phase of the development will generate additional traffic on the existing road network. CRTN predictions have been carried out to assess any potential changes in road traffic noise at existing and proposed receptor locations. Due to the operation of the development for the following scenarios:

- Scenario 1: 2019 Baseline;
- Scenario 2: 2025 Future Year without Proposed Development;
- Scenario 3: 2025 Future Year with Proposed Development Phase 1;
- Scenario 4: 2032 Future year without Proposed Development;
- Scenario 5: 2032 Future Year with total Proposed Development.

12.5.99 The existing receptor locations (identified as ESR1-ESR3 on figure 12.1, Appendix 12.8) have been chosen along those routes most likely to be affected by traffic associated with the Proposed Development.

12.5.100 The results of the road traffic assessment at existing sensitive receptors for each of the five scenarios are shown for the façade which is likely to be impacted the most. The results of the assessment are detailed in table 12.32 below and include the noise impact for each existing sensitive receptor in accordance with the significance criteria stated in the methodology section of this chapter. The traffic noise levels for each scenario are also shown in Figures 12.4-12.8 respectively in Appendix 12.8.

Table 12.32: Predictions for the 2019, 2025 and 2032 With and Without Development Scenarios and Changes in Predicted Road Traffic Noise Levels

Existing Sensitive Receptor Number	Predicted $L_{10\ 18hour}$ dB(A) at the façade of the Receptor					Change in Predicted Road Traffic Noise Levels (Figures in dB(A))		Noise Impact Criteria
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	2025	2032	
ESR1	48.1	48.1	46.1	48.1	46.1	-2.0	-2.0	Negligible
ESR2	52.4	48.7	48.8	48.8	48.9	+0.1	+0.1	Negligible
ESR3	56.7	52.8	52.9	52.9	52.9	+0.1	+0	Negligible

12.5.101 The changes in noise levels have been assessed against the significance criteria contained in the methodology section of this chapter. The results show that the highest increase will be a 0.1dB(A) at sensitive receptors when comparing the 'with development' and 'without development' scenarios in 2025 and 2032. The assessment shows that the impact of the traffic noise associated with the proposed development would be negligible and have no significant impact on receptors.

Assessment of Ambient Noise Impact at Proposed Sensitive Receptors

Assessment of Existing Daytime Noise Levels in Outdoor Living Areas

12.5.102 Noise levels measured at ESR1 are considered representative of noise levels at the proposed residential receptors. Table 12.8 shows that during the daytime, noise levels affecting the areas of development site would be 53.3dB L_{Aeq}. The BS8233 guidance

level of 55dB L_{Aeq} will not be exceeded in any outdoor living areas within the Proposed Development therefore no mitigation will be required.

Assessment of Predicted Daytime Noise Levels in Living Rooms and Bedrooms

12.5.103 The existing daytime noise levels, as detailed in Table 12.8, have been used to determine the noise levels likely at the façades of residential properties within the Proposed Development during the daytime period.

12.5.104 Before internal noise levels can be calculated 3dB(A) must be added to the freefield measured levels to allow for the reflection of noise from the proposed housing façades when the buildings are in place.

12.5.105 The calculated noise levels at the façades of the properties, together with the level of attenuation required to achieve 35dB L_{Aeq} in the living room and bedroom areas, are summarised in Table 12.33.

Table 12.33: Façade Noise Level at Properties within the Proposed Development and Level of Attenuation Required to Achieve the Internal Daytime Noise Guideline Level (Figures in dB(A))

Residential Properties	Noise Level at the Façade of the Property	Level of Attenuation Needed To Achieve Noise Guideline Level in Living Room and Bedroom Areas
PSR1 (Monitoring Location 1)	56.3	21.3

12.5.106 The façades of the buildings further into the Site will be protected by the buildings themselves and/or screened by other buildings. It is considered that the noise levels at these façades, and therefore the level of attenuation the façades would need to provide, to achieve noise guidance levels in accordance with BS8233, will be less than those detailed in Table 12.33.

12.5.107 With windows open, the attenuation provided by the façade will be approximately 13dB(A). It is therefore likely that some rooms, most exposed to surrounding noise sources, will require mitigation.

Assessment of Night-time Noise Levels in Bedrooms

12.5.108 The measured night-time noise levels, as detailed in Table 12.8, have been used to determine the noise levels likely at the façades of properties in the vicinity of the monitoring locations, during the night-time period.

