MAS ENVIRONMENTAL

Local Gov Issues, Acoustics, Health & Safety, Food Hygiene, Planning, Pollution, Licensing, Nuisances, Catering Design

Proposed Residential Development by Wrenbridge

New Settlement at Colworth, Bedfordshire

Review of Noise Impact

in relation to

Santa Pod Raceway

15th February 2018

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Provided by MAS Environmental Ltd

Prepared by: [redacted]

[redacted] (Additions to the Exec Summary March 18)

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1.0 Executive summary

1.1 MAS Environmental Ltd ("MAS") were appointed by Santa Pod Raceway to review a noise impact in relation to planning proposals for a new settlement in Sharnbrook, Bedfordshire.[1]

1.2 In addition, post the initial analysis described in this report, we have met with acoustic consultants for Colworth development at the site to enable them to understand the issues and difficulties. This Executive Summary includes some of the wider issues arising from subsequent analysis and discussions not covered in the main report. After a full day meeting with the Developer's acousticians it can be concluded:

- In relation to the critical issue, whether Colworth could be developed without resulting in the demise of Santa Pod; none of those represented were able to confirm or agree an appropriate decibel related criteria or range of controls that would protect Santa Pod from litigation for noise nuisance should the development proceed. No challenge has been made against the appropriateness of the criteria applied by MAS and which is based on common findings of the courts, other local authorities and also Bedford Borough Council in relation to other similar sites.

- There is no evidence to undermine the criteria applied by MAS and critically moving housing nearer and over a wider range of wind directions increases the frequency and duration of impact that must arise and not just increase the resulting noise level. Adverse impact is not just about noise level and noise character but the frequency and duration of occurrence. This substantially increases the risk of nuisance and is a consideration thus far unchallenged. We have obtained nothing from the meeting that enables us to be remotely positive about this problem.

- There is no challenge to the criteria adopted by the Council's EHO that average noise levels 10dBA above background sound level occurring on a regular basis would amount to unacceptable impact. This criteria concurs with judgements in other cases including the critical case of Lawrence versus Fen tigers 2011 upheld in the Supreme Court in 2014.

- There is agreement any mitigation required would be substantial and relate to significant limitations on the form of residential development as well as major infrastructure changes at Santa Pod. The latter requires planning permission on which there can be no guarantee and especially that additional controls would not be imposed. Furthermore, there is no evidence or reasoned logic that such measures would be, even remotely, sufficient. Conversely evidence indicates some of the more important elements of the noise impact cannot be readily mitigated, in relation to its impact upon much of the proposed development site.

[1] Preliminary Noise Impact Assessment Report and Environmental Sound Survey Report dated 17th February 2017.

- Evidence indicates whilst mitigation may reduce some sources of noise 7-9dBA as a best case reduction this remains less than half the reduction needed and not only can there be no assurance levels can be suitably mitigated, *prima facie* the evidence shows it cannot with a wide margin remaining. In other cases evidence indicates some sources may only reduce about half a decibel where the gulf remains.

- It is noted whilst there are various mechanisms such as removing all permitted development rights for all the dwellings, there are substantial complexities in such approaches and no guarantee of what can be achieved or could be mandated in the future. It was clear nothing can be mandated and there is therefore no evidential basis to conclude even forms of mitigation that can be engineered could be achieved.

- The developers can offer no evidence of the true level of impact at the development site and agree a major programme of monitoring and investigation would be required before the extent and degree of adverse impact expected could be fully recognised or more carefully predicted. There was no evidence level would be lower than the conservative values used.

- It was not disagreed that any possible way forward would need a substantial change to the current master plan and proposed layout such that the currently proposed Colworth and any future layout may need to be radically different, for example to include a substantial industrial buffer/screening zone. Discussions on the possibility of this were to be considered by the Developer's acousticians.

- There has been no challenge to the predicted levels of impact as indicated by the MAS evaluation and outlined in this report. In turn this indicates development is unsuitable as it would lead to the demise of Santa Pod.

- Modelling of noise emission levels cannot, at this stage, confirm with any certainty the resulting impact and a long programme of testing would be required to calibrate or validate any model. Furthermore it cannot address noise impact which relates to non-acoustic factors which are recognised as responsible for 2/3rd of noise annoyance.

- The meeting achieved consensus on a mechanism and process for better determination of the extent of the problem and also the extent of noise reduction achievable. This process could take 6-24 months and would then simply provide greater certainty over the size of the problem.

- The divide between surety of acceptable noise levels and what is achievable remains substantial and is indicated as remaining in excess of 10-15dBA, even when assuming theoretical best case mitigation is achievable. This remains too far above any criteria of acceptability and is, in any event, dependent on major infrastructure changes at Santa Pod. Achieving a suitable resulting development remains wholly unachievable and impractical therefore and the exhaustive meeting has not resolved any issues.

1.3 The fundamental principles of national planning policy of protecting existing development cannot be met in this case and the prospect of the demise of this nationally recognised facility if development proceeds is apparent. Current adverse impact at villages further away is adverse but does not exceed nuisance criteria due to the reduced sound energy levels, greater atmospheric and distance reduction in noise but also the reduced frequency and duration of impact caused by changing wind direction and upward sound refraction leading to far greater periods of sound shadow. These forms of protection would be lost in relation to Colworth due to its size and nearness.

1.4 MAS have historically undertaken a number of noise monitoring exercises for Santa Pod Raceway both on site and in the community and as such have significant experience and understanding of the nature and character of noise impact from the site.

1.5 The noise from Santa Pod contains a variety of acoustic features/characteristics and also non-acoustic elements that should be considered in any assessment of noise impact. Many of the characteristics attract and hold attention compared to other sources of ambient sound that are expected e.g. road traffic, birdsong. They intrude therefore at low sound energy levels.

1.6 The proposed development locates residential dwellings (i.e. noise sensitive land use) within close proximity of a noisy site. This goes against basic principles for avoiding adverse noise impact.

1.7 It is clear and consistent across guidance that when assessing noise impact, a range of factors must be considered in addition to the absolute noise (decibel) level. Assessment of decibel level alone from race events indicates that adverse impact will be generated at the proposed development site as a result of Santa Pod activities. Assessment of additional factors, such as noise character and music noise from events, including at night, serves to increase adverse impact.

1.8 Government guidance places emphasis on improving health and quality of life but also not placing unreasonable restrictions on industry or commerce. Substantially higher noise levels occurring much more often are predicted at the proposed development site than currently exist in nearby communities. Thus, health and quality of life for those at newer housing in the area cannot be improved compared to existing communities.

1.9 Existing communities have expectation of intrusion from Santa Pod as they have evolved along with Santa Pod. This same form and level of expectation cannot exist for any new community who naturally expect development is permitted with their quality of life already protected as part of the assessment process.

1.10 There is a unanimous acceptance across guidance for avoiding significant adverse impacts and for minimising and mitigating noise impact as far as practicable. Proposed mitigation affords minimal benefit and significant adverse impacts are demonstrated to continue.

1.11 When assessing noise impact from entertainment venues long term averages have generally been dismissed by the courts and shorter term average noise limits (5-15 minute LAeq) have been adopted. Noise limits set for other motorsport venues range

from 42-47dB LAeq,T again as a short term value. Maximum noise levels have also been considered and controlled at the site boundary and in the community, including within the Bedford district. The objective is to stop short periods of high noise which is precisely what happens at Santa Pod.

1.12 Conservative estimated noise levels at the proposed development site, based on levels previously measured in nearby community locations, exceed noise limits used at other raceways including within the Bedford district (42-47dB LAeq,T) by a significant margin, from around 10-30dB(A) depending on source type and meteorological conditions etc. This gulf is simply too large to be addressable by mitigation such as screening.

1.13 Maximum noise levels can be compared with noise limits set for Palmer Promosport at Thurleigh in the Bedford area, which is approximately 8km from Santa Pod and within the same local authority area. The Palmer Promosport site boundary level is set at 65dB LAmax and thus much lower levels are expected in the community. This site boundary level is exceeded across much of the proposed development site with maximum levels ranging from 65-74dB LAmax,f.

1.14 Decibel levels are set not just to protect dwellings but other users of the countryside and outside amenity areas. Specialised housing such as single aspect dwellings that are devoid of noise sensitive rooms facing a site cannot address this problem. The 65dB LAmax level was set in part to protect other countryside users.

