Written Representation, Appendices

Appendix 1 - A Review – Large Scale Infrastructure Projects and Their Impact on Stud Farms

A Review - Large Scale Infrastructure Projects and Their Impacts on Studfarms

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ABSTRACT

Industrial-scale solar and wind energy developments are central infrastructure developments to enable global decarbonisation strategies. However, substantial infrastructure placement in proximity to equine studfarms in Ireland raises significant concerns regarding animal welfare, operational viability, and rural economic stability. Developers and planners have often claimed that there is a lack of information on infrastructure developments related to equine health and welfare. This is not the case and so this review synthesises peer-reviewed literature and international planning precedents to evaluate the physiological, behavioural, and management impacts of renewable infrastructure on Thoroughbred horses kept on studfarms. Our findings indicate that noise, light pollution, visual flicker and dust, fire hazards and restricted access all pose substantial risks to equine health and safety, particularly for pregnant mares and foals. Independent environmental impact studies and implementation of effective mitigation strategies are essential. Other countries have adopted policy decisions in relation to industrial scale renewable energy developments and equine welfare and it is vital that Ireland should also create and enforce similar policies.

Keywords: Equine welfare, renewable energy, studfarm operations, noise sensitivity, planning policy, Ireland

INTRODUCTION

Industrial-scale solar and wind energy development is central to global decarbonisation strategies and the pursuit of renewable energy targets. As nations accelerate their climate agendas, large-scale renewable infrastructure has emerged as a key component of energy policy. Consideration of the potential adverse impacts of these developments on highly sensitive pre-existing infrastructures, such as adjacent studfarms, has received little attention to date.

Ireland's equine studfarms are internationally recognised for their contributions to national and international elite Thoroughbred breeding, rural employment, and animal welfare. Ireland is the third largest producer of Thoroughbred foals in the world – only the USA and Australia have more foal births, and the annual Irish Thoroughbred foal crop exceeds the combined totals produced by the UK and France (Weatherbys 2025). Studfarms occupy a critical niche in Ireland's agricultural economy, combining high-value investment with rigorous standards of equine care and performance. Beyond their economic significance, Irish studfarms embody a tradition of excellence in equine genetics, welfare, and global competitiveness (Department of Agriculture, Food and the Marine, 2022).

The significance of the need for reconciliation of industrial-scale infrastructure projects with preservation of the bloodstock industry is illustrated by the fact that some 2,400 acres of County Kildare are either approved or applying for permission for these developments. This area contains literally thousands of Thoroughbred mares, foals and yearlings, based in Kildare's 744 breeding operations, which represent a significant proportion of Ireland's racing and breeding industry which is worth some €2 billion annually to the Irish economy (source - HRI 2023).

Industrial scale infrastructure developments create *de facto* environmental disruptions that have the potential to impair equine health and behaviour, posing risks to both horses and handlers. Ireland has no policy in relation to the siting of industrial scale solar and wind turbine installations in immediate proximity to studfarms and this has been left to developers and the planning authorities by default.

Neither the developers nor the planners have any authoritative guidelines that they must consider in this context and have in more than one instance appear to have drawn upon inappropriate information to satisfy themselves that they have taken into account the significant animal welfare issues that can arise from inappropriate infrastructure placements.

Drawing on peer-reviewed studies, this review examines the multifaceted impact of industrial solar and wind installations on horse welfare and studfarm functionality. The following synthesis evaluates the scientific evidence surrounding renewable infrastructure and its influence on equine health, behaviour, and farm management and makes a series of recommendations for developers, planners, studfarm management and Government.

1. Renewable Infrastructure and Environmental Stressors

Industrial solar and wind installations introduce a range of environmental stressors that may affect equine welfare. These include elevated noise levels from construction and maintenance activities, increased airborne particulates / dust, artificial light fluctuations, and visual flicker from rotating turbine blades.

(a) Noise, light flashes and turbine flicker

Horses have been shown to have significant right forebrain dominance, i.e. they are exceptionally adept at processing sensory stimuli (Johnson et al. 2019). Vocal communication/whinnying by horses conveys information on their sex, body size and identity, and allows them to decode information (Lemasson et al. 2009).

Because they are a prey species, the sensory systems of horses have evolved to enable a prompt detection of potential danger, through a combination of visual, auditory and olfactory cues (Christensen et al. 2005, Saslow 2002, Tierartzliche Praxis 1997) and unexpected and hitherto unknown noises elicit rapid flight reactions more frequently (Christensen et al. 2005, Algers 1984). Horses are most easily scared by noise that arises outside their field of binocular vision.

Hearing ability is very important to the survival for a horse and its ears can pick up sound at a lower volume and a greater distance than will be detected by a human (Saslow, 2002). A horse's range of hearing is greater than a person's to higher frequencies (over 33 kHz in the horse compared with under 20 kHz in humans).

Horses can exhibit unpredictable anxiety behaviours during any noise producing events, including sweating, trembling and intense escape attempts, which may cause severe accidents for the horse

and the rider/handler. More than 84% of horses showed immediate avoidance and/or attempts to flee after perceived threat (Scopa et al. 2018).

Injury to those persons who work with horses is a significant occupational hazard and can extend to thousands of accidents with associated fatalities (Holler 1984, Gimsing 2001). Dealing with an anxious or fearful horse exacerbates this risk.

The results of a recent study (Riva et al. 2022) have confirmed that noise anxiety is a growing behavioural problem that leads to important welfare concerns for all horses, and that very severe injuries can occur because of noise events that result in related, unpredictable and very severe anxiety. Riva et al. 2022 have also shown that the effects of noise-related anxiety can persist for hours or even days after the noise event.

"Noise aversion" or "noise anxiety" are terms used when an animal over-reacts to noise. Unpredictable noise causes the greatest fear reactions. These noises can have long-lasting effects and have been reported to adversely affect food intake, growth and production rates (Broucek 2014; Tracy et al. 2007, Head et al 1993).

Severe noise anxiety is reported to cause serious welfare consequences, impacting both the physiology (e.g. gastrointestinal signs/colic, sweating) and behaviour (e.g. frantic running, collisions with and breaking fences) of the horse (Riva et al. 2022). Very anxious horses showed signs of noise reactivity frequently and their reactions did not improve with time (i.e. they do not habituate to these stimuli).

Light flashes and unknown odours have also been reported to be potent inducers of fear reactions (Gronquvist 2016, Dai et al. 2020). It is noteworthy that compared to visual and olfactory stimuli, unexpected unknown noises seem to elicit rapid flight reactions more frequently (Christensen et al. 2005, Algers 1984).

There is a high rate of incidence of injury (26%) among horses rated as either anxious or very anxious in the face of noise and/or light-related flashes, and simply moving horses to adjacent paddocks was found to be ineffective in 37% of cases (Gronquvist 2016). Noise has also been shown to elicit restlessness, vocalisation and colic/gastro-intestinal disturbances (Dai et al. 2020).

Noise arises during multiple phases of the construction and subsequent day to day running of these industrial/utility scale solar energy plants. It arises from multiple use of band saws and other equipment used to prepare the site by removal of trees and other vegetation. It arises as a result of the relentless repeated and unpredictable impact noise due to pile driving of literally hundreds of thousands of steel supports for the solar panels and the solar panels that are then erected on them. Pile or rotary driving for the mounting frames of the PV panels and security fences would to occur throughout the construction process.

Typical rural background noise in agricultural areas ranges from 30 to 45 dB(A) depending on wind, vegetation, and machinery activity. The normal background noise on a quiet stud farm environment is 25 to 35 dB. (ps://ia.cpuc.ca.gov/environment/info/aspen/cresseygallo/fmnd/5-12_noise.) Light machinery (e.g. tractors idling or distant chainsaws) may produce 50–65 dB(A), while the heavy equipment used in major infrastructure (e.g. piledrivers used for mounting solar panels) can create noise levels of 80 Decibels and can have an additive 10 Decibels of associated vibration. Noise is measured on a logarithmic (not linear scale) in which a 6dB increment can represent a doubling of the baseline noise, and thus an increase from 50db to 70dB represents a four-fold increase in noise. These potential noise levels have been recognised to cause "cosmetic damage to the external surfaces of

nearby buildings", i.e. it is sufficient to crack the external plasterwork on houses. Significant noise will also arise from the thousands of HGV movements necessary to deliver and install multiple solar panels and their mountings and inverters and similarly for wind turbines. Noise also arises when the industrial-scale plants become operational, in normal usage and when faults occur within them. These noise levels therefore far exceed the ambient acoustic threshold for equine comfort. There is therefore an essential need for to include site-specific acoustic modelling and mitigation in compulsory environmental impact assessments (EIA's) near studfarms. There is no legal obligation on developers or planners to ensure that EIA's are carried out and documented by impartial and objective providers.

Developers have not acknowledged the need for EIA's and have repeatedly cited a conference proceedings presentation on noise levels recorded at the Melbourne Cup as part of the Autumn horse racing carnival in Australia, which had a crowd of some 120,000 people in attendance (Huybregts, 2008) as baseline for extrapolation to studfarms in terms of noise tolerance. The noise exposure (LAeq,15 minutes) of horses during this and another major racing event was measured at 58-62 dBA in the stables (rising to 66-68 dBA during helicopter flyovers), and 65-70 dBA in the stalls. The Clerk of the Course's horse was exposed to 76 dBA LAeq,6h at Randwick Racecourse during the New Easter Carnival and 85 dBA LAeq,6h at Flemington during the Melbourne Cup. During the Melbourne Cup, the noise exposure (LAeq,15 minutes) of horses in the stables was measured at 54-70 dBA. Nevertheless, a recommendation was made that, if possible, noise levels not exceed 65dBA LAeq.

This figure has been adopted by both developers and planners. The responses of experienced mature racehorses to noise levels of up to 76dBA and 85dBA at the Melbourne Cup and other racing carnivals or to an arbitrary limit of pf 65dBA bear no relationship to the quiet peaceful agricultural environment of 25 35dBA that is universally acknowledged to be essential for Thoroughbred breeding and for the raising of foals and yearlings. Importantly, the author has stated that he never intended that his report would be used in this way (Huybregts - personal communication).

Another study (Le Blanc et al 1991) has also been used in an inappropriate way by developers who have sought to dismiss noise appraisal as a significant factor in the assessment of the impact of their projects on studfarms. Le Blanc et al 1991 examined the effects of exposure to jet aircraft noise on Thoroughbred mares. Importantly, the study did not include mares with foals at foot. The mares were only exposed to jet noise while they were in the confines of their familiar stables where they were unlikely to injure themselves during a behavioral flight response. This experiment did not measure the responses of mares kept in larger open or novel spaces. Nor did it use live flyovers where the mares might see as well as hear the planes. However, since all of the mares in this experiment showed flight behavior during at least the first simulated jet noise event, it is likely that in a larger spaces i.e pasture, the flight responses could result in a greater speed of gait (gallop) and distance covered. The authors stated that this increase in speed and distance may increase the risk of injury by running into objects. This study therefore cannot be taken as a baseline for noise level tolerance for mares and their foals on studfarms.

Developers and planning authorities have used these inappropriate measures because they report that there are no studies of the adverse effects of noise on mares and foals in the literature and that those quoted above are thus the benchmarks. This approach fails to recognize that any such experimental study would never be licensed because it would contravene all animal welfare licensing considerations. Reliance on observational field studies as quoted in this review, is therefore essential.

Highly sensitive mares and newborn foals are particularly vulnerable to environmental stressors. O'Connor & Walsh (2021) emphasised that pregnant mares exhibit heightened sensitivity to noise and light fluctuations, which may interfere with gestation and increase the risk of premature birth or

behavioural distress. Smith et al. (2020) reported that foals exposed to elevated noise levels during early development showed signs of sleep disruption, increased startle responses, and reduced social bonding behaviours and Green et al. (2021) noted that neonatal horses are especially susceptible to visual flicker and tonal noise, which can impair rest cycles and contribute to developmental instability.

Chronic exposure to such stimuli may result in heightened stress responses, altered behaviour, and compromised physiological stability as evidenced by Jones et al. (2019) who examined sensory sensitivity in horses, highlighting their vulnerability to environmental stimuli and the implications for welfare management. In addition, McBride & Mills (2012) explored psychological factors affecting equine welfare, emphasising the role of environmental consistency and stress mitigation and Green et al. (2021) investigated the impact of wind turbine noise and flicker noted increased agitation and avoidance behaviours in horses exposed to nearby wind farms. Exposure to these stressors may undermine welfare outcomes and elevate safety concerns for both animals and personnel alike.

The cumulative impact of noise, light fluctuations, and visual flicker may thus significantly adversely affect equine physiology and increase the likelihood of injury or behavioural instability (Smith et al., 2020; O'Connor & Walsh, 2021; Green et al., 2021). Thompson & Hannan (2023) presented evidence on circadian disruption in horses, linking artificial light exposure to hormonal imbalance and sleep disturbances. Green et al. (2021) also reported that horses exposed to wind turbine flicker exhibited signs of visual stress and disrupted rest patterns, suggesting a link between flicker frequency and behavioural instability.

(b) Dust

Dust arises during any type of construction. Construction dust is recognised as not just a nuisance, it is a real danger to the lung and many common construction processes can create high dust levels especially during industrial scale developments. The equine lung is particularly susceptible to inhaled dusts (Couetil et al 2016) and dust induced equine inflammatory airway disease/equine asthma is performance limiting and frequently chronic. Any condition that is performance limiting is disastrous for the Thoroughbred horses that are raised on studfarms.

(c Fire hazards

Fires can and do arise on industrial scale solar plants. There are multiple recent reports of their occurrence throughout the world. Fire and smoke are particularly potent inducers of panic in horses. Attempted rescue of horses terrified by fire is highly dangerous for all associated personnel.

Statistics revealed by the Australian Photovoltaics (PV) Institute showed that between 2018 and 2020, PV installations increased less than threefold, whereas the data from Fire and Rescue New South Wales(NSW), however, reveals that the number of solar fires attended by firefighters in the same period rose sixfold. The report also looks at a study by the UK's BRE National Solar Centre - entitled "FIRE AND SOLAR PV SYSTEMS - INVESTIGATIONS AND EVIDENCE". The study provided a detailed investigation into a total of 80 potential PV-related fire incidents that led to the overall conclusion that researchers "strongly suspected a degree of under-reporting, especially amongst solar farms and domestic thermal events that were resolved by a solar installer/maintenance engineer." Furthermore, it explores how this lack of transparency could prevent the industry from establishing an accurate baseline to continuously improve best practice. The report goes on to establish three root causes for photovoltaic fires, namely: 1) error in the design system, 2) a faulty product(s), or 3) poor installation practice. According to the report, the photovoltaic components that present the greatest fire risk are DC isolators, which cause approximately one third (33%) of solar fire incidents. However, DC connectors and inverters can also pose significant risks (Reassurance 2022). Solar panels contain silicates and other toxic chemicals, which when released from an industrial scale solar plant can be inhaled in the resultant smoke. Firefighters must have

appropriate all-weather access to the entire solar plant because fire can arise anywhere at any time within it. Inadequate roads within the plant can result in failure of access and ineffective firefighting. The run-off of water used to extinguish solar panel fires will also contain multiple toxic chemicals which will inevitably contaminate surrounding pastures and draining waterways.

Placing of solar panels and inverters immediately adjacent to stables, foaling units, hay and straw barns, equipment sheds and fuel stores that are part of the essential infrastructure of studfarms risks spreading fire originating in the industrial solar development onto the studfarms themselves. Furthermore, and also importantly, a fire arising on the studfarm can spread to the solar plant.

(d) Restricted access – its implications for the management of studfarms, insurance and investment

Studfarms have a 24/7/365 requirement for immediate access for the very wide range of support services and the multiple inward and outward movements that are inherent to this activity. Inward and outward freedom of access is essential for veterinary services - because life threatening illness and injury requiring immediate treatment and/or hospitalisation can arise at any time of the day or night. There is a constant demand for free access by staff, feed merchants, farriers, and all of the other myriad of associated support suppliers. The contention that this traffic flow can be readily managed without significant interruptions, by stop and go signs, on minor roads, which will then be filled with an enormous increase in HGV traffic - does not withstand scrutiny, as can be attested to by most private citizens who have found themselves experiencing prolonged delays under such circumstances.

Very many high value Thoroughbred horses are insured through underwriter syndicate members of the Lloyds Livestock Committee in London. Many of these horses, singly or collectively, are insured for substantial sums. The Lloyds Livestock Committee have advised through personal communication that the normal terms and conditions of their all-risks mortality policy are null and void if horses are knowingly maintained or placed in situations of risk. They have advised that policies for horses on studfarms immediately adjacent to industrial scale solar plants or wind farms may be subject to significant additional charges and exclusions or may be forfeit altogether.

Many of these farms hold stock for major international investors in Ireland's bloodstock industry. These investors have multiple alternative options available to them in this country and in competitor countries. They will not leave their horses in such hazardous circumstances. The result will inevitably be closure of studfarms, an unnecessary loss of rural employment and reduced net inward investment and reputational damage.

2. Mitigation Strategies

The European Commission (2020) has issued guidance on environmental impact assessments for renewable energy projects, recommending mitigation strategies to reduce ecological and agricultural disruption and Green et al. (2021) have emphasised the importance of turbine placement and construction timing to minimise disruption to equine routines and reduce stress-related incidents.

However, many management strategies used in efforts to control the effects of noise have been shown to be ineffective (Gronquvist, 2016). Placing horses in stables to try to prevent adverse effects is also unsatisfactory as those in single stables exhibit even stronger reactions to unknown stimuli, with an increased risk of accidents and adverse effects on welfare, which can include long term behavioural abnormalities (Lesimple et al. 2011). Sedation can often give disappointing results and

cause undesirable side effects (Dai et al. 2020) and long-term sedation and or stabling is impractical and inhumane.

Farm managers must navigate logistical constraints, including altered traffic patterns, restricted land use, and increased biosecurity risks from increased personnel and equipment movement, requiring enhanced sanitation and access control protocols. All mitigation strategies - such as buffer zones, noise barriers, and dust suppression - all of which require careful planning and resource allocation (Murphy & Keane, 2021; European Commission, 2020; Green et al., 2021). Developers and planners must be aware of and proactively manage and consider resolving the inherent conflicts between construction timelines and breeding or foaling seasons, necessitating coordination to avoid peak sensitivity periods and temporarily reducing turbine speed or halting operation during sensitive periods (e.g. foaling season or early morning rest hours) to minimise tonal and amplitude-modulated noise (EIAR – O'Reilly & Carr, 2024). Installing physical barriers such as earth berms, vegetation screens, or acoustic fencing to absorb and deflect sound waves (Fehily Timoney & Co., 2024) and using blade orientation and nacelle positioning to direct noise away from sensitive receptors (European Commission, 2020) have also been advocated as has scheduling construction and maintenance activities outside of breeding and training hours to avoid peak stress periods (Murphy & Keane, 2021).

"Foaling Area Protection" has also been advocated by locating foaling areas at maximum distance from construction zones and turbine installations, but relocation of foaling units is impractical and industrial-scale encroachment on these facilities should not be permitted under any circumstances because of the significant adverse impacts on animal welfare (reference?). The use of acoustic shielding and visual barriers to minimise exposure to noise and flicker (O'Connor & Walsh, 2021; Smith et al., 2020) have also been recommended but not implemented.