12.5.109 To be robust, the noise levels at these façades are based on the highest maximum noise levels measured during the night-time survey. Before internal noise levels can be calculated 3dB(A) must be added to the freefield measured levels to allow for the reflection of noise from the proposed housing facades when the buildings are in place.

12.5.110 The calculated noise levels at the façades of properties, together with the level of attenuation required to achieve 30dB L_{Aeq} and 45dB $L_{Amax,f}$ in the bedrooms, are summarised in Table 12.34.

Table 12.34: Façade Noise Level at Residential Properties in the Proposed Development and Level of Attenuation Required to Achieve the Internal Night-time Noise Guideline Levels (Figures in dB(A))

Residential Properties	Noise Level at the Façade of the Property (L_{Aeq})	Maximum Noise Level at the Façade of the Property ($L_{Amax,f}$)	Level of Attenuation Needed To Achieve the Noise Guideline Levels in Bedrooms
PSR1 (ML 1)	54.2	62.1	24.2

12.5.111 The façades of the buildings further into the Site will be protected by the buildings themselves and/or screened by other buildings. It is considered that the noise levels at these façades, and therefore the level of attenuation the façades would need to provide, to achieve noise guidance levels in accordance with BS8233, will be less than those detailed in Table 12.34.

12.5.112 With windows open, the attenuation provided by the façade will be approximately 13dB(A). It is therefore likely that rooms most exposed to surrounding noise sources will not achieve BS8233 noise guidance levels during the night-time with windows open. It is therefore likely that mitigation would be required to attenuate internal noise during the night-time in some bedrooms.

Assessment Summary

The assessment has concluded the following effects for each noise and vibration source summarised in Table 12.35.

Table 12.35: Assessment Summary

Source	Effect
Demolition and Construction Noise	Moderate to Substantial (short-term)

Demolition and Construction Vibration	Moderate (short-term)
Proposed Arena and Hotel Plant Noise	None
Proposed Service Yard Noise	None
Proposed Red Dragon Centre Plant Noise	None
Proposed Plant associated Proposed Hotels, Residential Buildings and Office Space	None
Proposed Arena Entertainment Noise	None
Proposed Arena Associated Crowd Noise	Substantial
Proposed Atlantic Square Entertainment Noise	Substantial

12.6 Mitigation

Demolition and Construction Phase

Noise from Demolition, Earthworks and Construction

12.6.1 To reduce the potential impact of noise levels generated by the demolition and construction phase of the Proposed Development at existing receptor locations in the immediate vicinity of the Site, mitigation measures will be required.

12.6.2 Best working practice will be implemented during each phase of the demolition, earthworks and construction works at the Site. The demolition and construction works will follow the guidelines in BS5228-1 and the guidance in BRE Controlling particles, vapour and noise pollution from construction Sites, Parts 1 to 5, 2003.

12.6.3 The following measures would be put in place to minimise noise emissions:

- When works are taking place within close proximity to those sensitive receptors identified, screening of noise sources by temporary screen may be employed;
- All machinery should be regularly maintained to control noise emissions, with particular emphasis on lubrication of bearings and the integrity of silencers;
- Site staff should be aware that they are working adjacent to a sensitive area and avoid all unnecessary noise due to misuse of tools and equipment, unnecessary shouting and radios;

- A further measure to reduce noise levels at the sensitive receptors would include, as far as possible, the avoidance of two noisy operations occurring simultaneously in close proximity to the same sensitive receptor;
- Adherence to any time limits imposed on noisy works by the local authority;
- Implement set working hours during the week and at weekends;
- Ensure engines are turned off when possible; and
- Should demolition, earthworks or construction activities need to be carried out during night-time hours, the local authority could include a planning condition which requests advance notice and details of any night working to provided.

Vibration from Demolition, Earthworks and Construction

12.6.4 BS5228-2 recognises that the most common form of vibration associated with piling is the intermittent type derived from conventional driven piling.

12.6.5 To minimise the potential for vibration to be generated by any necessary piling it is recommended that careful consideration is given to the type of piling to be used. For example auger bored piles would be preferable to driven piles with regards to a reduced potential for noise and vibration to be generated. However, it is recognised that the piling process will need to be selected on the basis of the strata to be encountered, the loads to be supported and the economics of the system.

12.6.6 The receptors likely to be affected by piling will vary depending on the phase of the Proposed Development under demolition or construction. Once the precise building locations, ground conditions for each location and type(s) of piling are confirmed, vibration levels could be estimated and recommendations for control made as appropriate.