1.15 At these levels, and given the specific character of motorsport noise, the sound environment in and around dwellings and generally at the proposed development site will often be dominated by Santa Pod noise. Noise levels will often be twice as loud as background sound levels and at times significantly above this. Santa Pod noise will be heard as a distinct noise source and will be heard indoors, on occasions and in many areas with windows shut.

1.16 Santa Pod emissions contain significant low frequency noise content which is recognised as more annoying than other sources of noise. As a consequence a greater margin of protection is needed than for many motor sport sites. Furthermore, screening and mitigation reduces the mid and higher frequency sound level content to a greater amount leading to a resulting source of noise that is more dominated by low frequency noise. None of this is factored into the considerations but indicates a greater disparity likely arises.

1.17 It is noted that the proposed development site will often be downwind of Santa Pod in prevailing wind directions and as such can expect higher noise levels for much of the time and limited respite due to meteorology and nearness. The incidence of adverse impact increases therefore compared to existing developments.

1.18 Comparison of predicted noise levels with current screening and the addition of an 8m high, 800m long barrier, when using modelling, shows that little additional reduction is afforded despite significant additional screening. Additional physical mitigation at the site, even in an extreme form, does not afford sufficient reductions to meet or come close to previously accepted planning criteria for motor sport noise.

1.19 Mitigating noise by altering the site layout will direct source noise towards nearby villages already effected by Santa Pod noise and in the prevailing wind direction,

which will serve to increase propagation. It would also place music venues used during larger events held at the site closer to villages to the north and east of the Santa Pod site thus increasing impact from this aspect of the site's operations. This is not therefore a viable option.

1.20 Altering the site layout would also require planning permission and in turn the Council will be obligated to impose noise controls not currently in place. This is a negative step imposing further restrictions on the operation of Santa Pod.

1.21 Mitigating noise by reducing the number of events held at Santa Pod would serve to reduce noise impact; however, significant reductions in activity at Santa Pod would be needed. Comparing a typical range of events at other venues, normally 1-3 event days could be of uncontrolled decibel levels and a further 4-10 event days typically restricted by absolute levels or a reasonably large exceedance of the background sound levels. For a greater number of event days, they would require restriction by their emergence above background sound energy levels. This would prevent all but a few events and even the majority of those would require significant restriction such that drag racing could not continue.

1.22 Current "Drifting" events benefit from reduced impact as their tyre squeal is of a higher sound energy frequency and so better screened by ground features and reduced by atmospheric absorption. These benefits would be reduced where housing development was much closer. The extent of the change is not easy to predict but is likely to be greater than adjustments for distance alone indicate.

1.23 The event days considered in the analysis above would include all music noise emissions and effectively would allow one major event a year only.

1.24 Those moving to the area are unlikely to have any experience or expectation of the noise from Santa Pod, particularly given the largely rural area around the proposed development site and lack of obvious visual clues indicating that there could be noise disturbance from a raceway. The norm is to expect their environment is adequately protected and thus unlike existing villages, absence of significant intrusion is what is normally expected.

1.25 The proposed housing development fails to meet numerous objectives of planning guidance and seeks to introduce a large number of noise sensitive receptors at a distance of 500m - 1km from the Santa Pod site. Noise at dwellings will be dominant, at times highly intrusive and significantly above background sound levels. Widespread complaints are expected and control by way of statutory nuisance (whether privately or by the Council), use of Community Protection Notices or common law action should be expected.

1.26 The proposal fails to meet the aims of the NPSE as described within the PPG on noise to mitigate and reduce adverse noise impacts to a minimum and to improve the health and quality of life through effective management of noise. It also fails to protect Santa Pod or any future development of the site.

1.27 The development site will be impacted by 3 turbines which, post their approval, are recognised to cause potential problems of excess amplitude modulation. Research shows this is a common noise feature of this size of turbine causing serious annoyance. The problem is internationally recognised as serious and common. Whilst

this impact is mainly at night, it adds cumulatively to the noise impact and therefore potentially exacerbates adverse reaction in the community due to the cumulative adverse features of the sound environment.

2.0 Introduction

2.1 MAS Environmental Ltd ("MAS") were appointed by Santa Pod Raceway to review noise impact of the raceway at proposed housing in a new settlement in Sharnbrook. This report reviews guidance and standards, levels of acceptability at other racing venues and considers whether an acceptable noise environment could be achieved at the proposed development site. Whilst the noise impact assessment for the proposed housing site should consider environmental noise as a whole including that from road traffic noise, wind turbine noise and Santa Pod Raceway, this report considers only noise generated at Santa Pod Raceway (Santa Pod).

2.2 Santa Pod is located in a predominantly rural area with villages located to the north west, north east and east of the site. The A6 runs to the north and east of the site. MAS have historically undertaken a number of noise monitoring exercises both on site and in the community and as such have significant experience and understanding of the nature and character of noise impact from the site. MAS have provided expert evidence in a number of court cases relating to motorsport noise impact and assessment.

2.3 An aerial view of the site is shown below in figure 1 with the proposed new settlement marker in red.

Figure 1: Aerial location of Santa Pod

2.4 In the absence of noise associated with Santa Pod the main sources of noise in the area are from wildlife and particularly birdsong, distant road traffic noise from the A6, local road traffic noise and occasional aircraft. The character of the area is typically rural with relatively benign ambient noise sources and natural sounds that are expected. It is noted that wind turbines have recently been erected in the area and this will influenced the character of the locality to some extent.

2.5 During Santa Pod events there are a range of noise sources that can be heard within the community including tyre squeal, engine noise, PA noise, music noise, noise

associated with fairground rides and helicopter rides. There are a range of noise sources generated at the site and events can run continuously throughout the weekend. The noise impact, and particularly that associated with racing, can be very intermittent and limited in duration. This results in bursts of activity that can be followed by periods with little / no noise. As such it is important to both witness the noise and use appropriate acoustic measures to accurately reflect both the nature and character of the noise. The acoustic character of the noise is such that its true impact is not reflected by considering only the decibel level. This is recognised within guidance.

2.6 The noise is very dependent on wind direction and upwind conditions can considerably reduce the audibility of Santa Pod noise.

2.7 The new settlement is proposed to the east of Santa Pod and expands from the existing settlement of Sharnbrook. The proposed location is shown in figures 2 and 3 below.

Figure 2: Proposed settlement location

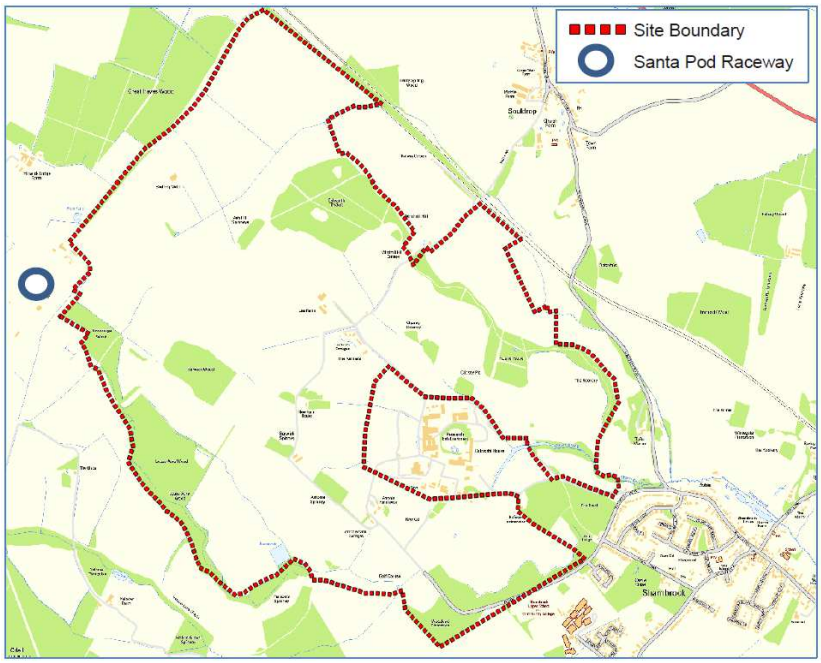


Figure 3: Indicative layout of proposed settlement

3.0 Guidance and criteria

3.1 This section provides a very brief summary of key points from guidance and criteria as they relate to this case.

3.2 One of the most basic principles in noise control is that noisy activities should be separated from noise sensitive uses as far as practicable i.e. to separate noise generating and noise sensitive uses via land use planning. Thus, noise sensitive land uses such as residential development should be located as far away as possible from sites that generate noise. In this respect the proposed development site fails to achieve this basic aim and instead locates residential development within 500m of a busy raceway. This goes directly against the most basic guidance for avoiding land use conflicts.