Veterinary involvement in environmental impact assessments and planning consultations to ensure welfare-sensitive siting and mitigation (Irish Planning Institute, 2023) has been recommended to include regular veterinary monitoring of behavioural indicators in pregnant mares and foals during construction and operational phases (Green et al., 2021; Thompson & Hannan, 2023).Such veterinary monitoring seems to have been seldom implemented. Similarly, Equine Emergency Response Planning **i.**e. the development of contingency protocols for behavioural distress or injury linked to environmental stressors, including rapid veterinary intervention and temporary relocation option has not received the essential attention that it must have.

These strategies should be tailored to site-specific conditions and integrated into planning applications and environmental impact assessments (EIA's) to safeguard equine welfare.

3. Policy Considerations and Future Research

Balancing renewable energy development with equine welfare necessitates informed policy frameworks. Regulatory bodies should incorporate equine-specific impact assessments into planning procedures for solar and wind installations near studfarms. EIA's are currently not mandatory and this review highlights the fact that they are essential in this context and must be commissioned by the planning authorities to avoid the inherent conflicts of interest that arise when they are produced by developers.

Further research is needed to quantify long-term effects, identify thresholds of tolerance, and develop evidence-based mitigation protocols, however, there is an immediate need for collaboration between energy developers, veterinary scientists, and agricultural stakeholders (Royal Society, 2022; Irish Planning Institute, 2023). Policy-oriented contributions from the Royal Society (2022) and Irish

Planning Institute (2023) align in advocating for equine-sensitive planning. The Royal Society sets a broad interdisciplinary agenda, while the Irish Planning Institute translates this into actionable protocols. The Royal Society (2022) emphasised the importance of sustainable energy development that coexists with agricultural practices, advocating for interdisciplinary collaboration and the Irish Planning Institute (2023) addressed planning considerations for renewable energy near equine facilities, proposing equine-specific assessment protocols.

4. Recent Planning Authority Statements (2025) and Planning frameworks in other countries

Recent statements from Irish planning authorities underscore the growing tension between renewable energy expansion and the protection of sensitive agricultural sectors, including studfarms.

An Bord Pleanála (2025) reported that of the 69 renewable energy cases reviewed in 2023-2024, several wind and solar farm applications were refused due to conflicts with local Development Plan policies. Notably, objections citing proximity to studfarms were among the reasons for refusal in multiple wind farm appeals. In several decisions, the Board cited concerns over elevated noise levels and their potential impact on equine welfare, referencing submissions from veterinary experts and local stakeholders. The Board emphasised the need to balance strategic infrastructure development with environmental and agricultural sensitivities.

The European Union (Planning and Development) (Renewable Energy) Regulations 2025 introduced new definitions and criteria for renewable energy projects, including co-located energy storage and solar installations on artificial surfaces. While the regulations streamline approval processes, they do not yet include specific provisions for equine welfare, prompting calls for sector-specific amendments.

The Climate Action Plan 2025, published by the Irish Government, outlines regional quotas for wind and solar capacity and proposes extending the lifespan of existing installations. However, the plan also acknowledges persistent local objections - particularly in rural areas with studfarms - and suggests that future planning must address these concerns through targeted mitigation and stakeholder engagement.

These developments highlight a policy crossroads: while Ireland accelerates its renewable energy goals, planning authorities are increasingly recognising the need to safeguard high-value agricultural sectors like Thoroughbred breeding. The integration of equine welfare assessments into planning protocols remains a critical next step.

Several EU member states and international jurisdictions have already adopted planning frameworks that address the intersection of renewable energy infrastructure and equine welfare (references?). In France, the Ministry of Ecological Transition mandates buffer zones of up to 500 meters between wind turbines and sensitive agricultural operations, including studfarms. French planning authorities also require site-specific environmental impact assessments that consider animal welfare. Germany's Federal Emission Control Act includes noise thresholds for rural zones, with specific provisions for livestock operations. In Lower Saxony, home to several major equine breeding centers, regional guidelines discourage wind turbine placement within 1 kilometre of studfarms. In the Netherlands, equine welfare is integrated into spatial planning through the 'Ruimtelijke Ordening' framework, which emphasises stakeholder consultation and adaptive zoning. Dutch municipalities often require

equine-specific mitigation plans for renewable energy projects near riding schools and breeding farms.

Outside the EU, Australia's New South Wales planning authority has issued guidance (reference?) for wind farm siting near equine facilities, recommending minimum separation distances and noise modeling. In the United States, Kentucky's Equine Industry Planning Board has advocated for local ordinances that restrict wind turbine development near Thoroughbred farms.

These international precedents highlight the feasibility and importance of integrating equine welfare into renewable energy planning. Ireland can draw on these models to develop robust, evidence-based policies that protect its bloodstock industry while advancing climate goals.

These international precedents highlight the feasibility and importance of integrating equine welfare into renewable energy planning. Ireland can draw on these models to develop robust, evidence-based policies that protect its bloodstock industry while advancing climate goals. These could include the creation of 500m to 1 kilometer buffer zones, as in France and Lower Saxony, or three times the turbine tips height ibn New South Wales. Mitigation measures such as sound barriers must be installed at the expense of the developer, not the adjacent studfarms and provision for halting operations during sensitive periods such as during essential equine rest periods and the foaling season must be included in these policies.

Ireland's *Animal Health and Welfare Act 2013* provides a robust framework for the protection of animals, and the *Animal Welfare Strategy 2021–2025* reaffirms the Government's commitment to continuous improvement. However, the *Planning and Development Act 2000* does not require planning authorities to consider animal welfare laws when evaluating applications. As noted in recent legal scholarship: "The general approach of planning authorities in the Republic of Ireland is not to have regard to animal welfare matters at the planning stage." — Strauss M (2020).

The *Planning and Development Act 2000* must therefore be amended to require planning authorities to carefully consider and document how they have considered animal welfare legislation and the issues identified in this review when assessing developments adjacent to, or otherwise impacting or potentially impacting, on studfarms. Independently commissioned EIA 's and veterinary-reviewed Animal Welfare Impact Statements must be included in this legislative amendment

CONCLUSIONS

Industrial renewable energy development offers significant environmental benefits, yet its intersection with equine welfare demands careful scrutiny. Irish studfarms represent a unique agricultural sector where animal welfare, economic investment, and cultural heritage converge. Protecting these values requires a nuanced understanding of how solar and wind infrastructure influence equine health and farm operations. Through interdisciplinary research and responsive policy, stakeholders can foster coexistence between renewable energy goals and the preservation of equine excellence.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest related to the content or findings presented in this review. Dr Leadon is the part-owner of a small equine studfarm.

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Appendix 2 - BESS Fire Impacts on Horses, Celia Marr (RCVS and European Specialist in Equine Internal Medicine)

ROSSDALES
VETERINARY SURGEONS

20 August 2021

Kildare County Council Planning Authorities

Dear Sirs,

I have been asked to comment as an Equine Internal Medicine specialist on the Proposal to develop a 212 MW Battery Energy Storage System in Dunnstown, Co. Kildare (Kildare County Council planning application 21608 and An Bord Pleanala case number 310841-21).

Specifically, I have been asked to comment on the danger of inhalation of toxic gases to horses in the event of a hazardous incident. I have also been asked to comment on the negative impact on the thoroughbred breeding and racing industry to the immediate locality around Dunnstown and to the bloodstock industry in Kildare.

As documented in reports by Fordham, Allison and Melville [1] and Larsson et al [2], during a Li-ion "battery fire," multiple toxic gases including Hydrogen Fluoride (HF), Hydrogen Cyanide (HCN)[and Phosphoryl Fluoride (POF3) are produced. The most important is Hydrogen Fluoride (HF), which may be evolved in large quantities (up to 200 mg per Wh of energy storage capacity). HF is toxic in ppm quantities and forms a corrosive acid (Hydrofluoric Acid) in contact with water. It is toxic or lethal by inhalation, ingestion and by skin contact even in small quantities. Major emissions of HF would form highly toxic plumes that could easily threaten nearby population centres.

The release of HF from a Li-ion battery fire can therefore be considered a severe risk to horses: lithium-ion battery fires generate heat and considerable amounts of gas and smoke and generate significant amounts of HF, ranging between 20 and 200 mg/Wh of nominal battery energy capacity, were detected from the burning Li-ion batteries. Larsson's team [2] showed that the measured HF levels, verified using two independent measurement methods, indicate that HF can pose a serious toxic threat, especially for large Li-ion batteries. The immediate dangerous to life or health (IDLH) level for HF is 0.025 g/m3 (30 ppm) [3] and the lethal 10 minutes HF toxicity value (AEGL-3) is 0.0139 g/m3 (170 ppm) [4] and a major fire at the proposed facility appears to be capable of generating such quantities of HF.

My specialist field is Equine Internal Medicine. I have a particular interest in cardiopulmonary conditions affecting horses of all ages. Horses are athletic animals and have proportionately higher lung surface area than humans. This means they are particularly exposed to the pathological effects of inhalation of toxins. Inhalation of Hydrogen Fluoride, Hydrogen Cyanide and Phosphoryl Fluoride at the higher levels are either likely to be severely debilitating or life threatening. Research on the effect of environmental pollutants is currently relatively sparse in horses in comparison to knowledge from human medicine. However, this is a growing field and it is known that particulate matter of any chemical origin can negatively impact equine airway health. Even low-level exposure can damage the lining of the alveoli in the lungs and the mucosal lining of the bronchioles, bronchi and trachea. This damage makes affected horses more prone to developing Inflammatory Airway Disease (IAD), asthma and exercise-induced pulmonary haemorrhage all which are performance limiting by reducing respiratory function while galloping. Indeed, respiratory diseases represent one of the two most common performance-limiting condition in racehorses, (musculoskeletal disorders being the other main cause). Furthermore, there is considerable evidence that smoke inhalation can induce life-ending interstitial pneumonia (also known as acute lung injury & acute respiratory distress syndrome).

Many of the horses being reared in Kildare are kept at pasture: there is real danger to these horses if frightened by fire, smoke and the attendant fire brigade services. Being injured in a fire is a horrible and life-threatening experience for a horse, just as it is for humans. However, it is well recognised amongst equine vets and horsemen that often more of the major injuries which result from fires involving horses are due to panicked horses sustaining musculoskeletal injury while galloping blindly than occur from direct burns. Groups of horses at pasture simply cannot be controlled safely if the herd instinct for flight is triggered by fear.

Kildare is home to a large number of Thoroughbred breeding farms, supporting Ireland's role as a major international producer of Thoroughbred racehorses. A facility which impacts the health of the animals on these farms has serious implications for owners, breeders and trainers in area surrounding Dunnstown. This is highlighted by the fire in Geelong, Victoria, Australia recently where the HF vapour cloud resulted in a stay in order all people and animals within a 7 km radius of the burning facility. It was fortunate that it was in an isolated location. A similar occurrence in Dunnstown would be devastating for the epicentre of thoroughbred horse breeding in Kildare.

Although based in Newmarket, UK, I am very familiar with some of the very important studs in the area and I have visited the area frequently, for example to consult on medical disorders in horses at Juddmonte's New Abbey Stud and His Highness The Aga Khan's Gilltown Stud and Sallymount Studs which are all in close proximity. As a veterinary consultant, I would have serious concerns in having valuable horses such as Sea The Stars in Gilltown Stud or youngstock related to Frankel who was reared in New Abbey Stud. In my opinion that the potential for a hazardous incident so close to over twenty of the top breeding establishments in Kildare is likely to lead to significant loss of confidence in keeping horses there. Many of the UK studs send mares to Kildare each year for covering by stallions based in Ireland. A BESS facility, which will be one of the largest in the world located in Dunnstown, will be a disincentive to locate their valuable stock close to it.

If helpful in your committee's deliberation, I would be happy to provide a more detailed report on the concerns for equine health that this proposal raises.

Yours faithfully,

[redacted]

Celia M. Marr, BVMS, MVM, PhD, DEIM, DipECEIM, FRCVS

RCVS and European Specialist in Equine Internal Medicine.

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Appendix 3 - The Impact on Noise Anxiety on behaviour and welfare of horses

animals

MDPI

Article

The Impact of Noise Anxiety on Behavior and Welfare of Horses from UK and US Owner's Perspective

Maria Giorgia Riva [1,†], Francesca Dai [2,†], Mirja Huhtinen [3], Michela Minero [1], Sara Barbieri [1] and Emanuela Dalla Costa [1,*]

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Simple Summary: Being a prey species, horses evolved to rapidly react to potential danger and loud noises may be perceived as such. Therefore, they can exhibit several anxiety behaviors during noisy events, including sweating, trembling and escape attempts, which may cause severe accidents for the horse and the rider/handler. Since noise anxiety can significantly impact on horse welfare, the aim of the present study was to investigate owners' perception of noise anxiety severity in their horses, their management strategies and perceived efficacy. In a survey, 409 out of 1836 owners reported that their horse shows unusual behavior during a noise event. Among those, two noise anxiety clusters could be identified: very and slightly anxious horses. Very anxious horses were reported to have higher frequency of all anxiety behaviors and higher frequency of signs of noise reactivity; furthermore, their anxiety did not improve with time. The most frequently used management strategies were providing hay throughout the night or turning out or moving horses to a paddock; though, most of these techniques were reported to be effective only in the slightly anxious subjects. Our results confirmed that noise anxiety is a widespread behavioral problem (22% of our respondents reported that their horse had ever shown any unusual behavior in relation to loud noises) that can lead to negative welfare consequences for horses.

Abstract: Noise anxiety is an over-reaction to loud noises commonly detected among pets and can greatly impact on their welfare and on their management. When exposed to noisy events, horses can show intense escape attempts, which may cause severe accidents for the horse and the rider/handler. The aim of the present study was to investigate, through a web survey, UK and US owners' perception of noise anxiety severity in their horses, their management strategies and perceived efficacy. The questionnaire was shared via social networking and advertised as "What is your horse afraid of?". Over a total of 1836 questionnaires filled out; 409 owners reported that their horse has shown unusual behavior during a noise event. A two-step cluster analysis identified two groups: very anxious (VA) and slightly anxious (SA). VA horses were reported to have higher frequency of anxiety behaviors; higher frequency of signs of noise reactivity; and their anxiety did not improve with time. The most used management strategies consisted in providing hay throughout the night, turning in/out their horse or moving it to a paddock. A binomial logistic regression identified that horses that have reported injuries during noise events were more likely to be clustered as VA (OR = 0.24, 95% CI: 0.08–0.76); while providing hay throughout the night was more likely to be very effective management strategy in SA horses (OR = 0.41, 95% CI: 0.16–1.01). Our results confirmed that noise anxiety is a growing behavioral problem that can lead to important welfare concerns for horses. New management strategies, including the use of medicinal products, should be considered to reduce behavioral and physiological signs and help horses to cope with noisy events.

Keywords: noise anxiety; horse welfare; management strategies; fear behavior

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1. Introduction

Fear can be defined as a reaction to the perception of actual danger, while anxiety as the reaction to a potential danger that threatens the individual [1]. Reaction to fear elicits behavioral and physiological modifications [2], such as active defense (attack, menace), active flight (hiding, escape) and passive avoidance (freezing) [3], heart rate and heart rate variability variations [4–9] and rising in cortisol concentration [10–12]. Horses can exhibit several behaviors as fear reaction, including sweating, trembling and escape attempts, which may be particularly dangerous, causing severe accidents for the horse and the rider/handler [4,13–15].

Noise can be described as unwanted sound, eliciting disagreeable feelings in the listener [16]. The response of animals to a certain noise, is determined not only by sound intensity, loudness, frequency, duration and pattern, but also by the animal's previous experience and the acoustic stimulus predictability [17]. Exposure to unknown sounds could elicit stress in animals [16,18–21]. For instance, aircraft and helicopter noise has been reported to affect feed intake, growth and production rates in domestic animals [22–24]. Compared with chronic background or repetitive noise, sudden high intensity unpredictable noises cause greater fear reactions in mammals, including startle response, freezing and fleeing from the sound source [16].

"Noise aversion" or "noise anxiety" occurs when an animal over-reacts to loud noises [25–27]; this phenomenon is well studied in pet dogs. Reported behaviors of dogs experiencing noise anxiety comprise trembling, shaking, salivating, hiding, panting, pacing, restlessness, inappropriate elimination, soliciting human attention, escaping confinement, hiding, destruction, loss of appetite or barking [27–29]. Data suggest that the prevalence of noise anxiety in dogs could reach 49% [26], representing indeed a serious welfare problem. Thunderstorms, fireworks and gunshots are the most commonly reported anxiety-eliciting sounds [25,26], a common characteristic is to be loud explosive noise. Other sound reported to cause anxiety problems are loud sounds on TV, cars backfiring and hoovers [26]. Evidence suggest that dogs commonly generalize fear of one to other noises [26].

Being a prey species, sensory systems of horses evolved to enable a prompt detection of potential danger, throughout a combination of visual, auditory and olfactory cues [14,30]. Compared to visual and olfactory stimuli, unexpected unknown noises seem to elicit rapid flight reactions more frequently [14,31].

Among other noise events, fireworks are the commonest sound causing a fear response [26]. Fireworks may elicit fear reactions in animals, including horses, due to unpredictable, intermittent and high-intensity sounds, with light flashes, odors and changes in barometric pressure [32–34]. Anxiety behaviors related to fireworks are very commonly detected among pets. In a survey conducted in New Zealand, 74% of owners reported their dog or cat to experience noise anxiety caused by fireworks [35]. The reported prevalence of noise anxiety in dogs ranges between 23% and 52% [26,29,36–38]. Breed, genetics, age, health conditions and environment are recognized risk factors for noise anxiety in dogs [26,36–38]. Full recovery from fireworks-related fear is reported to happen the next morning in 75% of dogs, while some subjects may even display milder symptoms for days or weeks after [38]. This clearly represents an animal welfare problem. Compared to dogs, cats are more likely to exhibit behaviors such as hiding or cowering in response to frightful noise stimulation, which owners often fail to correctly interpret as sign of anxiety [29]. Therefore, cat's noise anxiety caused by fireworks is less frequently reported by owners [29,39].

While a number of publications describe the incidence of fear behaviors in response to fireworks in dogs and cats [26,29,32,40], only few studies are published on horses. Gronqvist and colleagues [33] reported that 79% of horses in New Zealand were rated as anxious or very anxious around fireworks by their owners, and, as a consequence, 26% obtained injuries during fireworks. Young and colleagues reported that horses, listening to the sound of fireworks played from compact disk, had higher cortisol levels, indicative of anxiety, than horses reacting to sound from coat clippers or being kept in social isolation [41].

