PUBLIC SESSION

MINUTES OF ORAL EVIDENCE

taken before

HIGH SPEED RAIL COMMITTEE

On the

HIGH SPEED RAIL (LONDON – WEST MIDLANDS) BILL

Tuesday 21 July 2015 (Afternoon)

In Committee Room 5

PRESENT:

Mr Robert Syms (Chair)
Sir Peter Bottomley
Mr Henry Bellingham
Geoffrey Clifton-Brown
Mr David Crausby
Mr Mark Hendrick

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IN ATTENDANCE

Mr Timothy Mould QC, Lead Counsel, Department for Transport
Mr James Strachan QC, Counsel, Department for Transport
Mr Malcolm Griffiths, The Residents Environmental Protection Association
Ms Hilary Wharf, The Residents Environmental Protection Association

Witnesses:

Mr Tim Smart, International Director for High Speed Rail, CH2M Hill
Mr Peter Miller, Head of Environment and Planning, HS2 Ltd

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IN PUBLIC SESSION

INDEX

(At 14.00)

1. CHAIR: Order, order. Welcome back to the HS2 Select Committee. We have Mr Smart as a witness. Mr Strachan?

The Residents Environmental Protection Association (Cont'd)

2. MR STRACHAN QC (DfT): Thank you. We were just looking at costings of tunnels. Mr Smart, could you just look at 1238(47) of the petitioner's slides? I just want to show the Committee what the Promoter has done in terms of the costings and what Mr Craig has done. If one looks at page 47, you see that Mr Craig says he referred to the 2012 Appendix A rates for the calculation of his costs. That document is actually provided and it's at A1260(5). I'm afraid we just need to go there very briefly. You'll need to enlarge it as it's virtually illegible. If we just go to the heading 'Tunnels', you can see that this is in 2012 a general costing given for tunnels. A single-bored 9.8 metre internal diameter is at a rate of £66,300.

3. MR SMART: Correct.

4. MR STRACHAN QC (DfT): Then for a twin bore 7.25 metre internal diameter, a range from £32,400 up to £61,600.

5. MR SMART: Correct.

6. MR STRACHAN QC (DfT): It is not entirely clear what figure Mr Craig has used, but clearly the twin bore 7.25 metre would have to be factored up in any event to cover the tunnels here.

7. MR SMART: It would.

8. MR STRACHAN QC (DfT): Just to remind the Committee, the internal diameter of these bores –

9. MR SMART: 8.8 metres.

10. MR STRACHAN QC (DfT): We're told that where you use in the range would depend upon the length.

11. MR SMART: That's right.

12. SIR PETER BOTTOMLEY: It goes down with length?

13. MR SMART: Depending on how you view the information from the British Tunnelling Society, because there's some evidence of that, but there's other things that can push it up, as I think I was saying before the break. So it's very much you have to put that into the context of the ground, the machine –

14. MR STRACHAN QC (DfT): I was going to ask about the machine. As far as I'm aware – but you tell me – these Appendix A rates in 2012 weren't considering the differences between the types of machines that would be used for the different types of tunnels along the route.

15. MR SMART: They'd be looking at just general tunnelling. This was a report that was done for risk assessment and cost analysis for, if you like, getting an overall understanding of the risk. So this was before we even looked at the size of our tunnel and what particular ground conditions that we'd be in and the number of vent shafts and all those things. So this was a very early report.

16. SIR PETER BOTTOMLEY: You may not be the person to answer this, but in the 'Single bore' line above, where it goes from £45,000 to £66,000, do you have any idea why?

17. MR SMART: I didn't have an input into that, but I would suggest that that is to some extent a reflection of the increased diameter.

18. SIR PETER BOTTOMLEY: The point is that it is going from a previous rate to a current rate.

19. MR SMART: I think that's to do with uprating the indices in terms of what the rate was when it was done and then uprating it to a modern or to our current cost basis. Sorry, Sir Peter, I had misunderstood.

20. MR STRACHAN QC (DfT): Just to be clear, Mr Smart, the detailed costs that have been provided to REPA and the ones that we've looked at in the tables, do they cost the tunnels based upon the details of what's going to happen and the type of machine, or have they used Appendix A rates of these type from 2012?

21. MR SMART: Sorry? Are you referring to our costs or REPA's?

22. MR STRACHAN QC (DfT): Yes, our costs estimates.

23. MR SMART: No, our costs are based on what we believe to be the actual costs of the particular circumstances we're facing on the tunnel.

24. MR STRACHAN QC (DfT): Thank you. So that's Appendix A. If we can go back then to A1238(49). This is Mr Craig's slide 2. The figure he took for the costs of the route was £42,500 per route metre – that's at the bottom – so that's the Appendix A figure which we've just looked at.

25. MR SMART: Yes.

26. MR STRACHAN QC (DfT): I'm not quite sure how it was worked out from the range, but that's the figure he arrived at. The tunnelling guide he has given in the red would equate to £66,200 per route metre.

27. MR SMART: Yes.

28. MR STRACHAN QC (DfT): For the purposes of his comparators, he took four tunnels. Three of them are for CTRL and with outside diameters of 8.1 metres. They are to be factored up for the outside diameters. He got to the figure of £36,100 for three of them and £52,400 for another.

29. MR SMART: Yes.

30. MR STRACHAN QC (DfT): I asked him about this in terms of equivalent comparative tunnels for costs. You may recall this.

31. MR SMART: Yes.

32. MR STRACHAN QC (DfT): Are any of the comparators he has provided – UK1, UK3 and UK4 – equivalent in terms of the tunnelling conditions and the tunnel machines that are proposed for this route of tunnel?

33. MR STRACHAN QC (DfT): No, they're the EPB not in chalk, so they're relevant to tunnelling rates in general but not to the specific application of a slurry machine in chalk.

34. MR STRACHAN QC (DfT): P7535(13). I do not know if we need to get it up. It was that document that we had to turn on its side. We did have a 'UK Tunnel 2' cost comparator for a slurry machine in chalk on CTRL. It came out at a figure, I think I did the mathematics, of £95,000 per route metre.