3.3 The following paragraphs summarise key excerpts from relevant guidance documents *[my emphasis]*.

3.4 **Noise Policy Statement for England (NPSE):**[2]

- Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.
- Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.
- Where possible, *contribute to the improvement of health and quality of life* through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

3.5 **National Planning Policy Framework (March 2012) (NPPF).**[3] The NPPF states that planning decisions should aim to:

- avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;
- mitigate and reduce to a minimum other adverse impact on health and quality of life arising from noise from new development, including through the use of conditions;
- recognise that development will often create some noise and existing businesses wanting to develop in continuance of *their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established*;

3.6 **Planning Practice Guidance (2014) (PPG).**[4] The Planning Practice Guidance (PPG) removed guideline decibel values from the assessment of impact and broadened the

[2] Great Britain. Department for Environment and Rural Affairs (DEFRA) (2010) *Noise Policy Statement for England.* London: TSO
[3] Great Britain. Department for Communities and Local Government (2012) *National Planning Policy Framework*. London: TSO. Available from: http://planningguidance.planningportal.gov.uk/

noise impact assessment approach to include, for example, consideration of impact in context. The guidance notes that 'there is not a simple relationship between noise levels and the impact on those affected' and lists a number of factors that influence whether noise could be a concern. Factors that influence whether noise could be a concern include:

- the source and absolute level of the noise together with the time of day it occurs
- for non-continuous sources of noise, *the number of noise events, and the frequency and pattern of occurrence* of the noise
- the spectral content of the noise and *the general character of the noise*
- *cumulative impacts of more than one source* should be taken into account along with the extent to which the source of noise is intermittent and of limited duration
- If external amenity spaces are an intrinsic part of the overall design, *the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.*

3.7 It is also noted that the PPG states:

- The potential effect of a new residential development being located close to an existing business that gives rise to noise should be carefully considered. This is because existing noise levels from the business even if intermittent (for example, a live music venue) may be regarded as unacceptable by the new residents and subject to enforcement action.

3.8 **IEMA Guidelines for Environmental Noise Impact Assessment. (2014).**[5] This guidance provides general advice for undertaking an assessment of noise impact. It notes that:

- The noise impact and the consequential *effect can only rarely be properly determined solely by the simple numerical difference* in the value of a particular noise indicator.
- It is only by taking account of these factors that the magnitude of the effect of a given noise impact on sensitive receptors can be properly identified: averaging period, time of day, nature of the noise source, frequency of occurrence, spectral characteristics, absolute level of the noise indictor, influence of the noise indicator used.
- Averaging noise. The longer the averaging time period of the indicator, the more likely it is that a small change in it could be masking a larger and potentially substantial change that only occurs fro a short part of the averaging period.

[4] Great Britain. Ministry of Housing, Communities & Local Government (2014) *Planning Practice Guidance : Noise.* London: TSO. [Online: https://www.gov.uk/guidance/noise--2]
[5] Institute of Environmental Management & Assessment (IEMA) (2014). *Guidelines for the Environmental Noise Impact Assessment.*

- For a given level of noise, it is often considered that a source which emits a continuous level is less annoying or disturbing than a source that is intermittent enough to attract attention. This approach means that *the nature of the noise source and how its nature changes needs to be taken in to account.*

3.9 **World Health Organisation Guidelines (1995).**[6]

- By tradition, the exposure to noise from various sources is most commonly expressed as the average sound pressure level over a specific time period, such as 24 hours. This implies that the same average level of chosen time can either consist of a larger number of events with a relatively low, indeed almost nonaudible level, or a few events with a high level. This technical concept does not agree with common experience on how environmental noise is experienced, nor with the neurophysiological characteristics of the human receptor system.

- Thus, *it is relevant to consider the importance of the background level, the number of events, and the noise exposure level independently when assessing the effects of environmental noise on man*.

- Guideline Values for Dwellings. Recommended guideline values for bedrooms inside are 30 dB LAeq for steady-state continuous noise and 45 dB LAmax. *Lower levels may be annoying depending on the nature of the noise source.*

3.10 **World Health Organisation Guidelines (1999) (WHO 1999).**[7]

- LAeq,T should be used to measure continuing sounds, such as road traffic noise or types of more-or-less continuous industrial noises. However, *when there are distinct events to the noise*, as with aircraft or railway noise, *measures of individual events* such as the maximum noise level (LAmax), or the weighted sound exposure level (SEL), *should also be obtained in addition to LAeq,T*.

- The annoyance response to noise is affected by several factors, including the equivalent sound pressure level and the highest sound pressure level of the noise, the number of such events, and the time of day.

3.11 In summary, it is clear and consistent across guidance that when assessing noise impact, a range of factors must be considered in addition to the absolute noise (decibel) level. Government guidance places emphasis on improving health and quality of life but also not placing unreasonable restrictions in industry. There is a unanimous acceptance for avoiding significant adverse impacts and for minimising and mitigating noise impact as far as practicable.

[6] Berglund B., & Lindvall, T. (eds) World Health Organisation (WHO) (1995) *Community Noise*. Sweden: WHO
[7] Berglund B., Lindvall T., & Schwela D.H., (eds) World Health Organisation (WHO) (1999) *Guidelines for Community Noise.* Geneva: WHO

4.0 Guideline values for motor sport noise

4.1 The paragraphs below summarise controls set at other motor sport venues.

4.1.1 **Coventry v Lawrence 2014 -** Arguments based on the WHO guidelines were considered in considerable detail by the court and rejected. Reliance was placed on emergence of the noise over background sound.

- The primary control was set at 45dB LAeq,15min. At a later hearing, with agreement of the complainant, higher levels of up to 55dB LAeq,15min were permitted on a limited number of occasions (12 weekends per year).

4.1.2 Palmer Promosport – Thurleigh Bedfordshire

- 45dB LAeq Mon-Fri (40dB 17:30-20:00) at nearest residential property.
- Maximum level on the boundary of the site - 65dB LAmax 08:00- 17:30 (55dB 17:30 – 20:00).

4.1.3 Red Lodge Karting, Cambridgeshire

- Community limit of 42-46dB LAeq,5min at the boundary of residential property, depending on the time and type of vehicle operated.

4.1.4 Bruntingthorpe Proving Ground

- Community limit of 40dB LAeq(10 minute) applied to certain activities including karting that required planning permission.

4.1.5 Rockingham Motor Speedway – Northamptonshire

- Community limit 47dB LAeq during the day at the boundary of any residential property.
- One unsilenced event a year (i.e. Formula 1).

4.2 Guidance on levels of acceptability of motor sport noise can also be taken from legal judgements where the use of appropriate noise descriptors has been debated. Many have relied on use of WHO guideline values set over a 16 hour average daytime, a similar averaging approach has been proposed by the developer in this case.

