THAMESLINK 2000

Proof of Evidence on

Noise and Vibration

By
Rupert Thornely-Taylor

NR/8/A1

Town and Country Planning Act 1990
Planning (Listed Buildings and Conservation Areas) Act 1990
Transport and Works Act 1992

Railtrack (Thameslink 2000) Order 1997
Railtrack (Thameslink 2000) (Variation) Order 1999

1. Inquiry into applications by Network Rail for the Thameslink 2000 railway project sites at

11-15 Borough High Street, London SE1
2-4 Bedale Street, London SE1
7 Stoney Street, London SE1
16-26 Borough High Street and 7 Bedale Street, London SE1
Blackfriars Railway Bridge, London EC4
Blackfriars Station North, London EC4
Blackfriars Railway Bridge, London SE1 (includes proposed south bank station entrance)

2. Re-opened inquiry into applications made by Railtrack plc for orders under the Transport and Works Act 1992 and associated applications

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1.0 QUALIFICATIONS AND EXPERIENCE

1.1 My name is Rupert Maurice Thornely-Taylor. I am a Fellow of the Institute of Acoustics, a Member of the Institute of Noise Control Engineering of the USA and a Member of the International Institute of Acoustics and Vibration. I have specialised exclusively in the subjects of noise, vibration and acoustics for more than 41 years. I have been an independent consultant in these subjects for the past thirty-seven years, head the practice known as Rupert Taylor F.I.O.A. and am a director of the associated company Rupert Taylor Ltd. I was chairman of the Association of Noise Consultants 2003-2005.

1.2 A large part of my work has been concerned with noise and vibration from railways. I have had consultancy commissions from railway undertakings, objectors to railway proposals, rolling stock builders and equipment suppliers, and have carried out studies of noise and vibration on, among others, Tyne and Wear Metro, Glasgow Underground, London Underground, Kowloon-Canton Railway, Hong Kong Mass Transit Railway, Netherlands and Norwegian Railways, railways in Cologne, Rotterdam, Berlin, Munich, San Francisco, Washington D.C., and Seoul, South Korea. I prepared the terms of reference for the Environmental Impact Study of the Taipei Rapid Transit Systems in the Republic of China. I have been engaged in noise studies of Manchester Metro, Nottingham and South Hampshire Light Rapid Transit systems. I have been noise and vibration consultant to the Docklands Light Railway (DLR) and was involved in the City, Beckton and Lewisham Extension projects. I prepared the noise and vibration parts of the Environmental Statement for Croydon Tramlink. I was expert witness in both Houses of Parliament during the committee stages of all the DLR and Croydon Tramlink Bills.

1.3 I have been noise and vibration consultant to (and expert witness in Parliament for) the Crossrail and Jubilee Line Extension Projects, and was expert witness in the House of Commons committee on the Channel Tunnel Rail Link Bill on behalf of Union Railways.

1.4 I was engaged in the design of the Kowloon-Canton Railway West Rail project in Hong Kong, and am currently a consultant to the Citytunnel project in Malmö, Sweden, and to Västlänken in Gothenburg. I am part of the Independent Verifier team for Parramatta Rail Link in Sydney, Australia.

1.5 In 1989 I carried out noise and vibration studies of the designs for the bridges carrying the Eurotunnel railway over the A20 and M20 bridges. In 1992 I carried out a study of noise and vibration in the design of the Waterloo International Terminal for British Rail.

1.6 A substantial part of my experience relating to noise and vibration from railways has been in the field of the acoustical design of rolling stock. I carried out a noise study of the TGV as part of the acoustical design of the British Rail East Coast Main Line (Intercity 225) Mk IV Coaching Stock. I was noise consultant in the design of the GEC-Alsthom (Metro-Cammell) Networker Class 465, and in other Electric Multiple Unit (EMU) designs such as the Class 323 built by Hunslet. I also was engaged in acoustical design work on Channel Tunnel Shuttle vehicles in 1987/88, and provided computer software to a French company involved in the design of those vehicles. In 2005, I completed a train noise levels study of vehicles built by Rotem of Korea for Delhi Metro Rail Corporation, India.