35. MR SMART: Yes.

36. MR BELLINGHAM: Can we have a look, please?

37. MR STRACHAN QC (DfT): Yes, certainly. It's P7535(13). We may need to rotate it again. Thank you very much. It's the second one down. Unfortunately, as we zoom in we lose some of it, but we can see the fourth column along is the only comparator, which is a slurry machine, or at least one identified as a slurry machine.

38. SIR PETER BOTTOMLEY: In the UK.

39. MR STRACHAN QC (DfT): Sorry, the only UK slurry. There are some EU ones, which are different. It's moving four columns along. The ground conditions are chalk and we are told that it's pre-cast concrete and then we have the tunnel length of 8.15 kilometres. Moving across further, the exercise we did was to take the £38,954,234, convert it into metres and, as it is a single bore, you have to double it. First of all you have to factor it up for the right diameter tunnel we've got. To cut a long story short, that came to approximately £95,000 per route metre.

40. MR SMART: Yes.

41. MR STRACHAN QC (DfT): Just sticking with that figure, that reflects the slurry machine. I think Mr Craig suggested that there might be some cut and cover as part of that exercise.

42. MR SMART: That's right.

43. MR STRACHAN QC (DfT): If that had been the case, would that have –?

44. MR SMART: It is the case, in that as you come out of the Thames tunnel you go into a section of about 300 metres of cut and cover tunnel on each side and then on to a ramp and then on to the trace. The length that has been identified in this table is five kilometres, which actually is the amount that was the bored tunnel. It was a

2.5 kilometre drive and, times two, that gives you five kilometres. There's no doubt that the columns refer to a bored section of 2.5 kilometres. Mr Craig has said 'Well, it includes a cut and cover section and that would come out in the total cost of the scheme', so the question would be whether that – I believe, I'm finding it hard to read – £165 million there's an element of cut and cover in there. We would have to confirm that with the original compilers of these figures, and we can do that, but I would suggest that as that cut and cover section is only 300 metres on each side that, even if it were the case, it would pull down that figure. I haven't done the maths, but it would be reduced slightly but would still be a higher rate than has been given on the table.

45. MR STRACHAN QC (DfT): Mr Smart, you're obviously an experienced tunneller. Can I just ask you to step back a moment and answer this question? Does that costs comparison with a slurry EBM going through chalk, yielding a much higher cost, surprise you bearing in mind what's going on under the ground?

46. MR SMART: No.

47. MR STRACHAN QC (DfT): Thank you. If we go back to A2138(49) – there are a number of figures just to keep in mind here, but I'm going to try and do it without getting too many documents up – we have a rate of somewhere in the region of £95,000 per route metre from the UK2 tunnel comparator.

48. MR SMART: Yes.

49. MR STRACHAN QC (DfT): The HS2 example tunnel is £66,200 per route metre.

50. MR SMART: That's been derived by REPA, yes, but that guide was a seven-kilometre tunnel, I believe, in the example.

51. MR STRACHAN QC (DfT): As an example, the Chair asked about the 1.5 kilometre extension from the C6 exit at the green tunnel to the C5 REPA proposal. It's a 1.5 kilometre extension.

52. MR SMART: Yes.

53. MR STRACHAN QC (DfT): I think the calculation comes out at about £53,000

per route metre.

54. MR SMART: Yes. You're referring to the cost table that is at the back of the letter that we sent?

55. MR STRACHAN QC (DfT): Exactly.

56. MR SMART: It comes out at about that, I believe – we can go to it if we need the precise figure – but that of course does include the shafts etc, which are common to both schemes. So just the bored rate, if you take out the shaft, would be somewhere in the order of, I'd imagine, £44,000 per metre – is the rate that we've used in that comparison.

57. MR STRACHAN QC (DfT): Whether it's £44,000 or £50,000 or £55,000, what I really want you to comment on, Mr Smart, is whether you consider that cost for that length of extension to be in the right order bearing in mind the tunnel costs and the comparators you've seen.

58. MR SMART: Absolutely. Yes.

59. SIR PETER BOTTOMLEY: If we're thinking of a possible extension from Mantle's Wood to the west end of the green tunnel, or alternatively going off the green tunnel to where REPA suggests they would come out, do you need one shaft or two shafts?

60. MR SMART: One.

61. SIR PETER BOTTOMLEY: Just one. Whichever you do you only need one?

62. MR SMART: Whichever you do, you have one.

63. MR STRACHAN QC (DfT): I think the indicative location for that shaft remains the same in both options that are being considered.

64. SIR PETER BOTTOMLEY: In terms of what we might think of imprecisely as 'the extension', you don't need an extra shaft for that?

65. MR SMART: No.

66. MR STRACHAN QC (DfT): Mr Smart, I was going to just therefore take, I hope

relatively quickly, A1238(51). Mr Craig has sought to apply an 80 per cent figure to the cost of the tunnel to reflect the fact that once you've bought the machines, going a little bit further doesn't cost you the same per metre as the initial part of the tunnel so he's applied an 80 per cent/20 per cent split for a marginal cost rate. I think that's what he's done.

67. MR SMART: Yes, that's what he's done.

68. MR STRACHAN QC (DfT): If one were to apply such an 80 per cent figure to either of the comparator figures we've looked at – the £95,000 or £66,000 – are you getting a significantly different figure to that which we're calculating?

69. MR SMART: Well, you would, I think, because I don't necessarily disagree with what Mr Craig has on his slides. I think what that is sort of saying is that all the fixed costs of the tunnelling are completely borne by the original scheme and therefore any costs of the machine don't get carried through to the extension is what he's saying – not just the machine, of course there's backup and other things.

70. MR STRACHAN QC (DfT): Thank you. Can I just then ask you to move away from tunnelling costs to fit-out rates? We looked at this with Mr Ring, I think. For these purposes, if we can look at A1238(31). The nature of the dispute, just so that we can have it clear in our minds, Mr Smart, can be seen from the schedule. Column A is our tunnel boring rate of 80 metres per week in the light green and then some fit-out time for the fit-out of the tunnels once they're bored.