Moving the horse to a paddock away from the fireworks was reported by Gronqvist and colleagues [33] to be the most common management strategy adopted to mitigate this problem; the paper highlights, however, that 37% (374 out of 779) of the respondents reported that this management strategy was ineffective. In dogs and cats, several therapies are described to manage and eventually even overcome noise anxiety and fear. Generally, the condition can be treated using a system of desensitization and counter-conditioning [42], but this may take several weeks. As an immediate solution during the fireworks event, medications such as sedatives and anxiolytics can be used to manage the animal behavior [32,34,42–44]. To reduce animal's reactivity by sedation, Acepromazine has been used for decades, but it can often give disappointing results and cause undesirable side-effects [45,46]. Therefore, benzodiazepines, such as diazepam, or serotonin reuptake inhibitors are now recommended to provide an immediate anxiolytic effect during the anxiogenic event [47]. Diazepam is commonly used [48] and its reported efficacy is generally good [49], however adverse side effects include aggression, sedation and ataxia [45,49]. Moreover, undesirable effects of benzodiazepines includes a reduction of conditioned responses and memory deficits, thus potentially compromising behavioral modification [45]. The use of Detomidine for alleviation of anxiety during noisy events have been tested both in dogs [50] and in horses [34]. The studies suggest that this drug has a good efficacy in reducing anxiety-related behaviors, as reported by owners. While in horses no side-effects have been reported, in dogs observed side-effects included emesis, gastroenteritis, periorbital edema, drowsiness and sedation. The use of Detomidine for this purpose in horses, indeed, is off-label and more studies are needed to confirm its efficacy and safety [34].

To the authors knowledge, no data on horse anxiety around other noises are published. While owners can easily recognize noise anxiety in pet since they share the same house, noise anxiety in horses may not have taken very seriously, probably due to the fact that it is not obvious for owners if they are not around during the noise event [51].

Housing condition has an impact on horse reactivity. Single box housing is recognized as a risk factor for the development undesired behaviors, such as stereotypies, aggressiveness, hyperreactivity or unresponsiveness [52–59]. Lesimple and colleagues [60] demonstrated that horses housed in single boxes exhibit more strong reactions to unknown stimuli and are more prone to express "high locomotory components", thus increasing risks of accidents. Since noise anxiety can significantly impact horse welfare, the aim of the present study was to investigate, through a web survey, UK and US owners' perception of noise anxiety severity in their horses, the management strategies adopted to reduce anxiety behaviors, and their perceived efficacy.

2. Materials and Methods

2.1. Ethic Statement

Horse owners entered the study on a voluntary basis, they were informed about the objectives of the project. The study did not focus on human subjects or human data, no sensitive data were collected, it was not possible to identify the participants from the raw research data. Ethical consent was deemed unnecessary as no personal details of the participants were recorded and the EU Regulation No. 2016/679 does not apply.

2.2. Online Questionnaire

An online questionnaire was created using the commercial survey software Webropol Survey Analytics (Webropol Ltd., Helsinki, Finland). The defined target population was horse owners located in United Kingdom and United States. The questionnaire and its advertisement were written in English, for this reason and because of their renowned equestrian tradition the survey was conducted in these two Countries. The estimated horse population in Britain stands at 847,000 base on BETA National Equestrian Survey 2019 data [61], and American one at 3.8 million in 2017 [62]. Invitations to contribute to the survey were shared via social networking sites (Facebook, Meta Inc., Menlo Park, CA, USA) with the advertisement "What is your horse afraid of?" on a horse picture.

By clicking on the picture, respondents had access the questionnaire; separate links for UK and US were created. The questionnaire was open for one month (April 2018), and it could be completed anonymously. Participants were required to be over the age of 18, therefore Facebook's customers of age were selected, but no IP address or any other personal data were recorded. The questionnaire was organized in two parts, the first one included three multiple-choice questions (Table S1). Only the respondent who answered "yes" to the question "Has your horse ever shown any unusual behavior (e.g., restlessness, sweating, decreased appetite) during noisy events such as firework displays?" could access the second part of the questionnaire. The second part of the questionnaire consisted of 16 multiple-choice questions reported in Table S1. Closed-ended questions were chosen as it is reported that customers are more likely to respond and answers are easier to compare. The questions were formulated to be as consistent as possible with previous publication, Gronqvist's study [33]. For three questions (e.g., Which of the following behaviors has your horse shown during noisy events?; In your opinion, which are your horse's three most alarming behaviors related to noise reactivity?; Please indicate if you have tried the following management strategies for your horse during noisy events such as firework displays in previous years and how effective the management strategy was) the option "other (specify)" was provided, however, the collected answers were sometimes irrelevant (not related to the question) and sometimes difficult to interpret; for this reason they were excluded from statistical analysis.

2.3. Statistical Analysis

Data were analyzed with SPSS statistical package (IBM SPSS Statistic 27). For statistical analysis purposes dichotomous variables (Yes/No) were created for the replies to the questions "In your opinion, which are your horse's three most alarming behaviors related to noise reactivity?". Descriptive statistics including relative proportions were calculated. Anxiety behavior score was calculated adding the frequency (Never = 0; Sometimes = 1; Always = 2) of anxiety behaviors reported by horse owners. A two-step cluster analysis with automatic determination of the number of clusters was performed on the anxiety behavior score to identify groups of horses that were similar to each other for the considered variables. The association between horses' anxiety level identified with cluster analysis and other independent variables was investigated using binomial logistic regression, reporting odds ratios with 95% CIs. Differences were considered to be statistically significant if $p < 0.05$.

3. Results and Discussion

A total of 1836 questionnaires were correctly filled out, the majority coming from respondents living in the United Kingdom (n = 1220, 66%); this could be due to a diverse use of social media. Main information about owners and horse population are showed by Table S2. Most of the respondents owned one horse (n = 928, 50%), followed by respondents owning two or more horses (n = 846, 46%); only 51 (less than 3%) respondents did not own any horse. These last ones were considered in the survey because they actually managed their horses, even if without real possession (lease or half lease contracts). Considering the experience with horses, 114 respondents (6%) reported to have less than 2 years of experience with horses, 236 (13%) had between 2 and 5 years, while most of the respondent had from 6 to 20 (n = 754, 41%) and over 20 years of experience (n = 726, 40%). As shown also by surveys carried out in Sweden and Finland, by owning one or more horses there is a higher probability to be involved in noise anxiety episodes, and therefore be attracted to this kind of survey on the internet [63]. Likewise, the longer experience with horses the respondents had, the higher the probability to have ever observed a noise anxiety-related behavior. Only 409 owners (22%) reported that their horse had ever shown any unusual behavior and, therefore, completed the second part of the questionnaire. This result is lower than what was found in New Zealand by Gronqvist and colleagues [33], where 79% of participants reported their horse to be anxious or very anxious during fireworks display.

Furthermore, Lindstedt's survey reported higher percentages: 30% of Finnish participants and 55% of Swedish ones answered that their horse has shown signs of noise anxiety during loud noise events [63]. A subset of 376 informative answers in our survey were selected for further statistical analysis: questionnaires where owners left blank or answered "don't know" for more than half of the questions were excluded (n = 33). A two-step cluster analysis identified two clusters based on the anxiety score: forty-eight percent (n = 181) of the horses were assigned to the first cluster and fifty-two percent (n = 195) to the second. Horses in the second cluster showed a higher frequency of all these anxiety behaviors compared to horse in the first one. Therefore, cluster 1 was labelled as "slightly anxious" (SA) and cluster 2 as "very anxious" (VA).

3.1. Horse and Stable Characteristics

In the SA cluster, most of the horses were adults: only one horse was younger than 1 year old, a few from 1 to 5 years old (12%), the majority between 6 and 15 years old (59%) or over 15 years (29%). Horses clustered as VA were characterized by a similar age distribution: no horse was younger than 1, 6% was between 1 and 5 years, 60% of the horses ranged from 6 to 15 years old and 34% was older than 15 years. The VA cluster comprised a higher number of geldings (65%) and a lower number of mares (35%) compared to the SA, respectively, 54% and 46%. A lot of different and specific breeds were reported; therefore, they were grouped in three major categories (hotbloods, warmbloods and coldbloods) to simplify the data analysis. The majority of respondents reported to own warmbloods (SA 52%; VA 49%), followed by coldbloods (28% and 26%, respectively) and hotbloods (SA 17%; VA 22%). The most common use for these horses was riding (show jumping, dressage and eventing), followed by leisure and western riding activities. Only a few horses were retired, or used for breeding or driving. The majority of the survey participants reported to keep their horses in a rural (surrounded by farms) or semi-rural (adjacent to an urban area) location. A greater proportion of participants reported checking their animals during noisy events (SA 81%; VA 92%).

3.2. Anxiety Behavior

Noise anxiety was displayed through a variety of anxiety behaviors (e.g., fence/box walking, running, appetite loss, diarrhea, breaking fence, weaving, bucking, sweating, fever, trembling and vocalization). The frequency of different behaviors showed during noisy events in each cluster is reported in Table 1. Most of the anxiety behaviors were reported to be exhibited with "sometimes" frequency. This was particularly true for the VA cluster, while SA horses' owners have rarely observed behaviors such as diarrhea, fever, or breaking fences. These results already highlight the different level of arousal between the two categories. The higher anxiety level in VA horses causes more severe consequences both from physiological and behavioral perspective.

Table 1. Percentage of fear and anxiety behaviors shown during noisy events by horses in each cluster (slightly anxious and very anxious).

Behavior	Frequency	Slightly Anxious (SA) n = 181	Very Anxious (VA) n = 195
Fence/box walking	Always	5 (3%)	54 (28%)
	Sometimes	117 (65%)	127 (65%)
	Never	52 (29%)	10 (5%)
	Don't know	7 (4%)	4 (2%)
Running	Always	5 (3%)	43 (22%)
	Sometimes	121 (67%)	137 (70%)
	Never	49 (27%)	12 (6%)
	Don't know	6 (3%)	3 (2%)

Table 1. *Cont.*

Behavior	Frequency	Slightly Anxious (SA) *n* = 181	Very Anxious (VA) *n* = 195
Appetite loss	Always	2 (1%)	23 (12%)
	Sometimes	56 (31%)	117 (60%)
	Never	114 (63%)	49 (25%)
	Don't know	9 (5%)	6 (3%)
Diarrhea	Always	1 (1%)	16 (8%)
	Sometimes	41 (23%)	106 (54%)
	Never	133 (73%)	68 (35%)
	Don't know	6 (3%)	5 (3%)
Breaking fence	Always	0 (0%)	4 (2%)
	Sometimes	23 (13%)	74 (38%)
	Never	155 (86%)	110 (56%)
	Don't know	3 (2%)	7 (4%)
Weaving	Always	2 (1%)	18 (9%)
	Sometimes	46 (25%)	87 (45%)
	Never	124 (69%)	83 (43%)
	Don't know	9 (5%)	7 (4%)
Bucking	Always	2 (1%)	24 (12%)
	Sometimes	84 (46%)	119 (61%)
	Never	94 (52%)	46 (24%)
	Don't know	1 (1%)	6 (3%)
Sweating	Always	1 (1%)	38 (19%)
	Sometimes	107 (59%)	150 (77%)
	Never	70 (39%)	7 (4%)
	Don't know	3 (2%)	0 (0%)
Fever	Always	0 (0%)	3 (2%)
	Sometimes	3 (2%)	24 (12%)
	Never	166 (92%)	128 (66%)
	Don't know	12 (7%)	40 (21%)
Trembling	Always	1 (1%)	30 (15%)
	Sometimes	71 (36%)	128 (66%)
	Never	105 (54%)	32 (16%)
	Don't know	4 (2%)	5 (3%)
Vocalization	Always	3 (2%)	32 (16%)
	Sometimes	92 (47%)	129 (66%)
	Never	79 (41%)	27 (14%)
	Don't know	7 (4%)	7 (4%)

Fence/box walking and running were the most observed activities, immediately followed by sweating. Running was also the most noted sign found in Gronqvist and colleagues' study [33], whereas in Lindstedt's survey general anxiousness was the most reported sign, followed by decrease appetite, diarrhea or increased defecation, running in the box and sweating [63]. The odds of horses showing walking or running behaviors with a "sometimes" frequency was quite similar between the two clusters. However, 28% and 22% of VA horses' owners reported that their animals "always", respectively, walk or run during a noisy event, while 29% and 27% of SA horses have "never" shown, respectively, walking or running behaviors. A peak of 150 VA horses (77%) and 107 SA ones (59%) sweated with a "sometimes" frequency. Conversely, 39% of SA horses and only 4% of VA horses have "never" sweated during noisy events. A few respondents reported gastrointestinal symptoms: many of the horses classified as VA have "sometimes" shown appetite loss (60%) and/or diarrhea (54%), whereas SA subjects were quite unlikely to experience these conditions. Even though fever was a symptom that showed up rarely in the survey, 3 participants have "always" observed an increase in body temperature.

VA horses appeared to be more likely to break fences (40%) than SA ones (13%), even if the vast majority of the owners did not report this behavior at all (n = 265, 70% of the respondents). VA horses were also quite likely to rear or buck: 61% of the owners answered that their animals have "sometimes" shown these behaviors and 12% that they have "always" behaved in this way. A great proportion of the participants (55%) did not observe the occurrence of weaving behavior, but, respectively, 46 (25%) and 87 (45%) SA and VA horses' owners reported their horses having "sometimes" shown this symptom or other stereotypic behaviors. Even trembling and vocalization were reported as more usual in VA horses than in SA ones. Many of these behaviors, such as fence walking, weaving and other stereotypic behaviors, are reported in the list drawn up by Young and others [41] to identify a horse's stress level. The matching between the behaviors listed by Young and those reported by the questionnaire's respondents may indicate that fireworks cause medium to high levels of distress in horses and therefore they should be addressed as a cause of welfare issues.

Most of the owners did not know when the anxious reaction to noisy events had appeared for the first time (SA 48%; VA 35%). Regardless, when the first unusual behavior had been observed by the owners, the majority of them reported that to have happened in a range between 4 and 9 years old (SA 23%; VA 31%). Only 10 horses in each cluster (SA 6%, VA 5%) had shown their first anxious response before turning 1 year old. When the frequency of anxiety behavior is considered (Figure 1) in both groups, approximately half of the respondents reported their horses to have anxious episodes less than once a month (SA 57%; VA 50%). Nevertheless, in the VA cluster 35 (18%) horses showed signs of noise reactivity one a month and 61 (31%) even once a week. The vast majority of the SA horses' owners noticed that this behavior improved with time (54%) or did not change (42%). VA horses tended either not to change in their reactivity (49%) or to improve with time (36%), while others got worse (15%). Even in the Nordic answers, there were indications that the more anxious horses got worse with age [46]. Fireworks are intermittent and high-intensity noisy events and therefore totally unpredictable for a horse, making the habituation process hardly possible. Thus, particularly very anxious subjects might have no improvements or even get worse with age, which has already been proven to be common in dogs [36–38].

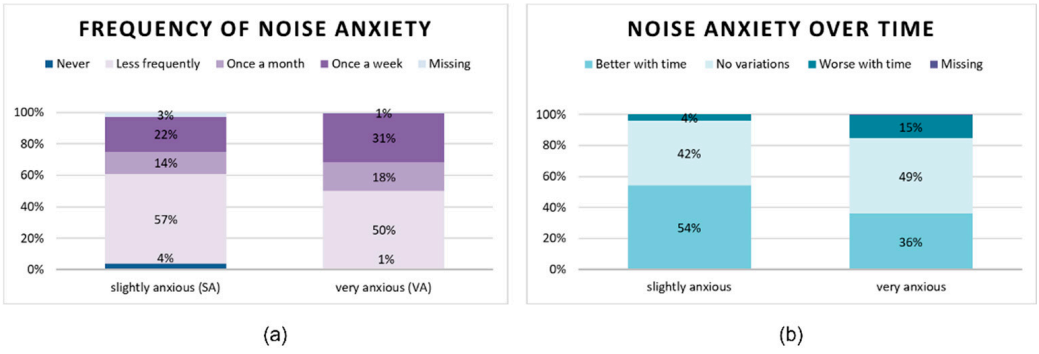

Figure 1. Graphs showing for each cluster: (**a**) the frequency of noise anxiety and (**b**) evolution of noise anxiety over time.

The majority of respondents reported their horses limit anxious behaviors to the duration of the noisy event (SA 80%; VA 49%). In some cases, especially with very anxious subjects, anxious behaviors lasted up to 2 h after the noisy event ended (35%) or even until the next day or longer (14%). In the Nordic questionnaire, owners that reported anxious signs lasting longer than the end of the fireworks had around four times higher risk of owning a horse with severe noise anxiety [46]. Literature reports similar findings in dogs, whose signs may last even for a few weeks [39].

Based on this survey, VA horses are more likely to injure themselves during noisy events (26%) than SA ones (5%). Gronqvist and colleagues' survey yielded an even larger proportion (a quarter) of participants reporting injuries associated with fireworks, and

multiple different types of injuries were described from minor cuts and sprains to broken limbs [33]. Therefore, noise anxiety in horses can be considered as a significant welfare issue, both due to the unnecessary fear and distress it causes to the animal, and due to its physical consequences, namely wounds and injuries. Another thing worth mentioning is the risk of potentially dangerous accidents for the rider/handler [13,14,29].

3.3. Most Alarming Behaviors

Owners' opinions on the most alarming behaviors are presented in Figure 2. A greater proportion of participants in both clusters stated to be worried about behaviors that lead to "excessive activity", such as running (SA 40%, VA 48%), fence/box-stall walking (SA 40%, VA 36%) and bucking/rearing (SA 27%, VA 33%). Additionally, sweating and trembling were regarded as alarming behaviors in both clusters. VA horses' owners reported breaking fences and gastrointestinal symptoms as most alarming behaviors more often than SA horses' ones. When asked to rate how anxious their horses were in these circumstances, only 12 owners (SA = 11, 6%; VA = 1, 1%) described them as "not anxious at all".

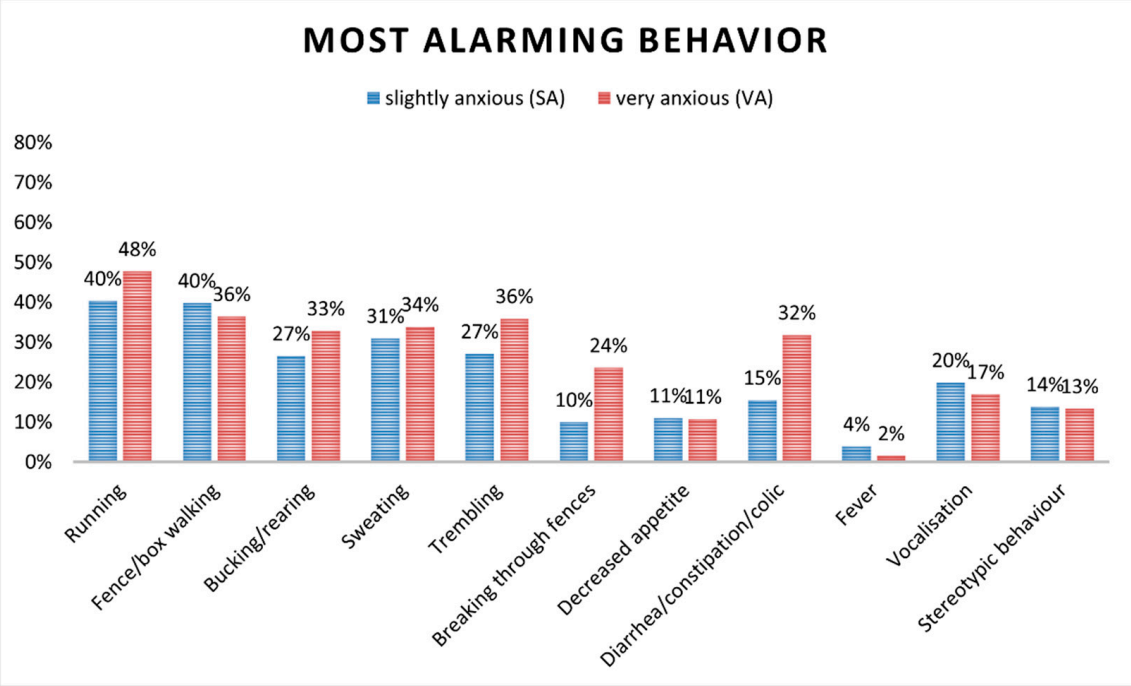

Figure 2. Graph showing, for each cluster, the reported percentages of most alarming behaviors perceived by horse owners.

