Residents' Environmental Protection Association

Proposal for a South Heath Chilterns Tunnel Extension

Contents:

REPA's response to the Environmental Consultation

Summary

REPA is an association of community based groups in the South Heath/Chesham/Amersham area of the Chilterns AONB who are concerned that HS2 Ltd have not correctly assessed (costed and valued) extensions to the proposed Chilterns bored tunnel.

We consider that HS2 Ltd wrongly dismissed a deep tunnel extension to the South Heath area (from HS2 Ltd's proposed end point at Mantles Wood) in 2012 on the basis that it would cost more. REPA are therefore challenging the justification for ending the tunnel at Mantles Wood. We have commissioned and submit an Engineering Report on the South Heath Chilterns Tunnel Extension (SHCTE) that demonstrates it is feasible and would on engineering grounds alone cost some £30m less than HS2 Ltd's proposal. An accompanying Environmental Statement for the SHCTE is also provided.

Our response also raises serious questions about HS2 Ltd's decision taking and transparency of process:

- The community has had to wait until the Draft Environmental Statement (DES) in May 2013 to discover that HS2 Ltd had already costed and rejected such an extension in 2012 – with the Central Chilterns Forum never being informed at the time of the decision.

- A year later, in 2013, HS2 Ltd (Alison Munro) agreed to examine a South Heath extension but failed to say it had already been costed and rejected, and are saying that their examination will not be reported on until the formal ES is laid with the Hybrid bill.

- HS2 Ltd is refusing to provide any report/costs to underpin their 2012 decision that it cost more. Those who are personally impacted by HS2 Ltd's decisions should be entitled to the evidence on which decisions are taken. REPA should not have had to commission a report to challenge HS2 Ltd's decision.

REPA look forward to discussing their report with HS2 Ltd. They believe it demonstrates that the 2012 decision was in error as there is good evidence that extending the tunnel would cost less than HS2 Ltd's latest proposals for these 3.6kms of the AONB – and before even any account is taken of the non engineering costs.

1. Introduction

1.1 Protection of the AONB

The Residents' Environmental Protection Association (REPA) is supported by a number of groups (listed below) in the South Heath, Chesham, Amersham and Great Missenden area as well as many individuals. We are concerned that the current plans for HS2 do not protect the Chilterns Area of Outstanding Natural Beauty (AONB) and the local communities from the environmental destruction that it causes – both in its construction and in perpetuity when it is operating.

In the planning of HS2 seemingly little regard has been paid to its passage through the widest part of an AONB. For example on the basis of the Draft Environmental Statement (DES) it is proposed that:

- HS2 should destroy large parts of three Ancient Woodlands (in the South Heath and Hyde Heath area) rather than follow a transport corridor
- HS2 should climb a steep hill and be on the surface at 180-190m above sea level – the highest point on the route – above the village of Great Missenden, rather than burrow underneath
- HS2 should sever footpaths, eliminate hedgerows and wildlife habitats, rather than avoid them
- HS2 should be routed within 1km of over 500 properties even in the small area from Mantles Wood to Potter Row (see Appendix 2) where people's lives, communities and tranquillity will be devastated bythe impact of HS2 – with a number many times greater affected during its 4-5 year build period.
- HS2 should permanently change the character of this part of the AONB in perpetuity for visitors and residents, rather than protect the landscape and respect its designation as an AONB

How and if HS2 Ltd have balanced the engineering costs of alternative options eg for tunnels with the impacts of HS2 on the environment is not transparent, particularly given they have ascribed no special value to the AONB.

1.2 Countryside and Rights of Way (CRoW) Act 2000

We see no evidence that HS2 Ltd has given serious consideration or weight to their obligations under Countryside and Rights of Way (CRoW) Act 2000. Such obligations require that public bodies such as HS2 Ltd *"have regard to the purpose of conserving and enhancing the natural beauty of the Area of Outstanding Natural Beauty"* (s 85). To cut through the widest part of the AONB and only provide a bored tunnel for 45% of the AONB (emerging in the midst of an ancient woodland) leaving the reminder to be crossed by viaducts, cuttings, green tunnels and embankments is unacceptable.

2. Justification for ending the bored tunnel at Mantles Wood

2.1 Costing tunnel options

We are concerned that a proper analysis with representative and realistic costings of the tunnel options through the Chilterns AONB has not been conducted. This is important for several reasons

- Decisions that devastate the environment should be taken on a credible and transparent basis
- With the figures and reports not released for scrutiny there is no evidence of consistency between decisions taken on one set of proposals with those of another
- People are suffering the effects of property blight with thousands of pounds wiped off the values of their property, and see no sound technical, economic and environmental justification for HS2 Ltd's proposals. The 500 properties within 1km of the line in the South Heath area are collectively likely to have lost well over £50m. The public has a right to the evidence when facing such large and uncompensated losses.

CRAG option

We are fully aware that an extended tunnel option has been developed by the CRAG tunnel group, and is being examined by HS2 Ltd[1], and has been the subject of a recent report by Atkins dated 7 June 2013 (on behalf of HS2 Ltd) with subsequent discussions[2]. These discussions however have been persistently hampered by the lack of both the provision of detailed costings and a transparency of approach.

REPA fully support the CRAG proposal, and believe it is the right solution for the AONB.

South Heath extension

We are also aware that after several requests HS2 Ltd agreed in Spring 2013 to examine and justify the basis of their decision for ending the bored tunnel at Mantles Wood, and not proceeding further (to South Heath). Given the environmental significance of a decision to route a high speed railway straight across the widest part of the AONB and the need for Government to justify its tunnelling decisions this was a very reasonable request.

Eventually a commitment was given by Alison Munro in March 2013 to the Chesham Society[3], who had raised it on behalf of the Central Chilterns Community Forum. This was reiterated to Cheryl Gillan[4] when in April 2013 Alison Munro confirmed in writing that the proposal (to examine extending the tunnel to South Heath) was now

> *"being explored by our engineering teams who will consider the proposal based on a number of factors including cost, technical feasibility and environmental impact.*

However the Draft Environmental Statement (DES) published on 16 May 2013 now unexpectedly reveals[5] that several options (including extending the tunnel from Mantle's Wood to South Heath) had already been examined

[1] As referred to in The Community Forum Report 9, para 2.6.8 page 29
[2] Meeting 25 June 2013 with Atkins/HS2 Ltd/CRAG/Bretts
[3] 6 March 2013 – email from Alison Munro to Jim Conboy of Chesham Society *"Many thanks for your submission, it has been passed to our specialist teams for further consideration who will assess your proposal against a number of factors including cost, technical feasibility and environmental impact*"
[4] In letter of 25 April 2013 from Alison Munro to Cheryl Gillan, MP

and rejected in 2012. This was stated to be on the basis that they incurred additional cost and that HS2 Ltd's preferred option could mitigate the environmental consequences of its proposal:

2.6.5 Subsequently, the Community Forums within the AONB continued to request that the Chiltern tunnel should be extended to pass beneath the entire AONB. Whilst a number of longer tunnel options were considered and discounted prior to the January 2012 announcement additional options were given further consideration at this stage with the objective of reviewing their impacts through the AONB. The scheme announced by HS2 in January 2012 was initially considered along with three further options, defined as:

- *Option A: The HS2 scheme announced in January 2012 (with the tunnel portal at Mantle's Wood);*
- *Option B: The HS2 extended bored tunnel to the northern end of the green tunnel at South Heath;*
- *Option C: The HS2 extended bored tunnel to the north-west of Wendover; and*
- *Option D: The HS2 extended bored tunnel to the north side of Leather Lane.*

Para 2.6.6 then says *"The extended tunnels, Options B to D, all performed well on environmental grounds compared with Option A as they avoided a range of impacts upon environmental receptors."*

Paragraph 2.6.7 concludes *"The Proposed Scheme, Option A would include environmental measures to mitigate the impacts associated with the open sections of the route through the AONB and providing longer tunnel lengths under Options B to D would have incurred additional cost for the project. This was consistent with the work previously undertaken in reviewing longer tunnel options prior to the announcement in January 2012 and so these Options B, C and D were not considered further.*

Neither the report nor the decision that Option B (to South Heath) was rejected on grounds of cost was ever communicated to the Central Chilterns Forum in 2012.

Since learning that the tunnel option had been investigated, costed and rejected, more details were requested:

- By Chesham Society (through Jim Conboy)
- MP for Chesham and Amersham (Cheryl Gillan)
- By FOI 651 (from CRAG tunnel group lead – Barnaby Usborne)
- From Charlotte Brewster (the Central Community Forum contact point), after asking questions at the Great Missenden on 30 May 2013 Roadshow

But no report or figure-work has been provided. HS2 Ltd has responded to requests for the details by claiming this was a "*variation on additional tunnel options considered in previous assessments of tunnelling options"* that they have published [6] – despite this being demonstrably not the case.

HS2 Ltd's response of 26 June 2013 states the additional work on the South Heath option will not be reported on until the formal ES (which is issued with the Hybrid Bill). But this is far too late to allow meaningful discussions.

2.2 Commissioning an Engineering Report on South Heath Chilterns Tunnel Extension (SHCTE)

Local residents have been unable to understand how the decision to end the tunnel at Mantles Wood could be justified on cost grounds. On the face of it extending the tunnel by running the boring machines underground for another 3.6 kms to emerge in the South Heath area where the land first falls away might be expected to be cheaper than the proposed arrangements (for two deep cuttings and a green tunnel). At the very least the detailed costings of that decision should be made available.

We therefore felt we had no alternative but to commission an independent engineering report to understand how the simplest extension can have been regarded by HS2 Ltd as costing more than their current proposals.

This report finds that on engineering grounds such an extension is both feasible and would save money (some £30m) compared to HS2 Ltd's proposals. The report follows in Section II.

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[5] As referred to in The Community Forum Report 9, para 2.6.5 -7 page 28

[6] *''The assessment was thus based on the earlier Arup work relating to alternative tunnel lengths and combinations, previously made available in 'Options for additional tunnelling through the Chilterns', a report to Government by HS2 Ltd".*

Appendix 1 shows in broad terms the area which relates to a South Heath Chilterns Tunnel Extension (SHCTE). The detailed plan and profile of SHCTE is in the Engineering Report in Section II of REPA's response.

2.3 Support for REPA proposals

In addition to the groups that are part of REPA, other groups have backed these proposals:

The **Woodland Trust** are keen to protect every ancient woodland that is fragmented by HS2 and three of the 33 ancient woodlands affected by Phase 1 of HS2 are saved by this proposal. The Woodland Trust have said

> *"The Woodland Trust is keen to work with others to protect irreplaceable ancient woodlands from loss or damage. The Woodland Trust recognises the benefits of proposals for tunnels in several sections of the HS2 route, and fully supports proposals that satisfy all of the following three criteria:*
> *1) No ancient woodland is lost or damaged during construction;*
> *2) The tunnel heads are at least 100m away from any ancient woodland and appropriately buffered from the woodland;*
> *3) The vents or affiliated infrastructure have no impact upon ancient woodland".*

The South Heath Chilterns Tunnel Extension meets all three of these criteria, as it saves three ancient woods.

The **South Heath Action Group** have said in their response to the DES:

> *"We fully endorse the local initiative for a longer bored tunnel that goes under South Heath. The DES informs us that such options were considered but rejected by HS2 Ltd in 2012. As this was never made known to the Community Forum, it shows total disregard for the environment and contempt for the Community Forum engagement process.*
>
> *The proposal from REPA to extend the Tunnel from Mantles Wood to the northern side of South Heath where the land starts to fall away would clearly have significant environmental benefits for the community of South Heath by avoiding the extensive construction works for the green tunnel, the loss of ancient woodland and the devastation to the landscape in the immediate area.*
>
> *It is unacceptable that REPA had to commission its own report to demonstrate the feasibility and cost of the proposal. Clearly if it is feasible and actually cheaper than the current proposal on engineering grounds alone then it must be incorporated in HS2 Ltd's plans."*

3. Response to the Draft Environmental Statement Consultation

REPA's response to the DES is made up of:

- REPA's concerns with the present proposals and the unjustified dismissal of the tunnel option
- The Engineering Report on the South Heath Chiltern Tunnel Extension (SHCTE)
- An Environmental Statement for the SHCTE

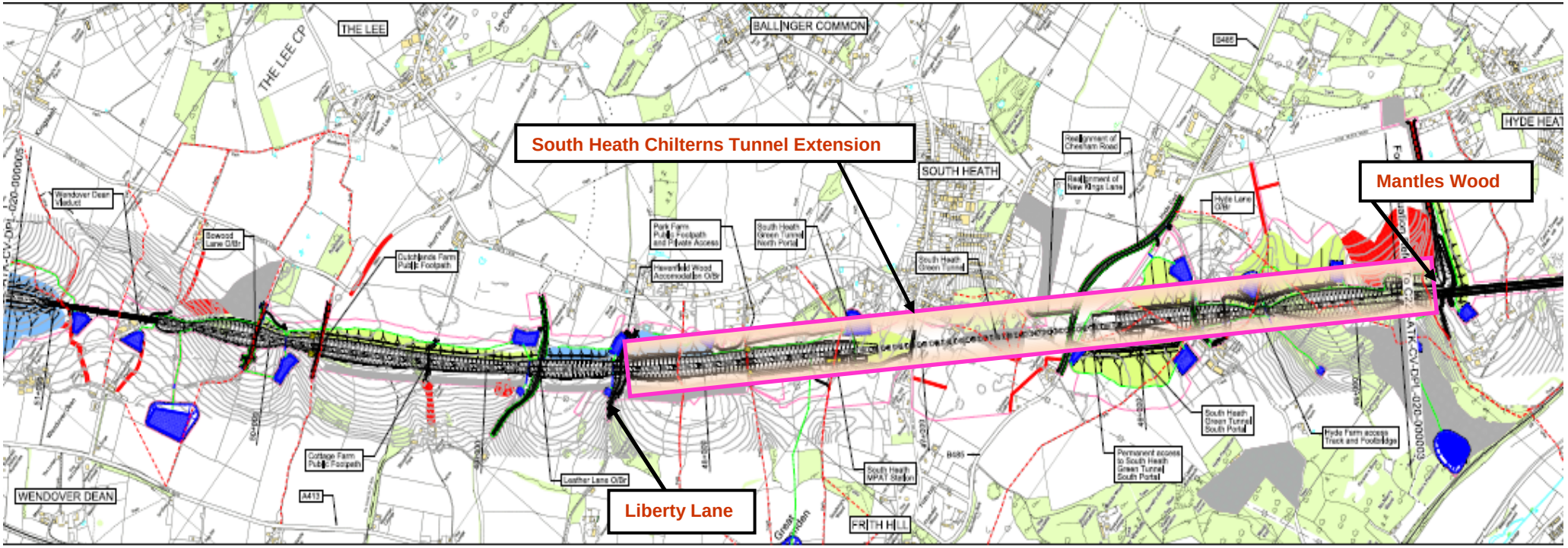
A meeting to discuss the proposal has been requested but no response has been given.

