# Impacts of HS2 in the Area around South Cubbington Wood and Considerations of Possible Mitigation Measures

A paper for consideration by the Offchurch and Cubbington Community Forum



The carpet of Wood Anemones in South Cubbington Wood (photo: Frances Wilmot)

A sight to be preserved for future generations?

Submitted by: The Cubbington Action Group against HS2
April 2012

# **Table of Contents**

1.	Intro	oduction	1
2.	Envi	ronmental Overview of the Area	1
3.	Rou	te Design	3
	3.1.	History of the Route Design	
	3.2.	Description of the Post-Consultation Route Design	
4.		acts of HS2	
	4.1.	Environmental Impact of the Post-Consultation Route	
	4.2.	Visual Impact of the Post-Consultation Route	
	4.3.	Noise Impact	
	4.4.	Construction Impacts	
5.		gation Proposals Associated with an Alternative Vertical Alignment	
٠.	5.1.	Proposal to modify the vertical alignment and include a bored tunnel	
	5.2.	Additional mitigation for the Leam Valley	
6.		sibility of and Cost Estimates for the Mitigation Proposals	
٠.	6.1.	Feasibility	
	6.2.	Cost Estimates	
	6.3.	Spoil Considerations	
	J.J.	opon considerations	14

Appendix 1 - Map showing two designated footpaths that would be severed by the post-consultation route

Appendix 2 - Details of the significance of South Cubbington Wood (letter from the Chief Executive of Warwickshire Wildlife Trust)

**Appendix 3 - Proposed vertical alignment changes (indicative)** 

Appendix 4 - Calculations of volumes (and areas, where required) of features

#### 1. Introduction

This paper assesses the environmental impact of the section of the proposed HS2 route within the Parish of Cubbington, that lies immediately northwards of where the proposed route would cross the River Leam on a viaduct (at OS ref: SP359675); this river marks the southern boundary of the Parish of Cubbington. The area under consideration is a valuable wildlife habitat and recreational resource.

The environmental sensitivity of this area was raised by submissions to the public consultation and HS2 Ltd revised the route design in response to these concerns. This revised design (the "post-consultation" route), which was published in January 2012, employs a retained cutting as a compromise solution. This compromise avoids a horizontal realignment that would bring the route closer to local communities, whilst lessening the impact on the environment.

However, the post-consultation route does not avoid the severance that the route would cause to this area and would still inflict severe damage upon wildlife habitats, including an area of ancient woodland.

This paper offers an alternative, more environmentally sustainable, route alignment (the "alternative alignment"), utilising the same horizontal alignment but lowering the vertical alignment to permit a bored tunnel to be employed under the area of ancient woodland.

This paper identifies the environment advantages of this alternative alignment and makes a preliminary assessment of its cost implications. It is being submitted to the Offchurch and Cubbington Community Forum to request that HS2 Ltd assesses the feasibility of this alternative.

The Cubbington Action Group against HS2 is also concerned about the impacts that HS2 would have in the area where the proposed route passes under an elevated section of the A445 Leicester Lane, but this area will be the subject of a separate submission.

#### 2. Environmental Overview of the Area

The locality is the most easily accessed area of open country from the village of Cubbington and is, therefore, an important recreational resource for its residents. It also attracts walkers from outside the village due to a well-developed network of designated and permissive footpaths, which include a section of the long-distance Shakespeare's Avon Way and a popular local footpath between Cubbington and the villages of Offchurch and Hunningham; these two footpaths are marked on the map presented in Appendix 1 as figure A.1.1.

The area is mostly farmland, with a mixture of arable and pastoral farming. Much of the land is managed under the Environmental Stewardship Scheme, ensuring that the ancient hedgerows are nurtured, field margins are wide and sown with wild flowers and that the value of the farmland habitat for wildlife generally is improved. Today's farmers are carrying on a long tradition of caring for the land, as is demonstrated by the clear evidence of medieval strip farming in one of the pastures.

The broad valley of the River Leam runs south-west to north-east across the area. This is an unspoilt valley with no major roads or overhead power lines to lessen its appeal and the only large buildings to be seen are farm buildings.

The most prominent environmental feature in this area is the designated ancient woodland and Local Wildlife Site (LWS) of South Cubbington Wood. This is semi-natural woodland, dominated by English Oak, and occupying about 15 ha. The Wood forms an outlying part of the Princethorpe Woods Complex, which is, according to the Warwickshire Wildlife Trust, the largest concentration of semi-natural woodland in Warwickshire.