71. MR SMART: Yes.

72. MR STRACHAN QC (DfT): Mr Ring and the petitioners say: 'Well, you can achieve a faster fit-out rate to stay within the critical time path for the tunnels'. That's effectively it.

73. MR SMART: Yes, I don't disagree with that. We can achieve a faster fit-out rate. The fit-out rate that we've assumed is not just about the Chilterns tunnel. Indeed, it's about all of the tunnels that we need to fit out from a railhead which needs to be on our trace, which happens to be at West Ruislip, so we have 'optimised', if you like, the fit-out in relation to the programme and it is therefore an efficient rate which we start

with. Now, that's not to say that we cannot improve on that and indeed that is what we would do in the event of a longer tunnel in order to mitigate the time. Although we can't, if you like, mitigate the actual length of the bore, which will come at the rate that the machine is doing at the time, we can mitigate the effect on the programme through the fit-out.

74. MR STRACHAN QC (DfT): Can I just try and correlate that with the costs. If we go to P7530, this again is our letter setting out the variable costs and we're looking for these purposes really at Option C5, you can see that we've got rates for boring the tunnels. We've got the civil engineering in the orange and then we have 'Extended preliminaries' and a figure at the bottom of £8.53 million. In a footnote – you can see option notes down at the bottom – what we are identifying is Options 1 and 5: 'Assume 12-month longer tunnel programme'.

75. MR SMART: Yes.

76. MR STRACHAN QC (DfT): So far as I can see, the only element of cost related to the extended programme is the extended preliminaries: the £8.53 million.

77. MR SMART: Yes.

78. MR STRACHAN QC (DfT): We haven't added on the consequential costs of extending the programme in other respect in these costs comparators.

79. MR SMART: No. It's just the cost of the extension of the contract, if you like, and no other benefits from if there was a delay to the project as a whole.

80. MR STRACHAN QC (DfT): If you were to speed up the process in fit-out, as you've indicated, what would be the effect on the costs of doing that to the project?

81. MR SMART: Well, our view is it would be more. What you have there with the extended preliminaries is, if you like, the costs of suffering a delay and, because that would actually knock through to the critical path and ultimately the operation of the railway, we would have to mitigate some of that. We have to mitigate two to three months of that. The costs would come, we believe, higher than the rate of the extended preliminaries; not massively more. We calculate in the order of £10 to £15 million probably to accelerate, as opposed to the £8 million plus that we've

got in there of extended preliminaries.

82. MR STRACHAN QC (DfT): All right. So for the figures at the bottom, the adjusted net total of £76.44 million and even for, say, Option C6, which assumed a nine-month programme delay – You would remove extended preliminaries and you would add in some additional costs for speeding up the fit-out, but you would get the delivery of the tunnel within the programme but at additional cost?

83. MR SMART: That's correct.

84. MR STRACHAN QC (DfT): Thank you. Can I then just pick up on one or two other things that were raised? I think there was an issue raised – we can stick with this slide – about excavation costs. If you could just go up the page, please, you will see here that under 'Civil engineering' there is a figure for cuttings and, if we go across to Option C5, you can see a minus £33 million figure.

85. MR SMART: That's correct.

86. MR STRACHAN QC (DfT): If you go up the page, you can see for portals a minus £10.38 million figure.

87. MR SMART: Correct.

88. MR STRACHAN QC (DfT): In the letter which accompanied this, it was explained to the petitioner that the portal element was part of effectively an excavation cost.

89. MR SMART: Yes.

90. MR STRACHAN QC (DfT): So portals are common to both Option C5 and to the original scheme. You still need a portal whether it comes out at Mantle's Wood or at Option C5.

91. MR SMART: Yes.

92. MR STRACHAN QC (DfT): There's a minus £10.38 million saving in respect of excavation around the Mantle's Wood portal and you add that to the minus £33 million in the other parts of the cutting, so it's a total of minus £43.38 million.

93. MR SMART: Yes, correct.

94. MR STRACHAN QC (DfT): Minus £43 million.

95. MR BELLINGHAM: Is that figure realistic?

96. MR SMART: Yes, it is. Based on the level of design we have, yes.

97. MR STRACHAN QC (DfT): Can we just compare that very briefly with what the petitioners have done on their costs? On A1238(63), they have a different figure for the cuttings. For the cuttings they have calculated it at minus £53.8 million, but they've still included a minus £10.4 million figure for the portals. Do you see what I mean?

98. MR SMART: Yes.

99. MR STRACHAN QC (DfT): So they've taken excavations from the portals and double-counted it in for the cuttings as well?

100. MR SMART: That's right.

101. MR STRACHAN QC (DfT): So if one takes off the £10.4 million that they've included for the portal – because of course there would be a portal for both schemes – you find there's a difference between us of minus £33 million versus minus £43 million.

102. MR SMART: That's right.

103. MR STRACHAN QC (DfT): That appears to relate to a difference in approach as to how you cost excavating certain amounts of material, which is the point that was raised by Mr Bridger, I think it was.

104. MR SMART: Yes.

105. MR STRACHAN QC (DfT): If you look at his slide A1238(57), he has sought to get to a figure of 16.3 cubic metres attributable to the cost of avoided excavation, but he's only used the £33.3 million rather than the £43.7 million figure that we've just been through.

106. MR SMART: That's correct.

107. MR STRACHAN QC (DfT): So it would give a higher rate. If you actually use the true amounts that are in our schedules, it comes to about £22 per cubic metre.

108. MR SMART: That's correct.

109. MR STRACHAN QC (DfT): Fine. Taking that figure, I think Mr Bridger's point was that SPONS gives a higher rate for excavation than the £22 per cubic metre which has gone into our calculations. Can I just get you to respond to that, Mr Smart, as to how we go about our calculations and whether they are robust and realistic?