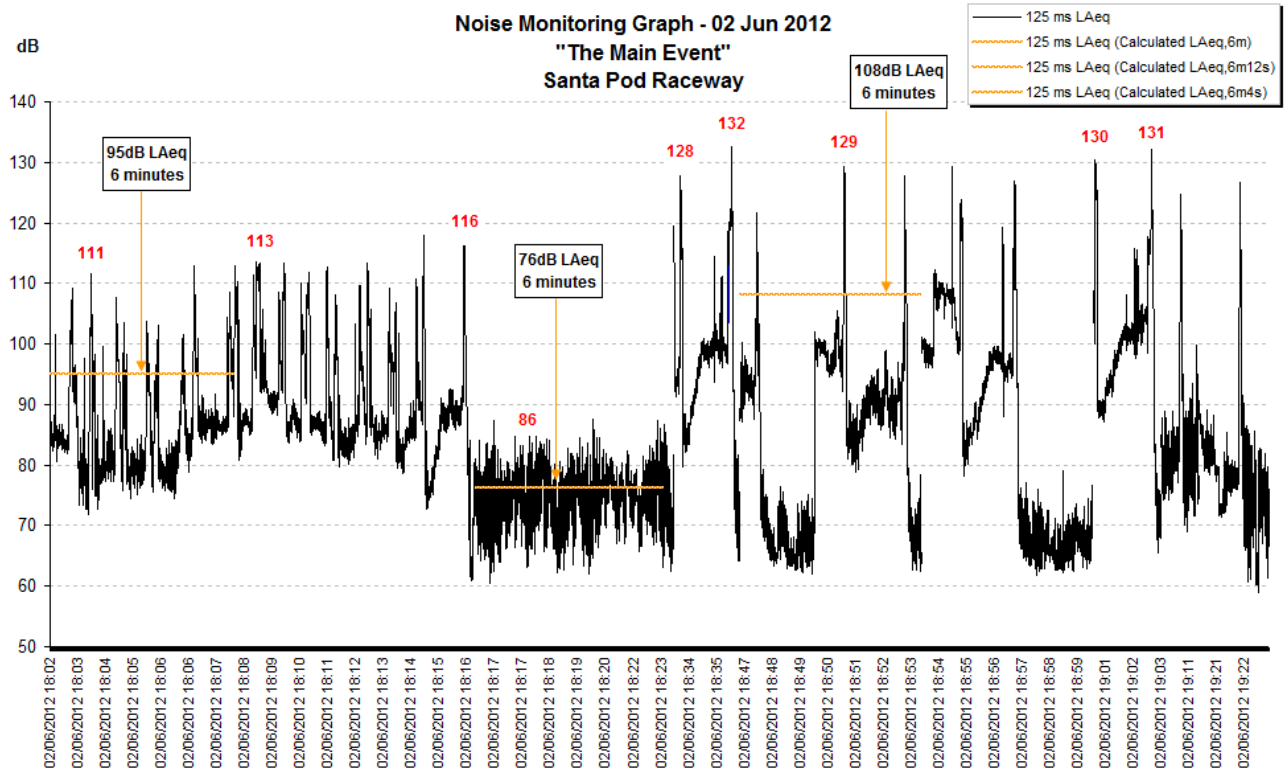
- **Elvington Estates v City of York Council 2009** - Motor sport case where reliance on the WHO rejected.
- **Watson V Croft Promo-Sport 2009** - Motor sport case where controls set by the court are wholly unrelated to WHO guideline values.
- **Bontoft and Others v East Lindsey DC 2008** (upheld in CoA) - Refuse truck noise on site and highway where reliance on the WHO Guideline values was rejected.

4.3 In summary, long term averages have generally been dismissed and shorter term average noise limits (5-15 minute LAeq) have been adopted. These range from 42-47dB LAeq,T. Maximum noise levels have also been considered and controlled at the site boundary and in the community.

5.0 Community noise impact

5.1 The graph below shows an extract from trackside monitoring at Santa Pod. The graph shows the intermittent and variable character of the noise on site. This will be reflected within the community. The measured noise levels are dominated by activity at Santa Pod with the peaks in noise levels corresponding to revving engines or racing.

Figure 4: Extract of trackside monitoring at Santa Pod



5.2 The red numbers above peaks in the measured data graph give the maximum noise level of the event. These can be seen to range from 86dB LAmax,f when there is no racing to 111-116dB LAmax,f and up to 132dB LAmax,f depending on the type of vehicle racing. Three short term averages have also been compared to show the variability of short term average noise levels on site, 76dB LAeq,6min when there is no racing and between 95dB LAeq,6min and 108dB LAeq,6min depending on the race event. The graph shows a highly variable noise environment with a range of noise level and noise character including intermittency, some regularity, impulsive and sudden onset sound etc. The racing continued in a similar manner between 2pm and 7.30pm.

5.3 Community monitoring was also undertaken throughout the racing season in 2012. Community noise levels were highly variable, as demonstrated in figure 4 above, and dependent on meteorological conditions. A sample of community measured noise levels from different events is summarised in table 1 below along with associated distances from the start and finish of the raceway and the end of the race strip.

Table 1: Summary of community measured noise levels (15min, LAeq)

Event	Location	dB LAeq, 15min	Wind direction / speed	Receiver location vs wind	Distance from start line	Distance from finish line	Distance from end of raceway
The Main Event	Podington	61	ESE 4-5m/s, cloudy	downwind	2km	2.1km	2.4km
	Souldrop	36		upwind / crosswind	2.3km	2.8km	3.3km
Easter Thunderball	Souldrop	38	W 3-4m/s, cloudy	downwind / crosswind	2.5km	3km	3.6km
Bug Jam	Souldrop	42	Variable, 1-2m/s, warm, part cloudy	n/a	1.7km	2.2km	2.6km
		41					
		47					

5.4 The table above shows a range of measured noise levels and a range of weather conditions. Given the large distances between Santa Pod and the community monitoring locations there are likely to be significant effects on noise propagation due to the meteorological conditions. Comparison of measured levels in Podington (downwind) and Souldrop (largely upwind) during "The Main Event" shows that over similar distances there can be a substantial difference, which will be largely influenced by meteorology. It is noted that the proposed development site will often be downwind of Santa Pod in prevailing wind directions and as such can expect higher noise levels for much of the time and limited respite due to meteorology.

5.5 Attenuation of sound over distance can be estimated for point sources (e.g. a stationary car revving its engine) and line sources (e.g. a road with constant road traffic flow). The noise source at Santa Pod has elements of both. The basic distance attenuation of a point source is 6dB per doubling of distance and for a line source, 3dB per doubling of distance. This is the loss of sound energy by distance alone and does not account for increased or reduced sound attenuation due to meteorology (wind vector, temperature inversions etc).

5.6 Table 2 below compares the simultaneous on site and community short term LAeq levels measured at two Santa Pod events. The reduction is given between levels measured on site and in the community simultaneously (3rd column). Distance attenuation has then been estimated assuming that all the noise is generated at the start line[8] i.e. using the distance between the community location and the start line at Santa Pod (4th and 5th columns). Comparison of the actual reduction and estimated distance attenuation shows that distance attenuation is better estimated by point source attenuation than line source.

[8] NB this is not the case in reality and considerable noise will also be generated along the track to the finish line.

Table 2: Summary of actual reduction over distance compared to estimated distance attenuation - short term LAeq events

Event	Community location	Reduction (on site - community)	Distance attenuation (line source)	Distance attenuation (point source)
The Main Event	Podington	44dB(A)	26	52
Bug Jam	Souldrop	54-55dB(A)	25	51

5.7 Using a simple distance attenuation calculation, an estimate of the 15 minute LAeq at nearest dwellings on the proposed development east of Sharnbrook can be provided based on levels previously measured in community locations. The estimated value at the proposed development site is based on point source attenuation[9] and it is noted that depending on the weather conditions values could be slightly lower and slightly higher than estimated. As above, the distance used is between the start line at Santa Pod and some of the nearer proposed residential development to the north east (approx 400-600m from the start) and south / south east (approx 600m from the start) of Santa Pod.

Table 3: Estimated 15 minute LAeq levels at nearest housing on proposed development site

Event	Measurement location	dB LAeq, 15min	Distance from start line	Estimated dB LAeq 15min at proposed dwellings NE of Santa Pod	Estimated dB LAeq 15min at proposed dwellings SSE of Santa Pod
The Main Event	Podington	61	2km	75	72
	Souldrop	36	2.3km	52	48
Easter Thunderball	Souldrop	38	2.5km	54	50
Bug Jam	Souldrop	42	1.73km	55	51
		41		54	50
		47		60	56

5.8 The final two columns of table 3 above can be compared to criteria from other raceways, summarised in section 4 above. Estimated noise levels exceed criteria (42-47dB LAeq,T) by a significant margin.