1.7 I have been engaged as noise and vibration consultant in the Thameslink 2000 project and its predecessors since 1990, having prepared the noise and vibration sections of the 1999 ES, and gave evidence at the 2000/1inquiry. I reviewed the findings of the ES2004 and contributed to the findings of the ES Addendum 2005.

2.0 SCOPE AND STRUCTURE OF EVIDENCE

2.1 The evidence presented in this proof is concerned with noise and vibration issues of the matters before the re-opened inquiry, and those associated with the new applications. This inquiry has before it no new proposals with noise or vibration characteristics materially different from those considered at the original inquiry, save for the already consented London Bridge Masterplan. However, in order to update the assessment, a new Environmental Impact Assessment was carried out, and an Environmental Statement was published in June 2004 (ES2004) (CD/164-169). An Addendum to the ES has been produced (ES Addendum 2005(CD/202)) which gives the results of work on detailed aspects of noise and vibration and its mitigation, and refines some of the conclusions of ES2004.

2.2 Because of:

a. Improvements in methodology,

b. the availability of further information, and

c. changes to baseline data,

there are some differences between the conclusions of ES2004 and the 1999 ES extant at the time of the original inquiry. These are summarised in the ES2004 - *Summary of Significant Changes*- which identifies differences in operational noise and vibration impacts in the vicinity of Blackfriars Station and London Bridge Station (CD/165). The updated assessment (CD/202, Section 4) reported in the ES Addendum 2005 has narrowed the differences between the assessments in the vicinity of Blackfriars Station and there is now no material difference between the noise assessments. Several of the differences in operational noise impacts that arise at London Bridge Station occur as a result of the consented London Bridge Masterplan.

2.3 In relation to this inquiry, the Secretary of State has identified a number of matters for consideration. The topics addressed in my evidence are the noise and vibration aspects of the following matters:

a. ***Matter 4 identified by the Secretary of State for Transport****:* the interface between the proposed Thameslink 2000 and Crossrail projects, particularly at Farringdon, including plans for coordinating the two projects in order to minimise disruption.

b. ***Matter 5 identified by the Secretary of State for Transport:*** the likely effects of construction and operation of the scheme on the character of the Borough High Street/Borough Market Area and on the setting and integrity of buildings within that area in the light of changed circumstances since the earlier inquiry, including the cumulative impact of the proposed new bui1dings in the area

c. ***Matter 10 identified by the Secretary of State for Transport*:** the effects of increased noise levels in the vicinity of Blackfriars Station, as discussed in ES2004 and measures to mitigate these effects

d. ***The planning applications relating to Blackfriars Station and railway bridge, London EC4 and SE1 (Tl6, Tl7 and Tl8)****:* the likely effect of construction on local residents and businesses including any impacts on pedestrian and vehicular traffic flows and impacts rising from noise, vibration and dust and the proposed measures to mitigate any adverse effects

e. ***The planning applications relating to the development in the Borough High Street area, at 7 Stoney Street, SE1 (TL3), 2-4 Bedale Street, SE1 (TL4), 11-15 Borough High Street, SE1 (TL5), and 16-26 Borough High Street and 7 Bedale Street, SE1 (TL9****)* : the likely effect of construction on local residents and businesses including any impacts on pedestrian and vehicular traffic flows and impacts rising from noise, vibration and dust and the proposed measures to mitigate any adverse effects.

3.0 MITIGATION OF CONSTRUCTION EFFECTS AND THE THAMESLINK 2000 NOISE AND VIBRATION POLICY

3.1 The Thameslink 2000 project team has developed a comprehensive set of project specific policies, procedures and systems to mitigate noise and vibration impacts during construction and operation of the scheme. The Planning and Environmental Management Strategy (PEMS) (CD169, Appendix E) sets out the framework for mitigating environmental impacts and was first adopted by the project in 1999 to describe how environmental impacts, including construction impacts, would be mitigated. Since 1999 a considerable amount of work has been undertaken to develop the mechanisms for controlling noise impacts, in agreement with the Inner London local authorities.