3.4. Horse Management during Noisy Events

The participants were asked to describe how they used to deal with their horses' noise reactivity and how effective the different management approaches had been. The vast majority of the strategies that had been used by the owners were reported to be more effective in the slightly anxious subjects than in the very anxious cluster. A greater proportion of the participants reported that, during fireworks, they had provided hay throughout the night, turned in/turned out their horse or moved it to a paddock away from the event. The last two were also reported to be the most popular strategies by Gronqvist and colleagues [33], possibly because they are easier management solutions than looking for areas off the properties or asking veterinarians for prescription medicines. Moreover, Lindstedt [63] showed quite similar results: keeping the horse in the stable, playing music/radio and providing hay throughout the night were reported to be the most used management techniques by Finnish and Swedish owners. Regardless, in the same study, none of these protocols were considered effective by all the owners.

Different perceived efficacy levels of the three main management techniques are shown in Figure 3. Providing hay during nighttime proved to be quite effective in the SA group; conversely, most of the VA horses did not show any improvement. Moving the horse to a paddock or turning it in/out tended to be assessed as "somewhat effective" in both clusters; however, VA horse owners reported moving the horse to a paddock as "not effective" more frequently than SA horse owners. Similarly, owners in the SA group reported turning the horse in/out to be "very effective" more frequently than the VA group, while VA perceived this procedure as "not effective" more frequently ($p = 0.002$). Only few respondents answered that they had sedated the horse (using prescription medicines), used over-the-counter products, used ear plugs/covers, moved it off the property, covered the windows or played music.

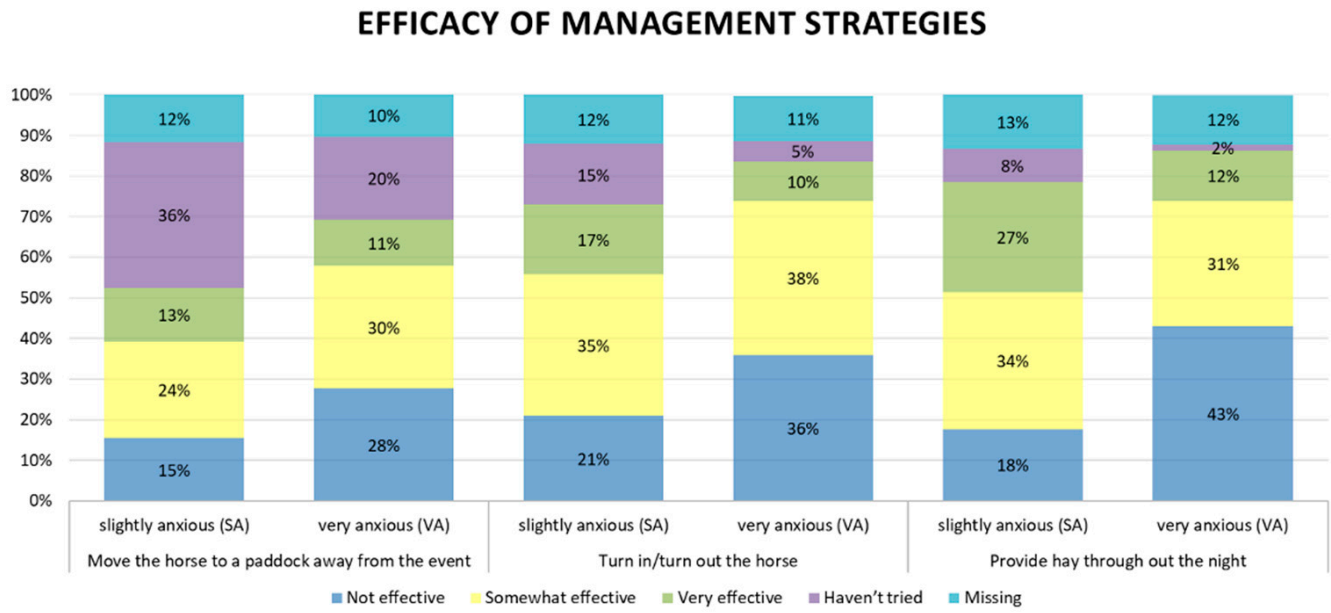

Figure 3. Graph reporting the perceived efficacy of different management strategies by horse owners of the two clusters.

When asked about future management strategies there were no differences between the owners of horses belonging to the different clusters. Most of the participants planned to provide hay throughout the night (SA 52%; VA 47%), turn in/turn out the horse (SA 38%; VA 45%) and play music or radio in the stable (SA 22%; VA 30%). Only five (3%) SA horses' owners would use sedation, while a few more (7%) VA horses' owners planned to sedate their horse during the upcoming noisy events.

The survey ended with a specific question on owners' interest in using new medicinal products for controlling noise anxiety. Most VA horses' owners stated to be quite interested, 23% and 39% of them answered "yes" or "likely yes", respectively. While SA horses' owners were less inclined to adopt this kind of management strategy, only 8% of them answered "yes", and 28% "likely yes". Paste and powder/granules were the preferred medication form (SA 85%; VA = 71%). Only 14% of SA horses' owners and 29% of VA ones chose oral liquid/solution, oromucosal gel or tablets. Similar results were yielded from Swedish and Finnish horse owners: the ones who reported severe noise anxiety in their horse also expressed their potential interest in the use of prescription drugs [63]. Dangerous and risky behaviors, longer duration and difficult management made VA horses' owners concerned about noise anxiety. As reported, these horses are more likely to injure themselves and literature reports a close link between anxious behaviors and physiological signs of distress [2–9]. Therefore, noise anxiety can be considered a health issue, both because the risk of wounds and cuts and because of the stressful condition that may lead to severe systemic disease. Consequently, it is crucial that the owners consult their

veterinarian to find the best management strategy, including medicinal products when necessary. Pharmacological treatment options are available for dogs with noise anxiety. Dexmedetomidine [50] and imepitoin [64] have an anxiolytic effect, especially with noise-related anxiety. However, there are no registered medicines for noise anxiety in horses, thus all drugs are used off-label.

A recent study [34] investigated the use of detomidine (Domosedan vet 7.6 mg/mL oromucosal gel—Orion Corporation, Espoo, Finland) in acute anxiety episodes in horses. The results suggested that detomidine could be effective in alleviating acute fear and anxiety triggered by firework-related noise, and no significant adverse effects were observed. However, this was a pilot study with some limitations (small sample size, possible uneven fireworks intensity and a horse selection based mainly on owners' reports), thus further research is still needed.

3.5. Logistic Regression

A binomial logistic regression was performed to ascertain the effects of the independent variables (e.g., breed and sex of the horse, location of the stable, noise anxiety frequency, duration and changes over time, age horse start showing noise anxiety signs, most alarming behaviors considered by the owner, injuries and effectiveness of the tree most used management techniques) on the likelihood to be part of the VA group. The model included the independent variables listed above except country and experience of the respondent (which were only included in the study for descriptive purposes), and horse characteristics such as age at the moment of the questionnaire and main purpose (on which the authors found no published data about how they are commonly associated with noise reactivity in this species). The model was statistically significant, χ^2 (39) = 152.150, $p < 0.001$, explaining 51.4% (Nagelkerke R2) of the variance in the anxiety level and correctly classified 81.5% of cases. Table 2 summarizes the results of logistic regression. Horses that have reported injuries during noise events (OR = 0.24, 95% CI: 0.08–0.76) were more likely to be clustered as VA. Horse owners who reported to be mostly alarmed by behaviors such as breaking through fences (OR = 0.17, 95% CI: 0.06–0.48), bucking/rearing (OR = 0.39, 95% CI: 0.18–0.87), gastrointestinal signs (OR = 0.23, 95% CI: 0.10–0.56), running (OR = 0.39, 95% CI: 0.18–0.83) or weaving (OR = 0.34, 95% CI: 0.12–0.92) were more likely to have a horse in the VA cluster. Gronqvist and colleagues [33] highlighted a possible association between certain alarming behaviors, such as breaking through fences, and an increase risk of injuries and lacerations. This may explain the higher concern of the VA horses' owners for all these "intensive activity" related behaviors: breaking through fences, bucking/rearing and running. In addition, horses, as a species, are highly susceptible to suffering anxiety-related problems [65], but, as mentioned by Stuijfzand and colleagues [66], also humans with higher anxiety levels tend to show hyperreactivity even to moderate or ambiguous threatening stimuli. Consequently, these hyperreactive subjects are more prone to manifest not only behavioral alterations but also physiological changes due to the chronic stress response [67]. Anxiety activates hormonal and neuronal pathways causing changes such as fluctuations in epinephrine and cortisol levels; as a consequence the heart rate increases and the blood flow is altered, leading to a reduction in gastrointestinal activity among others [68,69]. VA horses' owners may be particularly worried about gastrointestinal signs because in their animals these physiological changes turn into pathologies, such as diarrhea or even colic, more frequently than in less anxious subjects. Furthermore, this hyperreactivity status decreases the level of well-being of the horse, its ability to cope environmental changes while increasing negative emotional states [65]. Thereby, these high levels of frustration may justify the development of stereotypic behaviors such as weaving. Provide hay throughout the night (OR = 0.41, 95% CI: 0.16–1.01) were more likely to be very effective management strategy in SA horses compared to VA. Therefore, distraction techniques, as already reported for playing shooting music [70,71], may be useful only for horses with mild anxiety levels. No differences were found in characteristics such as sex, breed and location of the stable. Similarly, in the questionnaire conducted by Lindstedt, the

severity of anxiety in different stable locations did not differ significantly [63]. Instead, our results differ from what found in pets: while there is evidence that breed, genetics, age and environment affect the prevalence of noise anxiety in dogs [26,36–38,40], in our study only sex came out to be a significant factor, geldings being classified more frequently as "very anxious" compared to mares.

Table 2. Summary of binary logistic regression analysis. Odds ratios for the association between various independent variables and cluster horse anxiety level (slightly anxious vs. very anxious). Numbers in bold distinguish the different variables and the statistically significant results.

Category	β	OR	OR 95% CI		Sign.
Sex (ref: Mare)					
Gelding	0.398	1.49	0.77	2.86	0.23
Breed (ref: Hotblood)					
Coldblood	−0.637	0.53	0.22	1.30	0.17
Warmblood	−0.777	0.46	0.20	1.04	0.06
Definine the location of the stable (ref: Urban)					
Rural (surrounded by farms)	0.942	2.57	0.53	12.46	0.24
Rural village on a main road	−20.101	0.00	0.00		1.00
Semi-rural (adjacent to an urban area)	0.847	2.33	0.46	11.96	0.31
How long does anxious behavior usually last? (ref: Until the next day or longer)					
The duration of the noisy event	−2.281	0.10	0.01	1.22	0.07
Up to 2 h after the noisy event ended	−1.141	0.32	0.08	1.31	0.11
I don't know	0.346	1.41	0.32	6.27	0.65
At what age did your horse start showing these signs? (ref: <1 year of age)					
1–3 years	0.342	1.41	0.28	7.02	0.68
4–9 years	0.742	2.10	0.47	9.41	0.33
≥10 years	−0.005	1.00	0.17	5.70	1.00
Don't know	0.202	1.22	0.29	5.15	0.78
Has your horse's noise reactivity changed over time? (ref: Worse with time)					
Better with time	−1.198	0.30	0.09	1.05	0.06
No, it's the same	−0.259	0.77	0.23	2.64	0.68
How often does your horse show signs of noise reactivity? (ref: Once a week)					
Once a month	−0.203	0.82	0.38	1.76	0.61
Less frequently	1.501	4.49	0.22	93.15	0.33
Never	0.115	1.12	0.42	2.99	0.82
Has the horse injured itself as a result of the reactions caused by the noisy event? (ref: yes)					
No	−1.406	0.25	0.08	0.75	**0.01**
In your opinion, which are your horse's three most alarming behaviors related to noise reactivity? (ref: Yes)					
Fence/box/stall walking (No)	−0.224	0.80	0.38	1.70	0.56
Breaking through fences (No)	−1.747	0.17	0.06	0.48	**0.00**

Table 2. *Cont.*

Category	β	OR	OR 95% CI		Sign.
Bucking/rearing (No)	−0.934	0.39	0.18	0.87	**0.02**
Decreased appetite (No)	−0.078	0.93	0.32	2.71	0.89
Diarrhea/constipation/colic (No)	−1.459	0.23	0.10	0.56	**0.00**
Fever (No)	1.013	2.75	0.34	22.08	0.34
Running (No)	−0.947	0.39	0.18	0.83	**0.02**
Sweating (No)	−0.684	0.51	0.23	1.10	0.08
Trembling (No)	−0.779	0.46	0.21	1.00	0.05
Vocalisation (No)	−0.386	0.68	0.27	1.70	0.41
Weaving or other stereotypic behaviour (No)	−1.093	0.34	0.12	0.92	**0.03**
How effective "move the horse to a paddock away from the event" had been? (ref: Not effective)					0.53
Haven't tried	−0.342	0.71	0.29	1.75	0.46
Somewhat effective	0.064	1.07	0.45	2.52	0.89
Very effective	0.373	1.45	0.49	4.34	0.50
How effective "turn in /turn out the horse" had been? (ref: Not effective)					0.14
Haven't tried	−1.321	0.27	0.08	0.86	**0.03**
Somewhat effective	−0.134	0.87	0.42	1.84	0.72
Very effective	−0.44	0.64	0.23	1.79	0.40
How effective "provide hay through out the night" had been? (ref: Not effective)					0.07
Haven't tried	−1.972	0.14	0.02	0.82	**0.03**
Somewhat effective	−0.339	0.71	0.34	1.48	0.36
Very effective	−0.904	0.41	0.16	1.01	**0.05**

4. Conclusions

An online survey was used to investigate UK and US owners' perception of noise anxiety severity in their horses, the management strategies adopted to reduce anxiety behaviors and their perceived efficacy. The results showed that severe noise anxiety is reported to cause serious welfare consequences, impacting both physiology (e.g., gastrointestinal signs, sweating) and behavior (e.g., running, breaking fence) of the horse. Very anxious horses showed signs of noise reactivity frequently and their reaction did not improve with time (they do not habituate to these stimuli). The most used management strategies consisted of providing hay throughout the night, turning in/out their horse or moving it to a paddock far away; however, most of these techniques were reported to be effective only in the slightly anxious subjects, not in the very anxious ones. Our results confirmed that noise anxiety is a behavioral problem that can lead to important welfare consequences for horses. UK and US owners are quite concerned regarding this issue, particularly the ones whose horses have severe noise anxiety-related problems. New management strategies, including the use of medicinal products, should be considered to reduce behavioral and physiological signs and help horses to cope with noisy events. Since some differences were found in the answers from owners of different countries in terms of noise anxiety's magnitude and spread, further research is still needed to better understand this behavioral problem.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/ani12101319/s1, Table S1: Survey questions, Table S2: Owners and Horse populations main characteristics.

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Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author E.D.C.

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Appendix 4 - Veterinary Evidence BESS Safety Assessment for Lime Down BESS

LIME DOWN

Solar Farm and Battery Energy Storage System

VETERINARY EVIDENCE AND BESS SAFETY ASSESSMENT

Document type:	Technical Evidence for Planning Inspectorate Submission
Subject:	Equine welfare and BESS safety risks arising from the Lime Down development, including thermal runaway, toxic gas release, vapour cloud explosion hazard and environmental contamination from firefighting runoff
Location:	Lime Down, proximate to Badminton Estate, Gloucestershire/Wiltshire border
Prepared for:	Planning Inspectorate Inquiry / Community Objectors
Date:	April 2026

1. Introduction and Scope

This report sets out the veterinary and equine welfare evidence relevant to the Planning Inspectorate inquiry into the Lime Down Solar Farm and Battery Energy Storage System development. It has been prepared to address two significant gaps in the Environmental Impact Assessment submitted by the developer: first, the complete absence of any equine-specific assessment; and second, the inadequacy of the hazard assessment for the BESS component, which represents a development almost four times the scale of the Dunnstown BESS in County Kildare that prompted a formal expert response from Rossdales Equine Hospital in 2021.

The Lime Down site sits within one of the most active equestrian landscapes in England. The surrounding area supports a high concentration of stud farms, professional competition yards and everyday private equine use. Despite this, the developer's assessment concludes in effect that there is no material impact on horses. That conclusion is not supportable.

More than 400 of the nearly 5,000 public representations submitted specifically raise equine concerns. This volume of objection from people with direct professional knowledge of the equestrian environment is not merely anecdotal. It reflects an informed community's assessment that the development poses real and unmitigated risks to horses, riders, breeding operations and equine businesses.

The BESS component adds a further dimension that the developer's documentation does not adequately address. A lithium-ion battery fire at a facility of this scale is capable of producing toxic gas clouds, vapour cloud explosions, extensive environmental contamination from firefighting water runoff and long-duration thermal events that cannot be extinguished by conventional means. These are not theoretical concerns. They are the documented outcomes of real incidents at facilities a fraction of the size of what is proposed at Lime Down.

This report draws on the expert opinion of Professor Celia Marr BVMS MVM PhD DEIM DipECEIM FRCVS, RCVS and European Specialist in Equine Internal Medicine, provided in the context of the smaller Dunnstown BESS proposal in 2021. The risks she identified at Dunnstown apply with proportionally greater force at Lime Down.

2. Expert Opinion: Professor Celia Marr FRCVS

2.1 Qualifications and Standing

Professor Celia Marr holds the degrees BVMS, MVM and PhD from the University of Glasgow and has been a recognised RCVS Specialist in Equine Internal Medicine since 1998 and a European Board Veterinary Specialist since 2003. She is a Fellow of the Royal College of Veterinary Surgeons, an Honorary Professor at the University of Glasgow Faculty of Veterinary Medicine and Editor-in-Chief of the Equine Veterinary Journal, the leading peer-reviewed publication in the discipline. She has practised as an Associate in the Internal Medicine Service at Rossdales Equine Hospital and Diagnostic Centre in Newmarket since 2003 and has published more than 50 original research articles in the peer-reviewed literature.

Professor Marr has particular expertise in cardiopulmonary conditions affecting horses of all ages and has extensive clinical experience with horses in high-value racing and breeding environments, including visiting Juddmonte's New Abbey Stud and the Aga Khan's Gilltown and Sallymount Studs in County Kildare. Her opinion on the Dunnstown BESS proposal was provided in August 2021 to Kildare County Council Planning Authorities and An Bord Pleanala. That opinion is reproduced in summary below and its conclusions applied to the Lime Down proposal.