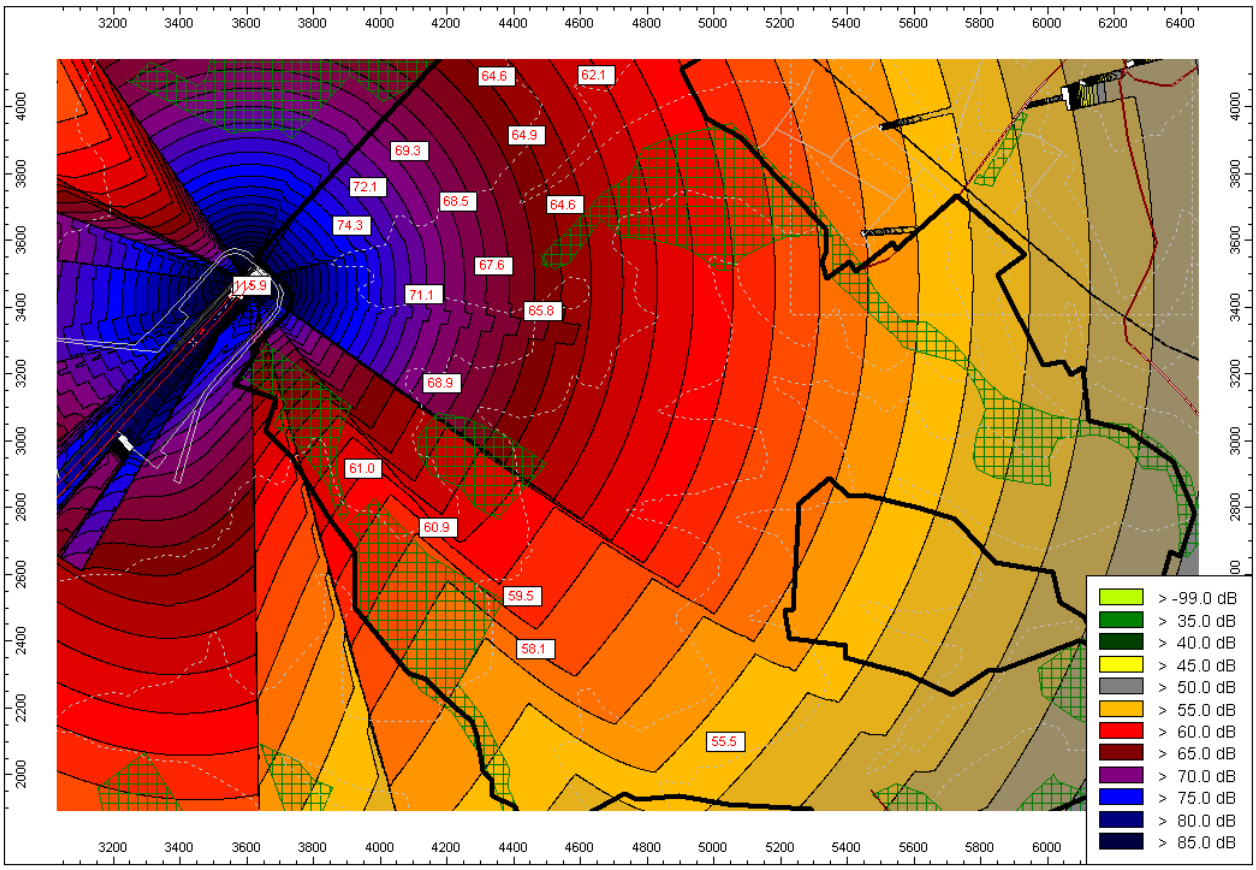
5.9 Predicted maximum noise levels were provided in a previous MAS report and are presented again below.[10] Maximum noise levels can be compared with noise limits set for Palmer Promosport, which is approximately 8km from Santa Pod and within the same local authority area. The Palmer Promosport site boundary level is set at 65dB LAmax and thus lower levels are expected in the community. With reference to figure

[9] This is shown above to be more accurate than line source attenuation.

[10] Hard / reflective ground at the site has been assumed but semi absorbent ground outside of the Santa Pod site. Structures on site have been mapped including spectator stands and on site buildings. Receiver spacing is at 2m and predicted noise levels are at 1.5m high. Predictions are made in accordance with ISO9613-2.

4 below, this site boundary level is exceeded across much of the proposed development site with maximum levels ranging from 65-74dB LAmax,f.

Figure 5: Noise map showing maximum noise levels predicted at the nearest locations of the proposed settlement



6.0 Mitigation and additional screening

6.1 As discussed above, community noise levels can be highly variable depending on meteorology. This will, inevitably, also have some influence on the effect of mitigation and results in uncertainty with noise mapping and estimated noise levels that are based on neutral / downwind propagation conditions. At times levels will be high and lower than suggested by modelling.

6.2 Notwithstanding the above limitations, an idea of the effectiveness of mitigation can be investigated by looking at a simplistic case. The noise model above assumes that there is already some screening on site, afforded by the existing spectator stands, bunding and buildings around the start line. Using this layout, a short term LAeq event has been modelled and the estimated noise levels at the nearest dwellings at the proposed development site are shown in figure 6 below.

6.3 The second noise map below (figure 7) shows the same scenario but this time with a 8m barrier in a U shape around the spectator stands and start line. It is approximately 800m in length. This is not a plausible mitigation measure but shows an extreme case looking at maximum potential reduction from screening.

6.4 Comparison of the two noise maps shows that little additional reduction is afforded despite significant additional screening. There is a 1-3dB reduction generally observed across the proposed development site.

6.5 This is due to diminishing benefits from adding screening where some already exists. As there is already a level of screening in place, the greatest benefit from screening has already been achieved and adding to this screening does not have the same benefit as if there were no screening currently at the site. For example, and assuming the same scenario, the difference in predicted noise levels with no screening at the site and with an 8m barrier around the spectator stands and start line is of the order of 3-8dB(A). This is more in accordance with that suggested in the noise assessments submitted with the proposed housing development to date. It suggests that predictions do not fully account for the screening currently on the Santa Pod site and so predicted mitigation has therefore been overestimated.

6.6 In summary, additional physical mitigation at the site, even in an extreme form, is shown to have limited benefit and is unlikely to reduce noise levels sufficiently to meet previously accepted planning criteria for motorsport noise.