3.2 The approach of the project to the control of noise and vibration is set out in the Thameslink 2000 *Noise and Vibration Policy (*CD/169, Appendix G*)*. The Inspector at the earlier inquiry said "*I conclude that the Thameslink 2000 Noise and Vibration Policy is satisfactory*" (CD/199, para. 6.3.88). The underlying principle behind this policy is to avoid significant construction and operational noise and vibration effects wherever this is reasonably practicable. Contractors will be required to control and limit noise and vibration levels as far as reasonably practicable and contractors must obtain 'prior consent' from the local authority under section 61 of the Control of Pollution Act. Where significant noise impacts cannot be avoided, the Noise and Vibration Policy sets out the arrangements that will be used to provide noise insulation or offer temporary accommodation.

3.3 A series of guidance notes has been produced to help to achieve the noise and vibration policy, notably:

a. Best Practicable Means: Control of Noise and Vibration (CD/ 214);

b. Section 61 Consent Application Process (CD/213);

c. Noise Insulation and Temporary Re-housing (CD/216);

d. Compendium of Standard Consent Conditions (CD/215); and

e. Operational Noise Modelling Strategy (CD/217).

3.4 The noise and vibration policy and supporting guidance notes have been accepted by the Environmental Protection Sub-Group, which is a forum made up of officers from the Corporation of London and the London Boroughs of Camden, Islington, Southwark and Lewisham. The project team will continue to work closely with the local authorities and revise and update the policies, guidance notes and procedures for managing noise impacts as appropriate. The LB Islington have raised some specific matters (in their letter dated 14 July 2005) about the Noise and Vibration Policy and, in particular, the night-time eligibility criteria for noise insulation and temporary re-housing. They are seeking a written undertaking that the Thameslink 2000 project team will ensure through their policy and actions that contractors fully understand that the threshold levels within the Noise Insulation and Temporary Re-housing Policy are not to be seen as 'acceptable' levels and emphasise Best Practicable Means. Such an undertaking is already given in the Noise and Vibration Policy and the supporting Guidance Notes. The Consents and Environment Team will nevertheless continue to discuss these matters with the LB Islington and attempt to address any outstanding concerns as far as possible.

3.5 The Control of Pollution Act 1974 provides specific statutory provisions to control construction site noise.

3.6 Local authorities can serve a notice under Section 60 of the Act imposing requirements to control construction noise. Alternatively, the person responsible for the construction works can make an application for 'prior consent' under Section 61 of the Act. The application must set out particulars of: (a) the works, and the method by which they are carried out; and (b) the steps proposed to be taken to minimise noise. The local authority must determine the application but can attach conditions to the consent and limit consent where there is a change in circumstances and limit the duration of the consent.

3.7 The Noise and Vibration Policy (CD/169, Appendix G, section G.2.1.2) requires contractors to obtain 'prior consent' from the local authority under Section 61 of the Control of Pollution Act.

3.8 The Thameslink 2000 team has developed a series of Guidance Notes (see para. 3.3 above), in consultation with the Inner London local authorities affected by the scheme, on the control of construction noise and these guidance notes detail the specific measures that will be used to mitigate the construction noise, vibration and dust impacts. A compendium of model conditions has also been agreed (CD/215).

4.0 MATTER 4 IDENTIFIED BY THE SECRETARY OF STATE FOR TRANSPORT: THE INTERFACE BETWEEN THE PROPOSED THAMESLINK 2000 AND CROSSRAIL PROJECTS, PARTICULARLY AT FARRINGDON, INCLUDING PLANS FOR COORDINATING THE TWO PROJECTS IN ORDER TO MINIMISE DISRUPTION.

4.1 The ES Addendum 2005 includes a section on the cumulative environmental effects of Thameslink 2000 and Crossrail. With regard to noise and vibration the conclusions were that there would be no significant operational noise or vibration effect from either scheme, considered separately or together (para. 2.7.13 et seq).

4.2 At Farringdon, significant temporary effects are deemed to occur where construction noise is predicted to exceed 75 dB L_{Aeq} during the day, 65 dB L_{Aeq} during the evening or at weekends and 55 dB L_{Aeq} during the night.