110. MR SMART: Yes. SPONS is a well-established industry standard. It's a 'look-up table', if you like, for establishing costs. It's more applicable to smaller scale projects. For a project the size of High Speed 2, I would not say it's the most applicable way of looking at it. What I think it does do, which I think is on Mr Bridger's slide, is it does actually demonstrate that there are different rates for different levels of cutting, and in fact we assume that that 22 metres is an average rate, but also it assumes a different type of plant, I think – backactors, etc – than we would have. We would generally have bigger plant. I suppose, most importantly, it doesn't really take account of location, the volume, procurement method and the type of plant we actually have and the construction methods. So it could only be that as a very high level guide, whereas we've done the pricing on what we believe to be the construction methodology that will be employed.

111. MR STRACHAN QC (DfT): Thank you. I'm not going to go through it, but can I just draw attention to a letter which accompanies that costs schedule, which is available at P7529(1). I don't think it's necessary to go to it. A lot of these things were set out in more detail. Finally then, Mr Smart, can we just come back to A1238(63), which is the aide-mémoire or a version of it? Sorry, this isn't the aide-mémoire. This is the costs dispute. Just dealing with the items which you have covered, you can see first of all that the bored tunnels is £181 million – our costs – versus £102.7 million. You've explained to the Committee how you arrive at your figure. Which do you see as the realistic figure to use for these purposes?

112. MR SMART: I believe it to be our figure because it's on the actual methodology that we're going to employ.

113. MR STRACHAN QC (DfT): We've covered cuttings and our minus £33 million is actually minus £43 million if you add in the portals, versus the minus £53 million which we've just looked at. There is a figure of minus £10.5 million for bridges and we've got minus £7.9 million. There's a difference between us of minus £2.6 million. I'm not sure how consequential that is. It comes under the heading of 'Underbridges'. Can you just explain to the Committee what that is?

114. MR SMART: It's not a very good way of describing it, because I think what the petitioner said about underbridges was correct, but that is almost a redistribution of preliminaries. It's almost a method of accounting. The costs engineers would be able to give the detail. But it's a question of adjusting preliminaries and it comes out in that way. I'd have to refer back to more detailed costings to give you more precise information, but what I can say is I don't disagree with what the petitioners said in terms of the underbridge; it's just a question of how that's portrayed in costs.

115. SIR PETER BOTTOMLEY: So preliminaries is not a major part of delay to the rest of the project?

116. MR SMART: Essentially.

117. MR STRACHAN QC (DfT): The other figure is the extended preliminaries of £8.5 million, which we've discussed. You would eliminate extended preliminaries if you reduce the programme, but you say that you would add to the cost by reaching that extension?

118. MR SMART: Yes, by accelerating. Effectively, yes.

119. MR STRACHAN QC (DfT): Can you just help the Committee with indirect costs? That's an £18 million figure there and the petitioners have disputed it.

120. MR SMART: We have had this before and it is the amount that we add to include for design – there's still more to design – project management, HS2 client costs and indeed value engineering, because we would expect to be able to reduce some of the costs when we get into the detailed design of achieving a more efficient design. So there's a whole basket of things which add up to that indirect cost that we add to the overall capital cost of the construction.

121. SIR PETER BOTTOMLEY: We've got 'ECP'. Can you remind us what 'ECP' stands for?

122. MR SMART: Yes, that's the efficiency challenge. In other words, Sir Peter, because of the scale of High Speed 2 we would expect to achieve, if you like, a more efficient way of working than you might get on a one-off, piecemeal job, so we have an overlaying, if you like. It's almost like having a golf handicap before you start to do the construction.

123. SIR PETER BOTTOMLEY: The 'P'?

124. MR SMART: It's 'efficiency challenge project', I think it might be, or 'programme'. 'Programme' perhaps might be the right term.

125. MR STRACHAN QC (DfT): Thank you. Mr Smart, I don't think you need to go through them, but just in answer to the Chair's original question, at P7530 there are the costings between C5 and C6. Those break it down between bored tunnels and then civil engineerings. There are one or two differences of course as one moves further west in terms of bridges, for example, and we can see that reflected. I'll just give an example. If we look at 'Overbridges', on C5 it's a minus £7.88 million saving and on C6 it's minus £4.02 million because there are one or two – I think there are two – overbridges which are still retained in the –

126. MR SMART: Less extensive works, yes. I can't give you a precise figure on how many bridges. I can check. Yes, there is more, if you like, surface infrastructure that would be retained.

127. MR STRACHAN QC (DfT): There are less extensive works at Leather Lane where the portal would come out at Option C5 because it's a larger structure, but there's still an overbridge, but these are reflected in the costing comparisons that are under 'Civil engineering'. Is that right, Mr Smart?

128. MR SMART: That's right, yes.

129. MR STRACHAN QC (DfT): Sorry for the detail, but I think that's all that I have for Mr Smart.

130. CHAIR: Mr Griffiths?

131. MR GRIFFITHS: Mr Smart, we didn't receive your submission until after we put ours in. If we could go in our pack to the second of the graph slides that shows the plot of the chalk tunnels.

132. MR STRACHAN QC (DfT): Slide 7522.

133. MR GRIFFITHS: The graphs. Bear with me.

134. MR BELLINGHAM: Is this on the screen as well?

135. MR GRIFFITHS: It's going to come up on the screen. It's slide 39. Yes, I think until we got the pack yesterday we didn't understand the extent to which you were depending really on the Beckton Lee tunnel for your assumptions. Could we distribute a little bit of information on that tunnel that we'd like to bring?

136. MR SMART: Before you do that, can I say that's just the most recent example. We also take account, as you saw in my slide, of all the other recent slurry/chalk projects that have been done so it's not just that one. But continue, yes.

137. MR GRIFFITHS: No, but is it fair to say – and it may well not be – that all of them are on this slide?

138. MR SMART: Well, it's your slide so I can't be totally –

139. MR GRIFFITHS: Well, you've got the two Crossrail and the CTRL. They're the short, mostly Thames, crossing tunnels basically. I think that's the database that you're dealing with and I pick the Beckton Lee because it's the longest.