Figure 6: Predicted short term LAeq with current site layout

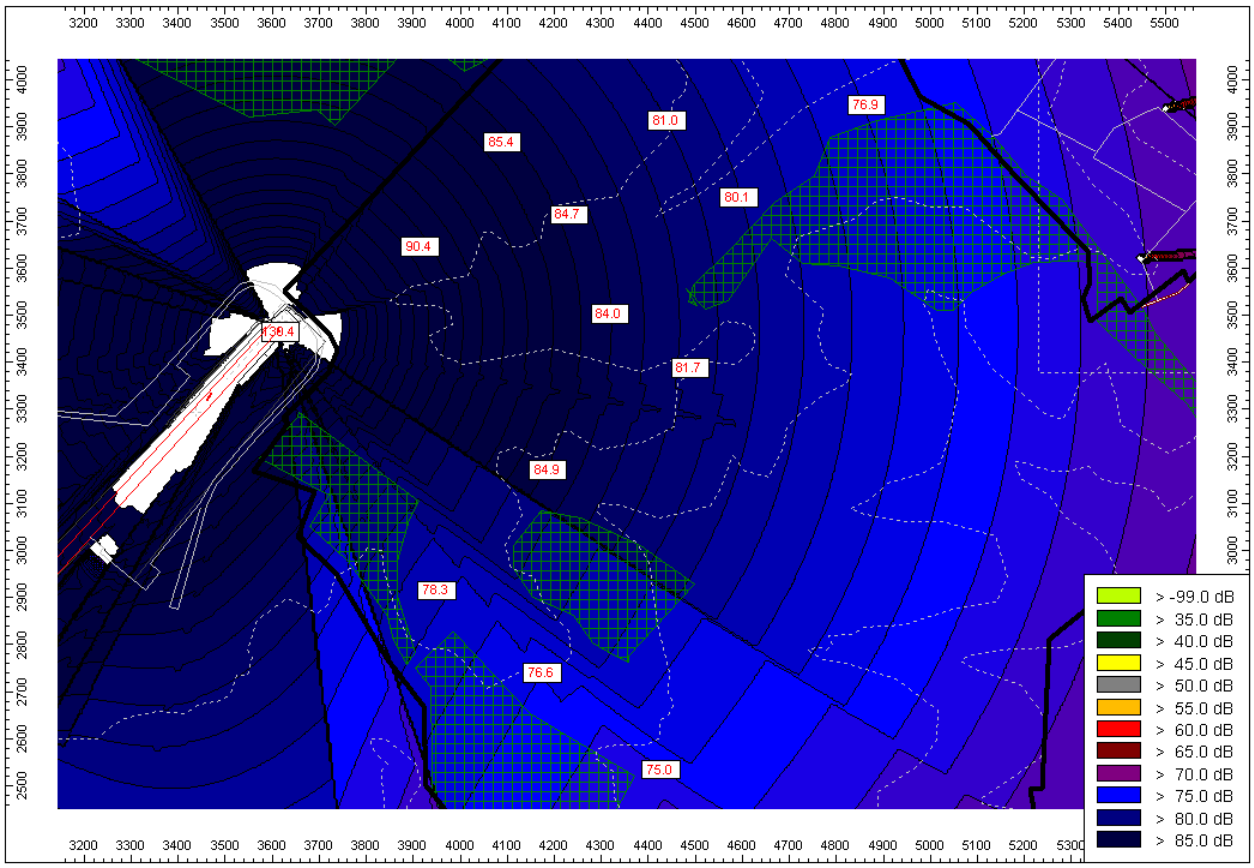
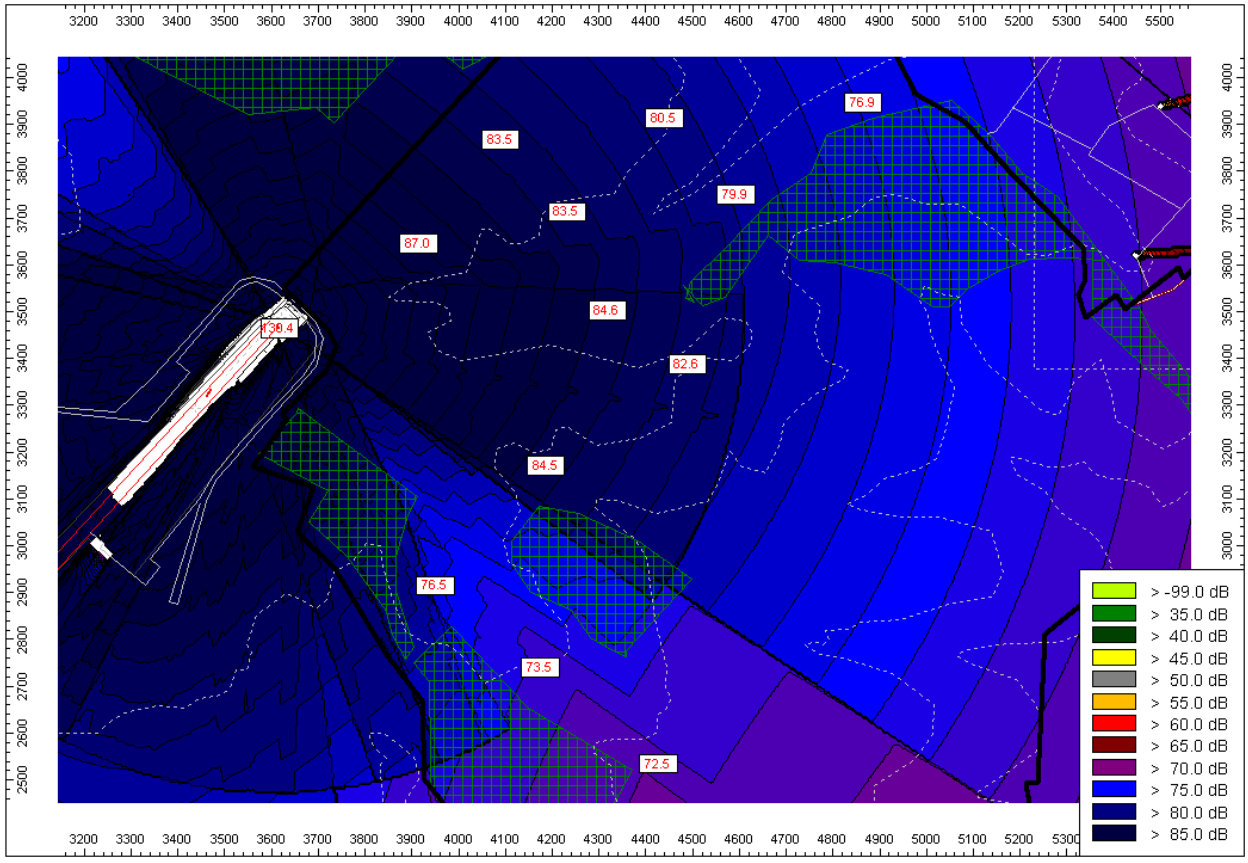


Figure 7: Predicted short term LAeq with additional 8m high 800m long U shaped barrier



6.7 Mitigating noise by altering the site layout has been proposed; however, changing the layout will direct source noise towards nearby villages already effected by Santa Pod noise and in the prevailing wind direction, which will serve to increase propagation. It would also place music venues used during larger events held at the site closer to villages to the north and east of the Santa Pod site thus increasing impact from this aspect of the site's operations. There are also complications with this proposal in relation to gaining planning permission for significant changes to the site and its operation.

6.8 Increasing respite from noise can also be used to mitigate against the effects of noise impact. This often includes having weekends, including bank holidays, where residents know there will be no noise impact for example, having regular planned respite such as 1 weekend of respite in every 3. Incorporating this type of respite management in to the Santa Pod calendar would result in a significant reduction to the number of events held. Events in 2018 are scheduled for every weekend throughout the summer (May - September) including some large events on successive weekends. Limits on the number of noisier events could also be considered and at other sites have been limited between 10-40 days. Assuming 10-20 noisier days are permitted, Santa Pod would need to cancel 2-3 of its major events, potentially more depending on the level and type of noise from the events.

7.0 Conclusions

7.1 The site is not considered suitable for residential development and fails to meet a fundamental planning objective of separating land uses that generate noise from those sensitive to noise.

7.2 The divide between surety of acceptable noise levels and what is achievable remains substantial and is indicated as remaining in excess of 10-15dBA, even when assuming theoretical best case mitigation is achievable. This remains too far above any criteria of acceptability and is, in any event, dependent on major infrastructure changes at Santa Pod.

7.3 Achieving a suitable resulting development remains wholly unachievable and impractical therefore and the exhaustive meeting has not resolved any issues.

7.4 In relation to the critical issue, whether Colworth could be developed without resulting in the demise of Santa Pod; none of the acousticians for the Developer are able to confirm or agree an appropriate decibel related criteria or range of controls that would protect Santa Pod from litigation for noise nuisance should the development proceed.

7.5 No challenge has been made against the appropriateness of the criteria applied by MAS and which is based on common findings of the courts, other local authorities and also Bedford Borough Council in relation to other similar sites.

7.6 Guidance repeatedly emphasises the need to consider a range of factors when deciding on the acceptability of noise impact and not relying on an average decibel level or change in this level alone. This is particularly important for sources of noise that are not steady and continuous but highly variable throughout the day and within shorter time periods as is the case here for Santa Pod.

7.7 Notwithstanding the need to consider a range of factors, estimated average 15 minute Santa Pod noise levels at the proposed development site exceed noise limits in place at other raceways sites in many cases by a substantial margin. Thus, noise level alone indicates adverse impact without additional consideration of character and context etc.

7.8 Maximum noise levels predicted at the proposed development site similarly exceed limits considered acceptable at other nearby sites by a substantial margin.

7.9 The general character of the Santa Pod noise is one that attracts attention and will stand out in stark contrast to the generally rural character of the area.[11] The Santa Pod noise consists of short bursts of high level activity. Those moving to the area are unlikely to have any experience or expectation of the noise from Santa Pod, particularly given the largely rural area around the proposed development site and lack of obvious visual clues indicating that there could be noise disturbance from a raceway.

7.10 There is a general aim within Government planning policy to improve the quality of new housing and this includes ensuring that housing and associated amenity spaces

[11] NB the character of the area will be changed to some extent by the operation of the 3 wind turbines in close proximity of the development site.

are not subject to adverse impacts. Within the PPG there is a requirement for external amenity spaces to be considered so that they can be enjoyed as intended. The indicative layout of the site, as shown in figure 3 above, shows green and nature spaces within very close proximity of the start line at Santa Pod. Given the high levels of noise within close proximity of the start line these spaces are likely to be avoided, including during weekends particularly during the summer, when residents would be expected to gain most use from these spaces but when racing at Santa Pod will be at its most frequent. As such there is a clear land use conflict.

7.11 The proposed housing development fails to meet numerous objectives of planning guidance including:

- Failure to promote good health and quality of life through the effective management of noise (NPSE). Estimated noise levels at the proposed development site are significantly higher than those at other nearby housing and thus a poorer standard of living is created. Proposed noise mitigation achieves minimal reduction.

- Fails to meet Government PPG objectives to avoid significant observed adverse effects and achieve a good standard of amenity. Noise from Santa Pod at the proposed development site is likely to result in residents avoiding use of gardens within close proximity of the raceway during events. Residents are likely to close windows to avoid the noise and there is the potential for sleep disturbance from late night music venues associated with some weekend events held at the site. This indicates significant observed adverse effect levels will arise at the proposed development site. Further, it is unlikely that external amenity space within close proximity of the raceway start will be used as intended due to high levels of noise. Thus, a good standard of external amenity is not achieved.

