Richard Hatton Associates

Chartered Civil and Structural Engineers

Proposed London Underground

(Victoria Station Upgrade) Order

Objection by Victoria Palace

Proof of Evidence of Colin Wilson OBJ21/P10

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1.0 INTRODUCTION

1.1 My name is Colin Wilson IEng AMIStructE. I have worked within the construction industry for over 25 years and have been practicing structural engineering for 20 years. I have worked on large and small structural projects for large and small engineering practices. I am now a Director of Richard Hatton Associates (2005).

1.2 I personally, working for Richard Hatton Associates (RHA), have been the structural consultant for the Victoria Palace Theatre working on various projects on this building since 1999 but Richard Hatton Associates have been consultant to the theatre since 1997. Since completion of the side extension in 2001 I have been involved in the justification of the loads on the theatre from incoming and outgoing shows, various small alterations and improvement projects. As part of these works we have conducted “opening up works” to expose the structure of the theatre. I therefore have a very good understanding of the structural fabric of this building.

2.0 SCOPE OF EVIDENCE

2.1 From the information London Underground Ltd (LUL) and Mott MacDonald (MM) have submitted to date, not enough consideration has been given to the impact of their proposals on the listed building that is the Victoria Palace Theatre (and surrounding buildings for that matter). In the long term, there should be no detrimental effect on the building's performance due to the Victoria Station Upgrade (VSU) works. This includes the fabric of the building and the use of the building as a theatre.

2.2 LUL have accepted that the buildings around their tunnelling and excavations will move. Having made their appraisal of the theatre's structure they are prepared to allow this movement to occur and state they will repair cracks and other damage at the end of their construction phase.

2.3 Other alternative schemes to the current proposals were considered by LUL, some of which would be a better solution for the theatre because they would reduce the risk of damage. The reasoning behind LUL's dismissal of the considered alternatives is discussed by other experts in their evidence.

2.4 My evidence is confined to the structural effects the proposed scheme, as submitted by LUL, will have on the Victoria Palace Theatre and why the other options considered by LUL would be a better solution for the Theatre.

2.5 My response is based on the most technical document submitted by LUL so far (referred to in most of their other documents) namely "MMD-V047-1159-GEO-DOC-50040 Rev E01 - Phase 3 Potential Damage Assessment of Victoria Palace Theatre" (PDA-VPT). All chapters and appendices referred to here after are from this document unless stated otherwise.

2.6 The points I will cover in my evidence, regarding structural engineering matters, are as follows;

- the theatre structure
- The difficult ground conditions
- The settlement predictions.
- The impact of the proposed works on the theatre.
- The mitigation of ground movements
- Demolition of surrounding buildings.
- The impact of the proposed works on the extension of the theatre.
- Alternative VSU schemes that would have less impact on the theatre

3.0 STRUCTURAL FRAMING OF THE THEATRE

3.1 I start with some background information of the building's construction as it is critical in understanding how the building will react to ground movements. The Victoria Palace Theatre, in its current form, was constructed in 1911 and built on the site of the previous music hall of 1848. The constraints on the site at the time were the existing Duke of York building and the Kings Scholar Pond Sewer (KSPS). The Architect tasked with its design, Frank Matcham, used the most modern construction materials available to achieve the large open spaces required, suspended mezzanine floors and cantilevering balconies, namely steelwork. A steel frame (skeleton) was designed by structural engineers Richard Moreland and Sons, around which Matcham wrapped his walls, ornate plaster and marble finishes.

3.2 As construction was labour intensive and very slow in this era, compared with modern techniques, it was common practice to utilise previously constructed structures wherever possible. However, the new steel Stanchions (columns) needed far superior concrete pad foundations to support the loads and so new foundations were constructed for these. It is likely, from looking amongst the sketches and original drawings, that only the walls under the stalls, barrel vault basements and Party Wall between the Duke of York Pub and minor load bearing walls were retained from the old pub music hall.