12.6.7 To keep ground borne vibration to a minimum the following measures, as referred to in BS5228-2, should be put in place:

- Substitution: Where reasonably practicable, plant and or methods of work likely to cause significant levels of vibration at the receptors identified, should be replaced by less intrusive plant/methods of working; and
- Vibration isolation of plant at source: This may prove a viable option where the plant is stationary (e.g. a compressor, generator) and located close to a receptor.

12.6.8 There are a number of measures which can be implemented, depending upon the type of piling chosen. BS5228-2 indicates that mitigation might include: use of alternative methods, removal of obstructions, provision of cut-off trenches, reduction of energy input per blow, reduction of resistance to penetration. Continuous flight augering would cause minimal vibration even when very close to the piling operation.

12.6.9 As the demolition and construction programme and methodologies become more defined it is suggested that demolition, earthworks and construction vibration be reconsidered and that a detailed strategy for control be implemented.

Operational Phase

Future Road Noise at Proposed Sensitive Receptors

12.6.10 The noise levels predicted at the proposed sensitive receptor locations, for the 'Without Development' and 'With Development' scenarios in 2025 and 2032, have been compared.

12.6.11 The results indicate that the increase in road traffic noise at proposed receptors due to the Proposed Development will be below the threshold of perception and will not be significant. Additional mitigation measures are therefore not necessary for the existing sensitive receptor locations.

Predicted Noise from Proposed Arena and Hotel

12.6.12 No mitigation measures will be required in order to reduce existing noise levels to meet guidance noise levels in outdoor living spaces throughout the Site.

Predicted Noise from Arena Service Yard

12.6.13 In order for any deliveries to have a low impact on receptors, deliveries should not exceed 34dB during the daytime and 33dB during the night-time at the nearest receptors. The following measures can be put in place in order to reduce noise levels:

- Noise management plan;
- Closing doors to delivery yard during deliveries;
- No idling engines;
- Stagger deliveries to avoid multiple deliveries at one time; and
- Minimise night-time deliveries.

12.6.14 Existing mitigation measures include the following:

- Only 6 vehicles at one time allowed access to the service yard;
- Vehicles awaiting access will remain off site; and
- No more than 30 vehicles per day will access the site.

Predicted Noise from New Red Dragon Centre

12.6.15 In order for any plant to have a low impact on receptors, any plant located at the nearest point to receptors should not exceed 52dB at 1m. Alternatively, plant could be placed further away from the receptors and/or screened from the receptors by bespoke barriers or selecting a location for the plant that is facing away from receptors.

Predicted Noise from Plant Associated with Proposed Hotels, Residential Buildings and Office Space

12.6.16 In order for any plant to have a low impact on receptors, any plant located should not exceed 5dB below background noise levels. In order to achieve this, plant with appropriate noise emissions can be selected. Plant can also be situated at locations furthest from receptors and on the screened side of buildings, or mitigation, such as noise barriers could be utilised.

Predicted Noise from Arena External Crowd Noise

12.6.1 Prior and post events within the arena, large crowds are expected which could have an impact on receptors. In order to minimise the impact from crowd noise, mitigation measures can be included as part of an Operational Management Plan (OMP). The OMP could include mitigation measures such as the following:

- Ensure safe and convenient site access to quickly move crowds into or away from the arena;
- Prepare crowd management plans to divert crowds away from sensitive areas where practical;
- Minimise pedestrian and transport disruption;
- Encourage phased arrivals by:
    - Offer entertainment before/after events;
    - Stagger the start and/or finish of events;

- Make early arrival or late departure enticing by offering good catering and welfare facilities;

- Ensure all key public exits are unlocked, pedestrian routes are clear and emergency arrangements are in place;
- Adopt an efficient queueing and security checking system;
- Install good signage to move crowds away smoothly; and
- Liaise with police and transport providers prior to events where necessary.

Predicted Noise from event within the Atlantic Event Square

12.6.2 During events within the public event square, there could potentially be an adverse impact at existing and proposed receptors with no mitigation in place. In order to minimise the impact from any proposed events, particularly any live music events mitigation measures should be included. The following measures are recommended:

- Liaising with police and environmental health prior to events;
- Preparation of a Noise Risk Assessment for each event;
- Appropriate level of sound equipment used for the predicted audience size;
- Direct speakers away from receptors;
- Use of sound system with relatively low powered speakers sited around the premises;
- Control of low frequency noise levels;
- Use of noise limiters on music equipment; and,
- Employ a sound engineer for events to check and manage sound levels and make adjustments as required.