South Cubbington Wood supports a good diversity of ancient woodland indicator species (including a stand of Wild Service Trees) and is particularly noteworthy for its display of spring flowers, including Wood Anemones and Bluebells. It supports a breeding population of White Admiral butterflies and a good range of woodland birds.

Although it is not a designated Site of Special Scientific Interest (SSSI) South Cubbington Wood is, in the opinion of the Warwickshire Wildlife Trust, "a highly significant site for both its wildlife interest and its importance for the local community". The Trust holds the view that it "is of sufficient quality to be designated and protected as a Site of Special Scientific Interest".

Although the ownership of South Cubbington Wood is in private hands, the owner of the larger part operates an open-access policy, greatly increasing the value of the Wood to the local community and visitors to the area, alike.

Confirmation of the opinions attributed to the Warwickshire Wildlife Trust above and further details of the significance of South Cubbington Wood may be found in Appendix 2 to this paper.

There are several venerable hedgerows in the area, with a wide range of plant species that provide good wildlife habitat and support wildlife corridors. In one of these, just to the south of South Cubbington Wood, a fine Wild Pear Tree specimen grows. This is a "champion" tree, listed by The Tree Register (a registered charity collating and updating a database of notable trees throughout Britain and Ireland), with an estimated age of 200 to 300 years. It is subject of a Tree Preservation Order (TPO) made by Warwick District Council (number 458, dated 20<sup>th</sup> January 2012).

There are two main designated footpaths that cross the area; the aforementioned Shakespeare's Avon Way (which links Cubbington and Weston-under-Wetherley locally) and a path from Cubbington to Offchurch and Hunningham. These are augmented by a number of permissive paths.

There are four dwellings on the Rugby Road that lie within the boundaries of South Cubbington Wood and, nearby, the premises of Metcalfe Timber & Builders Merchants Ltd. There are also two farm houses in the area, occupied by farmers of the fields through which HS2 would pass; these two dwellings are each about 500 metres from the proposed line of the track.

There are properties along the Welsh Road, in the section that runs between Offchurch and Cubbington.

The eastern side of the main village of Cubbington is exposed to the proposed route. The nearest houses are approximately 500 metres from the proposed route. The Cubbington Church of England Primary School is a particularly sensitive site on the edge of the village. Also near to the School is the Church of St Mary, which has its origins in the 12<sup>th</sup> century.

#### 3. Route Design

#### 3.1. History of the Route Design

The route design maps that were published at the time of the original announcement about HS2 in March 2010 showed a horizontal route alignment approximately 80 metres further north-eastwards at the River Leam crossing and 120 metres further north-eastwards at the crossing of the B4453 Cubbington to Weston-under-Wetherley road (known as "Rugby Road"). This meant that the extent of the cutting actually within South Cubbington Wood was about half as long again as in the current design. The cutting also had a conventional profile giving a width of approximately 110 metres at ground level.

In this initial design, the viaduct across the River Leam was approximately 22 metres above river height and the cutting section through the Wood and under the B4453 Rugby Road was up to 26 metres deep.

In September 2010 the horizontal alignment was changed to its current position; this move was purely a "knock on" from a change at Stoneleigh to move the line away from the village. One of the design aims that HS2 Ltd identified for this redesign was lowering the trackbed "to reduce the extent and height of viaducts and embankments".

This aim was reflected in the design of the embankment and viaduct across the Leam Valley; the viaduct height was reduced to around 9 metres. The maximum depth of the cutting through the Wood was also reduced, to around 20 metres. This allowed the width of the cutting to reduce correspondingly, to around 90 metres.

This was substantially the design that was published for the consultation in February 2011 (the "consultation design"), with only minor height corrections made.

In the light of comments made in response to the public consultation about the damage that the consultation design would cause to South Cubbington Wood, HS2 Ltd carried out a review of the horizontal alignment to determine whether reducing the design speed of that route section would allow the Wood to be avoided. This review is reported in paragraphs 4.3.16 to 4.3.21 of the document *Review of HS2 London to West Midlands Route Selection and Speed*.

The outcome of this review was the conclusion that designing to a lower speed would allow the horizontal track alignment to be re-routed to avoid South Cubbington Wood, but that this horizontal realignment would increase the impact upon local communities. In the light of this, and the increased travel time that would result from design speed reductions, the horizontal realignment was rejected and the post-consultation route employs an alternative strategy set out in paragraph 3.2.3 of the document *Review of possible refinements to the proposed HS2 London to West Midlands Route*. This alternative strategy is to employ a "retained" cutting design over a track section of approximately 1250 metres, including the portion that would cut through South Cubbington Wood. The aspiration of this alternative is to "minimise the impacts" on South Cubbington Wood rather than to save it from damage.