7.12 MAS have considered the practicality of mitigating noise at the Santa Pod site and due to the length of the drag strip and the moveable nature of various sources of noise, it was concluded that whilst reductions could be made they would be minimal and of limited benefit. This is further evidenced by the noise mapping provided above, showing that addition of an 8m high barrier results in reductions of the order or 1-3dB. This is not sufficient to reduce estimated 15 minute LAeq noise levels at the proposed development site to within planning criteria set for other similar motorsport sites.

7.13 The proposed development seeks to introduce a large number of new residential receptors that are unlikely to be familiar with the character and nature of motorsport noise to a site that holds regular events throughout the year and generates a number of noise impacts with specific character. This combination is highly likely to result in complaints to the local authority.

7.14 Previous noise impact assessments note that the local authority receives complaints relating to Santa Pod activity in the villages of Podington, Souldrop and Sharnbrook. These villages are located 2-3km from the Santa Pod site. The proposed development seeks to introduce a large number of noise sensitive receptors at a distance of 500m - 1km from the site. Complaints are expected.

Appendix A - Glossary of terms

This glossary is harmonised with relevant British and ISO standards which are referenced. Some definitions vary slightly due to updates since written and with other noise guidance documents.

A-Weighting - This is a function which attempts to simulate the characteristics of human hearing at lower levels. Hence a dB(A) reading is an estimate of what we actually hear for quieter sounds whereas dB(LIN), {dB(C) on simpler instruments}, is an objective reading of what is actually physically present. However, for louder and low frequency sounds dB(C) correlates better to the human ear.

Note, dB(A) has been proven not to be so effective in weighting for human hearing at low frequencies.

Acoustic environment – Sound at the receiver from all sounds as modified by the environment. The acoustic environment can be the actual environment or simulated, outdoors or inside, as experienced or in memory. [ref BS ISO 12913-1 2014]

Ambient sound – Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far. The ambient sound comprises the residual sound and the specific sound when present. [ref BS4142 2014]

Ambient sound level (La = LAeq,T) – Equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far at the assessment location over a given time interval, T. [ref BS4142 2014]

Attenuation – The loss in energy level of the sound usually used in relation to the loss due to sound passing through a structure or enclosure.

Background sound level (LA90,T) – The A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest number of decibels. It is the underlying level of noise in the absence of the source and normally excludes most short duration noises (depending on time interval relative to the presence of source noise) (see **Residual sound level**). [ref BS4142 2014]

Note: Many other guidelines and documents reference background noise level. There is a general move to sound level.

Background sound level ("influenced") - In many situations the background sound level can be measured either when the source or premises from which sound emanates, or is associated with, is not operating. Alternatively the intermittency of the source means that it does not have any appreciable effect on the background level, which is a statistical level based mainly on sound that continues with limited breaks. Where this is not the case the measured sound level will be increased and thus influenced.

Background sound level ("uninfluenced") - This refers to any measurement of the background sound level that has not been increased due to noise associated with the source.

Broadband Noise – This is noise covering the whole of the audible frequency range. Compare to narrow band noise which is noise made up of only a very narrow band of frequencies. It will normally exhibit tonality.

Character (of the noise) - Noise character refers to specific features of a noise or sound that render it more intrusive and / or more likely to attract a listeners attention. Noise character can refer to distinguishable or discrete continuous tones (for example hums, whines, hissing or screeching), distinct impulsivity (bangs, clatters, thumps, clicks, pulses) or any other irregularity that attracts attention or makes the noise readily distinctive in relation to the pre-existing acoustic environment.

Context - This includes the interrelationships between person and activity and place, in space and time. The context may influence the soundscape through auditory sensation, interpretation of auditory sensation and the responses to the acoustic environment (see **Soundscape**). Context is also objectively measured using weightings for character and emergence of the sound above the background sound environment (loudness and relative character).

C-Weighting – see **A-Weighting** above.

Decibel (dB) - A unit or level, derived from the logarithm of the ratio between the value of a noise energy quantity and a reference value. For sound pressure level the reference quantity is 20μPa, the threshold of normal hearing is in the region of 0 dB and 140 dB is the threshold of pain / instantaneous damage. A change of 1 dB of the same sound is only perceptible under special conditions.

dB(A): (see A-Weighting) - This is decibels measured on a sound level meter weighted by a scale which is designed to reflect the weighting placed on noise by the human ear. A noise meter incorporates a frequency weighting device to create this differentiation. The dB(A) scale is now widely accepted. Measurements in dB(A) broadly agree with people's assessment of loudness for broadband noise. A change of 3 dB(A) of the same sound is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background sound level in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).

dB(Z): The Z-weighting is a flat frequency response of 10Hz to 20kHz ±1.5dB. This response replaces the older "Linear" or "Unweighted" responses as these did not define the frequency range over which the meter would be linear.

DnT,w: See weighted level difference.

Equivalent continuous A-weighted sound pressure level (LAeq,T) - The sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period. LAeq is used to describe many types of noise and can be measured directly with an integrating sound level meter. It is obtained by continuously integrating ('adding up the energy of') a fluctuating sound signal and dividing by the elapsed time, to give the true mathematical average of any time varying signal. An LAeq reading must always be related to a measurement time interval and should not be read as an instantaneous value of sound pressure.

Façade level - Sound pressure level 1m in front of the façade. Façade level measurements are typically argued 1 to 2dB higher than corresponding free-field measurements because of the reflection from the façade in BS8233 2014 and 2-3dB in many other standards and guidance documents giving a range of 1-3dB.

FFT (Fast Fourier transform) Analysis – A method using digital signal processing to produce very rapid narrowband frequency analysis of acoustic signals. It can be used to equate audible sounds into decibel levels and / or enable a range of analysis of temporal sounds.

Filtering - Octaves & 1/3 Octaves - In general most noise is broad band i.e. it contains energy in virtually all the frequencies across the audio range in different combinations so that it has certain recognisable characteristics. To determine the frequencies at which most of the energy is concentrated, a sound signal is filtered into bands, commonly octave and 1/3 octave bands. Information from such filtering is widely used for diagnostic work and to determine noise control measures. (see **Octave band 1/1** and **Octave band 1/3**)

Free-field level - Sound pressure level away from reflecting surfaces. These are typically measurements made between 1.2 to 1.5m above the ground and at least 3.5m away from other reflecting surfaces. To minimize the effect of reflections the measuring position has to be at least 3.5m to the side of the reflecting surface (not 3.5m from the reflecting surface in the direction of the source). [ref BS8233 2014]

Frequency – This is the number of air vibrations or pressure fluctuations per second. The unit is the hertz (Hz).

Hertz (Hz) – See **Frequency** above.

Impulsivity - Used to describe an acoustic feature of single or repeated sound events of short duration such as a bang, shot or sudden impact of metal on metal etc. It is generally assessed subjectively as perceived by the listener and demonstrates rapid onset in the change in sound level and overall change in sound level. [ref BS4142 2014]

Lnight,outside - The long term equivalent outdoor A weighted sound pressure level established over a period of a year during night time hours (8 hours, typically 23:00 - 07:00). The Lnight,outside is a key parameter of the WHO 2009 Night Noise guidelines which was taken from the Environmental Noise Directive and is typically taken at the facade without reflections (free field level) rather than the facade level given for night time noise disturbance in the WHO 1999 guidelines. It is normally measured / calculated at a height of 4m.

Logarithmic – A scale where the exponent indicating the power to which a fixed number, the base, must be raised to produce a given number. The base used in acoustics is 10. Thus the logarithm of 10 = 1, the logarithm of 100 = 2 and the logarithm of 1000 = 3. In terms of sound energy, an increase of 10 decibels equates to a 10 fold increase. The human ear is sensitive to a very wide range of sound pressure levels (intensities). Measuring human response to sound with a linear scale would not be practical as the scale would be too large and hence a logarithmic scale, in the form of decibels, is used.

Loudness – An observer's auditory impression of the strength of a sound. It is a subjective effect which is a function of the ear and brain as well as the amplitude and frequency of the

sound. Whilst loudness is a subjective perception, a value can be attributed to loudness, which is typically measured in phons. Loudness is related to sound intensity and takes account of the sensitivity of the human to ear to certain frequencies.