4.3 With regard to construction noise and vibration the potential for cumulative impacts would be limited to the buildings in the vicinity of both Crossrail's Western Ticket Hall (Cardinal House) Worksite and the Thameslink 2000 works – that is, those buildings on Farringdon Road and Cowcross Street (see Figure 2.2(i), CD/202). If it be assumed that Crossrail and Thameslink 2000 construction occurs at the same time, significant daytime noise effects at Smith New Court House would be extended by a period of about 9 weeks over the 16 weeks reported in ES2004. Significant daytime noise effects at 46 Cowcross Street would be extended by a period of about 37 weeks over the 2 weeks reported in ES2004. Cumulative noise levels during the day would not cause impacts at any additional locations, however. The significant impacts reported by ES2004 at 52 Cowcross Street and the Cardinal House would, of course, disappear since these buildings are to be demolished by Crossrail.

4.4 Significant night time noise impacts from both projects could each affect residents at 34/35 Cowcross Street. Concurrent construction would result in higher cumulative noise levels. This would increase the risk of exceeding the evaluation thresholds, which could result in a significant effect over a longer period. This effect would be limited to about 2 weeks over that which would occur with

Crossrail alone. It is unlikely that the predicted increase in noise levels will affect more people.

4.5 The loss of screening brought about by the demolition of Cardinal House would result in significant noise effects at residential apartments at 17-23 and 25-27 Farringdon Road if Cardinal House is demolished before the construction of the Thameslink 2000 ticket hall. Any potential cumulative effect from the loss of this screening is likely to be small if not negligible.

4.6 No cumulative construction vibration impacts are expected. The significant vibration impacts reported in ES2004 for Cardinal Tower and 52 Cowcross Street, would no longer occur (CD/164, para. 6.8.4).

4.7 The significant positive effects from road traffic noise predicted with Thameslink 2000 and Crossrail are not cumulative.

4.8 Mitigation of construction noise and vibration effects is discussed in section 3 above. Contractors must apply for 'prior consent' and the application will set out the steps that will be used to minimise construction noise. The application for 'prior consent' can also provide an assessment of the noise impacts resulting from both projects and the steps that will be used to coordinate the two projects to minimise any potential cumulative effects.

4.9 The eligibility criteria for noise insulation and temporary re-housing, set out in the Noise and Vibration Policy (CD/169, Appendix G), are based upon noise levels emanating from the Thameslink 2000 worksites. The two parties (Network Rail and Crossrail) will offer noise insulation or temporary housing to eligible buildings in line with the respective policies in the event that the cumulative noise and vibration levels, resulting from the two projects, exceed the eligibility thresholds.

5.0 MATTER 5 IDENTIFIED BY THE SECRETARY OF STATE FOR TRANSPORT: THE LIKELY EFFECTS OF CONSTRUCTION AND OPERATION OF THE SCHEME ON THE CHARACTER OF THE BOROUGH HIGH STREET/BOROUGH MARKET AREA AND ON THE SETTING AND INTEGRITY OF BUILDINGS WITHIN THAT AREA IN THE LIGHT OF CHANGED CIRCUMSTANCES SINCE THE FIRST INQUIRY, INCLUDING THE CUMULATIVE IMPACT OF THE PROPOSED NEW BUILDINGS IN THE AREA

5.1 ES2004 reported significant impacts from construction noise at Borough Viaduct (CD/164, para. 8.8.4 et seq). The impacts are similar to those reported in the 1999ES. There is no change in circumstances with respect to noise and vibration in the Borough Market area but the London Bridge Tower is permitted which is located to the east of the Borough High Street area. The following section addresses the cumulative effects resulting from the construction of the London Bridge Tower and Thameslink 2000. I address the impacts of the replacement buildings in Section 8 of this proof of evidence.

5.2 Since the 1999 ES planning permission has been granted for the construction of London Bridge Tower. This is considered in the Noise and Vibration Specialist Report (CD/219, para 8.8.1) and in the ES Addendum 2005 (CD/202 para. 5.2.3 et seq). Despite the close proximity of the two developments, the potential for a cumulative increase in noise is limited to two locations.