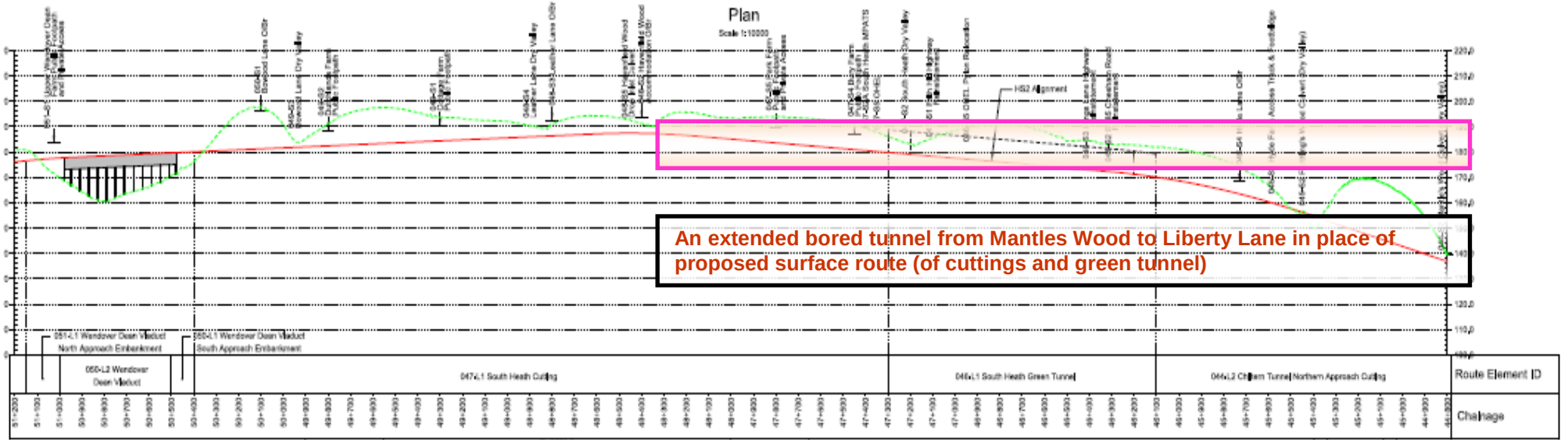
REPA members and supporters

Amersham A G (including Re-vitalisation Group)
Amersham and District Residents' Association (ADRA)
Chesham Society
Ballinger Road Residents' Association
Barn Management UK (2) Ltd (Cudson Court)
Grimms Dyke (Liberty) Estates Ltd
Lappetts Lane Neighbourhood Watch Scheme
Marriots Avenue Group
Potter Row Neighbourhood Watch Scheme
Sibley's Rise Residents' Group
Wood Lane Residents Association

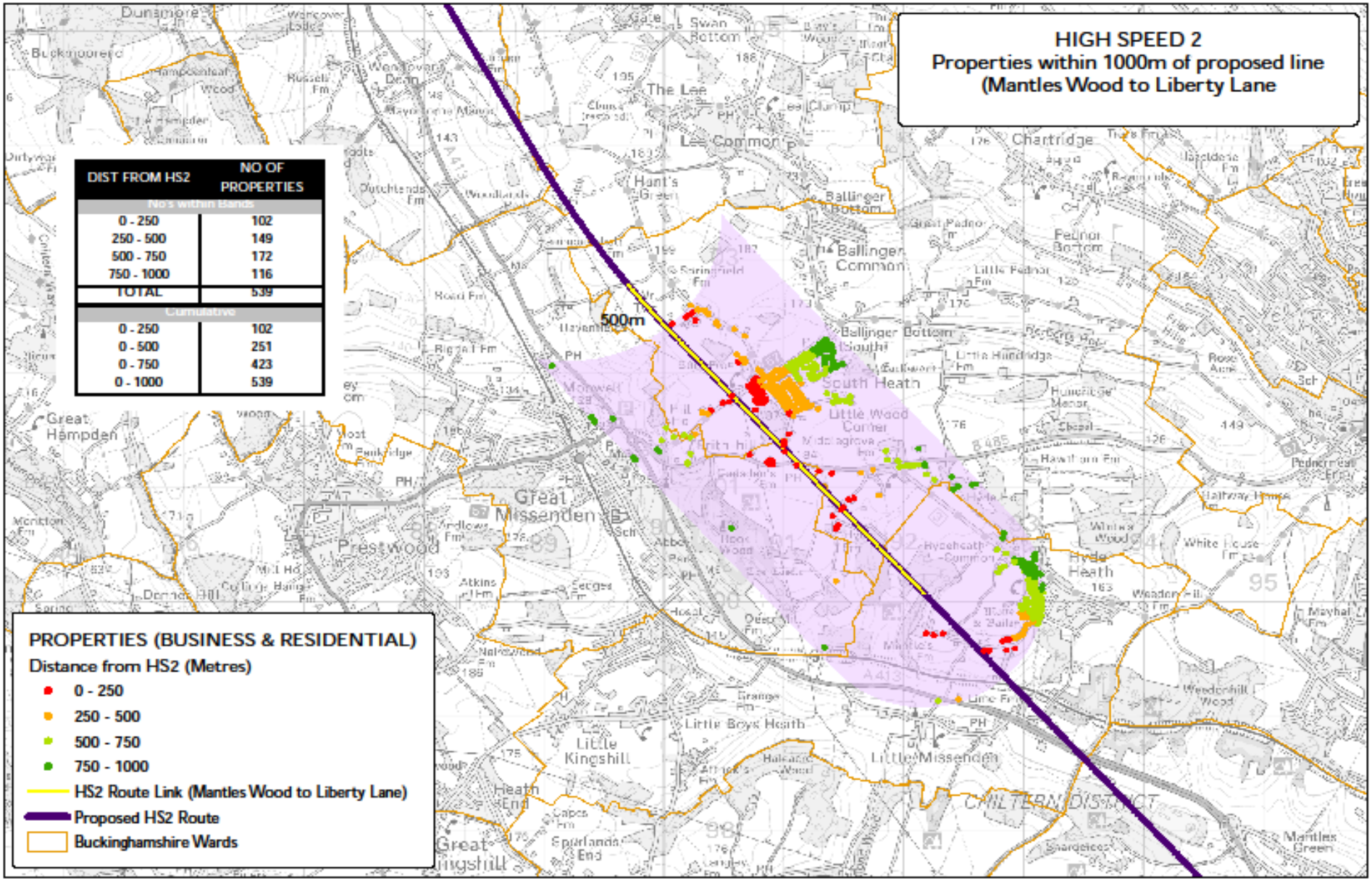
Appendix 1: Area covered by South Heath tunnel extension

Orange amendments by REPA, July 2013





Appendix 2: Location and number of properties within 1km radius of South Heath tunnel extension



Engineering Report on South Heath Chilterns Tunnel Extension

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10 July 2013

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Engineering Report on South Heath Chiltern Tunnel Extension (SHCTE)

1. Background

HS2 Ltd's proposals involve the Chiltern bored tunnel ending at Mantles Wood. The Central Chilterns Community Forum questioned why the bored tunnel is not planned to continue further to a suitable place beyond the end of the proposed South Heath green tunnel. Besides having considerable environmental benefits, it would seem to have no net engineering cost.

HS2 Ltd agreed to investigate this option, in correspondence between both the Chesham Society[7] and with Cheryl Gillan[8] MP in 2013. However, the Draft Environmental Assessment[9] states that the option of extending to the north end of South Heath and to Leather Lane had already been examined and rejected on cost grounds in 2012.

None of HS2 Ltd's work or findings on this option had been disclosed to the Community Forum, nor has it been forthcoming as a result of subsequent correspondence. HS2 Ltd assert that this matter was taken account of in their published tunnel reports that look at other options, but this is not evident. This inconsistency has yet to be resolved by local groups.

One local group – the Residents' Environmental Protection Association (REPA) whilst accepting that the only way to safeguard the Chilterns is to tunnel to Wendover – decided to commission an Engineering Report on the option, on both the technical issues and costs, with a view to establishing whether it would be likely to give rise to extra engineering costs or not.

The remit from REPA was to

- Examine the vertical alignment of the proposal to extend the bored tunnel from Mantles Wood to South Heath emerging at a natural point where the land falls away
- Provide estimates of the costs of the SHCTE proposal in comparison with HS2 Ltd's preferred proposal (for a green tunnel and cuttings)
- Set out the main environmental consequences of a SHCTE compared to HS2 Ltd's proposal. These would be balanced against any resultant net cost of SHCTE

This report sets out the findings. The work done by Atkins for HS2 Ltd on the longer tunnel options by CRAG (T1 and T2) has been used. The Atkins work has either been used directly to derive cost data or as a source of standards that the tunnel requires, or as a cross check on cost data that has otherwise been sourced from HS2 Ltd (in their HS2 Cost and Risk Model Report 2012) or Spon's Civil Engineering and Highway Works Price Book 2013..

2. Outline of proposal

Under HS2 Ltd's current proposal

- The line enters a 13.5km deep bored tunnel from inside the M25 and exits through a portal in Mantles Wood at Chainage 44.700.
- It then goes through a deep cutting for 1,560 metres before entering a 1,070 cut and cover ('green') tunnel around South Heath.
- Thereafter it continues in a cutting of variable depth until the viaduct at Durham Farm, Wendover Dean.

[7] Letter of 4 March 2013 from Chesham Society and response from Alison Munro of same day
[8] Letter of 25 April 2013 from Alison Munro, HS2 ltd to Cheryl Gillan, MP for Chesham and Amersham
[9] Page 28 of Central Chilterns Forum (Report 9) – option (b) to South Heath, and Option (d) to Leather Lane

Both the deep cutting from Mantles Wood and the green tunnel around South Heath are expensive to construct and will cause immense environmental damage in an Area of Outstanding Natural Beauty (AONB) both while being constructed and when built. The deep cutting will generate large quantities of spoil which would either need to be moved off site or be re-used in obtrusive structures and the cutting will irretrievably damage ancient woodland, as will the green tunnel.

Four roads will be cut by the cutting and green tunnel causing considerable disruption during construction and requiring new bridges or permanent diversions. Houses will need to be demolished and many more will be blighted. Footpaths will be severed. The currently protected landscape will be irreversibly damaged. There will be the physical impacts of noise, air quality, light pollution and obtrusive structures in an area of exceptional landscapes and tranquillity, currently accessed via a network of country lanes, quiet roads and footpaths.

All this could be avoided by the Tunnel Boring Machines (TBMs) continuing from Mantles Wood (44.700) another 3.63km (including the portal) to Liberty Lane at chainage 48.330 (approx). Under this proposal

- The continuous bored tunnel would be 17.1kms long, which is shorter than the 20kms limit beyond which special safety measures must be considered
- The vertical alignment would be some 20 metres lower where the line passes under Mantles Wood and Hedgemore Wood. This is necessary to ensure sufficient cover for the tunnels.
- The bored tunnel would continue upwards to pass 20 metres under the low point at 47.250 near Frith Hill exiting at a portal at 48.330 (at Liberty Lane)
- The line would then pass through a partially retained cutting until 49.330 where it would join the vertical alignment of the current HS2 Ltd proposed approach (at Cottage Farm footpath).

An additional vent would be required. This could be in the field behind Annie Baileys (at 46.000), with access to the Chesham Road. To comply with the 3km intervals, the vent should be at 46.000, but when discussed at a recent meeting on the CRAG tunnel proposals[10] it was suggested moving the vent 100m (to 46.100) would unlikely to be an issue. This would protect the dwellings on Hyde Lane.

Access to the portal could be along a new road next to Liberty Lane, northward to Potter Row. The TBMs would be removed along this more direct route to the A413 – as Leather Lane is considered too steep for this heavy traffic.