3.3 Many of the original construction drawings completed by Frank Matcham and Richard Moreland and Sons are stored in the archives of the Victoria and Albert museum, some photographs of which are in my appendix B for reference. These are a public record and can be viewed by appointment at any time.

3.4 I have reproduced some of the original engineers blueprints from the digital photographs in my appendix B to give a feel for the extent of steelwork framing used. These drawings are in my appendix D. They are not a complete reproduction of all steelwork (the year 2001 extension works, for example, have not been shown) but they do indicate the main concentrated load locations for reference. I created these by importing the photographs into CAD survey drawings (produced this year for the extension works) and scaling/rotating these to fit the survey.

3.5 It is worth noting that it was common practice that all masonry walls would be constructed on stepped brick foundations, whether they are load bearing or not, as this helps spread the loads/weight over a larger area thus reducing settlements.

3.6 Backstage from the proscenium arch to rear wall, the grid, fly galleries, pitch roof, lantern and counterweight flying system are all supported off steel trusses with secondary beams, all of which terminate at four stanchions, two within the Proscenium and two within the rear wall. Refer to my drawing 108 appendix D.

3.7 The auditorium dress circle and upper circle levels, due to the geometry of curves and tiered seating platforms (to achieve the required sightlines of the stage), are supported on singular cranked steel girders at dress circle and upper circle levels. On each girder are supported the raking steel beams (supporting the concrete tiered seating platforms). These raking members cantilever towards the stage area off the cranked girder. The intermediate mezzanine floor, affectionately known as the “long bar”, is suspended from the dress circle level. Both cranked girders are supported by spreader beams which in turn are supported by two doubled stanchions. Refer to my drawings 106 & 107 appendix D.

3.8 The complicated auditorium sliding roof is supported on a grillage of secondary steel beams, which in turn terminate on trusses. These trusses are supported on a primary roof truss. The flat roof is supported by steel beams which bear onto the masonry back wall of the auditorium and the primary roof truss. The primary roof truss is supported on a stanchion in the same line as the cranked girder stanchions at dress circle and upper circle level. Refer to my drawing 108 appendix D.

3.9 The side boxes are framed by a complicated arrangement of either cantilever beams on stanchions in the case of the dress circle level or suspension hangers from the roof in the case of the upper circle level.

3.10 The doubled stanchions hidden within each side wall of the auditorium are supporting approximately 75% of the total suspended seating and roof loads. The record drawings indicate substantial new concrete pad foundations were constructed for these, refer to my appendix B7. The engineers must have decided the masonry was not capable of supporting this load.

3.11 The rear wall back of stage is over 4 storeys high with no visible restraints along its length and, due to the counterweight flying ropes, is unable to have ties back to the main body of the building. This must therefore have vertical stanchions (as wind posts)[1] in the wall to resist the lateral loads as it is inconceivable the solid mass of masonry can do this alone. I must add I have not seen these for myself; they are probably buried within the wall.

1 Wind posts: vertical structural members required to add strength to a wall where wind loading is applied.

3.12 Most of the floors and galleries around the auditorium are constructed using filler joist construction (steel beams typically set at 14” apart with filler concrete between). These beams bear onto the masonry at one end and are either supported by suspension hangers from the main steel girder above or directly onto the main girder.

3.13 The theatre was extended to the side in 2001 spanning over the KSPS. Christopher Steadman Architects designed the tiered dressing rooms from which I (Richard Hatton Associates) designed the steel structure and supports spanning over the KSPS. The tiers were necessary to keep the loads on the Party Wall within capacity until the adjoining building is demolished.

3.14 The delicate and ornate plaster finishes are suspended from the structure as explained in Mr Satow’s evidence. It is worth noting however, the plaster has no physical fixing to the structure.