#### 3.2. Description of the Post-Consultation Route Design

The details of the proposed route of HS2 across the area that is the subject of this paper are detailed in drawings HS2-ARP-00-DR-RW-05021 (issue 3.0) and HS2-ARP-00-DR-RW-05022 (issue 4.0). These drawings are the versions published in January 2012 and show the "post-consultation" route.

Whilst these drawings specify figures for the vertical alignment at every 100 metre chainage point, which include the proposed trackbed level and the "cut and fill", no numerical information is given for the width of track features in the horizontal plain. Further it is understood that the representation of features, such as embankments and cuttings, in the horizontal plane of these drawings is indicative only, and cannot be relied upon for assessing dimensions.

The proposed route of HS2 would cross the River Leam at approximately chainage 133+800 on a viaduct, 170 metres long and rising approximately 11 metres above the River. It would then traverse the north-western side of the Leam Valley on an embankment that would stand above the natural ground level by between about 6 to 8 metres and run for approximately 600 metres, until it meets the rising ground of the valley at a point about 250 metres south-east of the south-eastern corner of South Cubbington Wood (at approximately chainage 134+500 and OS ref: SP355680).

The route would continue north-westwards in a cutting, necessitated by a hill which reaches its maximum height of 99 metres AOD at the alignment of the B4453 Rugby Road. For the first 250 metres this cutting would have "conventionally" sloping sides and a maximum width at natural ground level of about 90 metres. At approximately the point where the cutting would reach the southern end of South Cubbington Wood (at approximately chainage 134+800) it is proposed to reduce its width using a retaining structure. Together with the removal of the access road, this would allow the width of the cutting to be reduced; as far as we can ascertain no value of this reduced width has been published by HS2 Ltd. This reduced-width section of the cutting would run for 1250 metres, returning to a conventional profile (at approximately chainage 136+000 and OS ref: SP346693) approximately 350 metres before the proposed route crosses under Coventry Road.

The restricted-width cutting would pass through the southern part of South Cubbington Wood, dividing the section of the Wood that lies south of the Shakespeare's Avon Way footpath into two parts; one of these being approximately twice the area of the other.

The restricted-width cutting would cross the B4453 Rugby Road, necessitating a new road bridge to be built.

The depth of the cutting through the Wood would be a maximum of about 16 metres below natural ground level.

This paper proposes revisions to the vertical alignment of this post-consultation route that would considerable reduce the environmental impacts. No changes are proposed to the horizontal alignment.

#### 4. Impacts of HS2

#### 4.1. Environmental Impact of the Post-Consultation Route

The section of the post-consultation route proposed between the River Leam and Rugby Road would severely fragment three farm fields and take land from three others.

The proposed cutting would sever an important hedgerow and potential wildlife corridor linking South Cubbington Wood to the River Leam. The excavation of the cutting would destroy the Champion Wild Pear Tree growing in this hedgerow and sever the Shakespeare's Avon Way long-distance footpath and the important and well-used footpath that runs from Cubbington to Offchurch and Hunningham.

Even with the redesigned retained cutting, the damage that HS2 would inflict upon South Cubbington Wood would be severe. Paragraph 3.2.4 in the document *Review of possible refinements to the proposed HS2 London to West Midlands Route* concedes that the new cutting "would reduce land take of the ancient woodland, though would still result in some fragmentation". Regarding this latter point, the latest revision to the cutting design would have little benefit, since the horizontal alignment has not been changed and the cutting still severs the Wood. Accordingly, the section of the Wood that lies south of the Shakespeare's Avon Way footpath would still be divided into two portions, in the ratio of about one-third and two-thirds. All that the proposal to employ a retained cutting means is that the two parts would each be slightly bigger, but of course they would both be considerable smaller than the undivided woodland before HS2.

The land take from the woodland resulting from employing a retained cutting would, it is true, be considerably less than the proposal published for the public consultation. Removing a strip of vegetation and soil from the Wood, 20 metres or so wide, may not sound too severe, but this would not be the only damage inflicted.