140. MR SMART: Okay.

141. SIR PETER BOTTOMLEY: Are you trying to give something out?

142. MS WHARF: Yes.

143. SIR PETER BOTTOMLEY: If you are, just do it.

144. MR GRIFFITHS: There's three pages in the back.

145. SIR PETER BOTTOMLEY: Give Mr Smart one first. He probably needs it more than anybody else.

146. MR GRIFFITHS: Mr Smart, I'm going to take them in the order of the Lee tunnel and shaft schematic, then the paper that was done that got the Harding Prize dealing with the problems and issues on the tunnel, and then the rates graph. So you're using the tunnel as a comparator tunnel. If we can start with the schematic, would you be able to give the Select Committee a review of what was involved in this tunnel and, in particular, its depth, the water pressures that were being dealt with and also the access inasmuch as it was shaft-only access?

147. MR SMART: Yes, it was – Well, I mean all of that – You've just given this to me so what I can confirm is the diameter, which we've already said. It is shaft access, but it's going through one shaft. It's of a diameter slightly smaller than ours and it is in groundwater. In fact I would have to check, but I believe it might even be close to some of the Abbey Mill aquifers.

148. MR GRIFFITHS: I think the depth of the tunnel, based on the paper that you provided to us as a reference, is 140 metres. Can you just say how that would compare in terms of the impact of water and the pressures of water to the Chilterns tunnel?

149. MR SMART: That's what you have to control with the phased pressure and the slurry machine. In my view, that would actually act to actively slow down progress.

150. MR GRIFFITHS: Thank you. If I can go now to the second little handout, which is a paper that was done dealing with the issues associated with the tunnel. It got the Harding Prize. It's by David Clayton. In picking Beckton Lee as a comparator tunnel, are you aware of this paper?

151. MR SMART: The Harding Prize?

152. MR GRIFFITHS: Sorry?

153. MR SMART: The Harding Prize?

154. MR GRIFFITHS: No, that there was a paper that was prepared on this.

155. MR SMART: I'm not intimately aware of it, but I'm aware of a number of

papers. But continue, yes.

156. MR GRIFFITHS: Okay. Well, if I can briefly say, this paper deals with the issues of what was realised was going to be a very difficult going through a shaft and it deals with all of the issues they had to deal with because of the high pressure and particular problems associated with that. My question to you is, in using this as a comparator, have you taken that out of the number?

157. MR SMART: What? The Beckton?

158. MR GRIFFITHS: For the Beckton Lee, have you taken it out of –?

159. MR SMART: No, we've included that analysis to come up with 80 metres.

160. MR GRIFFITHS: So all of the seen problems associated with that shaft are included in the 80 metres?

161. MR SMART: Yes.

162. MR GRIFFITHS: Okay. In terms of shaft entry, the paper that you've referred us to explains the difficulties that they had and that they had to sort of lower the boring machine through the shaft and the difficulties with all the rest of the equipment and explained that they were going to take the beginning of the tunnel in a particularly slow fashion. Have you taken that into account in coming up with your 80 metres?

163. MR SMART: Well, we've taken it into account in terms of looking at the average rates they achieve when they're boring and it's in the hard average. Every drive has its own, if you like, predications and predilections in terms of what one encounters, how one launches the machine, problems with the ground, and if you just take one drive in isolation then one can point to all sorts of things, but what we're looking at is an applicable rate in chalk and with a slurry machine.

164. If I can take you to your own slide, which is A1259(48), you've highlighted that there is 85 metres per week and indeed above that we see – here we are – the Plumstead/Woolwich drive, which is the one we've highlighted for Crossrail, and you can see a hard average of 76 metres by your own figures in the REPA report and, yes, there's one at 92 metres. So all this is really highlighting is that there is a variation in

tunnel rates, which we've already tried to explain, depending on a number of parameters. What we have is the prudent rate based on the information that we have about the ground conditions and the issues we're going to encounter, which I will reiterate. We've heard about the Misbourne. We've heard about the aquifers. We've got poor ground when we start at the M25, where we know that there's a potential for solutions – hollows, and we may even have to do some pre-grouting – and so, taking all of these things into account, we end up with the rate that we have.

165. MR GRIFFITHS: Thank you. Can we go to page 40 in the petitioner's slides? It's the Channel Tunnel slides. I'd then like to come back and discuss the last Beckton Lee slide. Is this typically what you would expect to see from a tunnel drive, where it starts a little bit slower and then may, as you have said, deal with some issues, as they had to there, but then as the drive goes on they get to a more uniform and higher rate?

166. MR SMART: Well, they do, but I would highlight that at the moment, as we speak, there is a tunnelling machine in Seattle in North America which is stuck because the bearing shaft has gone. So yes, they can, but there are also problems with the machines' drive shafts and other issues. So it is typical, but one has to account for the fact that there can be problems with machines and they need maintenance. I also would add – I stand by what I said earlier – that these were not necessarily slurry machines and therefore they add to and inform the overall picture of tunnel rates in ground conditions generally, but I come back to the point that a 13.4 kilometre drive from one end is pretty unprecedented in the UK – in fact probably, to my knowledge, is unprecedented in the UK. There are therefore advantages in perhaps going for a longer drive in terms of efficiencies and the crew, but you have to balance that with the fact that you are pushing the machine hard, it's going a long way and you can get issues with machines breaking down – as I've just highlighted, there is one as we speak – and indeed needing more extensive maintenance. Some of the downtimes on CTRL were in excess of a month to do maintenance.

167. MR GRIFFITHS: Thank you. But I think my point is that if one were to do a two or three kilometre tunnel versus a 10 to 15 kilometre tunnel, given the learning curve and all of the effects at the front, would you expect the shorter tunnel to have higher average rates?