Outdoor Noise at Proposed Sensitive Receptors

12.6.3 No mitigation measures will be required in order to reduce existing noise levels to meet guidance noise levels in outdoor living spaces throughout the Site.

Internal Daytime and Night-time Noise at Proposed Sensitive Receptors

12.6.4 With windows open, the attenuation provided by the façade will be approximately 13dB(A). It is therefore likely that some rooms will not achieve BS8233 guidance levels

during the daytime and night-time with windows open. It is therefore likely that mitigation would be required to attenuate internal noise during the night-time in some bedrooms.

12.6.5 When assessing noise levels in living rooms and bedrooms, the noise attenuation provided by the overall building façade should be considered. To mitigate noise levels the composition of the building façade can be designed to provide the level of attenuation required. Glazing is generally the building element which attenuates noise the least, so the proportion of glazing in a building façade is an important consideration when assessing overall noise attenuation.

12.6.6 In the absence of design details for the building façades, it has been assumed that the glazing to buildings would comprise about 25% of the façade area. To calculate the overall attenuation provided by this percentage of glazing in a brick or block façades, a non-uniform partition calculation can be used.

12.6.7 The calculation combines the different degrees of attenuation of the wall element and the window element. A façade comprising a solid brick or blockwork, will attenuate by 45dB (British Standard 8233: "Guidance on sound insulation and noise reduction for buildings" 2014) whereas standard thermal double glazing will attenuate traffic noise by 26-29dB(A) (BRE Digest 379 "Double glazing for heat and sound insulation). The overall noise attenuation provided by this combination is, therefore, between 31.9dB(A) and 34.9dB(A).

12.6.8 A number of types of glazing would be able to achieve between 26-29dB(A). For example, 6/12/6 Pilkington glazing would achieve 26dB(A) attenuation and 10/12/4 glazing would achieve 29 dB(A) attenuation.

12.6.9 Where windows need to be closed to achieve guideline noise levels, an alternative form of ventilation, which does not compromise the acoustic integrity of the façade, would need to be installed in some of the noise sensitive rooms.

12.6.10 It is recommended that the acoustic ventilation proposed at the site should, as a minimum, comply with Building Regulations 2000 Approved Document F1 Means of Ventilation and British Standard BS5925 1991: "Code of Practice for Ventilation

Principles and Designing for Natural Ventilation". Acoustic ventilation is only recommended for noise sensitive rooms, which are bedrooms and living rooms.

12.6.11 The implementation of the recommended glazing together with appropriate acoustic ventilation should ensure that the required internal daytime and night-time noise limits are achieved.

12.6.12 Glazing and ventilation requirements can be confirmed, once a detailed design layout is available at a future reserved matter stage for the outline elements of the Proposed Development.

12.7 Residual Effects

Demolition and Construction Phase

12.7.1 The activities carried out during the demolition, earthworks and construction phase of the Proposed Development will have the potential to generate short term increases in noise levels above the recommended noise limits, set in accordance with current guidance, at existing and proposed sensitive receptors surrounding the Site. The use of heavy plant machinery associated with the demolition, earthworks and construction works is unlikely to give rise to ground borne vibration at the nearest ESRs.

12.7.2 To minimise the potential impact of demolition and construction works, mitigation measures would be put in place. These would include restrictions on working hours, the implementation of temporary screening where possible, and best working practices.

12.7.3 With the implementation of best working practices and restrictions on working hours, the noise and vibration impacts of demolition, earthworks and construction phases, will be generally negligible, with only brief periods of adverse effects of slight to moderate significance in the short term at the local level.

12.7.4 The sensitivity of the existing and proposed sensitive receptors is moderate and the magnitude of change, following mitigation, is small. Therefore, there is likely to be a direct, temporary, medium-term residual effect on existing and proposed sensitive receptors of none to moderate adverse significance, following the implementation of mitigation measures.

Operational Phase

Existing Sensitive Receptors

12.7.5 The sensitivity of the existing sensitive receptors is moderate and with mitigation in place, the magnitude of change is none. Therefore, there is likely to be a direct, permanent, long-term residual effect on existing sensitive receptors of no significance.

Proposed Sensitive Receptors

12.7.6 The proposed noise sensitive areas of the Proposed Development, i.e. the future residential areas will be subjected to noise from existing sources. The dominant source of noise at the sensitive areas of the Proposed Development is existing road traffic on the major roads in the vicinity of the Site.