4.0 STRUCTURAL FRAMING OF THEATRE – LUL ASSUMPTIONS

4.1 In order to assess the impact of the settlement predictions upon the theatre it is important to understand the construction methods used to form the building and how the loads from the building are supported by the ground under the foundations. There are no load take down to foundation calculations (refer to my appendix C) in the documents provided by LUL so I can only assume, from section 3.2 PDA-VPT and the framing layout in Appendix E of PDA-VPT, the load assessment, if done, has been assumed to give a uniformly distributed load at foundation level hence the category 1 score given in section 8.3 PDA-VPT.

4.2 This leads LUL to assume that the settlements will dissipate along the length of the walls in the form of additional horizontal stresses in the masonry. This is achieved by the bonding of brickwork.

4.3 LUL have based this assessment of the structure as described in the report by Alan Baxter & Associates, Appendix E PDA-VPT. This report makes assumptions of the likely construction, assuming the building has primary steel beams/trusses at high level on load bearing masonry walls. They go on to say that the front of the building is likely to be only of load bearing masonry.

4.4 As stated above in section 3, with the original working drawings, blueprints and my own experience of visual confirmation of elements, the building is predominantly a steel framed structure on concrete pad foundations. The masonry is used for stability and support of the lighter vertical loads only. Therefore the loads applied to the ground under the foundations are not evenly spread along the length of the walls but concentrated in one location.

4.5 The Theatre rear wall has not been identified as needing special consideration. On the basis that this wall is unrestrained by floors and is 18.5m high it will not readily tolerate movements at the base. Within this wall are at least the major steel stanchions supporting the roof and fly grids/gantries. However, should movement at the base occur and the wall bulge or lean this could render the stanchions and infill masonry unstable. An unstable wall will need remedial works to make it stable again. It would not be possible to install mitigating restraints or ties to stabilise the wall from inside the building as these would obstruct the running/ropes of the pullies above. Buttressing from the outside would be on someone else's land.

4.6 Allington Street slopes down to the rear of the theatre and stage door and record drawings indicate the foundations along this side to be stepped brick for the masonry and concrete pads for the stanchions. This side also has stepped level formation foundations, i.e. it is founded a reasonably consistent depth below pavement level along its length, stepping at convenient locations along the wall.

4.7 The nominal trial holes to expose the theatre's foundations conducted by LUL so far, have not considered the location of the stanchions, so they have not found pad foundations. Nor will they confirm the stepped formation levels.

4.8 Very large concrete pad foundations under the double stanchions indicate the stanchions are full height and do not load the masonry walls at all. Thus the 75% of suspended loads covered earlier in section 3 is applied very locally in one place and does not spread along the length of the wall as assumed by LUL.

4.9 Based on LUL's building assessment, they believe it to be satisfactory to accept the building will move and simply repair it

later. There are many reasons why a listed building with such delicate finishes should not be subjected damage in this way which Mr Satow & Mr Earl have explained in their evidence but any building subjected to significant ground movements that has the majority of its loads concentrated onto stanchions will not tolerate large movements under the stanchions without serious detriment to the fabric. Settlements will therefore be beyond what I consider “reasonable”.

4.10 Due to this error in assessment of building construction methods used, the theatre has been wrongly categorised in the scoring of its sensitivity to movements (section 8.3 PDA-VPT). All damage assessments therefore need to be revisited and better mitigation measures implemented or the theatre will suffer significant damage.

5.0 EXISTING GROUND CONDITIONS

5.1 Firstly I am not a specialist in geotechnical and tunnel engineering, but I do have a general understanding of the principles. I use geotechnical information provided by specialists in determining foundation types for new structures and remedial works to existing foundations.

5.2 The general make up of the ground in the vicinity of the theatre is reported in Appendix C of PDA-VPT to be made ground overlaying alluvium or silt overlaying gravel beds overlaying London clay. Water levels vary but of note are unusually in the shallow substrata. The tunnelling along Allington Street is primarily just under the alluvium into the gravels whereby the north escalator will tunnel through all ground types.

5.3 These are extremely difficult materials to tunnel through as borne out by MM in the Supplementary Environmental Statement Appendix F. The methods proposed in my opinion are high risk and covered in section 8 later.