It might be possible to combine the compound for the portal works with the compound that is required for the adjacent works at Leather Lane under HS2 Ltd's proposal, reducing costs and disturbance.

The engineering drawing by Peter Brett Associates (PBA) is at Appendix 1. It shows the plan and profile of the SHCTE proposal and in comparison to HS2 Ltd's preferred proposal. PBA have used the standards applied by Atkins in their adjustments to the CRAG tunnel proposals (and uses the Atkins map). SCHTE's vertical alignment is similar to the southern part of the CRAG proposal that has the break at Durham Farm, (T2), as adjusted by Atkins.

3. Benefits of SHTCE compared with the current HS2 Ltd proposal

There are substantial environmental benefits to the SCHTE proposal:

- Protects a further 3.63 km (20%) of the AONB on the route, and the amenity of the landscape, the character of the roads and footpaths for residents and visitors in perpetuity
- Deep cutting from Mantles Wood to Chesham Road is avoided
- Access to and construction of portal easier, with a shorter access on more level ground
- No need for a green tunnel around the community of South Heath (or its portals and access).
- Road diversions to Hyde Lane, Chesham Road, Kings Road and Frith Hill unnecessary.

[10] At a meeting of 25 June 2013 between Atkins/HS2 Ltd/Brett and the Crag Tunnel Group on their T1 and T2 proposals.

- Saves three ancient woods – Mantles Wood, Farthings Wood and Sibley's Coppice– this constitutes 10% of all the ancient woodlands being fragmented or destroyed by Phase 1.
- During construction avoids noise, dust, waste light, etc for residents of Hyde Heath, Hyde End, Cudsden Court, South Heath and most of Potter Row.
- During construction benefits users of the Great Missenden/Chesham Road, and users of local access to Great Missenden for residents of Hyde Heath, Hyde End, South Heath, Ballinger, Potter Row and Pednor
- Lowers the alignment of the route from the new tunnel portal (at 48.330) for one kilometre (to 49,330), and materially (over 3 metres) for 0.5km, reducing visual and noise impacts particularly towards the tunnel end (and hence benefits residents of Potter Row)
- Avoids light pollution for the 3.63km section
- Avoids noise impacts from the open cuttings and the two portals
- Saves changing 10 footpaths [11]
- Saves a number of houses from destruction, over 500 houses from being blighted by being within 1km of the HS2 Ltd proposal for this 3.63km section, and the loss of the local amenities of the gym and pub/restaurant.
- Avoids the need for 11 balancing ponds that are out of character in the Chilterns ridges.
- Reduces land take and compensation payments.
- Avoids the building of unsightly embankments of unused spoil and tree planting.

4. Disbenefits of SHTCE compared with the current HS2 Ltd proposal

- A 19.6 metre separation of lines coming out of the bored tunnel will result in an increased land take towards Bowood Lane. This is taken account of in the costings.
- Continuing the bore from Mantles Wood to Liberty Lane (chainage 48.330) would add about 1 year to the time, as it would take an additional 36 weeks to complete the bored tunnel at the expected incremental tunnelling rates (100m/week).

Appendix 5 discusses what impact the additional tunnelling and fitting out for rail systems that is needed might have on the overall completion of the project. It suggests that because there is a gap in HS2 Ltd's programme (of about one year) and it seems that fitting out the bored tunnel is planned to be done entirely from one end, it is practicable to do the additional tunnelling without prejudice to the overall timing of the project.

5. Comparison of the Engineering Costs

The table below examines the costs on several bases, using available data. It uses

- Average built up cost figures (Columns 3 and 4)
- Marginal cost (for deep bore tunnel) figures – a high and low end figure (column 5 to 8)
- Man-year figures using data from the DES (column 9)

Spreadsheets with the itemised costings are available but a summary is provided at Appendix 4.

Particular points on the costs are:

[11] From north to south these are: GMI/12/1 to Park Farm; GMI/2/1 from Great Missenden to Potter Row; GM1/13/3 from Great Missenden to Potter Row; GM1/80/1 eastern part of Sibleys Coppice; GM1/79/1 next to GM1/28/1; GM1/28/1 easterly edge of Sibleys Coppice; GM1/33/4 between Chesham road and GM1/33/3 footpath; GM1/33/3 between Chesham road and Chapel Farm; GM1/27/1 westerly edge of Hedgemoor; GMI/23/7 easterly edge of Hedgemoor and Farthings Wood; GM1/21/1 in Mantles Wood

- This report finds that the marginal bored tunnel costs are the appropriate basis on which to assess extending a bored tunnel. The reasons are discussed in Section 6 and at Appendices 2 and 3. But other bases are included ie the average built up cost figures and a simple man-years sense check.
- All figures are base costs only – as stated in the HS2 Ltd source and in the Atkins material.
- Various cross checks are also done on the data using the Atkins data provided as part of the meetings on the CRAG proposals
- The costs assume the cost of the portal, access and associated facilities are the same for Mantles Wood and Liberty Lane. In practice it may be cheaper at 'Liberty Lane', due to easier access.

Table 1: Analysis of costs (see Appendix 4 for more detail)

All costs are base costs only		**Average cost built up**		**Marginal bored costs high end**		**low end**		**Man-years**
	distance	cost/m	cost £m	cost/m	cost £m	cost/m	cost £m	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Additional costs								
Bored tunnel Mantles Wood to Liberty Lane	3,630	£42,496	154.3	£28,331	102.8	£18,909	68.6	275
Vent (cost is within bored tunnel)		Incl.		Incl.		Incl.		105
Deep(er) cutting Liberty Lane to Cottage Farm f/path	1,000	£16,694	16.7	£16,694	16.7	£16,694	16.7	
extra cost of wider 1st km			3.0		3.0		3.0	
Total			**173.9**		**122.5**		**88.3**	**380**
Savings on HS2 Ltd proposal								
Cost of cutting Mantles Wood to green tunnel	1,560	£16,863	26.3	£16,863	26.3	£16,863	26.3	
extra cost of wider 1st km			3.0		3.0		3.0	
South Heath green tunnel	1,200	£74,428	89.3	£74,428	89.3	£49,568	59.5	450
South Heath to Liberty Lane cutting	1,000	£13,032	13.0	£13,032	13.0	£13,032	13.0	
Liberty Lane to Cottage Farm footpath cutting	1,000	£7,884	7.9	£7,884	7.9	£7,884	7.9	
Roads, bridges, footpaths etc			14.8		14.8		14.8	
Total			**154.4**		**154.4**		**124.6**	**450**
Net cost of SHCTE			**19.5**		**-31.9**		**-36.2**	**-70**

Notes:

(3) Bored tunnel cost is the low figure (ie £32,400 for a long tunnel) per metre for twin bore tunnels from Appendix A[12] scaled up in proportion to the ratio of the radii to the power 1.4 for Chiltern bored tunnel (8.8m diameters) over the reference data (7.25m diameters), to give £42,496). The increase is less than the ratio of the cross sections, as some of the cost elements increase at less than proportionally to cross section (eg labour)
Cutting costs use same Appendix A for cutting and on site re-use for embankment, volume based on average cutting depth for each of the specific cuttings
Green tunnel cost is built up from digging cutting, structure construction, materials, but removing from site only the volume of spoil of green tunnel itself. Using Appendix A and also Spon's data.

(4) Costs per metre (at 3) are scaled by distance (at 2).
Cost of volume of spoil from wider cutting needed near bored tunnel portal (assumed as extending 1 km) costed as reused for on-site embankment.
Roads, bridges etc costed using Spon's.

(5) calculated as (3) but for bored tunnel takes the marginal cost to be 2/3 average cost in (3). This is similar to the marginal cost figure that can be derived from Atkins tunnel cost (ie £32.2k/m) [13] - but assumes the green tunnel costs the same as marginal costs of a bored one which is unlikely and hence gives a high end figure – see Appendix 2

[12] 'HS2 Costs and Risks Model Report', HS2 Ltd, March 2012
[13] Engineering Review of the Proposal by CRAG for an extended Chilterns Tunnel', 7 June 2013, Atkins, Table 4.8

(6) Calculated as (4) but based on costs per metre from (5)

(7) As (3) but bored tunnel marginal cost calculation (£18.9k/m) is derived from using Atkins tunnel costs for HS2 Ltd tunnel and CRAG T1 tunnel, assuming green tunnel has same cost as average cost per metre of £49.6k/m. See Appendix 3. Green tunnel cost is taken as the £49.6k/m average, to give low end estimate.

(8) Calculated as (4) but based on costs per metre from (7).

(9) Manpower costs in man-years derived from the average manpower and site duration figures given in the various volumes of the DES[14] It is assumed that the tunneling site at the M25 end would continue a year longer, an additional vent would be built and the construction sites at the north and south ends of the South Heath green tunnel would not be needed with the SHCTE. It is assumed the additional vent will have same manpower as the Little Missenden vent (which has the highest manpower requirement of the vents).

6. Discussion

Table 1 on costs indicates that the savings exceed the costs of SHCTE on the basis of marginal costs for extending the bored tunnelling. Appendix 2 discusses the alternative cost bases and suggests that the marginal cost basis is appropriate where it is an extension to a bored tunnel. Appendix 3 gives more detail on using the Atkins cost figures.

HS2 Ltd have refused to disclose detailed costings on the basis that they are commercially sensitive. This is despite it being several years before contracts will be let, and their obvious importance to addressing HS2 Ltd's own environmental responsibilities. As discussed earlier they have also given no figures or even a report to justify their decision in 2012 to reject Option (b). As a consequence several methods are used to estimate the relative cost of extending the bored tunnel against HS2 Ltd's plan, including figures provided in June 2013 by Atkins as part of the latest assessment of the longer CRAG tunnel option.

Bored tunnel marginal costs

This is done on several basis, and provides both a high end (col 5) and a low end (col 7) figure

- The high end figure is done on the basis of engineering judgment as two thirds of the average full cost built up figure (from HS2 Ltd source data) giving £28.3k/m (as shown in Table 1 col 5). This is cross checked by using Atkins figures that – which give a similar result (£32.2k) as a high end figure
- The low end figure is derived from using the Atkins figures, making more realistic assumptions

From Atkins costings (discussed at Appendix 2 and 3) the **average total** cost for the Chiltern tunnels is **£49.6k/m**, – as an average of 13.3km of bored tunnel and two green tunnels adding 2.45km, together with the vents and portals. Atkins give higher average tunnelling costs for both of the CRAG T1 and T2 options, but it is unclear why this is the case and no breakdown has been provided despite requests for this.

The bored tunnel comprises two 8.8m bored tunnels, while the green tunnel is a concrete section installed via surface excavation. It is plausible that the cost per metre of the green tunnels is higher than for the bored tunnel – in any event the marginal cost of extending a bored tunnel will be less than its average cost.

A key issue is how much less the **marginal cost** of the bored tunnel is than the **average whole cost** of the South Heath green tunnel. Appendix 2 uses the Atkins 7 June 2013 figures to estimate the marginal cost of the bored tunnel. From this it derives a range:

- High-end: a marginal cost of the bored tunnel of £32,200/m based on assuming the green tunnel costs are at this same level too – which is unlikely. The marginal cost of the bored tunnel is likely to lower than £32,200/m reflecting that the full cost of the green tunnel is above this level
- Low end: a marginal cost of the bored tunnel of £18,900/m based on the green tunnel costs being the same as the total average cost of the Chiltern tunnels (at £49.6k/m). This is considered more likely.

[14] 'Table 1 Location of construction compound sites' in Draft Environmental Assessment Community Forum Area Report – 9 Central Chilterns , and the same table in Reports 7 – Colne Valley and 8 – The Chalfonts and Amersham.

Tunnel built-up costs

Again the figures have been done from HS2 Ltd source data (col 3) but cross checked using Atkins data.

The built up base costs for the bored tunnel (using the costs from Appendix A of the 2012 Costs and Risks report) are **£42.5k/m**[15] and for the green tunnel **£74.4k/m**. This would give a total cost for the Chilterns tunnels in HS2 Ltd's option of £747.5m – 4.2% lower than the £780.7m given by Atkins and so in close agreement. The marginal cost of the bored tunnel might be expected to be approximately 2/3rd of the average cost for this length of tunnel, which gives a marginal cost of £28.3k/m, (col 5). As noted above, this accords with the high end of the marginal cost implied by Atkins figures, albeit both may be high estimates.

For the marginal bored cost low end calculation (col 7) the Atkins figures have been used and assumed that the costs of the green tunnel are at the same as the total average cost of the Chilterns tunnels (£49.6k/m).

Built-up cuttings costs

The costs for the deep cutting from Mantles Wood to the South Heath green tunnel, and the cutting from the green tunnel to Liberty Lane (in col 3, 5 and 7) have also been built up using the cost figures in Appendix A assuming that all the spoil from cuttings is used locally. This is unlikely to be the most environmentally sympathetic approach, but using the spoil locally is cheapest. It has been assumed that of the spoil generated from surface works only the volume of the concrete box in the green tunnel is taken off site.

Allowance has been made for extra width and depth of the cutting where it comes out at Liberty Lane and at Mantles Wood (under the HS2 Ltd proposal). This is shown separately in Table 1.

It is impossible to tell how Atkins have costed the deep cutting from Mantles Wood to the South Heath green tunnel, or the cutting from the green tunnel to Liberty Lane, and with what result.