Firstly, account has to be taken of what was said about the "rail corridor" in paragraph 3.1.1 on pages 8 and 9 of Volume 1 of the *Appraisal of Sustainability Main Report*, which is:

"Consideration has been given at this stage for using up to 25m clearance on each side of the route for landscaping, vegetation plantings, etc."

And, in the same paragraph:

"A more detailed corridor proposal would be developed following an assessment of vegetation along the perimeter of the proposed line of route in conjunction with third parties to assess the impact of 'leaf fall' on the operation of the railway and on any desired planting arrangements."

Although these extracts hardly provide a clear and unambiguous statement of the policy on preventing problems of leaf fall on train operations, there is an obvious implication that any of the native deciduous trees that predominate in South Cubbington Wood growing within 25 metres of the walls of the cutting would probably have to be felled. This would increase the effective width of the land take to, 70 metres or so.

Secondly, it is very likely that there would the damage to vegetation and soil disturbance resulting from the deployment of heavy earth-moving machinery within the Wood during the construction of the cutting. It is probably unrealistic to expect this damage to

be confined within the boundary of the finished cutting and associated clear-felled areas.

It is also worth noting from the description in Appendix 2 that the vegetation in parts of South Cubbington Wood relies on "heavy clay soils of impeded drainage"; that such conditions exist in the Wood is evident from the wet conditions underfoot in all but the driest periods. It is likely that the impeded drainage is due to an impermeable layer below ground surface, which might be breached by the excavation of a cutting, so risking changes to the whole ecosystem of the Wood.

#### 4.2. Visual Impact of the Post-Consultation Route

The visual impact that would result from the proposed HS2 route across the Leam Valley is a concern, because the embankment and viaduct would be a very significant visual intrusion into this previously unspoilt valley.

The severity of this impact would depend upon the height of the embankment and viaduct. In this respect the potential situation has worsened as the result of the post-consultation exercise, the aim of which appears to have been to reduce off-site spoil disposal quantities by raising embankments.

The revised height of the embankment has increased by around 2 metres and the embankment is approximately 70 metres longer.

## 4.3. Noise Impact

Information on HS2 noise impacts within the area that is the subject of this paper so far provided by HS2 Ltd is limited to two sources.

The first of these is the *Residential Airborne Noise Appraisal* maps in Section 3.5 of Volume 2 of the *Appraisal of Sustainability Main Report*, and in particular drawings HS2-BZT-00-DR-SU-00327 and HS2-BZT-00-DR-SU-00328. These drawings are of very poor quality when viewed on a computer screen, but appear to show that one of the farm houses referred to in section 2, above, and a number of properties along Welsh Road would be subject to more than a "noticeable increase" in noise (grey dot).

The second is the noise simulation provided at the Cubbington consultation roadshow. This demonstration indicated that noise from a train running within the cutting detected by a receptor by the King's Head public house in the village should not be a cause for concern, but did not demonstrate the impact of noise from a train crossing the Leam Valley.

It must be emphasised that both of these sources relate to the consultation design and do not reflect the vertical alignment changes that have subsequently been made. The increases in trackbed height now proposed are likely to have increased the impact from HS2 noise.

The potential for noise nuisance from the section of track proposed across the Leam Valley, currently an area of low ambient noise level, is a concern for the valley and the communities on the valley sides. Whilst higher ground between the track and the village of Cubbington may offer some protection, noise from the Leam Valley section cannot be ruled out as a source of annoyance for residents, particularly when the effects of weather are taken into account. The villages of Offchurch and Weston-under-Wetherley could suffer even higher noise nuisance levels, because of less favourable topography.

The post-consultation cutting design is shallower than the consultation design and has vertical hard, and therefore possibly sound-reflective, side walls (unless a sound-absorptive layer is applied). These design changes may increase the noise level emanating from the cutting and render the roadshow demonstration unrepresentative.

There is an urgent need for a detailed quantitative study by HS2 Ltd to assess the impact of noise from HS2 throughout the length of the route.

Cubbington Action Group against HS2 believes that the topic of how noise nuisance is estimated and the parameters in which it is expressed should be considered by the Community Forum. However we regard this topic, essential as it is in ensuring that any local noise mitigation proposals are properly targeted and effective, as outside of the scope of this current submission.

## 4.4. Construction Impacts

The excavation of a large cutting, a significant embankment and a viaduct at distances within 600 metres of a village and closer to some properties is bound to pose problems of noise, dust, inconvenience and disturbance. The possible effects upon the Cubbington Church of England Primary School are of particular concern.