5.4 The presence of piled foundation structures in the vicinity indicates the difficulty in working in these ground conditions.

6.0 SETTLEMENT PREDICTIONS

6.1 It should be understood that all settlement predictions provided by LUL are based on a MM in-house computer model as stated in section 6 of PDA-VPT. In the absence of better data this would be a reasonable approach but results are theoretical.

6.2 The conclusion MM make regarding the risks associated with the settlements is that they are as low as reasonably practical". "It is unclear to me on what basis this is assessed as being "as low as reasonably practicable". If this judgment was made taking account of what has been considered as "repairable damage" consequent upon settlement, I believe this judgment to be flawed as I explain below.

6.3 Ignoring for the moment the building is categorised wrongly in its sensitivity to movements, for reasons explained above, table 4 used in section 7 PDA-VPT gives an expected settlement value and a pessimistic value. MM states that they only used the expected values in their assessments. Given the nature of the ground, all settlements are predicted and the high risk of the works proposed, surely a more cautious view should be taken and the pessimistic value would be more appropriate for the assessments.

6.4 Having read the evidence of Mr Tim Chapman for Land Securities, who is a geotechnical engineer, I have discussed the values in table 4 with him and it appears even the expected value of 0.5% that LUL have used is at the very lower end of values normally used for this type of tunnelling in gravels. I would deduce from this that the settlement predictions LUL are quoting are underestimated and thus the effects on the structure and its finishes will be far in excess of "repairable damage".

6.5 I also note Mr Tim Chapman discusses in his evidence the risks of tunnel collapse. It is alarming to read that the risk of catastrophic failure of the treated ground into the tunnel seems to have been ignored. This I understand from his Evidence to be due to LUL relying solely on the jet grouting performing perfectly with minimal allowance for defects.

6.6 There are also references in LUL expert's proofs by Mr Brian Bell (PoE 8.4.3) and Mr Robert Essler (PoE 6.13 & 6.14) of different methods of ground improvement having been tried in this area of Victoria before with failures occurring. Yet LUL are still prepared to risk novel methods of ground improvement and tunnelling alongside a listed building with potentially 1700 members of public inside.

6.7 MM state (in section six PDA-VPT) that Long term consolidation settlements are not included in their assessments. This indicates that the actual final settlements could be in excess of the predicted ones and thus damage predictions will exceed those stated. Based on LUL's load path assumption this will increase the amount of repair work and prolong the period over which repair will need to take place (if accepting repair is reasonable at all). Given that the majority of loads are actually applied locally to stanchion's this has more serious consequences.

6.8 Contingency plans for unexpected movements beyond those predicted are vague and do not appear to have an allowance for tunnel collapse. I am informed by Mr Tim Chapman that it is a requirement of LUL, when conducting underground work near their own tunnels, to have an "Emergency Preparedness Plan" for just such an event.

6.9 As stated before, the predicted settlements are computer generated and thus more emphasis should be on "what if". The

suggested emergency procedure states that monitoring is to commence “over a sufficient timescale in advance of the works” but confirmation of this timescale is not given. I would suggest the more data available to set the base level to compare the actual settlements against, the better. I would expect at least one year in advance of any works starting to allow for seasonal variations.

6.10 MM propose trigger levels for ground movements which have supposedly been set to take account of the time necessary to implement a “recovery cycle”. This is misleading as NO RECOVERY can take place. If excessive settlements occur these cannot be reversed and will be permanent. Even if excavation is halted (which they propose to be the last resort), it is my opinion that movement will not halt instantaneously. I believe that it is likely that movements will occur for some time thereafter whilst consolidation of affected substrata continues around the tunnel into the excavated faces. Any halting of excavation will also only be temporary and I believe further movements will occur once construction resumes for the same reasons.

6.11 It should be noted that should a tunnel collapse occur in the gravels there will be very little time to react or implement a “recovery Cycle”.