2.2 Expert Opinion on BESS and Equine Health: Dunnstown 2021

Professor Marr was asked to comment on two matters in relation to the proposed 212 MW BESS at Dunnstown, County Kildare: the danger of toxic gas inhalation to horses in the event of a hazardous incident, and the negative impact on the thoroughbred breeding and racing industry in the surrounding area.

On the question of toxic gas, Professor Marr noted that lithium-ion battery fires produce multiple toxic gases including Hydrogen Fluoride (HF), Hydrogen Cyanide (HCN) and Phosphoryl Fluoride (POF3). She identified HF as the most significant, noting that it may be evolved in large quantities, up to 200 mg per Wh of energy storage capacity, and that it is toxic or lethal by inhalation, ingestion and skin contact even in small quantities. The immediate dangerous to life or health (IDLH) level for HF is 0.025 g per cubic metre (30 ppm) and the lethal 10-minute toxicity value (AEGL-3) is 0.0139 g per cubic metre (170 ppm).

Professor Marr observed that horses are athletic animals with proportionately higher lung surface area than humans, making them particularly vulnerable to inhaled toxins. She noted that even low-level particulate exposure can damage the alveolar lining and the mucosal lining of the bronchioles, bronchi and trachea, predisposing affected horses to Inflammatory Airway Disease, asthma and exercise-induced pulmonary haemorrhage. Smoke inhalation can also induce life-ending interstitial pneumonia, also known as acute lung injury and acute respiratory distress syndrome. Respiratory disease represents one of the two most common performance-limiting conditions in racehorses.

On the flight risk, Professor Marr was direct: it is well recognised among equine veterinarians and horsemen that more of the major injuries arising from fires involving horses result from panicked horses sustaining musculoskeletal injury while galloping blindly than from direct burns. Groups of horses at pasture cannot be controlled safely if the herd instinct for flight is triggered by fear.

Professor Marr cited the fire in Geelong, Victoria, Australia, where an HF vapour cloud resulted in a stay-in-place order for all people and animals within a 7 km radius of the burning facility. She concluded that a similar occurrence near the epicentre of thoroughbred breeding in Kildare would be devastating, and that the potential for a hazardous incident close to over 20 top breeding establishments was likely to lead to significant loss of confidence in keeping horses in the area.

2.3 Application to Lime Down

The Lime Down BESS proposal is reported to be approximately four times the scale of the Dunnstown facility that prompted Professor Marr's 2021 opinion. The hazard scales with the quantity of stored energy. A larger installation means more battery cells capable of thermal runaway, more flammable and toxic gas available for release, a larger potential vapour cloud, a greater volume of contaminated firefighting water and a more prolonged and difficult incident for any emergency response.

The equestrian context at Lime Down is at least as concentrated as at Dunnstown. Badminton Horse Trials is an international event of the highest significance, and the stud farms, competition yards and riding establishments in the surrounding landscape represent a concentration of equine value and welfare responsibility that is exceptional even by the standards of prime horse country. Professor Marr's reasoning in 2021 applies with proportionally greater force at Lime Down in 2026.

3. BESS Safety Hazards: Evidence from Real Incidents

The BESS component of the Lime Down development is not a passive storage installation. It is a large-scale industrial facility storing enormous quantities of chemical energy in a form that can release that energy rapidly, uncontrollably and with serious consequences for surrounding land users, wildlife and water bodies. The following section sets out the four principal hazard categories identified in the scientific literature and documented in real-world incidents, drawing on the EPRI BESS Failure Incident Database, which represents the most comprehensive public record of BESS safety events in existence.

3.1 Thermal Runaway and Cascading Failure

Thermal runaway is the foundational hazard of lithium-ion battery systems. It occurs when the heat generated inside a battery cell exceeds the rate at which it can be dissipated, triggering a self-sustaining exothermic reaction that does not require oxygen and cannot be stopped by conventional suppression. As one cell enters thermal runaway it releases heat, flammable gases and toxic compounds that raise the temperature of adjacent cells, triggering further runaway in a cascade that can propagate through a module, a container and ultimately an entire installation.

The process is well characterised. Thermal runaway in a single cell can be caused by electrical short circuit, overcharging, mechanical damage, manufacturing defect or thermal abuse. The initiating event may be minor. At the 2019 McMicken facility incident in Surprise, Arizona, a single cell failure triggered a sequence that filled a BESS container with flammable gas. When firefighters opened the door to investigate, an explosion occurred, causing serious injuries. The EPRI database records that at the time of a comprehensive 2022 review, at least 48 fire incidents and 8 explosion incidents had occurred across industrial and residential BESS installations globally.

The scale of the Lime Down proposal means that the quantity of energy stored in a single row of containers is sufficient, if released in thermal runaway, to produce a fire event of very considerable duration and intensity. Lithium-ion battery fires are notoriously resistant to extinguishment. At Moss Landing, California, in January 2025, the fire at the world's then-largest BESS was managed by allowing it to burn out rather than attempting suppression, a process lasting several days and requiring closure of Highway 1 and evacuation of approximately 1,200 residents.

3.2 Vapour Cloud Explosion

During thermal runaway, lithium-ion cells vent flammable gases including hydrogen, carbon monoxide, methane, ethylene and other hydrocarbons. In an enclosed or partially enclosed space, these gases can accumulate above their lower flammability limit before ignition occurs. The result is a vapour cloud explosion (VCE), also described as a deflagration, which can generate damaging blast overpressure extending well beyond the immediate installation.

Research using computational fluid dynamics modelling of full-scale BESS containers has demonstrated that when 48 batteries undergo simultaneous thermal runaway, explosion overpressure at 5 metres outside the container hatch can exceed 40 kPa, sufficient to cause serious injury to persons in the vicinity. At closer range, pressures of up to 583 kPa have been modelled at the hatch itself. These are not marginal values; they represent blast loads capable of causing structural damage and lethal injury.

The VCE hazard is distinct from the fire hazard and requires separate assessment. A suppression system that prevents a sustained fire may nonetheless fail to prevent a deflagration if flammable gases have already accumulated. This was precisely the sequence at the 2021 Beijing incident, where a 25 MWh BESS on a shopping mall roof produced a vapour cloud explosion that killed three people and injured one. The EPRI database and Professor Paul Christensen's technical

analysis, which is available in the published literature, both document the VCE pathway as a distinct and significant hazard at BESS installations.

The Lime Down application does not appear to include a hazard methodology assessment that addresses the VCE risk at the proposed scale. This is a fundamental gap in the safety case.

3.3 Toxic Gas Release and Plume Hazard

The toxic gas hazard from BESS fires is primarily driven by hydrogen fluoride, which is formed from the decomposition of fluorine-containing battery components including the LiPF6 electrolyte salt and the PVDF binder (Polyvinylidene Flouride). HF generation has been measured between 20 and 200 mg per Wh of nominal battery capacity in experimental studies. For a large-scale BESS installation, the total potential HF release in a major fire is measured in tonnes.

HF is acutely toxic by inhalation, ingestion and skin absorption. At the IDLH (immediate danger to life and health) concentration of 30 ppm it represents an immediate threat to life. At 170 ppm it is lethal within 10 minutes. It does not require direct contact with flame or even visible smoke at lethal concentrations; under certain atmospheric conditions a plume of HF at harmful concentration can travel significant distances downwind before diluting to safe levels.

The Moss Landing fire of January 2025 produced a confirmed plume of HF that Monterey County officials acknowledged at a public briefing. A shelter-in-place order was issued. The Geelong, Victoria, incident produced an HF plume requiring a 7 km radius stay-in-place order for both people and animals. The Dunnstown BESS against which Professor Marr provided her 2021 opinion was 212 MW. The Lime Down proposal is reportedly nearly four times this scale. The potential HF release in a major fire at Lime Down is correspondingly greater.

For horses, the consequences of HF exposure are severe. Professor Marr's evidence identifies the particular vulnerability arising from the horse's proportionately large lung surface area, the propensity for even sub-lethal respiratory insult to cause Inflammatory Airway Disease and exercise-induced pulmonary haemorrhage, and the risk of acute lung injury and acute respiratory distress syndrome from smoke inhalation. Horses at pasture in the path of a toxic plume cannot be moved quickly or safely, particularly if they are already distressed by fire, smoke and emergency services activity.

Beyond HF, thermal runaway also releases hydrogen cyanide, carbon monoxide, Phosphoryl Fluoride and a range of organic compounds. The combined toxicological profile of a major BESS fire is poorly characterised in relation to horses specifically, and no equine-specific toxicological assessment has been provided in the developer's submission.

3.4 Environmental Contamination: Firefighting Water Runoff

Lithium-ion battery fires require very large volumes of water for management, even when the primary strategy is containment rather than suppression. This water, once in contact with burning or thermally degraded battery materials, becomes contaminated with a range of hazardous substances including lithium, cobalt, nickel, manganese, boron and aluminium in ionic or particulate form, together with organic carbonates from the electrolyte and other complex organic compounds. Research measuring the composition of firefighting runoff from NMC lithium-ion battery fires has confirmed that the resulting water can be highly toxic to aquatic species.

A comparison with predicted no-effect concentrations (PNEC) established by the European Chemicals Agency shows that several metal contaminants in BESS firefighting runoff, in particular nickel with a PNEC as low as 0.0017 mg/L, can exceed ecotoxicity thresholds at concentrations plausibly present in runoff water. The potential for interaction between multiple contaminants further increases the toxicological risk.

The Moss Landing fire of January 2025 provided a real-world demonstration of the environmental contamination hazard. Research published in Scientific Reports documented that approximately

25 metric tonnes of heavy metals, principally nickel, manganese and cobalt, were deposited across roughly half a square mile of wetland at Elkhorn Slough adjacent to the facility. These metals were detected at hundreds to thousands of times the pre-fire concentrations and continue to be remobilised in the environment. Cleanup was estimated to take up to two years. The area affected was approximately 480 hectares of protected wetland.

The Lime Down site sits within the headwater catchment of the Bristol Avon, a river whose Sherston branch rises at Acton Turville and drains the Badminton estate via the Luckington Brook before flowing through Sherston and on to Malmesbury. The BESS, located within Lime Down D near Hullavington, drains to the same catchment. Wiltshire Council noted in its own planning assessment that the development sits within the Bristol Avon Corridor as defined in the Wiltshire Green Blue Infrastructure Plan, and that the proposal could affect Avon catchment ecology. The Environment Agency flood alert area for this region covers the Bristol Avon, Sherston Avon, Tetbury Avon and Dauntsey Brook, with Badminton itself among the listed locations.

Firefighting water runoff from a major BESS fire at this location would enter the upper Bristol Avon system, a watercourse of ecological significance flowing through settled agricultural and equestrian landscape before reaching the Severn Estuary. The volume of contaminated runoff from a facility of this scale, its metal and organic compound loading, and the capacity of any proposed bunding to contain it all require specific modelling and assessment against the watercourse ecotoxicology standards applicable to the Bristol Avon catchment. The developer's submission does not demonstrate that this has been adequately addressed.

3.5 Documented BESS Incidents: EPRI Database and Other Sources

The following table summarises selected significant BESS incidents drawn from the EPRI BESS Failure Incident Database and public records. This is not an exhaustive list. The EPRI database, which is the most comprehensive public record in existence, records dozens of incidents across jurisdictions.

Facility / Location	Date	Capacity	Incident Type	Consequence / Notes
McMicken, Arizona, USA	Apr 2019	2 MW	Thermal runaway; delayed-ignition VCE	4 firefighters seriously injured when deflagration occurred on opening container door. Pivotal event leading to revised NFPA 855 and UL 9540A standards.
Geelong (Moorabool), Victoria, Australia	Jul 2021	212 MWh	Thermal runaway fire; HF release	Stay-in-place order for people and animals within 7 km radius. Cited directly by Prof. Marr as the comparator for the Dunnstown assessment.
Beijing shopping mall, China	Apr 2021	25 MWh	Thermal runaway; VCE	3 killed, 1 injured. Explosion on rooftop installation.
Warwick, New York, USA	Jun 2023	Not disclosed	Two separate fires on consecutive days	Multiple container losses; incident led to calls for revised state-level regulation.
Moss Landing Phase 1, California, USA	Jan 2025	300 MW / 1,200 MWh	Major thermal runaway fire lasting several days	1,200 residents evacuated; HF plume confirmed; Highway 1 closed; approx. 25 metric tonnes of heavy metals deposited on adjacent wetland. Complete loss of facility. Cleanup estimated at 2 years.
Xerotech / Claregalway, Co. Galway	2022	Not disclosed	Fire	Cited in Irish planning objection context. Local equestrian and agricultural land use affected.

Escondido, California, USA	2022	Not disclosed	Container fire	Air monitoring confirmed HF release; shelter-in-place issued; no long-term public health impact reported.
South Korea	2017-2019	Multiple sites	Series of fires; 23 BESS incidents in 3 years	Korean government investigation found systematic safety failures. Triggered global reassessment of BESS fire safety standards.

The pattern across these incidents reveals two consistent features. First, fires at scale-up facilities are not reliably prevented by suppression systems designed for smaller installations. Second, the emergency response consequence radius for a major BESS fire extends well beyond the site boundary into surrounding residential, agricultural and equestrian land. At Lime Down, the concentration of high-value equestrian activity within that consequence radius is exceptional.

4. Equine Sensory Physiology and the Solar Farm Component

4.1 The Equine Visual System

The equine visual system is shaped by millions of years of evolution as an open-grassland prey animal. The horse has one of the largest eyes of any terrestrial land mammal, positioned laterally on the skull to provide a near-panoramic visual field extending to approximately 195 to 228 degrees of uniocular vision. Only two small blind spots exist: directly behind the poll and in a cone approximately 90 to 120 cm in front of the face.

The equine retina has a horizontal visual streak rather than a central fovea, giving broad horizon-focused awareness rather than a small area of sharp central acuity. Objects in the peripheral visual field have very low resolution but are exquisitely sensitive to motion. This is not a limitation; it is the primary survival function of the equine visual system. Motion detected in peripheral vision reliably triggers an alerting or flight response. The motion does not need to be dramatic or fast. Slow, large-scale movement across a wide arc falls within the stimulus parameters most likely to engage this response.

The horse's pupil is horizontally elongated, enhancing sensitivity to stimuli across the horizon. The retina has a rod-to-cone ratio of approximately 20:1, providing superior sensitivity to brightness contrast and to light moving against a background. The tapetum lucidum amplifies available light, making even subtle changes in reflected luminance perceptible. A single-axis tracking panel array, whose faces rotate continuously through the day, whose reflected and absorbed light profile changes with sun elevation and cloud cover, and whose shadow patterns shift hour by hour, presents an ongoing, unpredictable and species-specifically alerting stimulus.

4.2 Why Habituation Arguments Fail for Tracking Systems

Habituation is the mechanism routinely invoked by developers to dismiss equine concerns about landscape infrastructure. It requires a consistent and predictable stimulus. A single-axis tracking array is by definition never the same twice. The angle of panels changes continuously; reflected light intensity varies with sun position, cloud cover and season; shadow patterns shift continuously; inverter and transformer noise varies with power output and switching cycles. The equine nervous system cannot habituate to a stimulus that is not fixed.

The guidance from the British Horse Society on solar farms and equestrians was developed in the context of fixed-tilt, static panel arrays. Applying this guidance to a tracking system without acknowledging the dynamic nature of the installation is a methodological error. Evidence from wildlife research confirms that ungulates including roe deer and reindeer show avoidance behaviour and elevated faecal cortisol concentrations near operating wind turbine installations. These are animals sharing the fundamental prey-animal sensory architecture with horses and obliged to remain in the vicinity. Avoidance in the data does not mean no response; it means the response is behavioural displacement and chronic stress activation rather than flight.

4.3 Acoustic Sensitivity and Inverter Noise

The horse has a hearing range of approximately 55 to 33,500 Hz with peak sensitivity between 1,000 and 16,000 Hz. This range overlaps substantially with the principal acoustic output of grid-scale solar installations, in particular inverter harmonics and transformer hum. Inverter noise is characteristically tonal and intermittent, varying with load conditions and switching cycles. This is the type of acoustic stimulus that most reliably prevents habituation in horses: not uniformly loud, not continuous, but unpredictable in its timing and character.

No equine audiogram has been applied to the predicted noise environment in the developer's assessment. No evaluation has been made of inverter harmonic frequencies against equine peak auditory sensitivity. The interaction between acoustic and visual stimuli as compounding factors has not been considered.

4.4 Stress Physiology and Reproductive Consequences

The physiological stress response in horses is mediated by the hypothalamic-pituitary-adrenal (HPA) axis, activated by any stimulus perceived as threatening or novel. HPA activation produces cortisol release, mobilises metabolic resources and temporarily suppresses non-essential functions including reproductive endocrine function. Chronic or repeated HPA activation has effects extending beyond the acute stress response, impairing immune function, compromising gastrointestinal integrity and having direct suppressive effects on the reproductive hormone cascade.

Research measuring faecal cortisol metabolites in mares attending artificial insemination centres confirms that environmental novelty produces measurable cortisol elevations even without overt handling stress. Maiden mares in unfamiliar environments showed faecal cortisol concentrations more than three times those of habituated animals. Stressful events impair reproductive efficiency through glucocorticoid-mediated inhibition of hormone secretion, and the periconceptual window (approximately days 10 to 40 of gestation) represents the period of greatest vulnerability to stress-induced early embryonic death.

In a landscape with multiple active stud operations, this is not a theoretical concern. Badminton and its surrounding yards handle mares and foals of very considerable value during precisely the months when the solar installation's tracking system is most active and the breeding season is at its most critical. No assessment of this risk appears in the developer's submission.

5. Identified Deficiencies in the Developer's Assessment

The following six deficiencies have been identified across the equine and BESS safety elements of the Environmental Impact Assessment. Any one of these individually would undermine the reliability of the developer's conclusions. Together they render those conclusions unsupportable.

DEFICIENCY 1: Absence of Veterinary or Equine Behaviour Input

The developer's assessment contains no veterinary evidence, no equine behaviour expertise and no input from any practitioner with professional knowledge of equine physiology or welfare. This is the foundational deficiency from which many of the others flow.

By contrast, the Dunnstown BESS proposal in County Kildare, at roughly one quarter of the scale of Lime Down, attracted a detailed expert opinion from an RCVS and European Specialist in Equine Internal Medicine within the planning process. No equivalent input has been sought or provided for Lime Down, notwithstanding the significantly greater scale of the BESS component and the exceptional concentration of equestrian activity in the surrounding landscape.

The Inspectorate should not treat the developer's conclusions on equine welfare as carrying evidential weight in the absence of any specialist input.

DEFICIENCY 2: Static Panel Guidance Applied to a Single-Axis Tracking System

British Horse Society guidance on equestrian impacts from solar developments was developed for fixed-tilt, static panel arrays. The Lime Down development incorporates single-axis horizontal tracking systems in which the panel faces rotate continuously through the day. The distinction is fundamental.

