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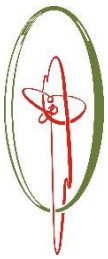

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Structural and Ground Dynamics

Addendum Report Responding to comments by :-
Alan Baxter Associates (ABA) and Cole Jarman (CJ)

Ref: AKS/3400/R1/i1/Addendum Report (22/04/16)

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1. Alan Baxter response (ABA) ref: 1693/11/MC/jmc dated 14th March 2016

Alan Baxter response (ABA) ref: 1693/11/MC/jmc dated 14th March 2016. Extracts from ABA response are highlighted in 3-D format text boxes, with CED response below.

1.1.

> In summary there is no structural damage, as clearly set out in our reports. This deals with CED's points 2.4.2, 2.4.3 and 2.4.4

We have not seen any deformation modelling or calculations to support this assertion. The classification of damage that can cause hairline cracks which can compromise acoustic integrity of the fabric of a building would fall below the horizon above which issues are deemed structural damage, refer to CED report para 9.10 to 9.12. Therefore, to state that there is no structural damage, without quantifying a damage metric is missing the issue raised. Furthermore, the resilient elements for base isolated studios are sensitive to load redistribution which can alter modal characteristics (CED report para 10.8 to 10.15). Movements can close gaps which themselves may only just be sufficient in certain parts of the building and such bridging can severely compromise the acoustic performance of base isolation (CED report para 10.2).

Therefore CED points 2.4.2, 2.4.3, 2.4.4 remain to be addressed in a quantitative way.

1.2.

> and leaves 2.4.1; ground borne noise and vibration from underground railway tunnels. I am surprised that CED are raising this, especially as the tunnels are deep and remote from the site,

It will be noted that groundborne noise, arising from groundborne vibration from the underground trains is evident in the Main Hall, both audibly and demonstrated by measurements. Therefore, it is clear that the tunnels are not so deep, or so remote as to be irrelevant. To the contrary they are a significant concern now, and were at the time the studios were conceived, having been noted and addressed at the time by the designers, who incorporated base isolation in parts but were unable to isolate the Main Hall owing to the listed building constraints.

1.3.

> but I am able to offer some comments on the situation based on our experience of the design of buildings containing or adjacent to vibration sensitive equipment much closer to LUL assets than Lyndhurst Hall.

> We have worked on several projects where underground railway noise and vibration has had to be considered, including a very large basement for the London Clinic, very close to the Metropolitan and Circle line tunnels and a basement at St Martins-in-the-Fields close to and above the Northern line (see attached details).

The example of the London Clinic has plant rooms in the basement, and those treatment rooms for radiotherapy are required to be in the basement which we understand was structurally upgraded accordingly (e.g. 1.5 m deep concrete slab). These treatment areas rely on targeting treatment, and so the vibration specification is not driven by levels that can generate groundborne noise, but more to do with lower frequency vibration that has the potential to deviate a beam for targeting the treatment area. The equipment can adapt to some movements and can in any case be isolated should the need arise, which is not the practical situation here at Lyndhurst Hall.

Without seeing vibration measurements of the cases and the site specifics, it is not possible to draw any comfort from the examples given, which depend also upon the groundborne noise levels and that of the background in the specific cases.

1.4.

> It is not credible that significant energy could somehow be reflected or reradiated into the structure of Lyndhurst Hall from the proposed new structures at number 11.

Given that groundborne noise from underground trains presently arise within the Main Hall, any potential mechanism that can increase what is already a difficult situation within the Main Hall needs to be fully examined, given any such deterioration cannot be reversed.

1.5.

> The vibrations from the Northern line, which have been measured by CED, are very small indeed and the direct noise path through the ground to Lyndhurst Hall that causes these is much shorter than any reflected noise path would be.

That the vibration is very small indeed and therefore dismissed is overlooking the point. Small needs to be qualified relative to a benchmark. It is small in relation to vibration perception which is not the primary issue, but tiny vibrations of surfaces can and do radiate sound and so the building and such internal surfaces act as a loudspeaker to generate groundborne noise. The vibration of surfaces can themselves be routinely described as miniscule, yet that leads to significant reradiated noise. Therefore, simply describing the vibration as very small indeed does not address the physics of the mechanism, and how small vibrations can lead to very big impacts. Paragraph 8.2 of the CED report clarified this.