6.12 A review panel is proposed in section 11 PDA-VPT to reassess why it has all gone wrong. This panel does not include a representative from the theatre who could provide explicit and valuable information. It appears all panel members will be LUL and there will be no independent audit

6.13 It must be stressed that the “Contingency Action Plans” noted in section 11 volume one of the MM report do not prevent further damage to the theatre. They are merely a means by which a greater understanding of the extent of movement or damage can

be gained. Once trigger levels are reached further damage is likely beyond that which LUL have deemed “reasonable”. The report does refer to an Appendix N and the list of contents for volume two does refer to Appendix M “Contingency Action Plans” but neither Appendix M nor N have been made available.

6.14 It is conceivable the pre determined mitigation measures, as there are none mentioned by LUL, will be to underpin the theatre foundations with further jet grouting. This is not in the best interests of the theatre. Refer to section 8.

6.15 On a purely technical note, there is an error in the table in Appendix K for the tensile strains at section F-F. The values printed suggest that CS2 should cause severe damage and not negligible damage as stated.

6.16 The settlement and volume loss calculations provided in section six of PDA-VPT and the tables, in which the values are entered, do not correlate.

7.0 IMPACT OF PROPOSALS ON THE THEATRE

7.1 The Victoria Palace Theatre, in its current form, has been in existence for nearly 100 years. The ornate and delicate finishes of fibrous plaster, faience and marble are all original, put their by the original craftsman apprenticed for many years. Listing a building is all about conservation which is well explained by Mr Satow and Mr Earl in their evidence. This building is listed for a reason and demands better protection and consideration against irrevocable damage.

7.2 SETTLEMENT

7.2.1 Due to the incorrect assessment of the theatre's construction I believe the effects of the predicted settlements are greater than the theatre's structure can tolerate and the consequential damage will be beyond repair. If the settlements were beyond predictions, as I have set out in section 6 may be the case, the results will be catastrophic.

7.2.2 Settlements of foundations to a steel stanchion have far more impact on a building, due to the concentration of load in a localised area, than that of a load bearing masonry structure. Localized differential movements of such magnitude will have detrimental effect on the finishes and the fabric of the building as there is no opportunity for settlements to be dispersed along the walls.

7.2.3 There are incidences, as referred to in other expert's evidence, of large areas of similarly delicate ornate plaster collapsing with little or no encouragement in other theatres. As these finishes age they become more brittle and easily persuaded to detach. This is best explained by Mr Satow in his evidence.

7.2.4 To allow the theatre's structure to "move around" would be putting at risk not only original plaster work but, also public safety if plaster were to fall during rehearsals or performances.

7.2.5 Should the works go ahead as proposed, stanchion settlements will have catastrophic effects on the cosmetic historic fabric of the building causing major cracking of masonry walls and floor levels deflecting. This will undoubtedly cause the delicate ornate finishes to be damaged beyond repair or detach from their nominal fixing and fall away. Damage will not be limited to just local hair line cracking.

7.2.6 A statement in the Alan Baxter report, section 3.2 structural development PDA-VPT, also says that should localised movement occur to a stanchion built into a wall, the loads would "most probably" be transferred into the masonry surrounding it. This statement assumes the masonry is fully bonded and solid throughout. I believe the reason stanchions were used in the first place is that the masonry is unable to support the high loads and likely to crush with the high stresses involved.

7.2.7 I know from intrusive opening up works, refer to my appendix A, we conducted in 2003, the front of the building has structural stanchions and I can confirm the masonry around the stanchions is only broken brick rubble to fill the void between stone faience and stanchion. Therefore, as the stanchion makes significant movements downward, as predicted it will, any loads applied to the masonry infill will begin to crush it. It would be impossible to predict when movements of the structure will stop and thus movements would be ongoing (as the masonry crushes and closes the voids) until equilibrium is reached or the stanchion takes back the load. By this time irreparable damage would have occurred to plaster and irreplaceable marble finishes (trying to find a match for these finishes in the past has proven unsuccessful).