5.3 New London Bridge House would receive a significant increase in daytime noise levels from the construction of both developments. However, it is unlikely that the intensity of the noise effect will increase since the two projects are likely to affect different façades i.e. the northern facade for Thameslink 2000 and the eastern façade for London Bridge Tower.

5.4 Significant night time construction noise impacts are predicted at Guy's Hospital as a result of Thameslink 2000. The construction of London Bridge Tower will result in significant daytime impacts and night time impacts but the night time impacts would be limited to relatively few nights when long concrete pours may occur during the third phase of the construction of London Bridge Tower, involving pile

and substructure forming. Consequently, significant cumulative adverse effects could occur at Guy's Hospital on the façade facing St. Thomas' Street in the event that the two projects proceeded simultaneously at this location. The extent of this potential effect will depend on how closely the two construction programmes coincide. The ES 2004 explained that the conclusion (section 9.8.6) that parts of Guy's Hospital are likely to experience noise effects at night for up to 120 weeks, assumes that the affected parts of the hospital are used at night. It went on to state that a further evaluation of specific use and building fabric will be required to refine this assumption. This evaluation is in hand and the results will be reported when they are available.

6.0 MATTER 10 IDENTIFIED BY THE SECRETARY OF STATE FOR TRANSPORT: THE EFFECTS OF INCREASED NOISE LEVELS IN THE VICINITY OF BLACKFRIARS STATION, AS DISCUSSED IN ES2004 AND MEASURES TO MITIGATE THESE EFFECTS

6.1 There will be no significant increase in noise levels in the vicinity of Blackfriars Station as a result of the Thameslink 2000 proposals. ES2004 referred to the effects of an increase in the duration and number of events (para. 7.8.11 et seq). ES2004 reported (CD/164) operational railway noise impacts at commercial buildings in the vicinity of Blackfriars Station and for residents of Quadrant House and the Blackfriar Pub. A marginal noise impact was reported at Falcon Point (para. 7.8.14) on the basis that the bridge noise component, which was assumed to be the dominant railway noise component, would be heard more often and for longer periods of time as a result of more frequent and longer trains.

6.2 The ES Addendum 2005 reported (CD/202 chapter 4) the results of further work undertaken to assess in more detail the composition of existing noise in the area and the actual noise levels inside buildings. This has enabled a more accurate assessment of operational noise effects to be made. The conclusions reported in ES2004 have been revised as a result of this assessment.

6.3 A comprehensive set of noise measurements was taken in each of the buildings where a significant noise effect was predicted in ES2004, to evaluate the incidence and relative importance of the different types of noise, and the specific mechanisms that are and will be generating that noise. Detailed evaluations of the relevant buildings were also carried out. These identified the uses of these buildings and any particular sensitivities to noise, and also established their ability to resist external noise (e.g. through noise insulation such as double glazing). Simultaneous noise measurements were taken inside and outside the buildings.

6.4 The measurements show that when an assessment is made taking account of the internal ambient noise and the predicted internal noise levels due to Thameslink 2000, the increase in noise levels is smaller than is the case for an assessment outside the façade (the basis of the assessment in ES2004). Increases in internal

ambient noise levels resulting from Thameslink 2000 are no more than 3.5 dB and generally between 1 dB and 2dB. Thus, in most cases the increases in internal ambient noise levels will be materially less than the 5-6 dB increases in external railway noise that were reported in ES2004. In all cases, internal noise levels will remain at 'reasonable' levels as set out in paragraph 4.3.1 of the ES Addendum 2005 (CD/202).

6.5 As a result of the detailed evaluations, no residual operational noise impacts are predicted at any of the commercial buildings in the vicinity of Blackfriars Station.