Built-up costs for reinstatement of roads etc

Appendix A data and Spon's data have been used for estimating reinstating roads (Frith Hill and Kings Lane over the green tunnel) and footpaths and the bridge over Hyde Lane, that would not now be required. This totals just under £15m. It is unclear from the DES whether most footpaths would be re-instated so this figure may be too low.

Summary

Two bases of marginal cost have been presented for the bored tunnel. One based on engineering judgement, that its costs would be about two thirds of the average cost, the other based on the Atkins tunnel costs with the assumption that the green tunnel has the same cost per km as the average cost for the bored tunnel for HS2 Ltd's proposed tunnel. Both marginal bases show a lower cost for SHCTE (between around £32m and £36m).

It is concluded that the SHCTE would reduce the engineering cost is further supported by the information that HS2 Ltd provided on manpower requirements for constructing the green tunnel, the bored tunnel and vents in the Draft Environmental Statement. The SHCTE appears to require 15% less labour to construct.

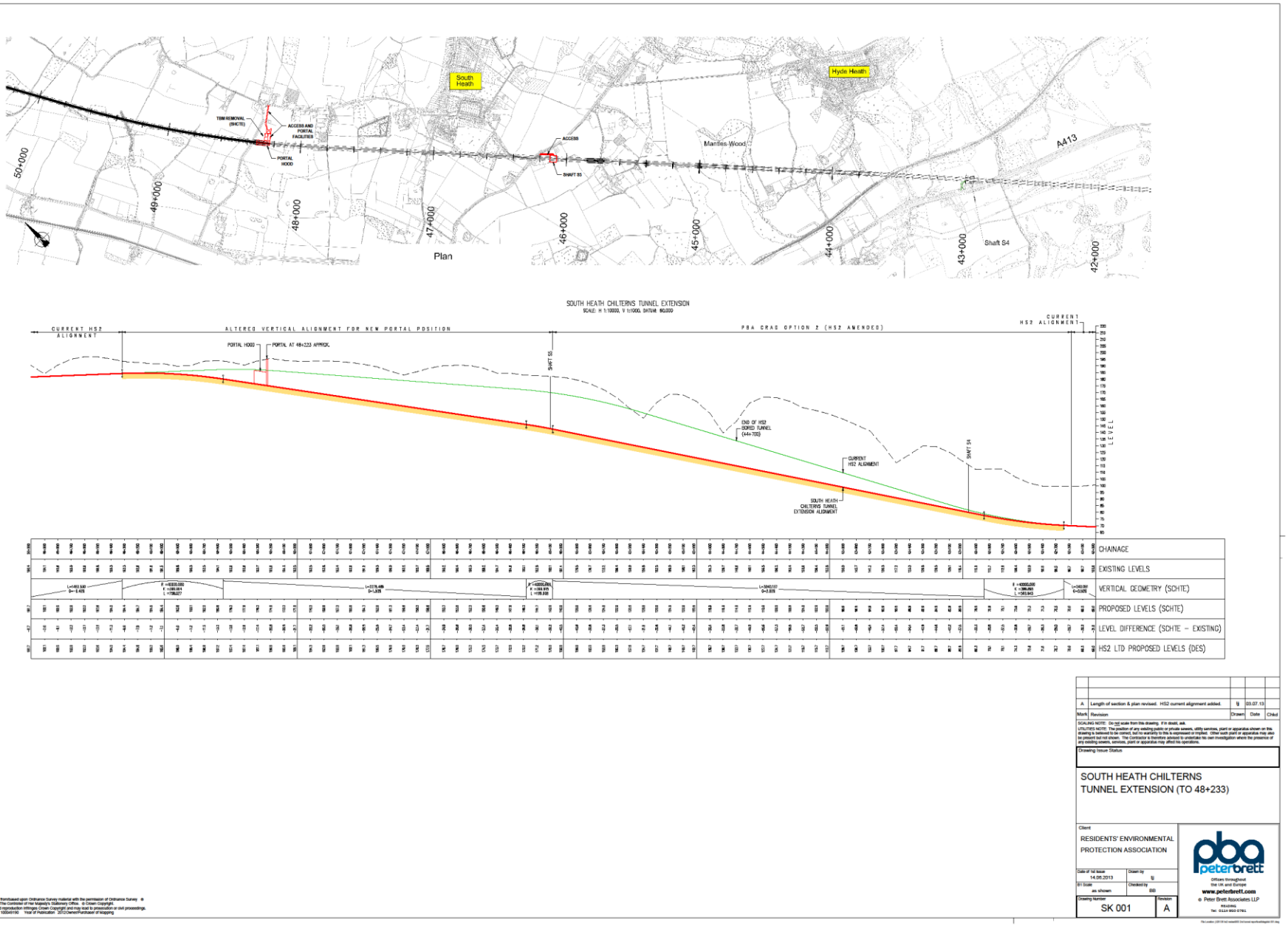
[15] Taking the longer tunnel figure of £32.4k/m from Appendix A for the twin bored tunnels of 7.25m internal diameter and scaling the cost up for tunnels of 8.8m internal diameter. The formula used is:
$C2 = C1 \times (2 \times \pi r_2^{1.4}) / (2 \times \pi r_1^{1.4})$,
where C2 is the cost/m of the Chilterns bored tunnel, C1 is the cost/m of the 7.25 diameter twin bored tunnel from Appendix A of the Cost and Risk Report (2012), r_2 is the radius of the Chilterns bored tunnel (8.8/2 m), and r_1 is the radius of the reference tunnel (7.25/2 m)

7. Conclusion

This report finds that the extension of the bored tunnel from Mantles Wood (44,700) to Liberty Lane (48,330) is feasible. The design takes account of the work that Atkins have done on the CRAG proposal and the standards that they applied to the tunnels.

The report also finds that marginal costs are the appropriate basis on which to assess the extension to the Chilterns bored tunnel. On this basis extending the bored tunnel to Liberty Lane would save money (between £32m and £36m) compared to the current HS2 Ltd proposal. Other cost bases are considered. ie the average built-up cost figures and a simple man-years sense check. The environmental savings and benefits are also very important.

Appendix 1: South Heath Chilterns Tunnel Extension (SHCTE): plan and profile



Appendix 2: Marginal and full costs

To assess whether SHCTE is cheaper than HS2 Ltd's proposal, the appropriate basis for costing is one that accurately reflects the costs of changes from the HS2 Ltd proposal.

There are many different bases on which to produce costs. What is critical in exploring the effect on costs of extending the Chilterns bored tunnel is to have the various elements of change costed on the same basis that allows valid comparisons. It is understood that the costs provided by Atkins to CRAG of the HS2 Ltd proposal and CRAG's two tunnel options[16] were on the basis of 'base costs', before optimism bias and risk adjustments are made. This seems to be similar and possibly identical to the basis of the unit costs given in the cost and risk reports published by HS2[17].

A key issue is what the costs incurred by boring the tunnel the additional length required by SHCTE are.

There are three sorts of cost that might apply:

- Unit costs
- Full costs
- Marginal costs

Unit costs are generally used in scoping exercises, where an average total cost for 'that sort of tunnel' for 'that sort of length' in 'that sort of ground' are used to estimate roughly what a tunnel might cost without detailed site specific information. The 2009 Arup cost factors were of this variety, as were those in the 2012 update of the 'HS2 Cost and Risk Model Report' by Davis Langdon (the producers of the Spon's compendium of current engineering costs) published by HS2 Ltd.

Full costs are the costs built up to reflect all the costs for a specific project. We understand that the HS2 Chilterns tunnel is costed in this manner. It is understood that the Atkins figures given to CRAG (eg on 25 June 2013) are also built up in this manner, but have then been aggregated so that individual cost elements are not distinguishable as given in Table 4.8 of the June 2013 Report.

The average full cost of tunnels for the Chilterns is about £49,600/m, but this is an **average** of 13.3km of bored tunnel and 2.45km of green tunnel. It includes vent shafts, but not fitting out the tunnels with track, signaling and OHLE.

The **marginal cost** is the extra costs incurred by an *incremental* increase in the length of the tunnel. These

- **Include** the costs of the extra materials, labour, running the various facilities, maintenance, spoil disposal (including extending the in-tunnel spoil conveyance system for the extra distance) and maintenance to support tunneling for the longer period.

- **Do not include** costs that are not increased by tunneling a bit further: which include the costs of building and decommissioning the access and spoil disposal site; the costs of purchase, build, extraction and removal the TBMs (unless the new extraction site (Liberty Lane) has different costs than the HS2 Ltd proposed one (Liberty Lane)); the costs of the tunnel portal unless this is different for Liberty Lane than Mantles Wood.. It is likely (due to accessibility) that Liberty Lane would not be a more expensive portal or extraction site than Mantles Wood.

The 2012 HS2 Ltd Cost and Risk Model Report (Appendix A) gives two costs for bored tunnels (£63,600/m and £32,400/m, for a twin bore tunnel of internal diameters of 7.25m). These costs vary by almost a factor of two with length. This is clear evidence that a fixed cost/variable cost split is appropriate for bored tunnels, with the considerable fixed costs (set-up and close down) being spread over the drivage: as the drivage increases, the average cost reduces.

[16] 'Engineering Review of the Proposal by CRAG for an extended Chilterns Tunnel', 7 June 2013, Atkins
[17] 'High Speed Rail London to the West Midlands and Beyond HS2 Cost and Risk Model ', December 2009 and 'HS2 Cost and Risk Model Report: A report to Government by HS2 Ltd ', March 2012, HS2 Ltd

HS2 Ltd's proposed Chilterns tunnel is likely to be at or beyond the long end of the range for which factor costs are given. If the Chilterns tunnel is longer than those used in deriving the Appendix A low figure, the 'economies of scale' would be greater and the average cost lower.

However, the Chilterns bored tunnel is of greater internal diameter (8.8m) than that given in Appendix A, so the Appendix A costs need to be adjusted to reflect this.

When assessing the cost of extending the proposed Chilterns tunnel, it is the **incremental or marginal costs** that are relevant, and as a substantial part of the total cost of HS2 Ltd's proposed tunnel effectively does not vary if the tunnel is made a little longer, these costs are less than the average full cost per unit length of HS2 Ltd's proposal.

Estimating unit and full costs

HS2 Ltd have not disclosed the details of their costings, but it is possible to use the information that they have provided to derive estimates of costs.

The 2012 Cost and Risk Model data gives unit costs for a twin bore tunnel, and while the lower cost may be more appropriate for the Chilterns bored tunnel, it is for considerably smaller tunnels. Were the £32.4k/m scaled up by the increase in internal cross-section this would give £47.7k/m . In fact the increase will not be directly related to the area, as while some items such as spoil will be by area, others such as the lining segments and labour cost are not. Experience indicates that costs increase in the ratio of the radii raised to the power of 1.4. This latter basis has been used, giving an average cost for the Chilterns bored tunnel of **£42.5k/m**. See Appendix 4.

The Chilterns tunnels costings (from Atkins) also can be used to derive tunnelling costs. Were green and bored tunnels to have the same average cost, the cost per metre is as shown in the table below.

tunnel	Twin bored (km)	Green tunnel (km)	Total tunnel (km)	Total cost (£m)	Cost per metre (£k/m)
HS2 Ltd proposal	13.3	2.45	15.75[18]	780.7[19]	49.57
CRAG T1	22.1[20]	1.45	23.55	1305.3[21]	55.43
CRAG T2	22.1	1.45	23.55	1330.9	56.51

It is assumed that the CRAG options are more expensive than the HS2 Ltd proposal per metre as it involves two bored tunnels working from opposite ends, with an average drivage of 11.05km rather than 13.3km.

Considering T1, which retains ending the southern Chilterns tunnel at Mantles Wood, albeit not at exactly the same place as HS2 Ltd's proposal. As a result the costs of the M25 to Mantles Wood tunnel is effectively common, so the additional cost must all be associated with the additional bored tunnel (given there is substantially less green tunnel). The 7.8km of additional tunnel costs £524.6m, or £67.3k/m. Given that the additional twin-bored tunnel is 9.0km long and the length of green tunnel is substantially reduced, it is unclear why there is such a difference in costs per metre.

Appendix 3 considers how the marginal cost of additional bored tunnel and the cost of green tunnels can be estimated from the Atkins costings.

A core question is how much less than the average full cost the marginal costs are. In the built up cost figures, it is assumed they are 2/3rds of full average costs; and this accords with the higher of the estimates derived from Atkins costings – although this is not inconsistent with both being high, for reasons discussed.

[18] See Engineering Review of Proposal by CRAG for an Extended Chilterns Tunnel, 07 June 2013, Page 9 Table 4.3 of C222-ATK-TN-REV-020-000001
[19] Op cit Table 4.8, Page 25
[20] Op cit Table 4.4, Page 14
[21] Op cit Table 4.8, Page 25

The marginal costs will include the cost of an additional vent shaft and for the cutting at the new portal being deeper than under the HS2 Ltd proposal.

The cost of the SHCTE are: these marginal costs (plus the additional costs of the deeper and wider cutting from Liberty Lane northwards) reduced by the savings for the works in the HS2 Ltd proposals that would not be required – which are the full costs for constructing the railway and the associated surface works (diverting roads and utilities, building bridges, etc) from Mantles Wood to Liberty Lane – as none of this would be required.