A static panel presents a fixed visual stimulus that in principle permits habituation. A tracking panel presents a continuously changing stimulus with variable angle, variable reflected light intensity, variable shadow pattern and variable acoustic output. The equine visual system is specifically adapted to detect and respond to large-area motion in the peripheral visual field. Applying static panel guidance to a dynamic system without acknowledging this distinction, or conducting any analysis of it, is a methodological error that invalidates the assessment's conclusions on visual impact.

DEFICIENCY 3: No Species-Specific Acoustic Analysis

The acoustic assessment treats predicted noise levels in terms of human residential amenity standards. No equine audiogram has been applied to the predicted noise environment. No assessment has been made of inverter harmonic frequencies against equine peak auditory sensitivity of 1,000 to 16,000 Hz. No consideration has been given to the tonal and intermittent character of inverter and transformer switching as a specific trigger for equine alerting responses.

Without veterinary interpretation of the acoustic data, any noise assessment in relation to equine welfare is incomplete.

DEFICIENCY 4: No Assessment of Breeding Season Vulnerability Windows

The assessment contains no recognition of the specific windows of heightened equine reproductive vulnerability during which environmental stressors carry disproportionate risk. The periconceptual period, the periparturient period and the early foal-at-foot period each present risks that are not present to the same degree at other times.

In a Thoroughbred context the breeding season runs from mid-February, with covering concentrated between February and May and foaling from January onwards. A development whose operational profile is constant year-round must be assessed against the period of greatest equine sensitivity. The developer has not done this.

DEFICIENCY 5: Dismissal of Riding Routes on Grounds of Usage Volume

The assessment dismisses riding routes in the area on the basis that they are not heavily used. This reasoning misunderstands how risk operates in an equestrian context. Risk is a function of consequence as well as probability. A route used occasionally by a young horse in schooling, a mare with a foal at foot, or a horse encountering solar infrastructure for the first time carries the same potential for a severe or fatal accident as a heavily used route.

This approach is inconsistent with BHS guidance that all routes used with horses should be assessed, and inconsistent with standard risk assessment practice across other sectors where consequence severity is weighted alongside frequency.

DEFICIENCY 6: Inadequate BESS Hazard Assessment: Scale, Precedent and Consequence

The BESS hazard assessment does not appear to engage with the specific risk pathways identified in the published literature and documented in real incidents: thermal runaway cascade, vapour cloud explosion from accumulated flammable gas, toxic gas plume including hydrogen fluoride and hydrogen cyanide, and contamination of watercourses from firefighting runoff.

The Lime Down BESS is reported to be approximately four times the scale of the Dunnstown facility that prompted expert veterinary concern in 2021 and approximately the scale of the Moss Landing Phase 1 installation that was evacuated in January 2025. The consequence radius for a major incident at this scale has not been mapped against the surrounding equestrian landscape.

No toxicological assessment of HF plume risk for horses in the vicinity has been provided. No modelling of firefighting water drainage pathways and their relationship to local watercourses has been provided. No equine-specific emergency response protocol has been specified. These are not minor omissions; they represent the core safety case for the most hazardous component of the development.

6. Conclusions and Recommendations

The developer's Environmental Impact Assessment does not provide an adequate equine assessment and does not provide a credible safety case for the BESS component at the proposed scale. The equine assessment was prepared without veterinary input, applied guidance designed for static installations to a tracking system, conducted no species-specific acoustic analysis, ignored breeding season vulnerability and failed to identify equine businesses as sensitive receptors. The BESS safety documentation does not address vapour cloud explosion risk, does not include a quantified HF plume assessment for the proposed scale, does not model firefighting water drainage pathways and does not engage with the evidence base from documented incidents at facilities of comparable scale.

Professor Marr's expert opinion at Dunnstown in 2021 established a clear principle: a BESS facility of this character, located in close proximity to high-value equestrian operations, requires specialist veterinary input and a detailed, site-specific hazard assessment. Neither has been provided for Lime Down. The proposal is four times larger than the Dunnstown facility. The evidentiary obligation is correspondingly greater, not lesser.

Inspectorate requirements:

1. Require the developer to submit a properly conducted equine impact assessment prepared by a suitably qualified veterinary surgeon or equine behaviour specialist, using methodology appropriate to a single-axis tracking solar installation and addressing each of the six deficiencies identified in this report.
2. Require that any such assessment specifically addresses breeding season vulnerability windows, reproductive risk to mares and stallions in adjacent operations, neonatal foal risk and the acoustic profile of inverter and transformer output as measured against the equine audiogram.
3. Require that equine businesses in the area are formally identified as sensitive receptors and that adequate mitigation is proposed, evaluated and conditioned for each affected business.
4. Require the developer to submit a full hazard methodology assessment for the BESS component that addresses thermal runaway cascade, vapour cloud explosion risk, HF and HCN plume modelling at the proposed scale with consequence radius mapping, firefighting water runoff containment capacity and drainage pathway analysis, and an equine-specific emergency response protocol.
5. Require that the BESS hazard assessment is reviewed by an independent specialist in battery safety, not by the developer's own consultants.
6. Treat the existing equine impact and BESS safety assessments as insufficient to discharge the relevant requirements pending submission of the above.
7. it is requested that conditions be imposed sufficient to protect against the identified risks during both construction and operation. These should include acoustic monitoring referenced to equine audiogram thresholds, operational restrictions during defined breeding season windows proximate to known stud operations.
8. It is requested that the bunded containment for BESS firefighting water is of adequate capacity.
9. It is requested that an agreed emergency response protocol with the local fire authority is formulated specifying the consequence radius for a major incident and how horses will be evacuated to safety.

Appendix A References

All sources cited or drawn upon in the preparation of this report are listed below by reference number.

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END OF REPORT

Lime Down Solar Farm and BESS Planning Inquiry | Veterinary and Safety Evidence Report | April 2026

Appendix 5 - Lime Down vet report by George Gemmell (DVM, MRCVs)

Potential Effects of the Proposed Lime Down Solar Project on Local Equine Populations.

The proposed Lime Down Solar Park spans 3,056 acres across rural Wiltshire and Gloucestershire. Construction is due to begin in 2027 and is expected to last for at least two years. During peak construction estimates expect 52 HGV deliveries per day plus commuter traffic which will be funneled through the area via narrow roads often used by local equestrians, including leisure riders, professional yards, and breeding operations. The abrupt shift away from a quiet agricultural landscape poses credible risks to equine welfare, rider safety, and daily horse management, as evidenced by nearly 5,000 public objections highlighting equine concerns.

Equine Behaviour and Sensitivity

Equids have evolved as prey animals and exhibit startle responses to sudden noise, movement, vibration, visual changes, and unfamiliar odours. These responses can trigger flight, elevated heart rates, and stress. Studies show that intermittent, loud stimuli such as reversing alarms, HGV engine noise, and machinery noise are likely to provoke stronger reactions than steady noise, with vibration also eliciting responses [Christensen et al. (2008); Visser et al. (2002); von Lewinski et al. (2013); Snoeks et al. (2015)]. British Horse Society (BHS) guidance advises halting construction within 20-50 metres of horses.

Traffic and Road Safety

The narrow rural roads in the area are routinely used by ridden horses, horseboxes, and horsedrawn vehicles. During the construction of Lime Down increased HGV traffic, combined with poor sightlines and limited passing spaces amplifies the risks to these road users. Sudden encounters with loud and unfamiliar machinery can cause flight reactions such as bolting, leading to collisions, or injuries. It had been shown that repeated exposure does not reliably habituate horses to stimuli, therefore it is unrealistic to expect horses to become used to the disturbances Lime Down will bring. Wiltshire Council has flagged the equestrian impacts and risks increased road traffic will bring and this aligns with BHS data that states close/fast vehicles cause 81% of equine incidents on roads.

Noise, Vibration, Visual, and Construction Disturbance

Construction introduces intermittent noises (machinery, alarms, hammering), vibration (piling, compaction), lighting, and movement, plus operational glare from solar panels along with inverter hum within equine hearing range (55Hz-33kHz). These provoke startle responses and lead to increased vigilance, and stress. This is likely to be worsened by BESS odours or fumes. BHS and other assessments state that construction near to equestrian sites should use low-vibration equipment and operate with timing restrictions to reduce stress on local equestrian populations.

Drainage, Ground Conditions, and Footing

The project includes areas located within Flood Zones 2 and 3 and proposes the introduction of drainage and runoff systems. This, along with soil compaction, track installation, and ditch modification may alter local hydrology. For equine management, even small changes in drainage can have huge effects not limited to:

Increased mud in gateways and high-traffic areas.

Reduced stability of tracks and access routes.

Higher risk of slipping and soft tissue injury.

Increased incidence of hoof-related conditions (e.g. abscessation, softening).

Greater prevalence of dermatological conditions such as mud fever.

These impacts not only affect the welfare of equids but also the safe handling and movement of horses, particularly for more vulnerable groups such as foals and older animals. [O'Grady & Poupard (2003); Scott & Miller (2011)].

Access, Rights of Way, and Route Fragmentation

A great proportion of current equestrian use relies on the connected networks of bridleways, byways, and quiet roads. While the developer proposes to maintain rights of way where possible, temporary diversions are anticipated.

Diversions may be unsuitable for equestrian use if they:

Increase exposure to traffic.

Reduce road/bridleway width.

Introduce poor/unfamiliar surfaces.

Pass close to construction activity.

Loss of safe circular hacking routes can:

Reduce opportunities for exercise and training.

Increase reliance on roadwork in less suitable areas.

Negatively impact equine fitness and behaviour.

For the local breeding operations the disruption of access routes could complicate the safe movement of mares and foals between grazing areas.

Dust, Air Quality, and Site Activity

Construction activity is likely to generate dust and airborne particulates, particularly during dry periods. The potential impacts of this include:

Irritation of the respiratory tract.

Contamination of forage and water sources.

Exacerbation of pre-existing respiratory conditions.

These risks are most relevant for:

Stabled horses near access routes.

Horses with known airway sensitivity.

Brood mares and youngstock in enclosed environments.

BESS Risks.

Professor Celia Marr FRCVS, RCVS/European Specialist in Equine Internal Medicine, assessed the 212MW Dunnstown BESS proposal (2021) and warned of

acute risks to nearby horses from lithium-ion fires releasing toxic gases such as hydrogen fluoride, hydrogen cyanide, and phosphoryl fluoride—lethal via inhalation/skin contact. The increased lung surface found in horses increases vulnerability to airway damage, inflammatory disease, asthma, and acute respiratory distress syndrome, even from low particulates.

Biosecurity and Human Factors

Increased vehicle movements and workforce presence introduce additional risks:

Potential transfer of pathogens between sites via vehicles or equipment.

Increased likelihood of gates being left open or boundaries compromised.

Unfamiliar personnel interacting with or moving near horses.

The presence of dogs or other disturbances associated with site activity.

These factors collectively increase the probability of management-related incidents.

Implications for Brood Mares and Youngstock

Brood mares represent a particularly sensitive subgroup due to the physiological and behavioural demands of pregnancy, foaling, and early lactation. Disturbance during this period may result in:

Heightened stress responses.

Increased risk of injury during flight reactions.

Disruption to grazing.

Hypervigilance leading to a decrease in resting behaviour.

Increased handling risks when moving mares and foals.

Given the evidence linking stress responses to environmental stimuli in horses , maintaining a calm and predictable environment is especially important during late gestation and the periparturient period.

Emergency Access and Veterinary Care

Changes to road access, traffic congestion, or temporary closures may delay:

Veterinary attendance in emergencies (e.g. colic, dystocia, foaling difficulties).

routine management activities

In time-critical conditions, even short delays can have significant welfare consequences.

Overall Assessment

The primary risks to equine populations associated with the Lime Down Solar Project are:

Increased HGV and construction traffic on unsuitable rural roads.

Unpredictable noise and visual disturbances.

Disruption to established equestrian routes.

Changes to drainage and ground conditions.

Indirect risks associated with increased human activity.

These risks are not even, but are likely to be significant for equestrian establishments located near construction routes, access points, or active work areas. Given the behavioural characteristics of horses and the sudden changes that would occur within the local landscape, these impacts should be considered carefully before construction begins. The Lime Down Solar Project would bring substantial and prolonged alterations to a rural environment that currently supports a significant equine presence. Based on established knowledge of equine behaviour and welfare, the proposed development presents credible, evidence-supported risks to both horse and rider/handler safety.

Appendix 6 - Morgan and Morecambe - Managing equestrian noise at Equestrian Receptors Technical Note - 22 October 2025

MORGAN AND MORECAMBE OFFSHORE WIND FARMS: TRANSMISSION ASSETS

Managing Construction Noise at Equestrian Receptors Technical Note

Deadline: 6
22 October 2025
Rev: F01

Document Numbers:
MRCNS-J3303-RPS-19251
MOR001-FLO-CON-ENV-NOT-0105

Document reference: S_D6_9/F01

Document status					
Version	Purpose of document	Approved by	Date	Approved by	Date
F01	Deadline 6	GL	October 2025	IM	October 2025

Prepared by:

RPS

Prepared for:

Morgan Offshore Wind Limited, Morecambe Offshore Windfarm Ltd

Contents

Glossary

Term	Meaning
Decibel	A unit used to measure or compare the intensity of a sound by comparing it with a given reference level on a logarithmic scale
Noise	An unwanted or unexpected sound.
Onshore Order Limits	Onshore Order Limits See Transmission Assets Order Limits: Onshore (below).
Sound	Fluctuations of pressure within a medium (gas, solid or fluid) within the audible range of loudness and frequences with excite the sensation of hearing.
Transmission Assets	The area within which all components of the Transmission Assets will be located, including areas required on a temporary basis during construction and/or decommissioning.
Transmission Assets Order Limits	The area within which all components of the Transmission Assets landward of Mean High-Water Springs will be located, including areas required on a temporary basis during construction and/or decommissioning (such as construction compounds). Also referred to in this report as the Onshore Order Limits, for ease of reading.

Acronyms

Acronym	Meaning
BHS	British Horse Society
ES	Environmental Statement
NSR	Noise Sensitive Receptor

1 Managing Construction Noise at Equestrian Receptors Technical Note

1.1 Introduction

1.1.1.1 The Examining Authority's Second Round of Questions issued on 8th September 2025 (PD-011) requested that the Applicants provide further information of how the impacts of construction noise on wildlife, livestock (cattle and sheep) and horses have been assessed and what specific measures are going to be implemented to mitigate the impact on animals during construction (Q2.14.1.5).

1.1.1.2 Livestock were not identified as receptors sensitive to construction noise and vibration at the pre-application or scoping stage and therefore impacts on these were not assessed or reported in the ES. The Applicants refer to their response to REP3-101.8 (REP4-094), which includes reference to available research on noise and livestock, how this relates to construction noise levels limits proposed for the Transmission Assets and the range of mitigation measures which may be considered to reduce noise impacts on both livestock and horses.

1.1.1.3 In its response (REP5-130), the Applicants confirmed that construction noise impacts had been assessed at both Wrea Green Equitation Centre and Quaker Wood Stables, and these are reported in APP-117. However, the Applicants also noted that, further to this assessment and issues raised with regard to potential impacts on horses and protected characteristics of users of the equestrian facilities in submissions to the Examination, it had commenced a study to identify the risk of noise impacts on equestrian receptors which will be used to inform specific noise mitigation at these receptors during construction. The Applicants committed to submit the outcome of the study at Deadline 6.

1.1.1.4 This technical note provides the findings of this study which includes a review of equestrian receptors at the businesses for which concerns have been raised. The technical note also sets out the scope of specific mitigation measures which should be considered at these receptors to minimise noise impacts on equestrian receptors during the construction phase.

1.1.1.5 Although the focus of this technical note is on construction noise, the Applicants have also given consideration to the impact of construction vibration on equestrian receptors, setting out further measures which can be applied to minimise these impacts.

1.2 Review of research, guidance and assessment approaches

1.2.1.1 As noted in paragraph 8.11.4.10 of Volume 3, Chapter 8: Noise and Vibration (APP-117), the Applicants acknowledge that horses can be startled and flee from noises, with reference to guidance published by the British Horse Society (BHS, 2025). This guidance was used to inform the assessment of impacts on Wrea Green Equitation Centre and Quaker Wood Stables, the latter which were identified as locations where horse riding would be undertaken during the daytime as a recreational activity.

1.2.1.2 However, in response to the issues which have been raised during Examination, the Applicants have undertaken a wider review of available research and guidance relating to noise impacts on horses, with a particular focus on construction noise, as well as reviewing assessment approaches undertaken to support other Development Consent Orders and major infrastructure schemes.

Research review

1.2.1.3 The Applicants have identified no research studies specific to the response of horses to construction noise. However, when reviewing wider research undertaken on horses' reaction to different sounds, the Applicants have found that several research studies concur with the British Horse Society (BHS) guidance, in that noise can lead to behavioural responses in horses (Christense et al., 2005), particularly where the noise is novel and unfamiliar (Janicka et al., 2022). Research also indicates that different horses, like humans, have different sensitivities to noise and therefore, when considering mitigating the impact of construction noise on equestrian receptors, a receptor specific approach is required.

1.2.1.4 When considering the risk of construction noise impact on equestrian receptors from individual construction activities and how this should be mitigated, understanding the hearing range of horses is an important factor. Research has identified that a horse's hearing can range from 55 Hz to 33.3 kHz, with a region of best sensitivity from 1kHz to 16 kHz (Heffner and Heffner, 1983). In comparison, the frequency range audible to humans is typically from 20 Hz to 20 kHz.

Guidance review

1.2.1.5 In addition to the guidance used to inform the assessment of equestrian receptors reported in APP-117, the Applicants have identified further guidance published by British Horse Society relevant to the impact of noise on horses from construction activities. In its specific guidance relating to construction (BHS, 2024), the British Horse Society reiterate that it is a horse's instinct to run from threat, with *'sudden noise and movement'* being likely triggers to a horse's reaction. In construction terms, it relates this to sudden movement or noises from machinery being more of a threat to those which are still.

1.2.1.6 The guidance also provides specific advice on how such reactions from horses can be managed by contractors, based on the following distances from construction activities:

- 20 metres:

  Machinery or activity should not resume until horses are at least twenty metres past. If it is not possible for activity to be halted, staff should be at the location to warn approaching equestrians as appropriate. Such 'sentries' should be obvious on approach, not hidden behind a tree or equipment as suddenly appearing could be an additional stress factor causing a horse to react.

- 50 metres:

If a horse appears distressed—freezes, jerks sideways, prances about, takes flight, spins round or shies away or acts in any way other than a calm forward motion—or an equestrian appears to be struggling for control, or shouts, all movement and noise should cease immediately to avoid escalating the situation. Activity should not resume unless the equestrian indicates that it is safe to do so or is out of sight or more than fifty metres away.

Approaches taken to assessing impacts in EIA

Approach taken in assessment reported in APP-117

1.2.1.7 In its assessment reported in APP-117, the Applicants identified noise sensitive receptors in accordance with the criteria set in Table 8.15, the latter defining their sensitivity according to different settings where human receptors may be present. The assessment methodology and receptor sensitivity are matters which have been agreed with Fylde Borough Council (AS-089, FBC.NV.8) and South Ribble Borough Council (REP4-080, SRBC.NV.8).