Talking about a direct path, as both direct and a singular path, is also missing the point. The source does not arise at one point nearest to Air Studios, and the receiver building of Air Studios is not a single point. The groundborne noise has spatial and temporal variation. If we take a slice in time, there are multiple areas generating groundborne noise, and this does not only arise from vibration

at the closest point of the building to the tunnel, but a complex combination from different parts of the building responding to the tunnel source, which itself is not a discrete point source, but a complex combination of an extended line source of correlated and uncorrelated inputs.

Therefore to think solely in terms of the shortest path, and then compare that to reflected paths, is focussing on just one part of a much larger complex picture.

1.6.

> The longer reflected noise paths (if indeed reflected noise is a factor, which we believe not to be the case) mean that more energy would be dissipated.

There is much attention in the response to reflected path, yet in the CED report the reflected mechanism is stated once (CED report para 8.20), yet other mechanisms are stated (CED report para 8.18) to which no comment has been addressed. For example, the many piles penetrate deeper into the ground, into ground conditions within which vibration energy may be more efficiently absorbed from the tunnel source and conducted to the buildings.

1.7.

> Also, the new concrete sub structures are very much stiffer than the clay in which they sit, so they will absorb energy from the ground much more than reflect it.

This statement states that the new concrete sub structures will absorb energy from the ground much more than reflect it. With this situation the absorbed energy will be available to be conducted to the Air Studios building via concrete paths more efficiently than the ground soil and so be more efficiently transmitted to the Air Studios building.

1.8.

> CED state that the basement structures may provide a more efficient transmission of ground borne noise and vibration. We do not agree that this is a possibility, based on the configuration and disposition of the new structures and the longer sound path in the ground to them, than the direct sound path to the Hall.

It is not just about proximity, i.e. whilst obvious to think the closest source is the worst, it is a function also of the track condition, and the rolling stock condition as it traverses the track. Therefore, the worst event could arise with the train upstream or downstream of the closest point, and this track condition is not a fixed situation but a variable. Therefore, there can be a situation where dominant train sources arise in a position placed such that the zone of transmission encompasses and is modified entirely by the basement structures and associated piling.

The closest point of the Air Studios building to the tunnel does not necessarily dominate the groundborne noise within Air Studios, which is dependent upon dynamics of surfaces, which will have some parts more easily excited than others and so vulnerable to different energy paths. Therefore it is insufficient to place ones attention on what is superficially obvious, but such closer examination is more revealing.

If we take an overall train length of 108m for the rolling stock used in the Northern Line, and superimpose it on the site aerial view below (one snapshot shown), it should be immediately obvious that modifications in the energy paths, can alter the levels of groundborne noise within Air Studios, due to changes in the efficiency with which energy is transmitted to the Air Studios buildings and significantly the surfaces within that can radiate sound. It should be recognised that this is a moving window. It should also be recognised that the dominant path may well either now, or at some point in the future, due to track degradation, be the paths that runs between the extended source and via the new basements to Air Studios.

Using the mechanism stated by ABA that their sub structures will more efficiently absorb energy within it therefore can also bring energy to the surface and to Air Studios more efficiently.

1.9.

> It is significant to note in CED's fig 7.2 that the noise from the further Northern line tunnel is much less than that measured for the nearer tunnel. The noise path from the further tunnel is 1.2 times longer than the noise path from the nearer tunnel, and the noise strength is approximately half. From the sketch I have produced, the noise paths (if there is any reflected noise) from the nearer underground tunnel via the new basements to Lyndhurst Hall are more than double the length (2.1 and 2.2 times) and as noted, the new basement structures will absorb most if not all of the noise.

There is focus of attention to a reflected path which is but just one of the many mechanisms. Their last sentence states 'the new basement structures will absorb most if not all of the noise'. The Council can therefore interpret this admission as one of the mechanisms of concern which has been fully recognised, at least in part, it is then a need to extend the logic in the energy flow and transmission, and how that compares to a soil path in absence of these new basement structures.

1.10.

> The BS references CED quote are about piles concentrating loads into the buildings founded on them and not into adjacent buildings.

The CED report quotes the relevant text from BS5228-part 2 in para 8.27, and the Council are encouraged to review the source document to see that the context quoted by CED is appropriate to draw attention to concerns. The preceding sentences in the quote refer to complexities and relevance of the propagation path characteristics, and clearly piles within the ground modify that, as noted in an ISO standard 14837 part 1 quoted subsequently in para 8.28 and 8.29. Even if we read the significance of piles is on changing the response of the building itself that is piled, that changes the energy uptake and therefore potential to conduct to adjoining buildings (see CED para 8.21). Therefore, whichever interpretation you take, they each lead you to a change in circumstances that have the potential to alter the environment in an immediately adjacent building.