Appendix 3: Deriving a marginal bored tunneling cost and a cost for green tunnels from Atkins' figures

If it is assumed:

- Bored tunnels can be treated as having two cost components: a fixed cost (for the tunnel access, spoil removal facilities, supplies and materials stocking and provision, acquiring, building and removing the TBMs), and a variable cost (that reflects labour, materials, other operating costs, maintenance etc.) that changes with length of drivage
- Green tunnels have the same cost as the incremental cost of a bored tunnel
- The CRAG option involves two lots of fixed bored tunnel costs compared to the HS2 Ltd option (as it has two sets of TBMs and access and extraction sites), and that both have the same fixed costs.

This allows a calculation of the marginal cost of the bored tunnel by eliminating the fixed cost of the bored tunnels, by using the table 4.8 tunnel cost figure in the Atkins report (of £780.7m):

1. Taking twice the costs of the HS2 Ltd option (which then includes two fixed costs) ie £780.7m x 2 = £1,516.4m
2. Deducting the CRAG costs from this (ie £1,305.3m).

This gives the marginal costs of £256.1m for a tunnel of 7.95km (15.75 x 2 – 21.1), **ie £32.2k/m.**

However, this marginal cost of £32.2k/m for the deep bore tunnel is on the assumption that the green tunnel costs are the same as the marginal costs of a bored tunnel. The cost of the green tunnel will be substantially **more** than the marginal costs of a bored tunnel. This means that the £32.2k/m is too high as a marginal cost for the bored tunnel.

The 7.95km of tunnel is made up of 3.45km of green tunnel (2 x 2.45km – 1.45) and 4.50km of bored. So were the green tunnel to have the **same** cost per metre as the **total average** cost of the bored tunnel, the marginal cost of the bored tunnel would be £18.9k/m.

Marginal cost of bored tunnel	Assumes	Basis of calculation
£32.2k/metre	Green tunnel costs the same as **marginal** costs of bored tunnel	£256.1m/7.95metres = **£32.2k/m** (£780.7m x 2 less £1305.3m) = £256.2m (15.75km x 2 less 21.1km) = 7.95 km
£18.9k/metre	Green tunnel cost the same as **total average** cost of bored tunnel	£85.1m/4.5km = **£18.9k/m** (£780.7m/15.75 = £49.57k/m) £256.1m – (3.45 (ie 2 x 2.45km – 1.45) x £49.57m/km) = £85.1m

An alternative approach to estimating the cost of green tunnels is to assume the 2012 Cost and Risk Model report based estimate of bored tunnel costs is correct and derive the cost of green tunnels from that.

tunnel	Twin bored (km)	Green tunnel (km)	Total cost (£m)	Cost of bored tunnel @ £42.5k/m (£m)	Green tunnel £k/m
HS2 Ltd proposal	13.3	2.45	780.7	585.2	88.0
CRAG T1	22.1	1.45	1305.3	939.2	252.5
CRAG T2	22.1	1.45	1330.9	939.2	270.2

The built-up cost of the green tunnel is estimated to be £74.4k/m, ie about 15% less than that derived from the HS2 Ltd proposal but substantially less than a third of those derived from the CRAG tunnel costings. While the cost of green tunnel derived for the HS2 Ltd proposal is credible, (at £88.0k/m) those for the CRAG options are not, presumably reflecting that the average bored tunnel cost for the CRAG options assessed by Atkins is substantially above that for HS2 Ltd's preferred scheme.

Appendix 4: Build-up of costs (behind Table 1 of the Report)

The costings in table 1 use HS2 Ltd sources as far as possible:

- The HS2 Ltd's 2012 Cost and Risk Model Report (Appendix A)
- Atkins data (from their 7 June 2013 Report on CRAG tunnel T1 and T2 options)
- Spon's Civil Engineering and Highway Works Price Book 2013
- Green tunnel and cutting assumptions based on engineering judgment and available data

The following tables set out the derivation of the key source numbers in Table 1 of the Report

2012 Cost Risk Model Report, Appendix A, HS2 Ltd				
twin-bore tunnel costs		**diameter**	**radius**	**2 x πr^2 (cross section)**
long tunnel cost/m	£32,400	7.25	3.625	82.56
Chiltern cost/m (area basis)	£47,735	8.8	4.4	121.64
			radius	**2 x πr$^{1.4}$**
long tunnel cost/m	£32,400	7.25	3.625	38.13
Chiltern cost/m (1.4 power basis)	**£42,496**	8.8	4.4	50.01

					difference	
Implied cost of HS2 Ltd tunnels	**Green**	**Bored**	**Total**	**Atkins cost**	**£m**	**%**
£/m	£74,428	£42,496				
length (km)	2.45	13.3				
total cost (£m)	**£182.3**	**£565.2**	**£747.5**	**780.7**	**£33.2**	**4.2%**

Green tunnel							
	volume (m^3)			**Depth (m)**	**Width at base (m)**	**Width at top (m)**	
excavation: spoil/m	1,027.28			15.36	40.00	93.76	
green tunnel: volume/m	300.00			10.00	30.00		
excavation cost/m	**volume (m^3)**	**cost/m^3**	**cost/m**				
open cut stored on site	727.30	£ 27.91	£20,299	all stored except green tunnel volume			
returned over roof	727.30	£ 11.02	£8,015	all returned except green tunnel volume			
removed from site	300.00	£ 30.00	£9,000	green tunnel volume			
total			**£37,314**				
slab cost/m	**volume (m^3)**	**cost/m^3**	**cost/m**	**Width (m)**	**Thickness (m)**	**height (m)**	
concrete base	41.31	£150.00	£6,197	27.54	1.50		
concrete roof	34.43	£200.00	£6,885	27.54	1.25		- includes propping
concrete walls (external)	18.13	£200.00	£3,625	1.25		7.25	- includes propping
concrete walls (internal)	7.25	£200.00	£1,450	1.00		7.25	- includes propping
concrete total			**£18,157**				
reinforcing cost/m	**t/m^3**	**cost/t**					
base	0.15	£1,250	£7,746				
roof	0.15	£1,250	£6,455				
walls	0.15	£1,250	£4,758				
reinforcing total			**£18,958**				
overall green tunnel total/m			**£74,428**				

	Cuttings							
1	**Mantles Wood to South Heath green tunnel South portal**							
		volume (m^3)			**Av depth (m)**	**Width at base (m)**	**Width at top (m)**	
	excavation: spoil/m	433.16			10.54	20.00	62.17	
	excavation cost/m	**volume (m^3)**	**cost/m^3**	**cost/m**				
	open cut stored on site	433.16	£27.91	£12,090				
	used locally	433.16	£11.02	£4,773	all used locally			
	Total/m			**£16,863**				
1a	**Extra cost for extra width for first km**							
		volume (m^3)			**Av depth (m)**	**Initial extra width (m)**	**Final extra width (m)**	
	excavation: spoil/m	78.33			10.73	14.60	0.00	
		volume (m^3)	**cost/m^3**	**cost/m**				
	open cut stored on site	78.33	£27.91	£2,186				
	used locally	78.33	£11.02	£863	all used locally			
	Total/m			**£3,049**	**(£3.0 for 1km)**			
2	**South Heath green tunnel North portal to Liberty Lane**							
		volume (m^3)			**Av depth (m)**	**Width at base (m)**	**Width at top (m)**	
	excavation: spoil/m	334.75			8.87	20.00	55.48	
	excavation cost/m	**volume (m^3)**	**cost/m^3**	**cost/m**				
	open cut stored on site	334.75	£27.91	£9,343				
	used locally	334.75	£11.02	£3,689	all used locally			
	Total/m			**£13,032**				
3	**HS2 Ltd cutting from Liberty Lane to Cottage Farm footpath**							
		volume (m^3)			**Av depth (m)**	**Width at base (m)**	**Width at top (m)**	
	excavation: spoil/m	202.51			6.24	20.00	44.95	
	excavation cost/m	**volume (m^3)**	**cost/m^3**	**cost/m**				
	open cut stored on site	202.51	£27.91	£5,652				
	used locally	202.51	£11.02	£2,232	all used locally			
	Total/m			**£7,884**				
4	**SHCTE cutting from Liberty Lane to Cottage Farm footpath**							
		volume (m^3)			**Av depth (m)**	**Width at base (m)**	**Width at top (m)**	
	excavation: spoil/m	428.81			10.47	20.00	61.89	
	excavation cost/m	**volume (m^3)**	**cost/m^3**	**cost/m**				
	open cut stored on site	428.81	£27.91	£11,968				
	used locally	428.81	£11.02	£4,725	all used locally			
	Total/m			**£16,694**				
4a	**Extra cost for extra width for first km**							
		volume (m^3)			**Av depth (m)**	**Initial extra width (m)**	**Final extra width (m)**	
	excavation: spoil/m	76.45			10.47	14.60	0.00	
		volume (m^3)	**cost/m^3**	**cost/m**				
	open cut stored on site	76.45	£27.91	£2,134				
	used locally	76.45	£11.02	£842	all used locally			
	Total/m			**£2,976**	**(£3.0 for 1km)**			

	roads/bridges	base cost(£m)					
1	new bridge over Hyde lane	4.00					
2	reinstating 2 roads over green tunnel	5.60					
3	Hyde Farm access and Park Farm footpath & fencing	5.20					
	Total	**£14.8m**	**(no allowance for reinstating other footpaths)**				

Appendix 5: The significance of extending construction times

The SHCTE will add to the construction and fitting out of the Chilterns bored tunnel.

The SHCTE is intended to be achieved through continuing the HS2 Ltd planned tunnel through a change of vertical alignment and a longer drivage. It is expected that the tunnelling will continue a further 36 weeks (at the expected final drivage rate of 100m/week). However, as the tunnel is used for spoil extraction, fitting it out with railway infrastructure cannot commence until it is complete.

The issue is whether the delay engendered by the additional bored tunnel drivage is critical to the project. There is a further question of whether a delay to completing Phase 1 would actually be detrimental, but this is not addressed here[22].

On HS2 Ltd's engineering drawings the last 2km at the northern end of the Chilterns tunnel are in the Central Chilterns Community forum area, with the body of it in Chalfont and Amersham, and its entrance and depot in the Colne Valley forum area.

Key dates from **Central Chilterns CFA** reports are:

- Tunnel boring, lining, adits and base slab works from 2nd quarter 2021 to 2nd quarter 2022 inclusive.
- Track laying and overhead line equipment in 3rd quarter 2023
- Rail systems and tunnel fit-out 2nd quarter 2024
- Vent shaft fit out 2nd quarter 2024 to 1st quarter 2025

Key dates from the **Chalfonts and Amersham CFA** reports are:

- Tunnel boring, lining, adits and base slab works from 2nd quarter 2018 to 2nd quarter 2022 inclusive.
- Track laying and overhead line equipment from 1st quarter to 3rd quarter 2023
- Rail systems and tunnel fit-out 3rd quarter 2023 to 1st quarter 2025
- Vent shaft fit out 1st quarter 2023 to 1st quarter 2025

Key dates from the **Colne Valley CFA** are:

- Tunnel boring, lining, adits and base slab works from 3rd quarter 2017 to 3rd quarter 2018 inclusive

The timing of the Colne Valley work indicates the tunnel boring commences as early as is practicable on HS2 Ltd's current plan – so starting earlier is not a way by which extra time can be spent on tunnel boring.

There are no key dates in Dunsmore Wendover & Halton area that affect timing of tunnelling or completion.

It seems that the Central Chilterns works on the Chiltern tunnel are sequential for the tunnel boring, but in parallel for other works with the exception of fitting out the tunnel that requires boring to be complete. Vent shafts are fitted out in parallel to tunnelling and fit-out. The potential critical path seems to be tunnel boring going through to completion in the Central Chilterns CFA, followed by rail systems and tunnel fit out in the Chalfonts and Amersham CFA. This activity runs through from 3rd quarter 2017 to 1st quarter 2025 – but there is **a gap of four quarters (from end 2nd Quarter 2022 to start of 3rd Quarter 2023)** between finishing tunneling and commencing the rail systems fit-out.

The rail systems fit out does not appear to be done from both ends, as there would otherwise be such activity in the third quarter 2013 in the Central Chilterns gantt chart (as opposed to in 3rd quarter 2024). Were the tunnel to be fitted from both ends, there would be 8.5km to do from each end for SHCTE, as opposed to 13.5 km from the Colne valley end (with the HS2 Ltd bored tunnel). The tunnel fit out for the Central Chilterns presumably relates to the green tunnel.

It seems that a further three quarters of tunnelling could be accommodated in the four quarters of gap, and that the tunnel could still be fitted out without compromising the project completion date.

[22] In response to challenges to the HS2 timetable at PAC (1 July 2013) David Prout pointed out that the economics (BCR) of HS2 improve with a deferred start, as DfT forecast demand to still be growing in 2026. This is consistent with the sensitivities done by HS2 Ltd that show an improving BSR with later completion (see Figure 6 page 54, 'Economic Case for HS2: The Y Network and London – West Midlands', HS2 Ltd, February 2011.