1.2.1.8 Both Wrea Green Equitation Centre and Quaker Wood Stables were identified as commercial receptors in accordance with guidance in Table 8.15, with a corresponding sensitivity to noise identified as 'low'. However, following further consideration of the particular sensitivity of horses to sound, noting that any noises may be considered as a potential threat from which horses flee, the sensitivity of those using these locations for horse riding as a recreational activity receptor was increased to medium.

1.2.1.9 However, the Applicants acknowledge that protected characteristic individuals using the equestrian receptors may, like horses, react differently to sound, including sudden and unfamiliar sounds arising from construction. Therefore, the Applicants' focus during the post-consent phase will be to further understand these specific receptors, including their users, and identify what receptor specific mitigation is appropriate to minimise impacts. This approach is further discussed in **paragraph 1.3.1.13** below.

1.2.1.10 The Applicants acknowledge that Midgeland Riding School is also a commercial receptor in accordance with the criteria set in Table 8.15. However, the building associated with the riding school is approximately 650m from the Order Limits and therefore lies outside the construction noise assessment study area of 300m from the Order Limits. Therefore, construction noise impacts at this receptor were not reported in APP-117.

Other DCOs and other major infrastructure projects

1.2.1.11 In its review, the Applicants have not identified any other EIA assessments submitted to support DCOs or other major infrastructure projects in which the noise impacts on horses have been considered in the original application documents. The Applicants have identified that the consideration of noise impacts on horses to invariably be in response to matters raised during examination of the developer's applications, the most notable of these being 'High Speed 2 Limited Phase One Noise effects on Livestock' (Arup, 2017) study.

1.2.1.12 This study focussed on the effects resulting from transportation noise effects during the operational phase of High Speed 2 (HS2), noting the following in relation to managing construction noise impacts on livestock, including horses:

'A number of protective measures are identified in the HS2 Phase One Environment Statement to control construction noise and vibration, including the requirement that best practicable means (BPM) will be applied during construction works to minimise noise (including vibration) at neighbouring residential properties and other sensitive receptors. Additional site-specific mitigation may be also identified in the local environmental management plans.'

1.2.1.13 Although the HS2 Phase One study referred to the application of BPM to minimise construction noise at properties and other sensitive receptors, it acknowledged that site specific mitigation may also be identified to minimise impacts on livestock receptors and such measures to be included in management plans.

Construction vibration

1.2.1.14 The focus of this study is on construction noise, however, the Applicants acknowledge that there is the potential for horses to react to vibration resulting from the construction of the Transmission Assets. Although the Applicants have not identified any specific research studies on this issue, the Institute for Environmental Research and Education (IERE, 2025) suggest that evidence is emerging which indicates horses can:

- Detect subtle seismic activity, such as small earthquakes.
- Respond to vibrations caused by approaching vehicles or machinery.
- Differentiate between different types of vibrations.

1.2.1.15 Therefore, the Applicants have also considered how vibration from construction sources can be managed so that the reaction of horses to it, and the consequential impact on equestrian receptors, can be minimised.

1.3 Outline approach to mitigating construction noise and vibration impacts at equestrian receptors

1.3.1.1 The study has confirmed that equestrian receptors are at risk of impacts due to sudden noises and vibration generated by the construction of the Transmission Assets.

1.3.1.2 The Applicants recognise the need to consider how horses will react to the construction works in close proximity to these receptors and identify what mitigation measures will need to be applied to minimise the risk of adverse noise and vibration impacts at them.

1.3.1.3 However, the Applicants also recognise that the approach to mitigation will need to be developed on a receptor specific basis, as this will vary depending on the specific construction activities (construction plant, timing, duration), the location and use of each equestrian receptor, and the sensitivities of the particular horses. Therefore, engagement with these receptors throughout the post-consent and construction phases will be key to identifying measures

which will be most effective at reducing the risk of adverse noise and vibration impacts at the time the works are undertaken.

1.3.1.4 The scope of mitigation measures and engagement to be considered by the Applicants, including reference to existing project commitments, are set out in further detail below.

Scope of mitigation measures

1.3.1.5 In its update to the Outline Construction Noise and Vibration Management Plan (oCNVMP) at Deadline 5 (REP5-054), the Applicants committed to give specific consideration to the control of noise at the following equestrian receptors, including the need for any receptor specific measures:

- Wrea Green Equitation Centre
- Quaker Wood Stables
- Midgeland Riding School

1.3.1.6 The oCNVMP sets out a number of measures which will be considered to minimise construction noise throughout the construction period. These include the use of plant fitted with measures to reduce the noise emitted from them, the shutting down of plant when not in use and the use of site hoardings/temporary noise barriers, including at temporary construction compounds.

1.3.1.7 The Applicants note that the measures already included within the oCNVMP will contribute to minimising construction noise and vibration impacts at equestrian receptors. However, the Applicants consider that further specific measures may need to be considered to minimise the impacts at these and other equestrian receptors identified in this study, with a particular focus on minimising the impact of sudden noise events. Such activities which may give rise to such events include but are not limited to:

- setting up and decommissioning of temporary construction compounds (Wrea Green and Quaker Wood Stables);
- deliveries to operational construction compounds (Wrea Green and Quaker Wood Stables);
- installation of sheet piling to support trenchless techniques entry and exit pits (potential for all receptors);
- drilling associated with trenchless techniques (potential for all receptors); and
- reversing alarms on vehicles (all receptors).

1.3.1.8 In these circumstances, additional measures are available to control the impact of such events, which include the following:

- timing such activities, as far as reasonably practicable, to days and times when horses not likely to be near them, or arrangements can be made to remove horses from land while activities are being undertaken;
- handling deliveries and materials in a manner which minimises noise and vibration;

- selection of low vibration equipment or operate equipment in low vibration modes where practicable;
- consider if non vibratory methods can be used for compacting haul roads and backfill material;
- consider enhancing sound insulation measures to any affected internal facilities; and
- applying BHS guidance to shut down machinery or stop movement and noise, as far as reasonably practicable, where horses are within 20 m / 50 m of construction activities. The application of any measures set out in this guidance will be informed by the bespoke Communications Plan between the equestrian receptor and their appointed Agricultural Liaison Officer (ALO) and Principal Contractor.

Engagement with affected receptors

1.3.1.9 As noted in **paragraph 1.3.1.3**, the Applicants recognise the key role that engagement with affected equestrian receptors will have in identifying measures which will be most effective at reducing the risk of adverse noise impacts at a particular location.

1.3.1.10 The Applicants are already committed to engagement with various receptors across the Projects, which include those equestrian receptors identified in this study as likely to be at risk of construction noise and vibration impacts. The relevant commitments are as follows.

Outline Code of Construction Practice (oCOCP) (REP5-044)

1.3.1.11 The Applicants are committed to appointing an Agricultural Liaison Officer (ALO), who will be the dedicated point of contact for ongoing engagement about practical matters with landowners, occupiers and their agents during the pre-construction and construction phases.

1.3.1.12 The scope of works included in the ALO role include arranging meetings with landowners, occupiers or their agents to minimise disruption where possible to existing farming regimes and timings of activities. Such meetings will provide the opportunity for these equestrian receptors to discuss planned construction activities with the potential to trigger horses and identify appropriate noise and vibration mitigation measures to minimise/avoid such events.

CoT79: Outline Construction Noise and Vibration Management Plan (oCNVMP) (REP5-054)

1.3.1.13 In the update to the oCNVMP submitted at Deadline 5, the Applicants committed to engage with specific sensitive receptors during the detailed design stage to further understand their use and identify any receptor specific noise and vibration limits and any potential mitigation measures required to minimise construction noise and vibration impacts. These included the following equestrian receptors:

- Quaker Wood Stables,
- Wrea Green Equitation Centre

- Midgeland Riding School

CoT35: Outline Communications Plan

1.3.1.14 As noted in ISH4, the Applicants have engaged regularly with Wrea Green Equitation Centre in respect of the Transmission Assets. Engagement has focused on the necessary communication and the potential impacts to the sensitivity of the horses. The concerns raised by this receptor include noise and vibration, as well as communication and potential visual and odour disturbance on the horses.

1.3.1.15 The Applicants have updated the Outline Communications Plan at Deadline 6 (J1.1/F05) to include a commitment to continuing this engagement through a bespoke communications plan for Wrea Green, which will be prepared in consultation with the Centre. A draft of the bespoke communications plan was shared with Wrea Green on 17th October 2025. The Applicants note the suggested amendments made by Wrea Green and an updated draft will be shared before the close of examination. .

1.3.1.16 The aim of the bespoke plan is to outline a dedicated communications plan for all stages of the Transmission Assets, including survey and construction, which will need to be in place throughout the Transmission Asset's presence near Wrea Green. The bespoke plan will be regularly reviewed and updated in consultation with Wrea Green, as appropriate. The objective of the Communications Plan is to provide tailored information to parties which may require more detail due to the nature of their operations. The purpose of the communications plan is to provide more detail to include (but not limited to):

Information provision / gathering

- Provision by the Applicants of a list of potential activities, including schedules of deliveries and activities (via the detailed Construction Traffic Management Plan) to discuss the context of Wrea Green Equitation Centre's current operation and mitigations that can be applied (i.e. timing and location of classes and works).

Engagement.

- Regular check-in calls prior to and during any works in the vicinity (in addition to any general project updates);
- Prior information and details about the works taking place in the vicinity of Wrea Green Equitation Centre (including agreement on what constitutes in the vicinity);
- Proposed start dates and durations of works;
- The agricultural liaison officer's contact details; and
- The contractor's details and landowner liaison contact.

Mitigations

- Bespoke mitigations to be employed, relating to the key areas of concern for Wrea Green Equitation Centre including, but not limited to:
    - Layout of the temporary construction compound to minimise potential odour and visual impacts;

- Appropriate fencing and screening; and
- Measures to minimise noise and vibration impacts associated with the setup, use and decommissioning of the temporary construction compound.

- Regular review (during check-in calls) of the efficacy of mitigation measures, including the protocols contained within the Wrea Green Communications Plan, to ensure measures can be amended as appropriate.

1.3.1.17 In addition, the Project has committed to provision of an equine veterinarian or other suitable specialist to support Wrea Green Equitation Centre by advising on potential additional mitigation measures during the construction phase. This will take into account the activities carried out during the pre-construction period and ensure expert input is available to understand the horses' behaviour and advice on measures that, alongside the Applicants' mitigation, can be taken to help them to acclimatise to any changes in their environment.

1.4 Conclusion

1.4.1.1 The Examining Authority's Second Round of Questions issued on 8th September 2025 (PD-011) requested that the Applicants provide further information of how the impact of construction noise on wildlife, livestock (cattle and sheep) and horses have been assessed and what specific measures are going to be implemented to mitigate the impact on animals during construction (Q2.14.1.5).

1.4.1.2 Livestock were not identified as receptors sensitive to construction noise and vibration at the pre-application or scoping stage and therefore impacts on these were not assessed or reported in the ES. The Applicants refer to their response to REP3-101.8 (REP4-094), which includes reference to available research on noise and livestock, how this relates to construction noise levels limits proposed for the Transmission Assets and the range of mitigation measures which may be considered to reduce noise impacts on both livestock and horses.

1.4.1.3 In its response (REP5-130), the Applicants confirmed that construction noise impacts had been assessed at both Wrea Green Equitation Centre and Quaker Wood Stables and these are reported in APP-117. However, the Applicants also noted that, further to this assessment and issues raised on horses in submissions to the Examination, it had commenced a study to identify the risk of noise impacts on equestrian receptors which will be used to inform specific noise mitigation at these receptors during construction. The Applicants have also considered the impact of construction vibration on horses.

1.4.1.4 Within this study, reported in this technical note, the Applicants have:

- reviewed available research and guidance which have reaffirmed its understanding that sudden noises can trigger horses to respond and therefore risk adverse impacts at equestrian receptors;
- identified approaches to mitigating impacts, referring to current commitments to managing construction noise within the oCNVMP and

potential additional measures to be considered on a receptor basis to control the impact of sudden noises and construction vibration; and

- identified the key role engagement with the affected equestrian receptors throughout the pre-construction and construction phases, referring to its current engagement commitments.

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Appendix 7 - Lime Down vet report by Dr. Annemarie Farrington

Veterinary Report (Lime Down)

The proposed large-scale solar development adjacent to equine grazing presents a material risk of clinically significant respiratory compromise in horses bred and managed for elite Thoroughbred performance. Construction activity will generate respirable airborne particulate matter, including dust and crystalline silica arising from soil disturbance, excavation, and heavy vehicular movement. In high-value equine populations, even subclinical lower airway inflammation is clinically relevant, with well-established effects on performance and future racing potential.

Peer-reviewed evidence demonstrates that inhalation of respirable dust induces neutrophilic airway inflammation, mucus accumulation, and reduced pulmonary function, with severity closely associated with exposure levels (Couëtil et al., 2016; Ivester et al., 2014). Importantly, even short-term exposure in susceptible horses may result in persistent airway inflammation, airway sensitisation, and sustained impairment of respiratory function, with potential for long-term or irreversible effects on athletic capacity. Given the horse's high minute ventilation, particularly during exercise, inhaled particulate dose is substantially amplified compared to humans.

From a reproductive perspective, pregnant mares represent a particularly sensitive cohort. Maternal respiratory compromise and systemic inflammation associated with inhalation of respirable dust may adversely affect oxygen delivery and physiological stability during gestation. In late pregnancy, where fetal growth and oxygen demand are maximal, even mild reductions in pulmonary function or chronic low-grade inflammation may have implications for fetal development and neonatal viability. Additionally, environmental stressors may influence endocrine responses in pregnant mares, with potential downstream effects on foal health and early development. While such effects may be subclinical, they are of clear relevance in high-value breeding populations where optimal maternal and foal outcomes are critical.

The potential for avian mortality associated with large-scale solar installations also raises secondary biosecurity considerations in equine environments. The presence of bird carcasses within grazing land may pose a risk to horses through contamination of pasture with pathogenic organisms, including Clostridium botulinum, which is recognised as a cause of botulism in horses following ingestion of contaminated forage or carrion material. Horses are highly susceptible to botulinum toxin, and even low-level exposure can result in severe and potentially fatal neuromuscular disease. From a veterinary perspective, the introduction of carcass material into grazing systems therefore represents an additional, avoidable risk to equine health.

Sustained exposure to construction-related particulate matter, together with potential biosecurity risks arising from carcass contamination of grazing land—particularly in downwind paddocks and training environments—represents a predictable and avoidable risk to equine respiratory health, reproductive outcomes, performance, and breeding value. Such impacts, even where subtle, are of clear clinical relevance and carry material welfare [redacted]

Signed: __ [redacted]

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Date: 28 April 2026

Appendix 8 - Lime Down vet report by Chris Shepherd (BVSc MRCVS)

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Veterinary report

Lime Down Development proposal

Introduction

I have been asked to comment and discuss veterinary concerns over the development of a large solar energy plant development project in the North Wiltshire area. I have been provided with a description of the development phase of the project along with a description of the completed site.

My comments are restricted to my professional capacity as an Equine Veterinary surgeon and do not include my personal opinions on the environmental impact of the development that I have documented and submitted elsewhere. My comments will include welfare and commercial concerns.

Background

I have been a veterinary surgeon for 43 years and for most of that time have been in purely equine practice. In particular, I have been involved in equine reproduction and stud medicine and I am the retained vet for a number of large studs within our practice area.

I am employed by B&W Equine Vets, a large multi centred practice covering Gloucestershire and Wiltshire. I am based at the Willesley branch which is situated approximately 5 miles from the centre of the proposed development.

B&W have the following client types within a 5 mile radius of the site;

1. Stud clients. 8 commercial studs producing thoroughbred or sports horses for sale.

2. Professional competition yards. This category includes eventing, dressage, showjumping and polo yards.

3. Hunting yards. Primarily associated with the Beaufort Hunt.

4. Private yards. Family run yards with pleasure horses and children's ponies. Numbers per yard vary between 1 and 5 horses.

There will be other veterinary practices that service clients included in the above categories in the development area over and above those serviced by B&W.

Veterinary concerns

1. Noise both during the development process and ongoing operational considerations.

The development process will necessitate huge numbers of lorries and HGV vehicles in the area along with construction noise including chain saws and pile driving. Ongoing noise will include inverters and associated infrastructure.

Horses are fight and flight animals and there are real risks of injury to themselves and their riders from unusual noise. They have very good hearing, far better than human hearing.

Young horses (foals, weanlings and yearlings) are particularly susceptible to noise, and I have had numerous examples where they have been spooked by loud noise and have injured themselves either by galloping and slipping within the field or by breaking through fencing. Lacerations from the latter have been extensive and in some cases life threatening.

Clients riding pleasure horses will be at risk from the noise and appearance of construction traffic during the development period. Riders must use country roads as part of their excursions and many are narrow and winding. Lorry and other HGV drivers do not always have the knowledge or consideration to slow down or stop when approaching horses that other rural road users do. Injury to horse or rider or both may result.

Horses from all categories can react unpredictably when being handled (groomed, shod, veterinary treatment etc) to unusual noise, again risking injury to themselves or their handler. Young horses are particularly sensitive, so stud clients probably will quite rightly be most concerned about potential implications.

2. Access

All equestrian properties necessitate a certain amount of light service traffic in and out. Feed merchants, farriers, staff and clients are examples. Most veterinary visits are not emergencies but occasionally they are. Delays in attending because of construction diversions, temporary road closures and slow HGV traffic could have disastrous consequences. This has occasionally been an issue with roads closed for other reasons, but would be a higher risk during the development phase.

3. Dust and toxic gas

Horses are athletic animals and reliant on a healthy respiratory system for performance. Inhalation of dust or toxic gases can cause primary disease and an increased likelihood of developing chronic respiratory conditions such as inflammatory airway disease and equine asthma.

There will be risk from dust during the development process, particularly for properties immediately adjacent to the development site.

Probably more concerning is the risk from a hazardous incident at the Battery energy storage system site. The implications of this have been discussed and submitted for consideration in detail elsewhere. In brief, a fire at the site could result in the release of a toxic gas plume consisting of a variety of gases with hydrogen fluoride being the most concerning. I would see this as a constant worry during the lifespan of the site and could result in significant injury and disease to the horses of my clients in the area.

4. Commercial considerations

As described, B&W Equine vets have a large number of clients in the vicinity of the Lime Down development. The concerns 1 – 3 listed above will be at the least an annoyance to some clients, and at the worst have considerable deleterious commercial implications for other clients. As a practice and business, we are concerned that some clients may decide to move themselves and their horses and businesses elsewhere. This would affect us and the rest of the local community who are dependent on the equine establishments in the area for their business.