Low frequency noise – This is normally considered to be noise ranging from 20 Hertz (pressure fluctuations per second) to 200-250 Hertz, depending on the reference. In music it is the bass region as opposed to alto and soprano.

Masking – The process by which the threshold of hearing of one sound is raised due to the presence of another.

Maximum (A weighted) sound level (LAmax) - The highest value A-weighted sound level with a specified time weighting that occurs during a given event. The time weighting (see below) used (F or S) should be stated. All measurements were 'fast' in this survey. [ref BS5228-1 2009+A1 201412]

Measurement time interval (Tm) - Total time over which measurements are taken. [ref BS4142 2014]

Meter response and time weightings - Most practical sound sources cause fluctuating readings. If the level fluctuates too rapidly, an analogue pointer may move so erratically that it will not be possible to obtain a meaningful reading, or with impulsive sound the meter may not respond quickly enough to obtain an authentic reading. Sound level meters are therefore provided with a variable time response control with settings:-

'S' Slow - Meter response is over damped with a time constant of approx 1 second or 1000ms. The setting tends to average out fluctuations in the readings.

'F' Fast - Permits the instrument to follow and indicate levels that do not fluctuate too rapidly; the time constant response is 125ms.

'I' Impulse - Uses a special electrical circuit with a time constant of about 35ms (of the same order as the response time of the human ear) to permit a very rapid response for investigating very sudden, short duration, impulsive sounds. This setting incorporates a detector which in effect stores the signal for sufficient time to allow it to be displayed. Also a slow decay rate is incorporated with time response of approx 1500ms to allow more easy reading of the maximum value as the indicator moves back relatively slowly.

'P' Peak - Higher grade meters often incorporate this setting which enables the absolute peak (as opposed to the rms) value of an impulsive waveform to be measured. A time constant of the order of 20 - 50 micro seconds is now involved to permit the following of very sharp impulsive events. Evidently electrical signal storage is also required to permit the meter to register the peak of such very fast events.

Noise - Sound perceived by the receiver to be unwanted.

Octave band 1/1 (single) - Band of frequencies in which the upper limit of the band is twice the frequency of the lower limit. [ref BS4142 2014]

[12] This edition of BS5228-1 2009 includes updates from February 2014.

Octave band 1/3 (third)- Band of frequencies in which the upper limit of the band is 21/3 times the frequency of the lower limit. [ref BS4142 2014]

Percentile level (LAN,T) - A-weighted sound pressure level obtained using time-weighting "F" which is exceeded for N% of a specified time interval. Typically the percentile level can be changed on modern sound level meters e.g. LA90,T, LA10,T, LA50,T etc. [ref BS8233 2014].

LA90,T: The A-weighted sound pressure level exceeded for 90% of the specified measurement time interval. It is a statistical measurement. In BS4142 2014 (and generally) it is used to describe the background sound level. Thus for a measurement time interval of 1 minute it would equate to the quietest 6 seconds of sound. For a measurement time interval of one hour it would be the quietest sound for 10% of the time (or 6 minutes). If a machine runs continuously without a reduction in sound for 54 minutes and then stops it would represent the quietest 6 minutes of sound but if run for 55 minutes it would represent the quietest period of machine sound.

LA10,T: The A-weighted sound pressure level exceeded for 10% of the time. It represents the highest sound pressure levels within any measurement time interval. The LA10,18hour is typically used as a measure of road traffic noise.

Pitch – Frequency is an objective measure whereas the term pitch is subjective and although mainly dependent on frequency, is also affected by intensity. See also **Tonality**.

Rating level (LAr,Tr) – The specific sound level of a source plus any adjustment (penalty or weighting) for the characteristic features of the sound. It is used in BS4142 2014 for rating and assessing industrial and commercial sound. [ref BS4142 2014 and BS7445-1 2003 for tonal character and impulsiveness of sound]

Receiver - Person or group of persons who are or who are expected to be exposed to environmental noise.

Reference time interval (Tr) - Specific interval over which the specific sound is determined. For BS4142 2014 this is 1 hour during the day from 0700 to 2300hrs and a shorter period of 15 min at night from 2300 to 0700hrs. [ref BS4142 2014]

Residual sound level - Equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T. [ref BS4142 2014]

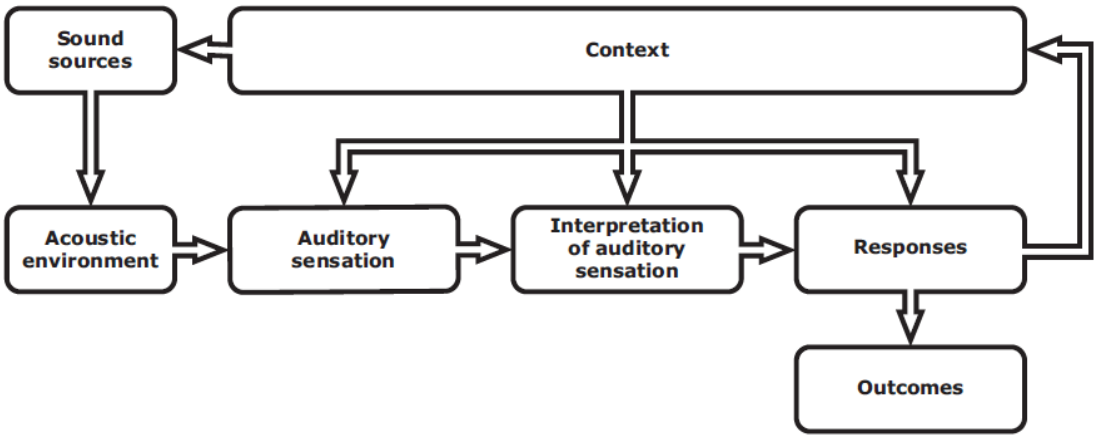
Rw - See Sound reduction index.

Sound power level - Sound power is a measure of the flow of sound energy with reference to a unit of time measured in watts (W). The sound power level is an expression of this energy in a logarithmic scale. The sound power level, unlike the sound pressure level, is independent of room or environmental effects and distance.

Sound pressure level - Sound pressure is measured in pascals (Pa) and is created by fluctuations in air caused by sound. The sound pressure level is an expression of this pressure in decibels. The sound pressure level is variable depending on distance from the source and the interaction of the source with the environment (e.g. reflections).

Soundscape – The acoustic environment as perceived or experienced and/or understood by a person or people, in context (see 'acoustic environment' and 'context'). Figure 1 illustrates that soundscape is people's perceptions or experiences and/or understanding of an acoustic environment. The measurement, assessment or evaluation of soundscape is through the human perception of the acoustic environment.

Figure 1 - Elements in the perceptual construct of soundscape



[ref BS ISO 12913-1 2014]

Sound reduction index, R, Rw, Rw + Ctr - a level that describes the sound reducing properties of a building element or partition. The weighted sound reduction index (Rw) is a laboratory measurement undertaken in accordance with ISO 717 and provides a standardised value, using a reference curve, which allows comparison between different building elements using the Rw value. The addition of the "Ctr" term, i.e. Rw + Ctr, provides an additional weighting which allows for sound sources with lower frequency spectral dominance.

Specific sound level (Ls = LAeq,Tr) - The equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given time interval, T. [ref BS4142 2014]

Tonality – Tonal sound gives a definite pitch sensation. It usually occurs where the sound energy in a narrow range of frequencies is greater than those either side of that narrow range. It will appear as a peak on a graph of sound energy shown in decibels versus the audible spectrum. It can often be shown by comparing adjoining octave band (1/3) spectra. A formal definition of tonality varies between standards. Where one 1/3rd octave band is more than 5dB above those either side, the noise contains a tone or alternatively as assessed by narrow band analysis. [ref BS7445-2 1991 / ISO1996-2 1987]. In BS4142 2014 the level differences between adjacent 1/3rd octave bands that identify a tone are:

15dB in the lower frequencies (25Hz - 125Hz)
8dB in the mid frequencies (160Hz - 400Hz)
5dB in the higher frequencies (500Hz - 1000Hz)

Weighted level difference Dw, DnTw, DnTw + Ctr - The weighted level difference gives a single number value for the airborne sound insulation performance of building elements or partitions etc. As with the sound reduction index, the DnTw is a standardised weighted level difference, standardised to a reverberation time of 0.5 seconds, and allows comparison of different building elements. The addition of the "Ctr" term, i.e. DnT,w + Ctr, provides an additional weighting which allows for sound sources with lower frequency spectral dominance.