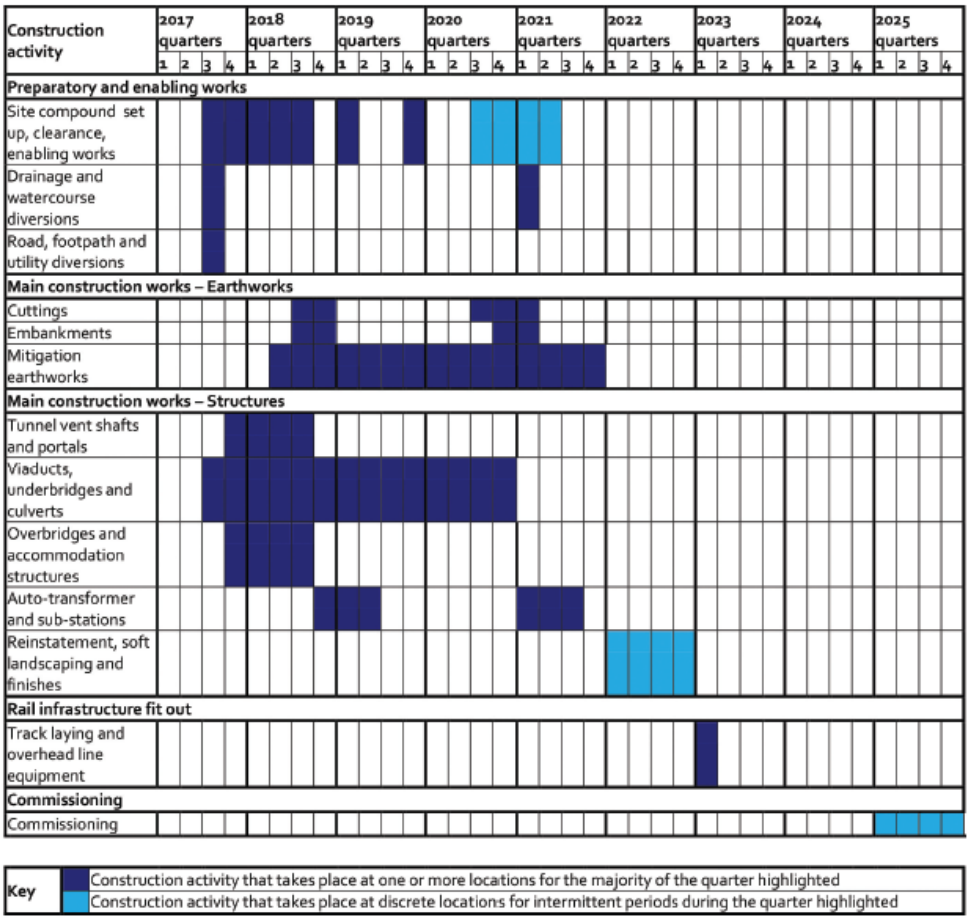


Figure 3: Indicative construction programme for the area

Chalfonts and Amersham

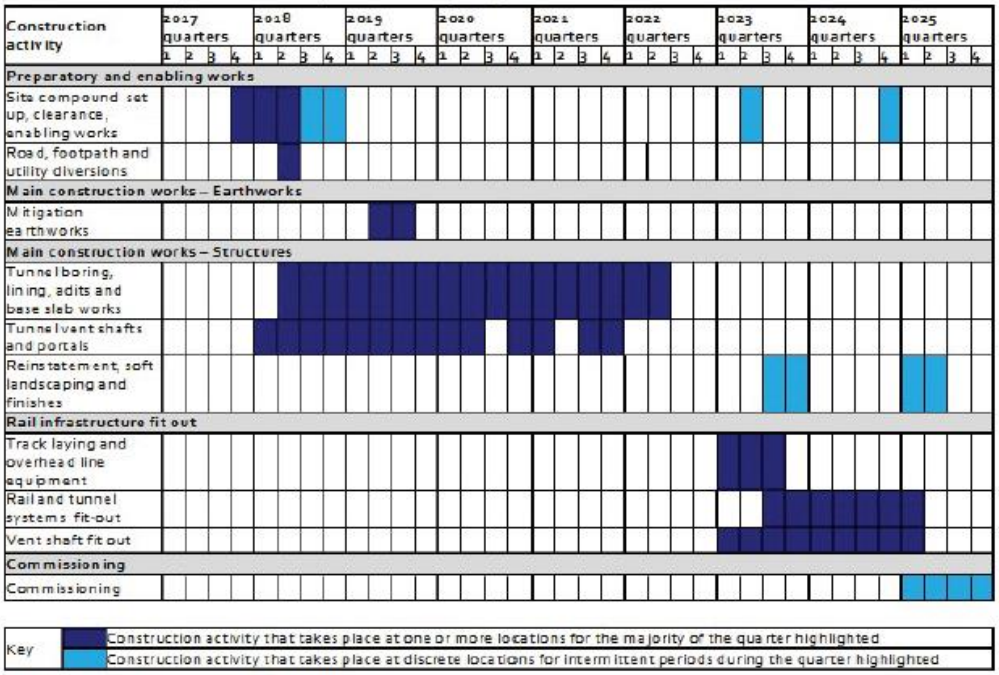


Figure 3: Indicative construction programme for the area

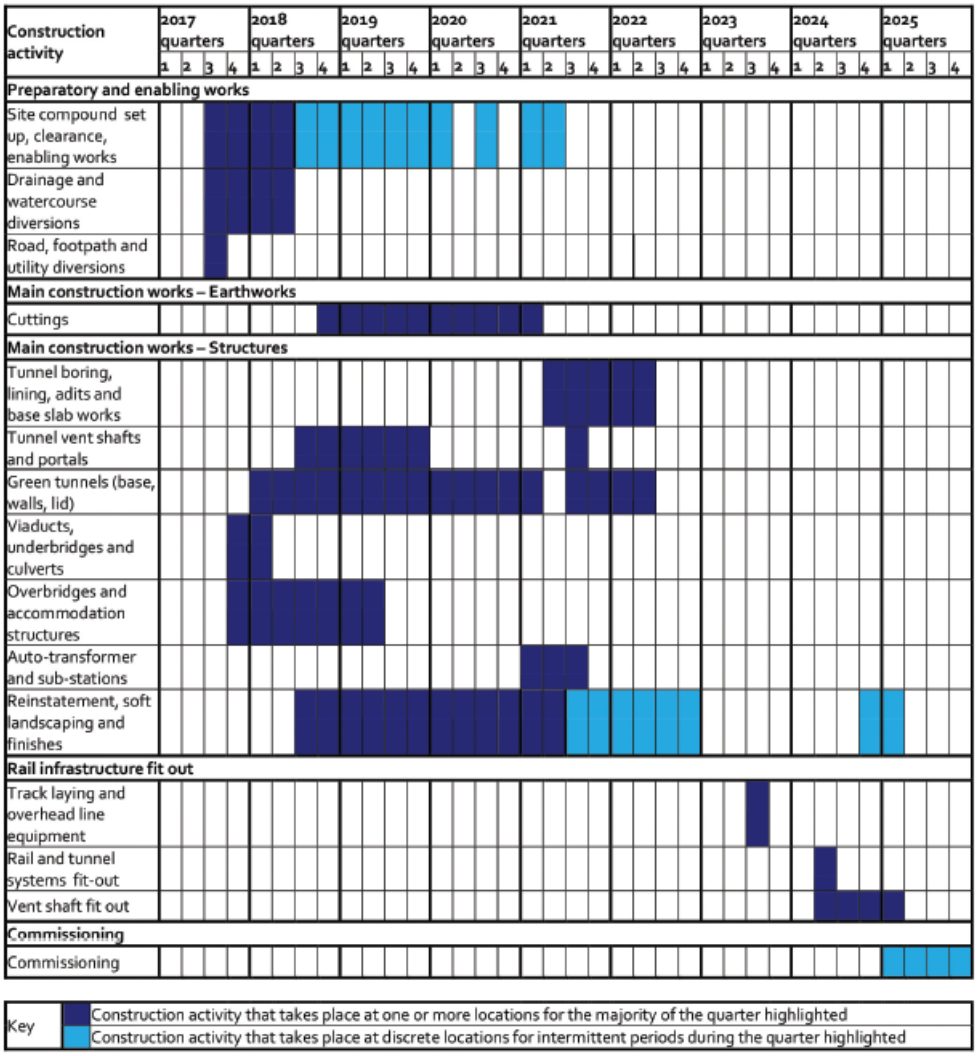


Figure 3: Indicative construction programme for the area

Dunsmore, Wendover and Halton

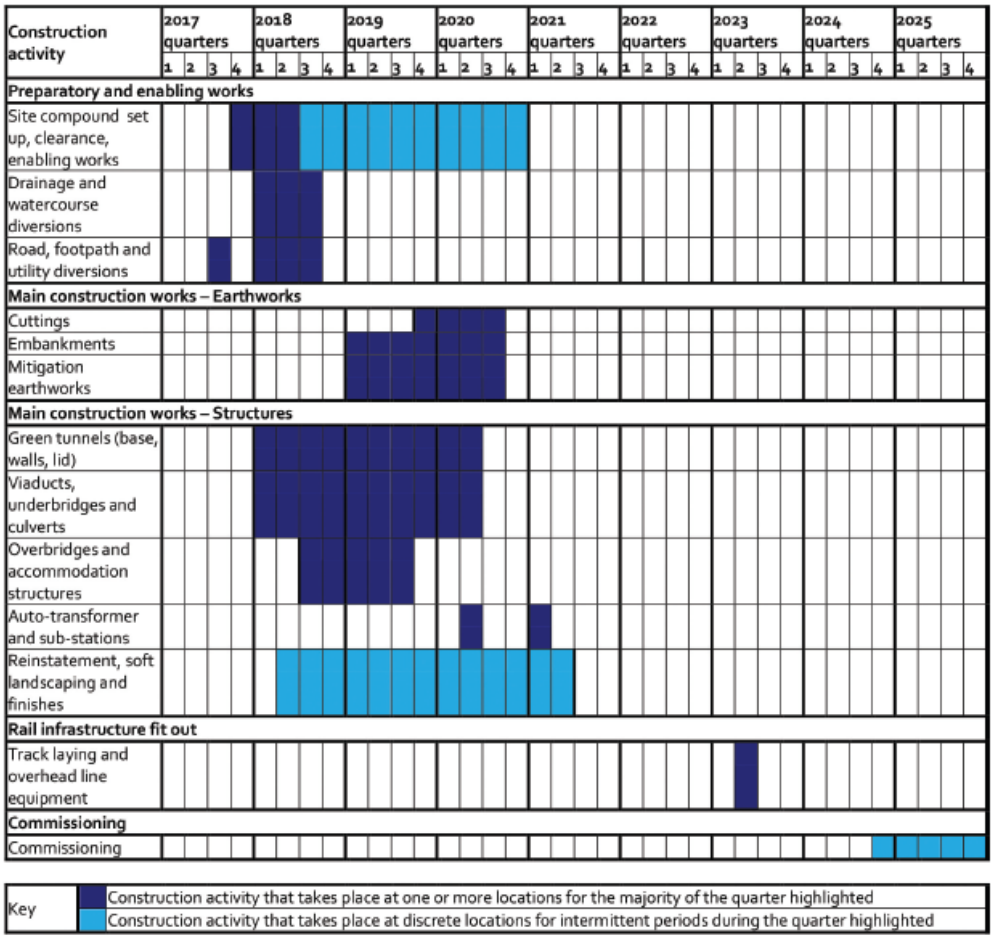


Figure 3: Indicative construction programme for the area

Appendix 6: Depth of cuttings eliminated and changed by SHCTE

The SHCTE eliminates the need for

- The deep cuttings from Mantles Wood to the South Heath green tunnel, and
- The cutting from the north portal of the South Heath Green tunnel to Liberty Lane.

It also results in a deeper (and wider) cutting from Liberty Lane to the Cottage Farm public footpath.

The following tabulates the surface level, cutting level and depth of cutting for these sections.