Chris Shepherd BVSc MRCVS

Appendix 9 - OBS March Sales results evidence

2026 Spring 2YO in Training Sale

Hip	Out	UT Time	Sex	Name	Sire	Dam	State	Consignor	Buyer	Price	PS
158	I	10.1	F		Good Magic	Silent Sister	ON	Best A Luck Farm LLC, Agent IV	D. Farrington	75000	N
211	I	9.4	C		Khozan	Starship Crystal	FL	Journeyman Bloodstock (Brent & Crystal Fernung), Agent I	D. Farrington	200000	N
538	I	10.0	C		Liam's Map	Betwixting	KY	Randy Miles, Agent I	D. Farrington	280000	N
570	I	9.3	F		Jackie's Warrior	Brazen Persuasion	KY	Hartley / DeRenzo Thoroughbreds LLC, Agent I	D. Farrington	2300000	N
851	I	20.2	F		Oscar Performance	Going Day	KY	Tom McCrocklin, Agent I	D. Farrington	675000	N

Appendix 10 - Racing Post Article June 2024 (Lime Down stud owners under threat)

Racing Post Bloodstock

[redacted] chats to well-known industry figures whose way of life is under threat from a solar farm project

[redacted]

'It's crushing, it would finish us

[redacted]

TWO stud owners are among those facing an uncertain future due to a plan backed by the Duke of Beaufort to build a 2,000-acre solar farm.

The Lime Down Solar Park scheme is designed to generate 500 megawatts of clean energy, but would ruin large areas of countryside near the Fosse Way, a Roman road.

Part of the solar farm would be on the duke's 52,000-acre Badminton estate in Gloucestershire, as well as on land in a triangle between the market towns of Malmesbury, Tetbury and Chippenham.

[redacted] owner of Ladyswood Stud in Sherston, Wiltshire, about five miles west of Malmesbury, and Dermot Farrington, based at West Park Farm, Corston, about three miles south of Malmesbury, strongly oppose the development along with thousands of like-minded local residents and businesses who fear it would wreck the area for walkers, riders, tourists and biodiversity.

The scheme, which is in the consultation stage, is classified as a Nationally Significant Infrastructure Project (NSIP) due to its scale, meaning permission needs to come from the Secretary of State for the Department of Energy Security and Net Zero, rather than Wiltshire Council. Claire Coutinho holds that position, but the general election on July 4 could change things.

[redacted] also chief executive of the Tote, says: "We're talking 13 square miles of villages, and everyone is vehemently against it. It would make a lot of noise and would make the whole area incredibly unattractive. You would have lorries coming along single-car lanes for two years.

"Wiltshire Council voted 75-2 against it a couple of Tuesdays ago. If this wasn't NSIP, it would have been blocked straight away, but because it goes to government level, you just have no idea.

"It's a very opaque process. Previously these things were very locally driven, quite formulaic and took a long time; now, because it's at state level, it's going to happen quicker."

[redacted] has owned Ladyswood Stud, which adjoins an area of outstanding natural beauty and provides boarding, foaling and rest and recuperation for racehorses out of training, since 2018, when it was purchased of[redacted]

Farrington is [redacted] on-in-law, having married his daughter January, and the couple lived at Ladyswood – so there is a strong connection between the studs under threat.

Frost continues: "We've got ten mares, 170 acres and employ six people. It's crushing really, it would finish us.

"I've been quite vocal but we've got an extraordinary number of people around us who have been much more vocal than I have.

"There are tenth-generation families in the village. They care about the footpath massively, and there's a huge mental health angle to this. There are lots of local bridleways, they'd all be shut down. It's difficult to see the upside."

[redacted] well-known bloodstock agent as well as stud owner, can't see one either.

"For starters. it's very unclear where they're going to try to put cable lines," he says. "If you don't agree with letting them do it, they can go as far as getting CPOs [Compulsory Purchase Order]. There's no clarity over how long it's going to take to build everything, if they get planning permission.

"We had a pretty snappy letter from a company that basically said fill in these forms as we're looking at your land as a possible cable route. There was a long questionnaire, a map of your property asking you to verify the land is yours, and we were asked to send it back by a certain date.

"Imagine if I sent you a letter today, saying can you verify this is your house, how many bedrooms have you got, and can you get the information back to me by such and such a date.

"These are not government bodies, they're private companies, and you can imagine the worry."

[redacted] has owned West Park for five years and fears the financial and emotional investment that has gone into it could be undone.

"In terms of trying to run a stud farm, there's obviously uncertainty there, including noise, both when under construction and after it's built," he says.

"Solar farms are a big issue for the equine industry, including in Newmarket and near Punchestown, as well as here. There are stud farmers in County Kildare facing the same thing.

"If you're sailing against it you're accused of nimbyism, which is ridiculous because nobody in their right mind would be against renewable energy, but you can't just not take into account the people who are living here or running businesses.

"This was an old dairy farm and we've invested in turning it into a stud farm. It's an important part of my business. We breed, and employ people locally.

"We've yearlings who'll be getting ready for the sales, close ties with Australia and a mare here in foal to Frankel on southern hemisphere time, and two fillies by Frankel arriving from Australia. Imagine, when I bring my punters here, if they are next to a building site . . ."

[redacted] ited a recent high-profile example of how easily horses can be affected by loud noises.

"Look at the army horses in London a few weeks ago, they're trained to the minute but can still get spooked and run around," he says. "We're at the end where we've got foals, yearling and mares.

"I'm all for progress but what do I say to my team here? 'Oh, we can't take these fillies because I don't want to be bringing them here with the construction.'

"Ultimately, if they came across my land with cables, I'd have to shut the place down."

[redacted] ke his near-neighbour, is adamant nimbyism is not something that should be levelled at protestors, who fear the development, comprising three and a half square miles of 14ft-high solar panels surrounded by security fencing and floodlights, would be turned into housing once the solar farm has served its purpose.

"There's absolutely no element of it," he says. "People here are pro-renewables, but the government's own guidelines state these developments should occupy brownfield sites, not greenfield.

"This is all agricultural land, it borders the Fosse Way, an area of outstanding natural beauty. It's an extraordinarily rich ecosystem, which we're trying to preserve. It's next door to [the King's] Highgrove.

"I don't think anyone in the UK would choose greenfield over brownfield, and brownfield sites around us haven't even been examined.

"It's already the most concentrated area of solar in the UK, out of all the counties, so they're just playing on a system. It's been outlawed in Germany, Italy, Spain, it's all brownfield and rooftops there."

James Gray, MP for North Wiltshire, last month made the same point in parliament about heavy local concentration of solar farms.

"If the minister [for Nuclear and Renewables, Andrew Bowie] had wanted to see the impact that a massive solar farm, such as the so-called Lime Down carbuncle in my constituency, will have on local people, he should have come to the public meeting I called in Malmesbury town hall last week, where 750 people were protesting against this appalling plan in North Wiltshire," he said.

"It's going to be 2,000 acres of panels, 3,000,000 panels, 5,000 acres blighted, and 30 miles to the nearest connection at Melksham. It's an absolutely disgraceful proposal. It comes at a time when Wiltshire has eight out of ten of the largest solar farms. We already have enough, vastly exceeding our county target for solar production."

[redacted] has reservations about solar power performance generally, saying: "I've real scepticism about its efficiency in the UK anyway; it's 40 per cent efficient versus the US, and then when you go even 20 miles [to a connection], it's even less so. We've had developers over and asked them why this is deemed to be attractive in their eyes, and they've just said, 'Because it's cheap.'"

Farmers are reported to have been offered in excess of £1,000 per acre per year to rent their land – multiple times the return which might be expected from farming – however [redacted] aid: "It sounds a lot of money, but the developers are making somewhere in the region of £50,000 an acre.

"And the Duke of Beaufort's family is among the most wealthy in the country. The whole thing is very strange."

A spokesman for the Duke of Beaufort told the Daily Telegraph: "The estate's decision is commercial and aligns with government guidance that the development of low-carbon infrastructure, such as solar farms, is a critical national priority."

Lime Down claims it would "contribute towards government targets to reach net zero by 2050" and could provide "enough clean, affordable electricity to power around 115,000 homes".

Lime Down's developer is a London-based company, Island Green Power, chaired by Bertie Ahern, the taoiseach of Ireland from 1997 to 2008.

"It's government policy and there seems to be a race to get these things off the ground," says Farrington.

"But what's going to happen in 40 years' time when all this land is covered with these? I don't think people realise how big this is; it feels like every day you wake up and there's a new story from somewhere else in the country.

"The developers seem to be running hard as there are good opportunities for them after the government said they wanted to get to net zero by a certain date."

> 66 IT'S GOING TO BE 2,000 ACRES OF PANELS, 3,000,000 PANELS, 5,000 ACRES BLIGHTED, AND 30 MILES TO THE NEAREST CONNECTION AT MELKSHAM

First-season sires with runners today in GB & Ireland

Sire	Progeny	Race
Arizona	Specified	Wetherby 6.30
Earthlight	Cayman Tai	Windsor 5.45
Hello Youmzain	Electrolyte	Ayr 2.15
Kameko	Rajeko	Windsor 5.45
Shaman	Pap's Turf	Ayr 2.15

Weekly sires of stakes winners table, page 99

Appendix 11 - Racing Post Article May 2025 (Lime Down Stud farmers in limbo amid anxious wait for solar farm resolution)

“I’ve not managed to speak to one guy who knows anything about horses or farming’ - stud owners in limbo amid anxious wait for solar farm resolution

[redacted] and Dermot Farrington chat to Andrew Scutts about concerns over the solar park project on their doorstep

A tranquil scene at Ladyswood Stud - Alex Frost and family and staff will be hoping it stays that way

Credit: Ladyswood Stud

[redacted]

MOR
- Kia inve Ame
- Lea cha to d
- Pub Gui Stak
- Fro[redacted] Richards to Japan and Godolphin stints - meet the Newmarket trainer who has won with his last three runners
- Who will follow in Field Of Gold's footsteps? Assessing the key contenders for the Solario Stakes

Associate editor
Published on 22 May 2025 in Britain
Last updated 05:12, 22 May 2025

This month's Badminton Horse Trials, seeing they were hosted by the Duke of Beaufort, seemed an opportune time to catch up with the stud owners facing an uncertain future due to a plan to build a 2,200-acre solar farm.

Part of the proposed Lime Down Solar Park would be on the duke's 52,000-acre Badminton estate in Gloucestershire, as well as on land in a triangle between the market towns of Malmesbury, Tetbury and Chippenham.

The duke is one of ten landowners backing the industrial-scale development which, if given the go-ahead, would dramatically impact England's oldest borough Malmesbury and surrounding towns and villages.

The Fosse Way, a Roman road and scheduled monument, would be enveloped by solar infrastructure, while the area contains historically significant footpaths and bridleways.

It is also home to Ladyswood Stud in Sherston, owned by [redacted], and West Park Farm in Corston, run by Dermot Farrington.

The pair spoke for themselves but also thousands of like-minded local people last summer when they shared fears the solar park would wreck the area for businesses, homeowners, walkers, riders, tourists and biodiversity.

The scheme, which has gone through two stages of community consultation, is classified as a Nationally Significant Infrastructure Project due to its scale, meaning permission needs to come from

the secretary of state for the Department of Energy Security and Net Zero, rather than Wiltshire Council, which has voted against it.

Ed Miliband was appointed to that position on July 5 last year after the Labour Party's general election win and **within a week had approved the equally controversial Sunnica solar and battery farm close to some of Newmarket's most important gallops**.

That was despite a four-year campaign against it by key racing bodies, local MPs and several councils.

And, as [redacted] points out, despite UK government policy mandating the prioritisation of brownfield sites and rooftop development for renewable energy initiatives.

In the Sunnica case, the plan is to cover 2,800 acres of arable land on the west Suffolk and east Cambridgeshire border. While that is bigger still than the Lime Down proposal, Wiltshire already has eight out of ten of the largest solar farms in Britain.

[redacted], Farrington and the army of campaigners opposed to the Lime Down development hope the tide is turning, in terms of public acceptance of renewable energy projects and concerns about land use and environmental impact, to the extent planning permission is never granted.

"Miliband's now talking about the logical stuff like putting these on rooftops – and I think this is the core of the argument," says [redacted], who is also chief executive of the Tote.

Stud owner and Tote chief executive [redacted]: 'Nobody has any quandary with green power, it's just where you put it' Credit: Tote

"Nobody has any quandary with green power, it's just where you put it. Devastating the British countryside feels like a suboptimal solution, which I think everyone agrees upon, and government policy is brownfield sites and rooftops."

As of last summer, brownfield sites in the local area had not even been examined. Updating on that, [redacted] says: "Nothing's been done. There are some areas that have been identified but what it comes down to is that they can make more money taking out local farmers."

Farrington's frustration is equally clear, and while he has attended several consultation meetings, he is not much the wiser for the experience.

"In terms of the core questions for my business, they've not really clarified anything," he says. "Every time you ask a question, you don't get definitive answers. Most of it is spin. Everything is very unclear, timeframes, traffic, noise levels.

"There's been no clarity over what's going to happen when you start banging posts into the ground for weeks or years on end, how long it's going to take. Does it, or does it not, make noise?

“They’re trying to point out positives, but when you’re putting in millions of solar panels, there’s got to be some noise for a long time around the countryside.

“There’s nobody there at the meetings who’d have any knowledge of the effect it would have on an equine business. Nobody had a grasp on a subject like flooding.

“They don’t know what effect the building of, and operation of, a solar plant next to a stud farm would have.

“I’ve not managed to speak to one guy who knows anything about (a) horses, (b) stud farming, or (c) farming.

“They’re perfectly nice people, but unqualified, and it seems extraordinary that you’d let them loose on the countryside.”

Dermot Farrington: 'In terms of the core questions for my business, the consultation meetings haven't really clarified anything' Credit:

Aside from the impact on England’s increasingly less green and pleasant land, which in itself is surely reason enough to harbour huge doubts, there is growing concern over the safety of lithium-ion battery storage, including fire risk and toxic emissions.

[redacted] says: “There’s no net economic impact survey done by these guys, they don’t mind that they’re going to smash up the local area, and it’s the same with the other site, Sunnica.

“There’s huge concerns with the local community, there’s massive fire risk, a survey has been done and it reckons the impact area is nine miles in radius. The batteries they are putting into this plan are about 100 yards away from a railway line.

“There are any number of horses, animals and people living next door to them. It just doesn’t bear thinking about.”

[redacted] adds: “It’s worth mentioning that it’s essentially been banned in most of Europe, and there are huge restrictions in the US; that’s why you’re getting this flood of capital coming from people like Macquarie.

“They bought out their business partners; it was a 50-50 joint venture between them and an Irish group called Island Green Power. They have raised huge amounts of money for green energy funds and have got very few opportunities now, with most of Europe and the US shut down.”

Farrington certainly isn’t convinced by environmental arguments either.

“The whole idea of this is you’re trying to be environmentally friendly, but people are starting to cop on to the fact these panels will ultimately end up in landfill after not all that long a lifespan, 20 or 30 years or whatever it is,” he says.

“This whole solar panel thing is debatable and dubious about whether long term it’s going to be

good for the environment. There are huge doubts.

“There’s no clarity about what’s actually going into these panels, what chemicals, what precious metals are being minded to go into them, how often you are going to have to change them or who is going to do this. At the consultation meetings, there were very wishy-washy answers to most questions.”

Referring to the Badminton host, the Duke of Beaufort, [redacted] says: “If one guy had his way, he’d do another 50 of them as he’s a bit of a zealot when it comes to the ideology of this.

“But Tony Blair made some pretty good points, saying there’s got to be a balance here and that we don’t need to be putting this stuff in areas that are core to what we’d refer to being the fabric of the country.

Tony Blair: former prime minister has called for a rethink on net zero policies — Credit: Getty Images

“There’s panic about an arbitrary net zero target the next generation would have to live with. It would look very out of place in three or four years’ time – all this carbon-capture technology is mega-sophisticated; 1.3 million solar panels across an area of 11 miles in diameter is just going to look very stupid very quickly.”

The local stud owners are among the near-1,200 signatories to an open letter sent to landowners urging them to reconsider their decision to participate in the solar project.

The Stop Lime Down campaign is certainly doing all it can to generate interest and support, while its website has a simple opening message: 'Yes to solar, no to these irresponsible proposals, protect our countryside.'

Farrington says: "The local community has worked very hard, with lobbying and raising awareness of why this isn't a good idea for anybody.

"The protest group, Stop Lime Down, have had information evenings, and the halls have been jam-packed with concerned people.

"Thanks to a lot of people who have worked really hard to point out what's going on, the penny is starting to drop that this government is hellbent on pushing this through without a real mandate from the people to do it.

"In this locality, and generally, people are starting to realise what's being forced on them. People are starting to realise that there's going to be an adverse effect on their property values, whether you're right next to it or not. If they do get planning permission, this will change the face of the countryside.

"You might not open the curtains and see the solar panels, but all of a sudden you might have to drive through a solar park to get to your house."

He adds: "A neighbour of mine had a house for sale, it's fallen through and is directly linked to all

of this, the prospect of the unknown. They're now looking at a 30 per cent hit on the price.

"These guys' attitude to people who've got a mortgage on a house and then the next thing you know, your value's gone down, is, 'Oh, too bad'. It is disgusting really. I feel strongly about how such a small number of people can have such a huge effect on so many.

"When you start covering 2,200 acres, that's a lot of people caught up. Bar those who would get money directly from the developers, most are anti this and scratching their head about how it's going to work."

[redacted] and Farrington's equine businesses are somewhat in limbo, and will be until the matter runs its course.

"We have got 18 mares now, up from ten when we spoke last summer – we bought an extra couple of paddocks, annoyingly, just before all this broke out," says [redacted]

[redacted] Ladyswood Stud is up to 18 mares having expanded just as the Lime Down project was being envisioned

Credit: Ladyswood Stud

"It's very frustrating because we're a small business that will be absolutely devastated."

Farrington recounts: “The other day I had a low-flying helicopter go over, which spooked my yearlings and I had one go over a gate and ended up with nearly three grand worth of surgery to put humpty-dumpty together again.

“It's an example of a change in the status quo on the farm. So you could imagine what happens if these guys are next door. We have just been left wondering, and hoping that they won’t get permission.

“It’s worrying, and it stops progress. We were hoping to put planning in for a new barn, and add more staff to the farm, grow the business, but you’re reluctant and you’ve one eye on this all the time.

“You’re thinking, is a new barn a good idea because will I be able to run a horse business from this farm in five years’ time? We’re at a standstill as far as growing the breeding business and the pinhooking business is concerned. We can’t do it and it’s very disappointing for me and my staff.

“It holds up progress. We’re not stopping but, at the same time, everyone likes the excitement of getting bigger.”

He adds: “What sticks in my gut, and I’m sure a lot of other people’s, is that if you go for planning permission yourself, if you wanted to build a house, or change a house, put an extension on, etc, you’ve rightly got all these rules to follow and it’s quite the job to get permission. Yet there’s this, and you get called that awful word ‘nimby’ because you’re objecting.”

That certainly can be a lazy, shallow term to apply, and, let’s face it, how many people would want a

solar farm in their back yard, whether there are horses about the place or not?

Whether the Stop Lime Down campaign is successful remains to be seen, but there is a sense that whatever zeal is out there for such large-scale developments is looking less likely to ultimately hold sway.

Farrington says: “Every time that they put in planning for a new solar farm around the country, they say this will power 100,000 houses and electricity is going to be cheaper, but I don’t think anyone is buying that any more.

“I feel that from the north of England to the south, people are beginning to realise that when all this stuff connects up, it’s huge. Eventually, people aren’t going to put up with it, and I just hope it’s in time for us.

“I’m just hoping that by the time these guys put in planning permission, the tide will have turned and people realise this isn’t the answer.”

This article first appeared in Good Morning Bloodstock.