The B4453 Rugby Road is an important commuter route. Disruption to this road is bound to result from the need to bridge the cutting and a suitable temporary diversion would have to be provided.

Cubbington Action Group against HS2 believes that the mitigation proposals for our area should include effective measures, such as restricting working hours whenever practical, in order to minimise the effects of construction nuisance upon our community and environment. Whilst we believe that such measures should be considered by the Community Forum, we regard this topic as outside of the scope of this current submission.

#### 5. Mitigation Proposals Associated with an Alternative Vertical Alignment

#### 5.1. Proposal to modify the vertical alignment and include a bored tunnel

In its response to the public consultation, the Cubbington Action Group against HS2 suggested that the problem posed by South Cubbington Wood would best be solved by a bored tunnel under the Wood; a design choice that has already been adopted by HS2 Ltd under Ufton and Long Itchington Woods.

This suggestion appears to have been ignored by HS2 Ltd, as no reference to it can be found in the documents that were e-published on 10<sup>th</sup> January. This may have been because the original suggestion contained insufficient detail and so the Cubbington Action Group against HS2 wishes to take the opportunity of the Offchurch and Cubbington Community Forum to resubmit this proposal with additional information.

The recently published *National Planning Policy Framework* document gives an indication of the importance of protecting "irreplaceable habitats", such as "ancient woodland" (like South Cubbington Wood) and "aged or veteran trees" (such as the Wild Pear Tree), from "loss or deterioration". It states that "planning permission should be refused for development" in such cases "unless the need for, and benefits of, the development in that location clearly outweigh the loss".

We suggest that HS2 Ltd has an obligation to the environment and future generations to avoid inflicting "loss or deterioration" upon South Cubbington Wood and the Wild Pear Tree if this is at all possible and that the proposal described in this paper may provide the means to do this.

This proposal is to replace a section of the retained cutting by a twin-bored tunnel, running on the same horizontal alignment as the present route, but with a lower vertical alignment to allow for the necessary minimum track depth below ground of twice the tunnel diameter, as advised in paragraph 2.3 of *High Speed 2 Route Engineering Report* (Arup, February 2011). Since the topology and required tunnel length is similar to the Ufton and Long Itchington Woods tunnel, the same design has been assumed; this tunnel has a specified internal diameter of 10.2 metres for each of the twin bores, making the minimum headroom about 21 metres.

An indication of the way in which the vertical alignment could be modified to accommodate this tunnel is shown by a red line in Appendix 3. The proposal is for the section of the retained cutting between chainages 134+650 and 135+850, approximately 1200 metres in length, to be replaced by a bored tunnel. This change brings the southernmost tunnel portal close to the southern edge of South Cubbington Wood, but should remove the need to excavate within the Wood. Also, with careful design and construction, it should be possible for the Wild Pear Tree and the hedge in which it is growing to be preserved intact and the existing Cubbington to Offchurch/Hunningham footpath to be retained.

The proposed tunnel would remove the need to construct a road bridge to carry the B4453 Rugby Road over the HS2 track and would avoid severing the Shakespeare's Avon Way footpath, and the consequent requirement to provide an alternative route for this important footpath.

For the purposes of this paper, it has been assumed that, north of about chainage 135+850, the proposed cutting designs would still be employed, but with increased depth between chainage 135+850 and 136+600; this is to allow the trackbed height to be reduced progressively to accommodate the required tunnel headroom. The maximum cutting depth increase would be about 7.5 metres.

An added advantage of this proposed vertical realignment is that it allows the height of the trackbed across the Leam Valley to be significantly reduced, on both sides of the valley. With this proposal the height of the viaduct above the River Leam could be reduced to about 6.5 metres (more than a 40% decrease in height). Subject to satisfying the minimum flood water level clearance requirements specified by the Environment Agency, this decrease in viaduct height should significantly reduce its cost. Also the embankments on the rising sides of the valley could be reduced in height by up to 7 metres, subject again to flood water height considerations. In addition, the proposal reduces the length of the embankment north of the River Leam from about 650 metres to only about 400 metres.

The reduced height of the embankments would of course mean that less spoil from the cutting excavation could be disposed of in their construction. The comparison of the spoil impacts of the post-consultation and the revised alignments in section 6.2 below indicates that the quantity of spoil for disposal using the revised alignment would increase by about 30%.

Some of this additional spoil could be put to good use to construct noise reducing bunds for the section crossing the Leam Valley, but this would depend upon whether such bunds are found to be the most appropriate solution in this area (refer to section 5.2, below).