7.2.8 The stanchions support long span elements such as trusses and plated girder beams. Depending on the amount of movement and which truss or floor beam moves with its stanchion, this could affect the auditorium balconies (finishes to the underside, ornate plasterwork to the front and levels/sight lines), the boxes that are hung from the roof (level and decorative plaster finishes), auditorium roof (the ornate plaster finishes and sliding roof), proscenium arch (ornate plaster finishes and safety curtain running gear), access stairways and floor levels (finishes to stairs out of level floors) or fly galleries (out of level disturbs the sensitive setting up of the fly gallery pullies and distributes loads on each pulley unevenly).

7.3 NORTH TICKET HALL CONSTRUCTION WORKS

7.3.1 There are considerable works being done over and near the KSPS. A very large and deep sump is proposed but little information is given regarding its construction. Secant piling is proposed for the North Ticket Hall (NTH) excavation. All of this work needs exceptional care because, should the sewer leak due to damage at any point during or after completion, this water would have serious and considerable consequences for the foundations of the theatre due to their close proximity. In particular, fine particles within the gravels are likely to be moved around by the huge volume of water, possibly resulting in further damaging settlements.

7.3.2 The secant piling proposed on the North Ticket Hall may also affect the ground below the foundations of the theatre. During the temporary stage, when the basement is being excavated, the secant pile wall forming the retaining walls will deflect and may change the performance of the adjacent ground and thus the theatre’s foundations.

7.4 NORTH TICKET HALL ESCALATOR

7.4.1 When I first received the proposed scheme drawings from LUL the escalator was at least 6m further north than is currently proposed (refer to drawings in Mr Satow's appendix H). Progressively the escalator tunnel has moved south increasing the risks to the rear wall of the theatre.

7.4.2 We are awaiting justification from LUL behind the reasoning for moving the escalator tunnel further south. Discussions with MM have lead us to believe the reasons are the width available for an escalator (the running tunnels converge at the North end) and the recently fitted out Signal Equipment Room (SER). We also understand experimental tunnelling techniques were used during the construction of the running tunnels at this end, for which LUL have little "as built" records. MM have said they will produce a drawing showing the original position and the current position but this has not been forthcoming.

7.4.3 I do not have the experience to comment on the number of escalators required (thus the width required) and this can be dealt with by other experts, but I can comment that the current scheme shows a new SER within the NTH, presumably negating the need for the one on the platforms. It appears another department within LUL has installed the SER on the platform without consultation with VSU.

7.4.4 As Elliot house is being demolished to enable construction of the North Ticket hall and escalator, the only building at risk by the tunnelling is the Theatre, a listed building. Therefore the further away the escalator is from the rear wall of the theatre the less risk to the theatre.

7.5 IMPACT ON THE THEATRES ASPIRATIONS TO IMPROVE

7.5.1 The theatre has made an application to extend the rear wall of the theatre north by 6m and install elevators to the east elevation. This works includes rebuilding the stage area completely providing for power flying and a stage pit. (refer to Mr Satow's drawings in appendix C).

7.5.2 The current proposed position for the North Escalator shaft clashes with the foundation requirements of the theatre's new rear wall, to be extended 6m rearward. It is clear no bridging over the tunnel option can be acceptable (unless it is part of LUL's tunnel in a form of culvert) as the foundations will extend into Allington Street outside of the Theatre's demise.

7.5.3 Unless LUL accept they need to take the lead in providing a foundation for our proposed extension the theatre cannot extend.

8.0 PROTECTION OF BUILDINGS

8.1 It has been accepted by LUL that the predicted settlements are not acceptable and that “mitigation” measures are required to reduce them – not remove them. The measures considered by LUL to limit settlement look at three possibilities;

a. Underpinning. This is dismissed as it could cause further settlements.

b. General ground improvement. This is dismissed due to the complexity.

c. In-tunnel mitigation. This is selected as the preferred option.