6.6 The further work to which I have referred also highlighted the influence, on the noise climate around Blackfriars Bridge, of noise from wheel squeal caused by flange contact, and the effect of joints in the rails and of points and crossings. The benefits which will arise from the proposed remodelling of the track, in which many of the points and crossings will be removed, and rail joints replaced by continuously welded, or long-welded, rail were analysed. Where flange contact remains after the track remodelling and renewals have taken place, electric lubricators or an alternative equivalent will be installed to minimise any residual flange contact noise. The substantial reduction in bolted joints and the reduction in flange contact noise will provide a significant reduction in train event noise levels, especially at receiver locations to the south of the railway bridge. Consequently, the significant reduction in flange contact noise will, by itself, significantly reduce noise levels, reducing the predicted noise impacts in terms of L_{Aeq} levels. Minimising wheel squeal will actually reduce maximum noise levels from train events and will provide an improvement in the perceived train noise at several receivers. This is set out in paragraph 4.4 of the ES Addendum 2005.

6.7 The overall reduction in train noise, resulting from minimising flange contact noise and joint noise, will offset the predicted noise impacts at the Blackfriar Public House and Quadrant House so that no residual operational noise impacts will occur. A significant benefit is now predicted at Falcon Point as a result of the

reduction in flange contact noise and joint noise. Commercial buildings will also benefit from the predicted reductions in flange contact noise and joint noise.

6.8 The change in design at Blackfriars has not led to any change in the position as regards the effect of the public address system. Noise from the new public address (PA) system at Blackfriars Station will be controlled through design, siting and specification of the PA system. At Blackfriars Station, noise radiated from the bridge will, potentially, require the PA system to be amplified in order to be heard by passengers. Mitigation of PA noise impacts will therefore be achieved by controlling the emission of structure-radiated noise into the station.

6.9 A draft planning condition has been agreed with LB Southwark and the Corporation of London that will effectively limit and control noise from the PA system such that there is no significant effect (CD/169 Appendix E).

7.0 THE PLANNING APPLICATIONS RELATING TO BLACKFRIARS STATION AND RAILWAY BRIDGE, LONDON EC4 AND SE1 (TL6, TL7 AND TL8)THE LIKELY EFFECT OF CONSTRUCTION ON LOCAL RESIDENTS AND BUSINESSES INCLUDING ANY IMPACTS ON PEDESTRIAN AND VEHICULAR TRAFFIC FLOWS AND IMPACTS RISING FROM NOISE, VIBRATION AND DUST AND THE PROPOSED MEASURES TO MITIGATE ANY ADVERSE EFFECTS.

7.1 The main construction programme at Blackfriars is expected to last for slightly more than 30 months. ES2004 reports significant construction noise and vibration impacts at several commercial and residential buildings in the vicinity of Blackfriars Station (CD/164, para. 7.8.5 et seq).

7.2 Some disruption from construction works is inevitable and the predicted noise levels are expected to cause significant disturbance and annoyance. At several locations the adverse effects are predicted for a relatively long period. For example, adverse effects are expected at Falcon Point for most of the 30 month programme. The commercial buildings in the area generally have good sound insulation and air-conditioning. Residential receivers are more sensitive to construction noise because the effects will be felt at night and weekends as well as during the day. Noise insulation and supplementary ventilation will be provided to residential buildings that will be exposed to excessive levels of noise for a substantial period of time in accordance with the Noise and Vibration Policy. It is expected that the residential parts of the Blackfriar Public House will be eligible for the noise insulation package and an undertaking has already been given to the residents of Falcon Point to insulate the building and provide supplementary ventilation before the construction works start. These measures will serve to minimise the adverse effects from construction noise on those residential buildings where higher noise levels will occur.

7.3 Temporary vibration effects are predicted at Puddle Dock, the Blackfriar public house, 245 Blackfriars Road and Bridge House as a result of piling. The proposals take into account the mitigation afforded by the use of rotary bored or drilled

piling. It is likely that significant vibration effects can be avoided by employing effective control measures under Section 61 of the Control of Pollution Act.

7.4 Mitigation of construction noise and vibration effects under PEMS is discussed in section 3.

7.5 Specific measures would include: hoardings on the north bank of the Thames, around the site at 179 Queen Victoria Street, and screening of the street works to maximise the acoustic protection.