168. MR SMART: It depends on the ground conditions, but certainly by a couple of kilometres. I don't really think that the crew are going to get much better, in terms of they've been tunnelling for – So when you get to the longer end, I would say factors such as intermediate pumping stations for the slurry, factors like when you have to get out in emergencies, where you have self-rescuers that you can only use for 20 minutes and therefore you have to have intermediate safety stations – this is one of many – getting to the face at 15 kilometres per hour in a man-rider, all of these things mean that there's a counterpart, if you like, to these efficiencies and I think that any efficiency that you'll get will come at the sort of first end of the drive; I can't be precise, but probably after the first couple of kilometres. As you go on from that, other factors become relevant and I've gone through some of those in terms of machine wear and the amount of logistics you have to handle, that you've got to pump air, you've got to bring the bentonite back, you've got more recycling distances. All of these things become relevant. So I think all we have to do is take all of that and balance it up.

169. MR GRIFFITHS: Finally on the Beckton Lee tunnel, back to the third slide. Rodney has found for us the actual rates for that tunnel. As I've mentioned, there was the difficulty in putting everything down the shaft to get started and to go towards the intermediate shaft and, as you can see from this graph, that is a very slow rate. From that intermediate shaft to the end is, I think, about 5.7 kilometres and you can see that from there the rate has improved quite considerably. I think the average is about 110 metres per week.

170. MR SMART: I don't think so. Can I go back to your exhibit A1259(48)? If you see here, 'Overall average: 85 metres per week', that's the figure. I don't think it's too dissimilar to that shown on our slide. I've already acknowledged that I can't verify these high rates that you've just put in front of me at 785 etc, but based on what I understand I don't disagree with the figure you've got there. It's a fact that we've taken account of. I have already said in my evidence that that tunnel did achieve much, much higher rates during its drive, and I don't necessarily deny that there are higher rates, but you've got to come back to the hard average with all the other factors built in.

171. MR GRIFFITHS: I think the REPA report explains that that is the average for the total, including that understood slow part at the beginning and the crossing of a particularly difficult shaft, so the higher rates that I was referring to is, as they came out

of that shaft, a year's worth of boring produced about 110 metres. The issue we're dealing with here is what you would expect to be the incremental rate if they were to have gone another two or three kilometres. I wonder whether you think it would revert to the average or whether it would continue to go at those higher rates.

172. MR SMART: Well, if it did go faster at the end then it would have to have also gone faster elsewhere to appreciably change the average rate. As I've already said, what we start with is a prudent rate based on the relevant information and we would hope to achieve to go faster, but what we can't do at this stage is plan that we can, when all the evidence of these sorts of machines in this sort of material would point to a rate that is of the order that we have.

173. MR GRIFFITHS: This is my final question on this because I'm trying people's patience. I can feel it. When you say there's lots of evidence, in terms of your comparators, is there anything other than these short Thames crossing tunnels and the Beckton Lee tunnel?

174. MR SMART: Around the world there is evidence, for example in Kuala Lumpur, where they've just completed the Metro which is in karst limestone, so not directly applicable, where there is a lot lower rate because they have mixed density shields. So if one wants to do a complete trawl around the world then there may actually be something that is more relevant, but certainly we've taken account of the UK slurry drives in chalk. That is what we are in. We've heard all the problems that we could encounter with that from Dr Bailey, who told us there were problems with flint etc and that our rates would not be what they are, so there's been a number of arguments from the petitioners saying that our rates should be slower and we wouldn't achieve what we would get. You're saying it's faster. The fact of the matter is we have to balance that all up and come up with what we believe to be the prudent rate and that's what we've done.

175. At our meeting on the 26th, the tunnelling expert that attended that meeting indicated that there was consideration to go up to a higher rate, I think 90 metres, within HS2 Limited. Is that right? Have you thought about putting the rate up?

176. MR SMART: Absolutely. Clearly we would like to achieve a higher rate, of course, but we will be able to reassess that. I remind you of what I said earlier. We do not have the bespoke geotechnical investigation for this drive. We've based this at the

moment on what is published rates, although we haven't got any from the public archive which does include a lot of bore holes. When we get our geotechnical information and get better ground information we might be able to reassess that rate, but where we sit today that would not be a wise decision.

177. MR GRIFFITHS: Okay. Thank you. Moving on, can we talk about the portal and a £10 million saving by moving the portal from Mantle's Wood to Leather Lane and you saying that that impacts the quantities. The portal is about 200 metres long. I'm sure you have to do an excavation bigger than that.

178. MR SMART: Yes.

179. MR GRIFFITHS: Can you tell us how much material that actually involves; just an indication? It's a very small percentage of the total cutting length, yet it's attributing 30 per cent of the cost.

180. MR SMART: Off the top of my head I can't carry all the facts and figures about every particular number. We can certainly clarify that. It's not just a cutting for the portal. You've got to remember that for these longer tunnels you have to have a head-house and you have to have 500 square metres of hard-standing. It's about how you enclose the necessary M&E parts and equipment that you require. It isn't just a simple calculation of saying 'Oh, it's a slope of 1 in 2.5, 1 in 2' or whatever at its depth, so I'd have to clarify that for you. What I can say is that for the scheme that we have proposed, which is the shorter tunnel extension to the end of approximately the south-east portal, we would actually come up in a slightly deeper cutting at one end, but we would come up and that would be slightly balanced by the other –

181. MR GRIFFITHS: Basically, Leather Lane would be, other things aside, a better place to have a portal than in Mantle's Wood, with the fractured chalk and all of the issues there presumably. Mr Smart, I'm wondering, and I'm asking, would a portal at Leather Lane be. It's £10 million cheaper so given the choice, other things aside, you would presumably rather be doing the portal at Leather Lane.

182. MR SMART: No, not necessarily because it's not quite as simple as that. You've got to look at levels and where we are. What we've said is that the costs are based on continuing to tunnel where we are on surface and therefore you get less of an impact in

terms of what you're mitigating by the tunnel as you go forward. At Leather Lane, we'd have to look also at mitigation of works because we have a portal there and that would have to be dealt with in terms of environmental mitigation. So it's not quite as simple as 'Would we rather have it?' It's a question of valuing the job as a whole and siting what you have to do around the portal for mitigation and everything else.