8.2 I concur that underpinning is likely to cause further settlement issues as it tries to correct others. The entire theatre would need to be underpinned. Underpinning would therefore be extremely disruptive to the theatre, as much work would need to be carried out from within the theatre itself. Many of the floor finishes would be damaged and the theatre would need to close for a significant period.

8.3 I also concur that general ground improvement is not an option, but not for complexity/cost reasons. This method is likely to cause greater acoustic transfer problems which are unacceptable to the theatre and are considered in more depth by acoustic experts elsewhere.

8.4 Hence in-tunnel mitigation is left, but this mitigation is not full mitigation and thus ground movements will occur.

8.5 Tunnelling into the gravel and alluvium is a high risk activity. A fundamental part of the in tunnel mitigation measures and allowing tunnelling at all is to use jet grouting to improve the ground in the immediate vicinity of the proposed tunnels. This has adverse effects on the operation of the theatre, this is covered by Mr Greer's evidence.

8.6 The proposed method of tunnelling is to form a jet grouted shroud to tunnel through and to jet grout compartment walls to limit the effects of tunnelling works and allow dewatering. There will always be an exposed tunnel excavation face at the front of the works.

8.7 Having had the benefit of reading Mr Tim Chapman's Proof for Land Securities, this has highlighted to me the experimental nature of the proposed works, the big risks to construction personnel and public and the real potential of collapse of the tunnel (with examples of previous failures using a similar method). I am deeply concerned that should a tunnel collapse occur at the stanchion locations, a significant proportion of the theatre will fall into the tunnel excavation.

8.8 I also have grave concern for the area where the proposed tunnelling along Allington Street changes direction and starts to cross under the corner of the theatre (at the Party Wall with the Duke of York Public House). Undermining the corner of a building has just as serious consequences on the structure as undermining stanchions. To lose a corner of the building into the excavation or even cause it significant damage would have a similar effect as set out above because the loads cannot be shared/bridged over plus the corner is part of the robustness and resistance to wind loads of a building.

8.9 From my limited experience in geotechnical matters I know jet grouting is a relatively new technique for ground improvement. It therefore has no proven longevity. Whilst its use on the VSU is for temporary works during the tunnelling process it will remain in place as it cannot be removed. It is not in the best interests of the Theatre to have a solid mass constructed along its side and rear walls which will tend to transfer vibration and sound arising from the LUL infrastructure (both existing and proposed).

8.10 Most of the MM drawings indicate the jet grout being confined to a small zone that follows the profile of the tunnel, but this will not be the case. At best, the zone will be very irregular as indicated in their own Appendix I figure I.3, which will generate uneven settlements in the ground above. Moreover, the process of injecting grout will leave “spikes” of hard grouted materiel around each drill probe as the liquid cement follows the path of least resistance through the gravels. This will further exaggerate the localised differential settlements and act as direct pathways for acoustic transmission. Refer to Mr Satow’s drawings in appendix D which represents a more realistic installation. The detriment of this process to the theatre is covered by Acoustic experts elsewhere.

8.11 The information regarding the process of jet grouting is taken from LUL/MM Powerpoint presentation to me and others by their jet grouting specialist.

8.12 The environmental statement seems to dismiss alternative schemes too easily and does not explain the reasoning behind the proposed scheme, thus dismissing responsibilities that should be afforded to a listed building. This is covered in more detail in section 10 and in the evidence or Dr Loveday, Mr Spiers, Mr Greer and Mr Edge.

9.0 DEMOLITION OF SURROUNDING BUILDINGS

9.1 Demolition of Elliot House behind the theatre will have significant impact on the workings of the theatre. With disruption during Matinee performances and rehearsals due to the vibration and likely noise. It appears, from other experts evidence, the vibrations and noise will also cause structural damage. Therefore the method of demolition of this building requires review.