12.7.7 The results of the baseline noise survey and noise prediction calculations indicate that the noise levels at the Proposed Development should not be a determining factor in granting planning permission in accordance with current guidance. Mitigation measures will need to be incorporated into the Site design to ensure that the required internal daytime, and internal night-time noise levels, are achieved at the proposed residential areas. Once these measures are implemented the effect at existing sensitive receptors from the future road traffic noise would be negligible.

12.7.8 The sensitivity of the proposed sensitive receptors is moderate and the magnitude of change is none. Therefore, there is likely to be a direct, permanent, long-term residual effect on proposed sensitive receptors of no significance, following the implementation of mitigation measures.

12.8 Assessment of Cumulative Effects

12.8.1 With mitigation in place there will be no change in the observed noise levels at existing or proposed sensitive receptors when considering the potential cumulative effect within the locality of the Proposed Development.

12.9 Conclusion

Introduction

12.9.1 A noise assessment has been carried out for the Proposed Development. This chapter has assessed the results of the noise survey carried out in accordance with current guidance and includes recommendations for noise mitigation as appropriate.

Baseline Conditions

12.9.2 The existing baseline conditions were identified through aerial mapping and photography. The process identified the locations of existing sensitive receptors, and suitable locations for the baseline noise monitoring.

12.9.3 To establish baseline noise levels an attended noise survey has been carried out at locations representative of the existing noise sensitive areas.

12.9.4 Traffic data was provided by WSP and noise emissions data for the Proposed Arena and Hotel was provided by Vanguardia.

Potential Effects and Likely Significant Effects

12.9.5 The activities carried out during the demolition, earthworks and construction phase of the development will have the potential to generate short term increases in noise and vibration levels above the recommended noise limits, set in accordance with current guidance, at existing and proposed sensitive receptors surrounding the Site.

12.9.6 A noise survey was undertaken to establish the baseline ambient noise levels on the Site for existing sensitive receptor locations.

12.9.7 The activities carried out during the demolition, enabling works and construction phase of the development will have the potential to generate short term increases in noise levels. The use of plant and machinery associated with the demolition, enabling and construction works, including piling, has the potential to give rise to ground borne vibration. The predicted residual noise and vibration impacts of demolition, enabling works and construction phases is considered to be minor at some nearby locations, however this will occur only temporarily and generally there will be only brief periods of minor adverse effects. To minimise potential noise and vibration impacts mitigation measures will be put in place. These mitigation measures will include a restriction on working hours, the implementation of temporary screening, and best working practice. The impact following mitigation is **moderate adverse to none** on existing and proposed sensitive receptors.

12.9.8 The sensitivity of the sensitive receptors is moderate and with mitigation in place, the magnitude of change is **none**. Therefore, there is likely to be a direct, permanent, long-term residual effect on existing sensitive receptors of **no significance**.

Mitigation and Enhancement

12.9.9 To control the effect of demolition and construction works on the nearest sensitive receptors, mitigation measures may need to be put in place. These would include restrictions on working hours, together with best working practice where possible; it is likely these measures will be included within a CEMP.

12.9.10 No further mitigation is required to reduce noise from the arena or hotel.

12.9.11 No further mitigation is required to reduce noise from future traffic.

12.9.12 A range of mitigation measures have been proposed to minimise the potential impact of noise from events within the public event square and of crowd noise relating to the arena events. These are detailed in Section 12.6.

12.9.1 Noise from any deliveries associated with the arena service yard should achieve a noise limit. This can be achieved using a range of mitigation measures as detailed in Section 12.6.

12.9.2 Noise from any proposed plant associated with the new Red Dragon Centre, proposed hotels, proposed residential space and office space should achieve a noise limit. Additionally, plant could be situated on façades furthest from the receptors and on the screened side of the building facing away from receptors.

12.9.3 Standard thermal double glazing and alternative glazing has been proposed to achieve noise guidelines in some rooms of the proposed residential properties in order to achieve noise guideline levels. The exact glazing and ventilation requirements can be determined at the detailed design stage.

Conclusions

12.9.4 With the implementation of best working practice and restriction on working hours, the noise effects of demolition, earthworks and construction phases, will be **none**.

12.9.5 With mitigation measures in place it is considered that the operational effect of the Proposed Development at existing sensitive receptors will be **none to moderate** in both the long and short term.