183. MR GRIFFITHS: Okay. Can we go to the cuttings? Can we go to the slide that's in Part 4 for C5, please? It's the same costs schedule.

184. MR STRACHAN QC (DfT): P7530.

185. MR GRIFFITHS: Thank you. As before, we'll need to get it a bit bigger, I think. You've got money in for cuttings. There's nothing in for embankments. I think on the materials we are more or less agreed that there's about 2 million cubic metres less material in the REPA scheme being excavated and presumably that's being deposited somewhere in an embankment or off the trace somewhere. Would we not expect to see some saving within the embankments?

186. MR SMART: Well, what you're talking about is the mass haul. In AP2 of course what we use is the material that comes out. We would try and use it in earthworks and mitigation to the north of this area. I'm not sure, and I'm actually not too clear, on what you're asking. Clearly if there's embankment that we're not having then we would have costed that.

187. MR GRIFFITHS: If you look at this particular area, from Mantle's Wood portal through to the viaduct, your original scheme had a material balance, which is absolutely normal. You can't take the material out one way or another. So that was in absolute balance and everything else was in absolute balance because that's why you launched the Environmental Statement and everything sort of makes sense. You're now reducing by two million cubic metres the amount that you excavate. There's no reason for that to go anywhere else and yet you haven't put any money in for wherever it does go.

188. MR SMART: Well, that's included in, if you like, our rate that we've already said. We went through the £22 per metre cube because we're hauling material anyway so we would have to take that and use that in mitigation to the north and that's included in the rate for how we've effectively valued the cutting. So that's where you get the

benefit of that, if you like.

189. MR GRIFFITHS: But you don't need any material up in the north.

190. MR SMART: No, but we do to the north of the trace out of this area, up towards Wendover and beyond, where we've got mitigation earthworks etc, and we would reuse good fill in those mitigation earthworks.

191. MR GRIFFITHS: Mr Smart, you had a balance system at the time that you went into the ES that involved putting –

192. MR SMART: Well, we didn't. We didn't have balance. It depends where you are balancing it over. We didn't have complete balance along this area. We actually had some sustainable placement at Hunt's Green. If you call that 'balance' then maybe that's what you're saying, but what we're saying now is that, whilst we were looking at having a sustainable placement at Hunt's Green Farm, we will now not use that as a sustainable placement via the mass haul 'redistribution', if you like, of what we're doing along the mass haul bearing in mind there have been a number of changes that have come out of AP2. You can't just look at this particular section of the route. This goes down the whole mass haul. So we will now use Hunt's Green, if I may use the term, as a place to 'regulate' where we hold fill and take it straight to mitigation earthworks to the north. Whether we hang on to the rate of progress depends on how much material we would need to use Hunt's Green for, but I don't think you can look at it as just taking A to B. You have to look at the whole mass haul along a more general area and about where we would take material to. You're correct that we would aim of course to try and balance it as best we can within the local area, but that isn't always practical.

193. MR GRIFFITHS: So the £22 rate is for excavating, basically storing it, taking it up the trace and building embankments. That includes everything for a cubic metre?

194. MR SMART: Not building embankment. It means taking material to a place of deposit and then the reuse of that will be in the other – It means taking it somewhere we can use it.

195. MR GRIFFITHS: Okay. But you actually have embankments within this section. It's not just cutting volumes. You're building on your scheme embankments within the

south-east area regardless of Hunt's Green and you've given no credit for not having to build those now.

196. MR SMART: Are you saying that we wouldn't have –? Well, we'd have to look at where you're saying we've got embankment that we now don't need because we are actually replacing the cutting.

197. MR STRACHAN QC (DfT): I don't want to interrupt, but if it assists there is a minus £3 million figure for earthworks/landscaping. It may be that what Mr Griffiths is referring to is an embankment, treating it as part of the earthworks.

198. MR GRIFFITHS: Yes.

199. MR STRACHAN QC (DfT): There are savings in respect of the C5 option in terms of earthworks that would otherwise occur, but they are reflected in the costs calculations we've got here at minus £3 million.

200. MR GRIFFITHS: What I was referring to was 300,000 cubic feet of materials that are placed as embankments and in the scheme to not have Hunt's Green it's intended that further embankments be placed there. So that's what I was referring to, but thank you.

201. MR STRACHAN QC (DfT): I don't know what other ones you're referring to.

202. MS WHARF: Could I just go back to Appendix A, which I'm afraid I have in our document and I believe you have it in yours.

203. MR STRACHAN QC (DfT): Appendix A?

204. MS WHARF: Sorry. It's in the cost and risk report. We have it in our A1259.

205. MR STRACHAN QC (DfT): It's A1260(5).

206. MS WHARF: I'll only be brief. Could we just go back to that row again, which is the twin bored 7.25 metre internal diameter? Looking at the figures, what the scale of those figures are, could we just look to see what they are in terms of the size and the range, where it says: 'Range dependent on length'?

207. MR SMART: Yes. This report was done as part of a cost and risk exercise in

terms of, if you like, looking at probabilistic analysis based on the original estimates. This was before we had designed our tunnels and before we'd sized our tunnels. This was a very early piece of work which just gives indicative type rates. What that does bear out of course is that there are higher rates per metre.

208. MS WHARF: One particular aspect is that, yes, the date of this report was early on. However, we had our meetings with HS2 Limited and we were told that obviously in the beginning this was what was used, but of course the decision to reject anything else other than coming out at Mantle's Wood was actually made in January 2012.

209. MR SMART: Yes.

210. MS WHARF: So presumably when that decision was made, you were actually using these figures.

211. MR SMART: No, because this report might have been published in 2012, but these were based on early work, looking at, if you like, the range of costs for an overall costs estimate. Once we'd got into the slightly more detailed design that is necessitated by the hybrid Bill, which looks more closely at the spatial arrangement and tunnel sizing etc, we were able to come up with a better cost. It's just a question of more detail. So I don't actually see quite how you can relate directly back to that. It is of relevance and is indicative, but what we're doing is doing a costing on what we see in terms of the amount of detail that we have and we do it on a more precise level.