1.11.

> The Royal Free will be subject to similar minor underground noise and vibration, but from what we are able to establish, they are not taking any special measures in their new development proposals which include a new basement and with piled foundations and housing sensitive medical equipment.

Medical equipment does not follow the sensitivity associated with vibration levels that can generate groundborne noise, and in any case they either contain some degree of vibration isolation to cope with localised sources, and can in any case be provided with local isolation were the issue to have been underestimated. To the contrary groundborne noise affects a building as a whole and cannot be mitigated locally. The risks are therefore significant as there is no recourse to mitigation, given isolation at the railway source will also not be an option in this case.

They imply similar minor underground noise and vibration, and the issue is that they refer to it as minor, but in the context of Air Studios where excellent acoustics is a prerequisite for their business model, it is not minor. As for the Hospital, we are not provided with details of measurements or the specific plans and designs which may yet evolve, but as far as noise, they may have less sensitive uses, or maybe they can increase background noise, and for equipment they have options for local isolation. Structural and ground dynamics is site and context specific, and the examples cannot be relied upon to ensure that there will not be a problem at this site.

1.12.

> Nothing that our clients are proposing will change this once their project is complete and they have dealt with the issues that need to be considered during construction, as far as I am aware.

We are yet to see this demonstrated technically and robustly, given the huge risks to Air Studios. We assume the Council will ensure Air Studios is safe guarded against risks that have been so clearly brought to their attention.

2. Cole Jarman (CJ)

We address the comments from (Cole Jarman) CJ, ref 16-0692 L04-0, dated 2nd March 2016, with extracts reproduced where required within speech marks, with the CED response below.

2.1.

Regarding the first point made, we cannot comment on the scope of works of another consultant reporting to Air Studios, but it was clearly within our scope of works to investigate these issues.

2.2.

CJ bullet point (a) refers to CED paragraph 8.32 which we clarify that it is the structure borne noise transmission and the mounting considerations of a potentially powerful loudspeaker in the Home Cinema Basement Room, which was a constructive comment with the direction of a solution offered rather than a comment that would prevent the scheme going ahead. We find the CJ comment does not consider the physics in the detail necessary. Turning to the specifics of their comment regarding the thermal break to prevent cold bridging, it must be noted that acoustic bridging and thermal bridging follow different rules of physics. Whilst it may happen that complying with one might by a happy coincidence assist with another, it does not necessarily follow. The simple reason is that often thermal treatments are layered systems, which themselves are inherently dynamically very stiff, and at the certain acoustic frequencies of interest will not provide isolation, as they create an albeit different set of resonant frequencies that may be matched by a signal within the amplifier. There are many cars fitted with unnecessarily powerful loudspeakers, so we cannot comment upon the actual loudspeakers and amplifiers that will be sourced for a domestic situation. Whilst the present owners may well be sensible in this regard, it may be subsequently acquired by any owner that will be free to deploy whatever they choose. However, given that a solution can be achieved by a designed isolation system for the loudspeakers, the risk of a permanent problem is removed with the appropriate restrictions on domestic use under planning and a condition that any installed sound system does not generate audible noise in adjoining premises. So we return to the point that it was a constructive comment that occupied one paragraph with the direction of a solution given and hope the Council will not be distracted any further from the many other substantive points.

2.3.

We turn to the other comments regarding groundborne noise from the railway, highlighted as their bullet point (b).

"It is noted from the Civil Engineering Dynamics report that underground train noise is audible within the main studio."

When such events do cause a problem on recording, which we understand they do, the material is re-recorded. The problem is that what is already a difficult situation, borne out by the original designers having to make a listed building a functional facility, having been compromised in their design for the Main Hall by the listed building constraints. That means that any further additional intrusions during recording time, would make the opportunity to re-record all the harder to achieve. This relates to construction impacts, as well as the risk that the already difficult groundborne noise issue in the Main Hall could worsen, and tip the balance on viability of that recording space.

We would also draw attention to the original acoustic design criteria set out by the original acoustic designers of Air Studios, covered in our report (section 3), so any criteria for future works will need to take that into account, where such information was not available at the time of the Vanguardia report.