## 5.2. Additional mitigation for the Leam Valley

The section of the proposed HS2 route that crosses the Leam Valley is likely to have severe visual and noise impacts. The adoption of the proposed vertical realignment that is outlined in section 5.1, above, would reduce these impacts by keeping the trackbed level closer to the natural ground level. Further mitigation of the impacts seems appropriate, however.

The proposed viaduct should be of a visually pleasing and unobtrusive design and be as low as possible. It should incorporate high quality noise absorptive trackside barriers into its design, as unobtrusively as is feasible.

The track should be screened with vegetation, preferably using native trees and shrubs, to reduce the visual impact. However, this method of mitigation would be of reduced benefit in winter and when the Leam Valley is viewed from higher ground, such as can be found near South Cubbington Wood and within the village of Offchurch.

Noise mitigation should be provided and should not rely upon absorption by vegetation. High quality absorptive trackside barriers are likely to be the simplest method to adopt, although due consideration should be paid to the visual impact of such barriers and some suitable natural screening, such as vegetation planting, provided in addition. Alternatively, a "green screen living" type absorptive barrier might be employed.

If the suggested lower trackbed height is adopted, then noise reducing bunds may become feasible. Such bunds could be planted with vegetation to naturalise them and reduce the visual impact. They would also provide the opportunity to dispose of more spoil locally, but have the disadvantage of increasing the size of the footprint of the railway. The placement of "Gabion wall" absorptive barriers on the crest of the bunds could also be considered.

Where sound barriers or bunds are employed they should be of sufficient height to attenuate the train noise measured at the nearest affected dwelling by at least 10 dBA, at all points across the audible spectrum.

## 6. Feasibility of and Cost Estimates for the Mitigation Proposals

#### 6.1. Feasibility

The line of the proposed revised vertical alignment shown in Appendix 3 has been constructed from sections of arc of 56000 metre radius and straight gradients forming tangents to these arcs and, accordingly, complies with the design parameters specified in paragraph 2.1 of *High Speed 2 Route Engineering Report* (Arup, February 2011).

The revised vertical alignment over the whole section between chainages 132+600 and 136+700 involves a maximum difference in trackbed levels of approximately 16 metres (sag to crest); the comparable level difference for the post-consultation design is over 21 metres.

The revised vertical alignment allows the trackbed to be at least the minimum depth of twice the tunnel diameter below ground level, as required by paragraph 2.3 of Arup's *High Speed 2 Route Engineering Report*, along the entire length of the proposed tunnel.

The amount to which the track section across the Leam Valley may be lowered will depend upon flooding considerations. However, the markings of the flood plain limits on drawing HS2-ARP-00-DR-RW-05021 indicate that flooding is limited to a fairly narrow strip of land, due to the confining nature of the topography.

The tunnel proposal has been made without any examination of the suitability of the geology of the area. This analysis will obviously be necessary, but is considered outside of the scope of this current submission.

The tunnel proposal has been made without any examination of the hydrogeology of the area. This may be particularly important for two reasons. Firstly, as has been noted in section 4.1 above, South Cubbington Wood is, in character, wet woodland and this characteristic may be changed significantly by any excavation in the area. However, it is more likely that the excavation of a tunnel, unlike the currently-proposed cutting, would not breach any impermeable layer near the surface that might be responsible for the impeded drainage of the area.

Secondly, flooding has proved to be a problem in Cubbington. In 2007 over forty properties in Cubbington were flooded and flood alleviation measures in the area southeast of the Village are due to be implemented in the near future. The source of the flood was determined as surface water run-off from the fields that lie between the eastern side of the Village and the proposed route of HS2.

Hydrogeological analysis of the additional effects of HS2 will obviously be necessary, but is considered outside of the scope of this current submission.

It is assumed that, subject to geotechnical survey, the construction techniques employed to tunnel under South Cubbington and Ufton/Long Itchington Woods would be similar. The close proximity of the two sites should allow for economies of scale and for any necessary plant (such as tunnel boring machinery, if this is required) to be shared.

#### 6.2. Cost Estimates

The unit cost figures employed for these estimates have been taken from Appendix A of HS2 Ltd document *High Speed Rail London to the West Midlands and Beyond HS2 Cost and Risk Model* (December 2009).

Volumes and areas of structures have been calculated using the Excel spreadsheet reproduced in Appendix 4 to this paper.