Table 1: Mantles Wood (44,700) to South Heath Green tunnel southern end (46,000)

chainage	46000	45900	45800	45700	45600	45500	45400	45300
surface[23]	180.5	178.4	174.6	170.1	162.6	156.3	154.9	166.9
HS2 Ltd[24]	168.6	166.9	165	162.8	160.4	157.7	154.7	151.7
depth	11.9	11.5	9.6	7.3	2.2	-1.4	0.2	15.2

chainage	45200	45100	45000	44900	44800	44700	Average
surface	169.1	166.1	159.9	148.4	139.2	155.6	
HS2 Ltd	148.7	145.7	142.7	139.7	136.7	133.7	
depth	20.4	20.4	17.2	8.7	2.5	21.9	10.5

Table 2: South Heath green tunnel northern end (47,400) to Liberty Lane (48,300)

chainage	48300	48200	48100	48000	47900	47800	47700
surface[25]	195.3	195.3	193.8	193	193.7	193.4	193.1
HS2 Ltd[26]	187.1	186.6	185.9	185.1	184.3	183.6	182.8
depth	8.2	8.7	7.9	7.9	9.4	9.8	10.3

chainage	47600	47500	47400	Average
surface	191.9	190.5	188	
HS2 Ltd	182.1	181.3	180.5	
depth	9.8	9.2	7.5	8.9

[23] Peter Brett SK001 *(Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[24] C222-ATK-CV-DPL-020-000004
[25] Peter Brett SK001 *(Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[26] C222-ATK-CV-DPL-020-000004

Table 3: Liberty Lane (48,300) to Cottage Farm public footpath (49,300) (cutting will be wider to reflect wider separation of tracks coming out of the bored tunnel)

Chainage	49300	49200	49100	49000	48900	48800
surface[27]	193.5	192.6	192.1	191.2	189.3	19240
HS2 Ltd[28]	184.4	184.8	185.2	185.6	186	186.4
SHCTE[29]	184.5	184.7	184.7	184.4	183.9	183.1
SHCTE depth	-9.0	-7.9	-7.4	-6.8	-5.4	-9.3
difference from HS2 Ltd	0.1	-0.1	-0.5	-1.2	-2.1	-3.3

Chainage	48700	48600	48500	48400	48300	Average
surface	194.1	193.9	192.4	190	195.3	
HS2 Ltd	186.8	187.1	187.4	187.4	187.1	
SHCTE	182.1	180.8	179.3	177.8	176.3	
SHCTE depth	-12	-13.1	-13.1	-12.2	-19.9	
difference from HS2 Ltd	-4.7	-6.3	-8.1	-9.6	-10.8	-4.2

[27] Peter Brett SK001 *(Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[28] C222-ATK-CV-DPL-020-000004
[29] Peter Brett SK001 *(Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*

Appendix 7: Levels of surface, HS2 Ltd's current proposals, and the SHCTE

The tables below show the depths at 100 chainage intervals from where the SHCTE diverges from the vertical alignment of HS2 Ltd's Chilterns deep tunnel to Cottage Farm public footpath, where it re-joins the alignment (at 49300). The deep bore tunnel sections are shaded blue, and the HS2 Ltd green tunnel is shaded in green. Particular phases are

- From the point of divergence from the Chilterns tunnel (42800) to Mantles Wood (44700) where the currently planned bored tunnel emerges
- From Mantles Wood (44700) to the end of SHCTE deep tunnel proposal (Liberty Lane at approx. 48200, plus portal ie approx. 48300))
- From end of SHCTE (48300) to the point where it meets up with HS2 ltd proposed alignment (at 49300)

It shows the increased depth of the cutting where it emerges at Liberty Lane (48300) ie almost 20m deep, by comparison to current proposed depth of 8.2m

It also shows that the different maps have different current surface levels (row 1 and 2). The differences (in row 5) have been taken from surface levels shown on the Brett Map SK001, that in turn used the latest Atkins assessment of the CRAG tunnel proposals (in the map series C22-ATK-TN-DGA-000251 through to 265, all dated end May 2013). These will post-date the Plan and Profile maps published alongside the Draft Environmental Statement (DES) – shown in row 2 for information only.

	Chainage	49300	49200	49100	49000	48900	48800	48700	48600	48500	48400	48300	48200	48100	48000	47900
1	Surface (PBA) [30]	193.5	192.6	192.1	191.2	189.3	192.4	194.1	193.9	192.4	190.0	195.3	195.3	193.8	193.0	193.7
2	(surface (DES)[31])	(195.8)	(193.7)	(193.2)	(192.5)	(190.5)	(191.0)	(193.8)	(194.3)	(193.4)	(191.3)	(193.8)	(195.7)	(194.3)	(193.5)	(193.9)
3	HS2 Ltd (DES)[32]	184.4	184.8	185.2	185.6	186.0	186.4	186.8	187.1	187.4	187.4	187.1	186.6	185.9	185.1	184.3
4	SHCTE[33]	184.5	184.7	184.7	184.4	183.9	183.1	182.1	180.8	179.3	177.8	176.3	174.8	173.3	171.8	170.3
5	Below surface (row 4-1)	-9.0	-7.9	-7.4	-6.8	-5.4	-9.3	-12.0	-13.1	-13.1	-12.2	-19.9	-20.5	-20.5	-21.2	-23.4

	Chainage	47800	47700	47600	47500	47400	47300	47200	47100	47000	46900	46800	46700	46600	46500	46400
1	Surface (PBA)[34]	193.4	193.1	191.9	190.5	188.0	184.7	183.9	187.0	189.5	190.2	190.5	189.4	186.5	184.7	184.1
2	(surface (DES)[35])	(194.0)	(193.4)	(192.7)	(191.2)	(189.4)	(186.1)	(183.2)	(188.5)	(188.4)	(190.0)	(190.5)	(190.4)	(188.2)	(184.4)	(184.4)
3	HS2 Ltd (DES)[36]	183.6	182.8	182.1	181.3	180.5	179.8	179.0	178.3	177.5	176.7	176.0	175.2	174.5	173.7	172.9
4	SHCTE[37]	168.8	167.3	165.8	164.3	162.8	161.3	159.8	158.3	156.8	155.3	153.8	152.3	150.8	149.3	147.8
5	Below surface (row 4-1)	-24.6	-25.8	-26.1	-26.2	-25.2	-23.4	-24.1	-28.7	-32.7	-34.9	-36.7	-37.1	-35.7	-35.4	-36.3

[30] Peter Brett SK001 *(Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[31] C222-ATK-CV-DPL-020- 000004 (from DES)
[32] C222-ATK-CV-DPL-020-000004 (from DES)
[33] Peter Brett SK001 (*Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[34] Peter Brett SK001 *(Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013*)
[35] C222-ATK-CV-DPL-020- 000004 (from DES)
[36] C222-ATK-CV-DPL-020-000004 (from DES)
[37] Peter Brett SK001 (*Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*

Appendix 7: Levels of surface, HS2 Ltd's current proposals, and the SHCTE

	Chainage	46300	46200	46100	46000	45900	45800	45700	45600	45500	45400	45300	45200	45100	45000	44900
1	Surface (PBA)[38]	183.2	182.7	181.7	180.5	178.4	174.6	170.1	162.6	156.3	154.9	166.9	169.1	166.1	159.9	148.4
2	(surface (DES)[39])	(183.0)	(182.7)	(181.9)	(181.3)	(179.4)	(176.7)	(172.5)	(167.1)	(157.6)	(150.6)	(163.3)	(169.2)	(168.2)	(163.4)	(154.1)
3	HS2 Ltd (DES)[40]	172.2	171.2	170.1	168.6	166.9	165.0	162.8	160.4	157.7	154.7	151.7	148.7	145.7	142.7	139.7
4	SHCTE[41]	146.3	144.7	142.9	140.9	138.9	136.9	134.9	132.9	130.9	128.9	126.9	124.9	122.9	120.9	118.9
5	Below surface (row4-1)	-36.9	-38.0	-38.8	-39.6	-39.5	-37.7	-35.2	-29.7	-25.4	-26.0	-40.0	-44.2	-43.2	-39.0	-29.5

	Chainage	44800	44700	44600	44500	44400	44300	44200	44100	44000	43900	43800	43700	43600	43500	43400
1	Surface (PBA)[42]	139.2	155.6	164.6	166.9	164.9	161.6	157.1	155.3	152.4	145.5	144.4	137.1	129.0	117.8	123.3[43]
2	(surface (DES)[44])	(139.6)	(148.8)	(162.2)	(166.5)	(166.2)	(163.4)	(158.5)	(156.2)	(153.8)	(150.0)	(145.7)	(141.3)	(130.3)	(117.0)	(123.3)
3	HS2 Ltd (DES) [45]	136.7	133.7	130.7	127.7	124.7	121.7	118.7	115.7	112.7	109.7	106.7	103.7	100.7	97.7	94.7
4	SHCTE[46]	116.9	114.9	112.9	110.9	108.9	106.9	104.9	102.9	100.9	98.9	96.9	94.9	92.9	90.9	88.8[47]
5	Below surface (row 4-1)	-22.3	-40.7	-51.7	-56.0	-56.0	-54.7	-52.2	-52.4	-51.5	-46.6	-47.5	-42.2	-36.1	-26.9	-33.5

	Chainage	43300	43200	43100	43000	42900	42800									
1	Surface (PBA)[48]	129.8	129.5	125.1	118.4	112.2	112.7									
2	(surface (DES)[49])	(129.8)	(129.5)	(125.1)	(118.4)	(112.2)	(112.8)									
3	HS2 Ltd (DES)[50]	91.7	88.7	85.7	82.9	80.4	78.1									
4	SHCTE[51]	87.8	85.8	83.8	81.8	79.8	77.8									
5	Below surface (row 4-1)	-42.0	-43.7	-41.3	-36.6	-32.4	-34.9									

[38] Peter Brett SK001 (*Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[39] C222-ATK-CV-DPL-020- 000004 (from DES)
[40] C222-ATK-CV-DPL-020-000004 (from DES
[41] Peter Brett SK001 (*Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[42] Peter Brett SK001 *(Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[43] C222-ATK-TN-DGA-020-000260
[44] C222-ATK-CV-DPL-020- 000003 (from DES)
[45] C222-ATK-CV-DPL-020-000003 (from DES)
[46] Peter Brett SK001 (*Source: Atkins with plans dated May 2013, accompanying the "Engineering Review of Proposal by CRAG for extended Chilterns tunnel" dated 7 June 2013)*
[47] C222-ATK-TN-DGA-020-000260
[48] C222-ATK-TN-DGA-020-000260
[49] C222-ATK-CV-DPL-020- 000003 (from DES)
[50] C222-ATK-CV-DPL-020-000003 (from DES);
[51] C222-ATK-TN-DGA-020-000260

South Heath
Chilterns Tunnel Extension

Environmental Statement

Photography: www.chartridgephotographic.co.uk

Environmental Statement on the South Heath Chilterns Tunnel Extension by REPA

This document assesses the likely significant environmental effects of an extended tunnel from Mantles Wood portal to Liberty Lane – the South Heath Chilterns Tunnel Extension (SHCTE) – and makes comparison of the environmental effects of this proposal against those effects detailed by HS2 Ltd for their proposed route in their Draft Environmental Statement.

Part A Introduction

1.1 Purpose of this report

This report presents the significant environmental effects of extending the Chilterns bored tunnel from Mantles Wood to Liberty Lane, called the South Heath Chilterns Tunnel Extension (SHCTE). It also gives a comparison of the environmental effects on that part of the AONB between Mantles Wood and 49.330 (when the proposed route re-joins the vertical alignment of HS2 Ltd's proposed route) between HS2 Ltd's scheme (as set out in consultation documentation reports Volume 2 Report 9 covering the Central Chilterns Community Forum area) and the extended tunnel proposals contained in section II of REPA's response document.

HS2 Ltd's Draft Environmental Statement (DES) provides totally inadequate information on the benefits of this tunnel, although it does concede that:

> *'The extended tunnels, [which includes the SHCTE] …, all performed well on environmental grounds compared to Option A [HS2 Ltd's own proposal] as they avoid a range of impacts upon environmental receptors. This included the reduction of landscape and visual, ecological, cultural heritage, noise, socio-economic impacts and agricultural impact within the AONB. …' page 28 'CFA 9 – Central Chilterns'*

This comparison demonstrates clearly the benefits to the environment of the extended tunnel options

1.2 Structure of this report

The overall structure of this report follows that of the HS2 Environmental Statement Volume 2 Community Forum Area Reports.

- **Part A** is this introduction

- **Part B** is an overall description of the extended tunnel proposal and a linear comparison of the scheme between Mantles Wood and a point near the south of the Wendover Dean viaduct (Cottage Farm footpath) where the proposal re-joins the HS2 Ltd vertical alignment. It also details the differences between the HS2 solution and SHCTE and the deeper and wider cutting north of the new north portal of the Chilterns bored tunnel.

- **Part C** is a summary and a comparison against each environmental topic as listed in the HS2 documents.

This report is supported by a plan and profile of the proposed tunnel extension (at Appendix 1 in the Engineering Report, in Section II of the REPA response).

This report takes only limited account of understated or unidentified impacts in the DES. Such impacts when identified will increase the benefits of the extended tunnelling.

Part B: Overall description of the extended tunnel proposal and comparison with that proposed by HS2 Ltd

2 Overview of SHCTE

2.1 Overview of the area covered by the extended tunnel proposal

The overview of the area is covered in the HS2 Volume 2 Report 9 section 2.1 and is not be further commented on in this document, beyond observing that the baseline against which HS2 may have an impact is in general not established.

2.2 Description of the extended tunnel proposal

Overview

The extended tunnel follows the horizontal alignment defined by HS2 from Mantles Wood to chainage (Ch) 49,330. The vertical alignment of the extended tunnel proposal is lower from 42,250 to 49,330, for the tunnel to allow sufficient ground coverage to meet Atkins' specification in passing under Mantles Wood and the low point in the surface near Frith Hill, and from the tunnel portal at 48,330 to 49,330 to re-gain the level of the HS2 Ltd alignment from the portal that is at a lower level.

The tunnel length between the M25 portal near Denham and the proposed end of the tunnel at 48330 at Liberty Lane is 16.9km, which is less than the maximum of 20km before special safety considerations apply under TSIs.

One additional vent shaft will be required slightly north of Hyde Lane, behind Annie Baileys (positioned at 46,100).

In effect the portal at Mantles Wood would be moved to Liberty Lane, where access is easier.

From inspection of the proposed extended tunnel drawings it is clear that the permanent impact on the AONB, and the communities of Hyde Heath, Hyde End, South Heath and Potter Row is reduced. The construction impact is similarly reduced but the reduction affects a wider area (than just these villages). It includes those using affected roads of A413, B485 and the roads by which the villages are accessed. In particular the impact on the routes between Chesham and Great Missenden; and Amersham and Wendover is reduced.

A further 3.6km of the AONB is preserved to the benefit of residents and visitors in perpetuity.

2.3 SHCTE section by section

The HS2 Ltd Chiltern Tunnel portal at Mantles Wood is eliminated together with all cuttings and is replaced by a continued bored tunnel to a vent shaft behind Annie Baileys at Ch 46100.