7.6 To the south of Blackfriars Bridge, a tall hoarding at the perimeter of the south bank worksites will be used. Screening would be put in place at the east side of the station, especially during the works on the east side of the bridge deck i.e. in the first half of the programme, in order to maximise the screening for properties to the east of the station. In addition, it would be possible further to refine the night-time working schedule during the detailed design phase, in order to seek to reduce the amount of work, especially lifting, at night.

7.7 The above measures are likely to reduce the scale and duration of the noise impacts reported in the ES 2004.

8.0 THE PLANNING APPLICATIONS RELATING TO THE DEVELOPMENT IN THE BOROUGH HIGH STREET AREA, AT 7 STONEY STREET, SE1 (TL3), 2-4 BEDALE STREET, SE1 (TL4), 11-15 BOROUGH HIGH STREET, SE1 (TL5), AND 16-26 BOROUGH HIGH STREET AND 7 BEDALE STREET, SE1 (TL9) THE LIKELY EFFECT OF CONSTRUCTION ON LOCAL RESIDENTS AND BUSINESSES INCLUDING ANY IMPACTS ON PEDESTRIAN AND VEHICULAR TRAFFIC FLOWS AND IMPACTS RISING FROM NOISE, VIBRATION AND DUST AND THE PROPOSED MEASURES TO MITIGATE ANY ADVERSE EFFECTS.

8.1 Construction of the new viaduct at Borough Viaduct will entail widening the existing viaduct between the Hop Exchange and Park Street, constructing a new viaduct over Borough Market, constructing a new bridge over Borough High Street and constructing a new viaduct into London Bridge station. These works include the demolition of:

a. 7 Stoney Street and partial demolition of number 8 Stoney Street,

b. Numbers 2, 3, 4 and 7 Bedale Street,

c. Numbers 1,3 and 5 Green Dragon Court and Numbers 16-26 Borough High Street, and

d. Numbers 11, 13 and 15 Borough High Street and 2 London Bridge Street.

8.2 The scale of the works associated with the replacement buildings is similar in scale and character to many other redevelopment projects in Central London. The noise impacts associated with the construction of each of the replacement buildings will be limited to the adjoining buildings and within the immediate vicinity of each site. The significant impacts reported in ES 2004 will occur mainly as a result of the construction of the new viaducts and bridges. The scale of the construction impacts reported in ES 2004 is not materially different from that reported in 1999.

8.3 Mitigation of construction noise and vibration effects is discussed in section 3 above. Contractors must apply for 'prior consent' and the application will set out the steps that will be used to minimise construction noise.

9.0 CONCLUSIONS

9.1 The Thameslink 2000 project team has developed a comprehensive set of project specific policies, procedures and systems to mitigate noise and vibration impacts during construction and operation of the scheme. The *Thameslink 2000 Noise and Vibration policy* [CD/169 Appendix G] aims to avoid significant construction and operational noise and vibration effects wherever this is reasonably practicable.

9.2 Contractors must obtain 'prior consent' from the local authority under Section 61 of the Control of Pollution Act for all the construction works to be carried out in London. The application for 'prior consent' must set out the steps proposed to be taken to minimise noise.

9.3 At Farringdon, the potential for cumulative construction noise impacts would be limited to the buildings in the vicinity of both Crossrail's Western Ticket Hall (Cardinal House) Worksite and the Thameslink 2000 works – that is, those buildings on Farringdon Road and Cowcross Street. The application for 'prior consent' can provide an assessment of the noise impacts resulting from both projects and the steps that will be used to coordinate the two projects to minimise any potential cumulative effects. The two parties (Network Rail and Crossrail) will offer noise insulation or temporary housing to eligible buildings in line with the respective policies in the event that the cumulative noise and vibration levels, resulting from the two projects, exceed the eligibility thresholds.

9.4 There is no change in circumstances with respect to noise and vibration in the Borough Market area but the London Bridge Tower which is located to the east of the Borough High Street area has been granted planning permission since the first inquiry. Significant cumulative adverse effects could occur at New London Bridge House and Guy's Hospital, on the façade facing St. Thomas' Street, in the event that the two projects proceeded simultaneously at this location. This assessment assumes that the affected parts of the hospital are used at night. A detailed evaluation is in hand to determine whether the affected parts of the hospital are used at night and to assess the noise impacts inside the building. The noise impacts

associated with the construction of each of the replacement buildings will be limited to the adjoining buildings and within the immediate vicinity of each site.