# Elements of the post-consultation design (using a retained cutting)

Section 1 - embankment between 133+900 and 134+550	
159,866 cubic metres of embankment at £21.5 per cubic metre	£3,437,119
Section 2 - cutting between 134+550 and 134+800	
131,640 cubic metres of cutting at £17.85 per cubic metre	£2,349,774
Section 3 - retained cutting between 134+800 and 136+030	
387,530 cubic metres of cutting at £17.85 per cubic metre	£6,917,411
35,230 square metres of retaining structure at £370 per square metre	£13,035,100
Section 4 - cutting between 136+030 and 136+700	
214,773 cubic metres of cutting at £17.85 per cubic metre	£3,833,698
Additional item - B4453 road bridge	
205 square metres of road surface at £1,900 per square metre	£389,500
Total	£29,962,602

# Elements of the alternative alignment (using a bored tunnel)

Section 5 - embankment between 133+900 and 134+150	
14,878 cubic metres of embankment at £21.5 per cubic metre	£319,877
Section 6 - Cutting between 134+150 and 134+650 (tunnel portal)	
148,964 cubic metres of cutting at £17.85 per cubic metre	£2,659,007
Section 7 - Bored tunnel between chainages 134+650 and 135+850	
1200 metres of twin-bore tunnel at £61,625 per metre (see note below)	£73,950,000
Section 8 - retained cutting between 135+850 and 136+030	
86,537 cubic metres of cutting at £17.85 per cubic metre	£1,544,685
7,867 square metres of retaining structure at £370 per square metre	£2,910,790
<u>Section 9 - cutting between 136+030 and 136+700</u>	
307,107 cubic metres of cutting at £17.85 per cubic metre	£5,481,860
Total	£86,866,219

## Other savings/costs associated with the alternative (bored tunnel) alignment

Lower viaduct over River Leam (saving)	No data available
Reduced land take (saving)	No data available
No temporary diversion of B4453 Rugby Road (saving)	No data available
No footpath diversions or footbridges (saving)	No data available
Disposal of additional spoil – see section 6.3 (cost)	No data available

#### Additional cost of the alternative (bored tunnel) alignment

Total cost of alternative alignment	£86,866,219
Total cost of post-consultation route	£29,962,602
Additional cost of alternative alignment	£56,903,617

Note: The unit cost figure of £61,625 per metre for a twin-bore tunnel given in Appendix A of *High Speed Rail London to the West Midlands and Beyond HS2 Cost and Risk Model* is for a 7.5 metre internal diameter bore. No figure is available for a 10.2 metre internal diameter bore.

#### 6.3. Spoil Considerations

The Excel spreadsheet reproduced in Appendix 4 to this paper may also be used to compare spoil quantities for the two alternative alignments.

## Elements of the post-consultation design (using a retained cutting)

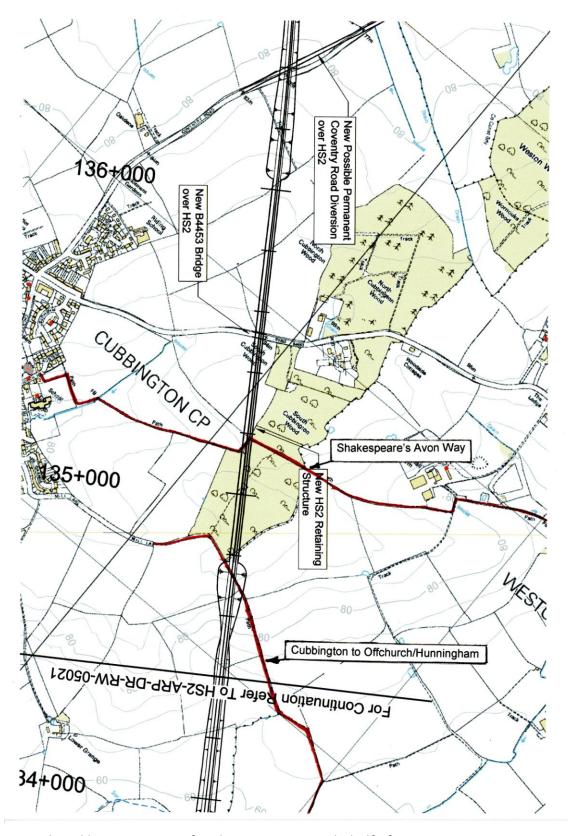
Section 1 - embankment between 133+900 and 134+550	
Spoil utilised in constructing embankment (cubic metre)	-159,866
Section 2 - cutting between 134+550 and 134+800	
Spoil generated from excavating cutting (cubic metre)	131,640
Section 3 - retained cutting between 134+800 and 136+030	
Spoil generated from excavating cutting (cubic metre)	387,539
Section 4 - cutting between 136+030 and 136+700	
Spoil generated from excavating cutting (cubic metre)	214,773
Spoil requiring disposal off-site	574,086