The satellite compound at Mantles Wood is moved to Liberty lane (48,330). There is an additional vent shaft at Ch 46100 which is accessed from the B485.

The route continues in a bored tunnel to the portal located at Ch 48330 where Liberty Lane crosses the line of route.

This length of tunnel eliminates the following significant impacts arising from the HS2 scheme between Mantles Wood and Liberty Lane:

- The access route from Hyde Heath Road
- Construction of the Mantles Wood portal and portal building
- Loss of some of Mantles Wood ancient woodland

- Loss of some of Farthings Wood ancient woodland.
- Loss to Hedgemoor Wood
- Take of agricultural land
- All utility diversions (including the National Grid)
- All the fencing, cuttings, embankments and landscaping works including new planting and noise bunds.
- Extensive drainage and 11 balancing pond requirements
- Hyde Farm access track and footbridge
- Hyde Lane over bridge and road diversion
- Demolition of Rowen Farm and Dar Lor and associated out buildings on Hyde Lane
- Demolition of outbuilding related to Chapel Farm and Sheepcotes Cottage on Hyde Lane
- Demolition of Meadow Leigh on Chesham Road
- Demolition of Annie Bailey's public house restaurant
- The Chesham Road and Kings Lane diversions
- Demolition of numbers dwellings and out buildings at 86, 90 and 94 Kings Lane, Chiltern Cottage and Weights and Measures Gym on Frith Hill and buildings at Elwis Field Farm
- Removal of approximately half of The Coppice and Sibley's Coppice ancient woodland
- Temporary closure of Frith Hill, and its use for construction traffic
- The construction of the South Heath green tunnel, two portals and associated tunnel and ATS buildings and access track
- Footpath disruption and diversion from Mantles Wood to South Heath involving eight footpaths:
    - GM1/80/1 northern part of Sibley’s Coppice
    - GM1/79/1 southern part of Sibley’s Coppice
    - GM1/79/1 and GM1/28/1 Southern part of Sibley’s Coppice;
    - GM1/33/4 between Chesham road and GM1/33/3 footpath;
    - GM1/33/3 between Chesham road and Chapel Farm
    - ; GM1/27/1 westerly edge of Hedgemoor;
    - GMI/23/7 easterly edge of Hedgemoor and Farthings Wood;
    - GM1/21/1 in Mantles Wood
- Footpath disruption and diversions at South Heath, which involves three ancient pathways:

  - GMI/13/3: Great Missenden North East via Stockings Wood, Bury Farm and Jenkins Wood to link with the Chiltern Way National Trail and Long Distance Route at Ballinger Bottom:

  - GMI/12/1: from Great Missenden via Park Farm, Field End Grange to link with the Chiltern Way National Trail and Long Distance Route at Lee Common:

  - GMI/2/1: from Great Missenden via Potter Row, Croft Dell to link with the Chiltern Way National Trail and Long Distance Route at Lee Common.)

- Footbridge construction at Mulberry Park Hill

- Demolition of 2 main building (including a dwelling) and outbuildings on Mulberry Park Hill

- Temporary use of extensive areas for materials and spoil storage needed for the cuttings and green tunnel.

The portal at Ch 48,330 will require permanent access to be provided. This can be achieved from Potter Row without additional impact, over and above what HS2 Ltd's plan entails. Landscaping and planting may be required..

The route continues at a lower alignment to a re-join HS2 Ltd's vertical alignment at ch 49,330 near the Cottage Farm public footpath.

This length of deeper cutting reduces noise and visual impact from the HS2 scheme, although the portal may emit additional noise in this area.

The new vent shaft (and associated building) near Annie Bailey's (46,100) would be accessed from B485 Chesham Road. Landscaping and planting will be required.

2.4 Land required for the extended tunnel options

Land requirements are reduced compared to the HS2 scheme, although the land take from the new bored tunnel portal (48,330) north will be greater (to 49,330) due to the increased separation of the tracks on exiting the tunnel (at 48,330)

2.5 Construction of SHCTE.

This section only addresses those matters which are different from the HS2 scheme.

Construction site compounds

The construction of the extended bored tunnel will require the HS2 Ltd scheme tunnelling operations to be extended in length and time.

The drive north from the M25 portal will stop at Liberty Lane instead of Mantles Wood in the HS2 Ltd scheme. The tunnel boring machines will be extracted at Liberty Lane, and removed via Potter Row.

The following changes in construction compounds are required

- **Eliminated:**

  The Mantles Wood satellite compound

  South Heath Green Tunnel satellite compound 1 at B485 Chesham Road (near south portal)

  South Heath Green Tunnel satellite compound 2 (near HS2 Ltd's planned north portal)

- **Required**

A satellite compound for the vent shaft at ch 46100, accessed from the B485 Chesham Road

A satellite compound is required for the tunnel portal at Liberty Lane ch 48330 accessed from Potter Row

- **Extended operation**

  The main tunnelling compound near the M25 will need to be operational for spoil extraction and disposal for about a year longer to support the additional tunnel boring

Cumulatively the new compounds will have much less impact than those proposed for the HS2 scheme.

Construction site traffic and access

The HS2 scheme has a significant impact on the local roads, residents and visitors of the AONB from Hyde Heath to Liberty Lane, in particular the A413, B 485 Chesham Road, Frith Hill South Heath leg, Kings lane, Hyde Heath Road, and Potter Row.

The SHCTE eliminates the majority of the construction traffic in the South Heath, Hyde Heath and Hyde End areas – other than that required to service the additional vent shaft and the re-sited portal. This will bring significant reduction in impact to the area.

Spoil from the extended tunnel would be extracted using the Chiltern tunnel facilities at the M25 end of the tunnel and give rise to no traffic movements in the Central Chilterns.

Preparatory and enabling works

Demolition works

The demolition works required for the HS2 scheme are eliminated up to Ch 48330 under the extended tunnel proposal.

There are no demolition requirements from the greater depth and width of from the Liberty Lane portal (48,330) until it re-joins the HS2 Ltd alignment (at ch 49,330).

Drainage and culverts

The drainage requirements from Mantles Wood to Liberty Lane are eliminated compared to the HS2 scheme requirements.

Watercourse Diversions

There is no requirement under the extended tunnel option

Utility Diversions

The extensive utility diversions needed under the HS2 scheme will be eliminated for the 3.63 km section from Mantles Wood to Liberty Lane.

The deeper and wider cutting north from Liberty Lane is not expected to have any more effect than that anticipated for the HS2 Ltd vertical alignment.

Highway and road diversions

All road diversions required from the HS2 scheme at Hyde End and South Heath are eliminated.

Footpath, cycleway and bridleway diversions

The extensive diversions and over-bridges required under the HS2 scheme will be eliminated south of Liberty Lane.

No footpaths cross the route where the SHCTE has caused the cutting to be deeper, so this will have little additional impact.

Main construction works – Earthworks

All major earthworks south of Liberty Lane will be eliminated.

Main construction works – Structures

All surface structures between Mantles wood and Liberty Lane are eliminated, although a vent and a road access will be required at Ch 46,100.

Green tunnels

The HS2Ltd scheme's green tunnel at South Heath is eliminated.

Viaducts

The proposal makes no changes to the HS2 proposed viaducts at Wendover Dean and Small Dean.

Bridges

All over bridges and under bridges required under the HS2 scheme are eliminated south of Liberty Lane

Bored Tunnel.

The HS2 Ltd's bored tunnel ending at Mantles Wood is extended to Liberty Lane. Construction is covered in the above sections.

The portal structure required effectively replaces that which HS2 Ltd plan for Mantles Wood. The portals for the South Heath green tunnel are not required

Vent shaft

An additional vent shaft at Ch 46,100 is required.

Rail Infrastructure fit-out

Power supply

The ATS at Mantles Wood would be relocated to Liberty Lane.

Landscaping and permanent fencing

The extensive landscaping requirements from the cuttings are eliminated.

The extensive permanent fencing required for the HS2 scheme for the surface route to Liberty Lane are eliminated, as is the fencing required for the 11 balancing ponds that would not be required

Only localised permanent fencing for the vent shaft is required.

Construction programme

There are consequential changes to the construction programme. The most significant of which is continuing the boring of the tunnel to achieve the additional 3.63kms. However as discussed in the Engineering Report (at Section II of the REPA response, and in Appendix 5) this should be able to be accommodated in the year gap currently planned by HS2 Ltd between the completion of the tunnel boring and the rail systems fit out for the tunnel. By fitting out the tunnel from both ends no additional elapse time is required for this stage

Part C: Environmental topic assessments

This section summarises the difference in impacts between the HS2 scheme and extended tunnel (SHCTE).

Agriculture, forestry and soils

All issues and impacts south of Liberty Lane to the HS2 bored tunnel portal at Mantles Wood are eliminated by the extended tunnel option apart from localised impacts the vent shaft.

The land take will be larger from Liberty Lane for 1-1.5km northwards (as the track be will be 14.6m wider at the portal). (For the costings we used 1km).

Air Quality

Air quality impacts arising from construction activities will be significantly reduced from that of the HS2 scheme due to the vastly reduced surface work south of Liberty Lane.

Community

In general the impacts from the HS2 scheme south from the north end of the extended bored tunnel are eliminated except and for the vent near Annie Baileys..

Residential Property

All demolition requirements of the HS2 scheme are eliminated by the extended tunnel south of the new tunnel portal.

Community Infrastructure

The loss of amenities; Annie Bailey's on Chesham Road, Weights and Measures gym on Frith Hill under the HS2 scheme are eliminated by the tunnel extension.

The disruption to the community of South Heath during construction of the HS2 scheme will be eliminated.

Public rights of way and open space

The impact on public open space at South Heath by the HS2 scheme will be eliminated.

Cultural Heritage

Designated and non designated assets

The impact on designated and non designated assets under the HS2 scheme will be eliminated along the extent of the extended other than at the vent shaft location which will be insignificant compared to the HS2 impacts

Ecology

The impact on ecology under the HS2 scheme will be eliminated along the extent of the extended tunnel other than at the vent shaft location, which will be insignificant compared to the HS2 impacts.

Land Quality

The impact on Land Quality under the HS2 scheme will be eliminated along the extent of the extended tunnel other than at the vent shaft location, which will be insignificant compared to the HS2 impacts.

Landscape and visual assessment

The impact on landscape and visual assessment under the HS2 scheme will be eliminated along the extent of the extended tunnel other than at the vent shaft location, which will be insignificant compared to the HS2 impacts.

The additional depth at Liberty Lane especially for the first 0.5km will reduce the railways visibility and contribution to light pollution

Socio-economics

The socio economic effects under the HS2 scheme is not provided in the Draft ES however given the disruption to the AONB and the local communities it is clear that extending the tunnel will reduce the impact upon tourism and leisure use of this area of the Chilterns, as the footpaths and roads from Great Missenden will be unchanged. Also the dislocation during construction will be eliminated with the elimination of adverse effects on journey times and additional cost to businesses.

A high proportion of residents in the vicinity commute to London, so that impeding access to Great Missenden station will further depress the areas attractiveness for London commuters.

Visitors will find that visual and noise pollution of HS2 detracts from its attractiveness as a leisure destination in the AONB – with loss of business for shops, pubs and restaurants.

Sound, noise and vibration

The wide reaching and nature of the sound and noise impacts caused by the construction and operation of the HS2 scheme will be eliminated by the tunnel extension south of the new portal except at the vent shaft location, as will the need for all the mitigation such as bunds and barriers.

The vent shaft will be similar to those on the HS2 Ltd's planned Chiltern Tunnel and are provided with mitigation.

The new tunnel portal at Liberty Lane is in a deep cutting and away from the housing of South Heath and that on the South Heath end of Potter Row. As it will be considerably lower than the cutting part of the HS2 Ltd plan, this should mitigate the additional noise.

The cutting from Liberty Lane is lower than the HS2 Ltd one for1km, where it joins the HS2 Ltd vertical alignment. For this distance the greater depth should allow more effective mitigation, with less noise beyond the land occupied by the railway and its embankments.

The route of the extended tunnel will pass under dwellings saved from demolition, eg at Hyde Lane, Chesham Lane, Kings Lane, Frith Hill, and Mulberry Hill. Vibration from tunnelling operations and rail operations would not be different from elsewhere on the route and would be mitigated in the same way.

Traffic and transport

Under the HS2 scheme the local roads will incur heavy impacts from both heavy haulage and light vehicles accessing and egressing the works. Also there are many road diversions and closures which will cause confusion and disruption.

The extended tunnelling will considerably reduce the amount of traffic on the local roads and eliminate the need for diversions and closures between Liberty Lane and Mantles Wood. Neither of the two South Heath green tunnel satellite construction sites and storage compounds would be needed, and so the traffic associated with them will be eliminated. A smaller compound would be needed in connection with the additional vent, but this requires considerably less manpower and materials, and will have good access to the Chesham Road, the largest access route to the A413.

Spoil from the extended tunnel would be extracted via the main compound near the M25, so disposal of spoil will not use the A413 or the smaller roads between it and the line of route.

Water resources and flood risk

The impact on water resources and flood risk under the HS2 scheme will be eliminated along the extent of the extended tunnel other than at the vent shaft, which will be insignificant compared to the HS2 impacts

The deeper cutting from Liberty Lane to Cottage Farm Level crossing is in an elevated position and should have little effect on water resources or flood risk.