9.5 There will be no significant increase in noise levels in the vicinity of Blackfriars Station as a result of the Thameslink 2000 proposals. A comprehensive set of noise measurements was taken in each of the buildings where a significant noise effect was predicted in ES2004. Detailed evaluations of noise impacts inside commercial buildings have shown that no residual operational noise impacts are predicted at any of the commercial buildings in the vicinity of Blackfriars Station. The overall reduction in train noise, resulting from minimising flange contact noise and joint noise, will offset the predicted noise impacts at the Blackfriar Public House and Quadrant House so that no residual operational noise impacts will occur. A significant benefit is now predicted at Falcon Point as a result of the reduction in flange contact noise and joint noise.

9.6 A draft planning condition has been agreed with LB Southwark and the Corporation of London that will effectively limit and control noise from the PA system such that there is no significant effect.

9.7 ES2004 reports significant construction noise and vibration impacts at several commercial and residential buildings in the vicinity of Blackfriars Station. It is expected that the residential parts of the Blackfriar Public House will be eligible for the noise insulation package and an undertaking has already been given to the residents of Falcon Point to insulate the building and provide supplementary ventilation before the construction works start. Specific mitigation measures, in addition to those assumed in the assessment, are likely to reduce the scale and duration of the noise impacts reported in the ES2004.

10.0 GLOSSARY

Ambient Noise	Totally encompassing sound in a given situation over a given time period, measured as an Equivalent Continuous Sound Level.
CRN	Calculation of Railway Noise (1995). Published by Department of Transport. ISBN: 0 11 551754 5
CWR	Continuously Welded Rail. A type of track which is constructed so that the joints between adjacent sections of rail are welded to form a continuous running surface.
dB(A)	Human hearing is not equally sensitive to all frequencies. The A-weighting therefore attenuates low frequencies, which are less readily detectable by humans and, to a lesser extent, high frequencies (i.e. > 4kHz) which also require progressively higher sound levels for detection by the human hearing system as the frequency is raised.
eVDV	Estimated vibration dose value. Where a measurement over the full period of exposure to vibration is not possible an approximation of the total dose is given using eVDV. BS6472:1992 outlines the procedure for calculating eVDV values.
L_{Aeq}	Equivalent Continuous Sound Level. The $L_{Aeq, T}$ is the notional steady sound which, at a given position and over a defined period of time, T, has the same A-weighted acoustic energy as the actual fluctuating sound.
L_{Amax}	The A-weighted rms maximum noise level for a single event.

$L_{Amax, s}$	The A-weighted rms maximum noise level for a single event using a 'Slow' response setting.
SEL	Sound Exposure Level. The level at a reception point which, if maintained constant for a period of 1 second, would cause the same A-weighted sound energy to be received as is actually received from a given noise event.
SPL	Sound Pressure Level. Ten times the common logarithm of the ratio of the square of sound pressure under consideration to the square of the standard reference pressure of 2×10^{-5} Pascals.
VDV	Vibration Dose Value. Vibration Dose Values may be used to assess the severity of impulsive and intermittent vibration. Where possible the Vibration Dose Value should be determined from a measurement obtained over the full period of exposure to vibration.
Airborne	For the purposes of this report, airborne noise is defined as that mainly generated by the train and the interaction of the wheel and the railhead. The route of sound propagation is through the air.
Groundborne Noise	Vibration generated by trains in tunnels and transmitted to the receiver through the intervening ground and then re-radiated as sound inside the building.
Crest Factor	The crest factor of an event is determined by dividing the weighted peak acceleration by the weighted rms acceleration over the full period of the event concerned.
Residual Noise	The measured ambient noise level excluding all train passbys.

Structure	For the purposes of this report, structure radiated noise is defined as that
Radiated Noise	mainly generated by the excitation of and subsequent radiation via structural elements (viaducts and other supporting structures). The route of sound propagation is through the air
TOC	Train Operating Company