9.2 Demolition of number 124 Victoria Street adjacent to the theatre also has some complications. The existing Party Wall is to remain as the theatre is afforded support from this wall, and indeed will use this wall for further support in the proposed extension. It is only proposed to leave the wall up to ground level where all loads are applied. This is reasonable as the remaining wall would be unstable if left freestanding but there does not appear to be suitable weather or sound protection afforded to the theatre's internal wall abutting the party wall that will become exposed. As the proposals to this site are not finalised, the wall could remain exposed indefinitely, which is not acceptable.

10.0 ALTERNATIVE SCHEMES

10.1 With the high risks to the theatre associated with the tunnelling LUL propose I, along with the other experts, have looked into alternatives that provide the best compromise.

10.2 We have reviewed the original scheme options selected by LUL that were carried forward to appraisal stage and believe option A4, A6 and 2B/C should be looked into again. In particular 2B/C given that the theatre is more susceptible to damage than LUL previously assumed.

10.3 We have also looked at the proposals Land Securities have put forward in their proof of evidence, namely option 1A. However, this shows the escalators in their current proposed location which for reasons stated earlier is not an acceptable outcome for the theatre.

10.4 Firstly LUL's Option 2B/C looks at the PAL being constructed from the NTH on the other side of the KSPS. Obviously this is a much better location from the theatre's perspective as it removes the tunnelling along the length of the Allington Street elevation and under the corner of the theatre. It also shows the escalator further away from the theatre's rear wall.

10.5 The reasoning behind this option being rejected by LUL appear to be based on the impact on the Saudi Arabian Airline building, a non listed relatively modern building, which is believed to have a deep piled foundation and the travel distance which is covered by the other experts.

10.6 There will be structural risks to the Saudi Arabian Airline building if 2B/C is adopted. The weighing of these risks against the risk of harm which the scheme proposed by LUL will present to the theatre is a matter of planning judgment which will be addressed by others. But it is first necessary for LUL to recognize the full extent and potential impact to the theatre. This they have not yet done.

10.7 The Land Securities option 1A also removes the risky Allington Street tunnelling. However, it proposes a tunnel under the theatre. This tunnel is to be constructed using more conventional tunnelling methods with potentially less settlement risks involved. It also does not have an exposed excavation face and thus the risks of collapse are far less. Whilst a tunnel is still proposed under the theatre, the method of construction is safer (thus less risk) and will leave no physical connection between theatre and tunnels on completion. Any sound issues are covered by Mr Greer's evidence.

10.8 There will be no physical connection unlike the jet grouting proposals and so this also appears to be a better compromise than the current LUL proposals.

10.9 No tunnelling along Allington street will remove the risk associated with;

a. Tunnelling under the Duke of York pub and the underpinning proposed for it.

b. Tunnelling under the corner of the theatre building which is extremely close to the crown of the tunnel.

c. Tunnelling parallel to the Allington Street Victoria Palace Theatre elevation with considerable vertical loads applied via stanchions.

11.0 CONCLUSION

11.1 LUL's predicted settlements due to their tunnels appears optimistic and the actual settlements are likely to be much larger than this and thus the damage to the theatre is going to be far in excess of LUL's predictions and unacceptable.

11.2 LUL appear to have ignored the possible event of tunnel collapse relying on the jet grouting to be a complete system. The method of tunnelling appears to be experimental and there are proven cases of this method failing in Victoria.

11.3 The Victoria Palace Theatre has the majority of the structural loads applied to steel stanchions on pad foundations concentrating the loads in a very local point. LUL have assumed the theatre loads are spread along the length of the masonry walls. Therefore the structural response to the settlements will be outside of the scope of LUL's predictions and will be catastrophic.

11.4 Finishes on a steel structure are more sensitive to movements as the movements will be differential to the rest of the structure.

12.0 APPENDICES

12.1 The following appendices are attached to this POE

A. Photographs of opening up works
B. Photographs of archive drawings from Victoria and Albert Museum a letter of authenticity from V&A.
C. Technical information for appraisal of load take down to foundations
D. A1 drawings showing some of the steel framework and section through Allington street.

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