2.4.

"They speculate that the new constructions at 11 Rosslyn Hill will increase the underground train noise in the main recording studio due to the piled foundations and connection between the studio building and the new constructions at 11 Rosslyn Hill."

Concerns were raised in the CED report arising from a vacuum of information on risks that emerge from engineering considerations, we therefore request that the matters are addressed with relevant technical analysis and scrutiny to address the potential risks identified, which have serious consequences to Air Studios.

2.5.

"The main recording studio is actually closer to the tube lines than the proposed TV room basement extension. Therefore the dominant sound transmission path to the main studio is through ground which will not be affected by the construction. That will remain unchanged."

There is a focus on the nearest point of the tunnel as if it is a point source and if the nearest point of the Air Studios building is the only receiving point. Our response to ABA addresses this simplistic view. The underground trains are an extended line source, with correlated and uncorrelated inputs which affect all points of the building in varying degrees, and specifically it is the varying local dynamics response of radiating surfaces, that ensure that the building as a whole must be considered. It has also been stated that the source of groundborne vibration is dependent upon track condition as well as the rolling stock, and it is the track condition that varies along the alignment, which might not just be at its worst at the point of closest tunnel alignment and the condition of the track can vary over time. Therefore there is a zone of ground, that encompasses multiple paths that are affected by the multiple basements and piling associated with the extensions. The other mechanisms of change associated with piling deeper into the ground changing transmission characteristics has not been addressed, amongst the many other points raised in the report.

2.6.

"As Alan Baxter make clear the studio buildings and the proposed TV room basement extension will remain structurally separate."

Our understanding is that the TV room basement structure will have a gap of 200mm or even less to the adjoining Air Studios foundation (CED report para 8.19). Noting that groundborne vibration at low frequencies have long wavelengths far in excess of this dimension, the buildings of Air Studios and the neighbouring basement will become dynamically coupled, and so a structural separation as small as noted will in no way provide dynamic decoupling.

2.7.

"The effect of the basement extension rather than amplifying train vibration will be to act as a partial vibration screen to the studio, as a consequence of the discontinuity in ground conditions it will create."

The screening limitations are noted in the reference cited due to flanking transmission. There are changes under different mechanisms, and some compete with others, but it is the net effect that needs to be examined. The issue was alluded to in competing factors stated in CED para 8.33.

2.8.

"With the other smaller studios they are on isolated bearings and so there is currently no noise impact. That will continue to be the case with the TV room basement constructions present."

There are risks that the performance of existing base isolated structures will change under even small ground and building movements (CED para 10.1 – 10.5). There are also risks that the ground vibration spectrum may change in magnitude and spectral shape, which could alter the situation within the presently isolated studios (CED para 10.15). Their performance under groundborne noise from the rail source is one issue and their ability to cope with groundworks related vibration sources another, noting the building isolation system is not a very low frequency isolation system but relatively higher and so are potentially vulnerable (CED para 10.12, 10.13,10.16).

2.9.

"Civil Engineering Dynamics also speculate as to the impact of other train lines. The nearest of those are some 100m to the north. The others are over 150m away to the south. They do not identify any impact of these upon the studios currently and so this would continue to be the case for the reasons identified above."

We have not extensively analysed the data for other rail events, and the only cautionary point to add is that freight trains might infrequently use such lines, and there may be certain trains that could feature a detectable issue, and is mentioned for completeness.

3. Closing Remarks

3.1.

We assume the Council will also note that the CED report covers many aspects, some of which are interrelated which have not been addressed in the comments produced by ABA or CJ.

3.2.

It may help the Council to note that the Author of the CED report is Convenor and Chairs an ISO working group ISO TC108/SC2/WG8 (Groundborne Noise and Vibration from Rail Systems). International experts have been assembled to grapple with the very complex subject of ground and structural dynamics to provide guidance to practitioners, and it is the deeper complex issues which are often overlooked. Recently this working group produced a part on 'Measurement of dynamic properties of the ground' (ISO 14837 Part32), which shows the complexity of the subject matter.

3.3.

It must again be borne in mind that there is no practical fix after the proposed build to solve an increased ground borne noise problem, and the huge risk to the Air Studios has been made clear. No study has been commissioned by the Applicant to begin to address these concerns, which may also adversely affect their own building and others in the immediate area.