212. MS WHARF: But the decision was made in January 2012 to say where the tunnel was going to come out, so the costing of looking at all the alternatives in the draft ES and the ES – the earlier versions of that – and when the decision was made where it was coming out – There weren't any other figures.

213. MR SMART: Yes, and what you have here is a range, so when you feed that into some sort of probability analysis it would give you a range of costs depending on where you are.

214. MS WHARF: So this range, was it based on any actual tunnels?

215. MR SMART: Well, those figures are based on actual tunnels and when that was done I'd have to check because I was not party to the detail of this work.

216. MS WHARF: So perhaps then, just remembering these figures of £32,000 to £61,000 as being the range, almost doubling, could we then go to slide 50 and the British Tunnelling Society unit cost graph?

217. MR STRACHAN QC (DfT): Your slide 50?

218. MS WHARF: Yes, our slide 50. Of course we have to double the figures there in order to get them into the same coin. So on the scale up the left-hand side, we've got figures that appear to be £20,000 to £40,000, if you just take the black dot.

219. MR SMART: Yes.

220. MS WHARF: On the right-hand side, they go down much lower. What sort of scale or range is one looking at on that, bearing in mind you're going to be doubling those to get them into the same coin? What is £30,000 on the left-hand scale would be £60,000.

221. MR SMART: I'm sorry? I'm not clear what you're actually asking me.

222. MS WHARF: There's a slope there.

223. MR SMART: That's a range of tunnelling costs per kilometre. It shows a variation of £60,000 to somewhere around the £20,000 and you'd have to look at each. That was a slide that was attempting to demonstrate whether there was any cost reduction that came out of the length of tunnel and that report says there is some evidence to support a tunnel being cheaper as you go over the length, but it said it was slight and it also reported that there was a high degree of scatter. I think you can use it only from a very high level. What we've done is actually cost it on what we know in terms of the machine we're going to use and the length we're going to tunnel. I wouldn't regard that as a robust analysis.

224. MS WHARF: I could go into the statistics, but I won't because there is a difference between just scale effect and actually what is squared and therefore whether something is statistically significant. I'll just do one last thing. If I could just go to our slide 49, which we've seen a few times. There was a suggestion that nobody seemed to know how we'd actually done our calculation. The fact is that we gave three engineering reports and we went in detail how to do it. That slide even has an

asterisk on HS2 Appendix A and I believe it actually says there underneath: 'Adjusted to the 9.06 OD of HS2 Limited example tunnel'. I think in the earlier evidence Rodney actually said exactly how we did that, using the power of 1 to 1.4, and he had advised Mr Weston as to how to do the calculation.

225. MR STRACHAN QC (DfT): Sorry, that's my fault, if I've caused any misunderstanding. I can see what you've done by the adjustment. I'm just looking at the figure, the appendix A has a range from 31 to 62.

226. MS WHARF: Yes. And?

227. MR STRACHAN QC, (DfT): And there's no identification of which −

228. MS WHARF: Right. If in our report −

229. MR STRACHAN QC (DfT): − point in the range you plump for.

230. MS WHARF: In our reports, of which we have done three detailed reports and discussed them, but, had no feedback, of course, from HS2 Ltd., we were extremely disappointed in. We took, and we said we took the lower range, because if that is dependent upon length, you couldn't have a much longer tunnel then the one we're looking at. So took, and we made very clear we took the far end, and we took the marginal rate, 0.8, as we explained on another slide, so, literally, our calculations is no more than 42.5 times 0.8 times the length and that comes up exactly, for people with calculators, it comes up to exactly the figure which is on the aide memoire here.

231. MR SMART: I understand that. As you've already heard, is that when we've actually calculated, on asking, the cost of the tunnelling per metre, we've actually done that, and we don't actually have a massively different rate. This is just showing that you can get a variation of rates depending on what you're doing with the tunnelling graph, and everything else, which I'm now in danger of repeating myself. But, I come back to that point that we have, in terms of cost comparison between, used a similar rate to that as you, but, I think we went through that earlier when we referred to our cost line, when we showed you how we built it up.

232. MS WHARF: I think just the point I'll make is that we're actually very disappointed in the sense that we are here having to talk about these figures, because for

two years had been trying to talk in order to understand it. Because we tried to do the job properly. And, you know, we've found it very difficult when all we get is answers and we haven't been allowed to know the derivation of your figures and you being prepared to go through our figures and to understand where the differences are, because, if you had, we wouldn't be here discussing, actually, these figures.

233. MR SMART: I wasn't part of the discussions. I can only comment that I believe that we had, you obviously don't have that view and I can't really comment any further on that.

234. MS WHARF: Okay. Thank you.

235. CHAIR: Mr Strachan? Is there anything else?

236. MR STRACHAN QC (DfT): No. The latest document you were handing – the Beckton tunnel, Mr Smart, those behind me have confirmed, but, I don't know if you have a view on this, that the averages of 83 metres per week are taken from when the tunnel boring machine was active from July 2012 to December 2013, excluding the time it took to set up the tunnel boring machine through the shaft. So, this is boring time. Sorry, to use that expression. Boring time, from which there's a hard average derived across the various figures. Does that reflect your understanding?

237. MR SMART: It does. But, I was faced with this committee and I am on record, so, I wouldn't want to say something that I wasn't too sure about, without caveating it, but, what I would say is that it just shows that even with. Yes. It is my understanding.

238. CHAIR: Okay. Thank you. Another witness?

239. MR MOULD QC (DfT): Could I ask Mr Miller briefly to come in, if I may?

240. CHAIR: Thank you, Mr Smart. Good afternoon.

241. MR MOULD QC (DfT): Mr Miller, you gave evidence in response to the Chiltern Councils and their associates on 15 July at paragraphs 133 to 314 of the morning transcript. That sets out the detail of your evidence in relation to the comparative environmental performance of the various options that are being considered by the committee. But just very briefly, if you would, sum up in a few sentences what