# Elements of the alternative alignment (using a bored tunnel)

Section 5 - embankment between 133+900 and 134+150	
Spoil utilised in constructing embankment (cubic metre)	-14,878
Section 6 - Cutting between 134+150 and 134+650 (tunnel portal)	
Spoil generated from excavating cutting (cubic metre)	148,964
Section 7 - Bored tunnel between chainages 134+650 and 135+850	
Spoil generated from excavating tunnel (cubic metre)	207,816
Section 8 - retained cutting between 135+850 and 136+030	
Spoil generated from excavating cutting (cubic metre)	86,537
<u>Section 9 - cutting between 136+030 and 136+700</u>	
Spoil generated from excavating cutting (cubic metre)	307,107
Spoil requiring disposal off-site	735,546

The alternative (bored tunnel) alignment would, accordingly, generate approximately 30% more spoil to be disposed of off-site.

<b>APPENDIX</b> 1 – Map showing two designated footpaths that would be severed by the post-consultation route
The Ordinance Survey mapping upon which the footpaths have been overlayed has been reproduced in accordance with the principles of fair dealing as set out in the Copyright, Designs and Patents Act 1988.



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**Figure A.1.1** – The routes of two designated footpaths passing South Cubbington Wood

**APPENDIX** 2 – Details of the significance of South Cubbington Wood (letter from the Chief Executive of Warwickshire Wildlife Trust)



Mr P Delow 11 Pinehurst Cubbington Leamington Spa Warwickshire CV32 7XA

10 July 2011

Dear Peter

#### The significance of South Cubbington Wood, near Leamington, Warwickshire

Thank you for your recent letter. I would like to confirm that Warwickshire Wildlife Trust is strongly opposed to the route of HS2 and is particularly opposed to the section which is aligned through South Cubbington Wood.

This woodland is a highly significant site for both its wildlife interest and its importance for the local community. In the Trust's opinion this woodland is of sufficient quality to be designated and protected as a Site of Special Scientific Interest and is one of few remaining ancient woodland sites in Warwickshire.

In summary, according to recent surveys in 2000 and 2010/11, the significance of the wood is summarised in the attached sheets.

The Trust would be opposed to any proposal which involved the destruction, damage or disturbance of South Cubbington Wood. Any proposals to create a cutting or cut and cover tunnel would not be acceptable to the Trust because it would involve irreversible and permanent damage to the woodland's special qualities. If HS2 is approved, the only option to protect this important site would either be to drive a tunnel bored beneath the wood or to reroute the line to avoid the area completely.

Please let me know if you have any further queries or if we can help with further information.

Yours sincerely

Stephen Trotter Chief Executive

Brandon Marsh Nature Centre, Brandon Lane, Coventry, CV3 3GW

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Vice Chairs Graham Harrison Ron Hill | Chief Executive Stephen Trotter
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#### South Cubbington Wood - Site Description

South Cubbington Wood is an ancient semi-natural woodland of 15 ha in size situated to the east of Cubbington near Leamington Spa. The wood forms an outlying part of the Princethorpe Woods Complex which is the largest concentration of semi natural woodland in Warwickshire.

South Cubbington is an excellent example of a traditional Warwickshire woodland. It is surrounded by an intact boundary ditch and ridge and contains old coppice stools of Ash (*Fraxinus excelsior*) and Wild Service Tree (*Sorbus torminalis*). In the North East of the wood there is a high density of vigorous Hazel (*Corylus avellana*). The large number of stools, suggests that coppicing appears to have been practiced here relatively recently.

English Oak (Quercus robur) is the dominant standard tree with some Ash and Birch (Betula) invading since the cessation of coppicing. The canopy is dense as is the shrub layer of Hazel stools. The ground layer is shaded to exclusion of ground flora in small parts of the densest shade, elsewhere Bluebell (Hyacinthoides non-scripta) is the vernal dominant. The vegetation here is W10 Quercus robur-Pteridium aquilinum-Rubus fruticosus woodland (English Oak-Bracken-Bramble woodland). Moving South and West through the wood Oak decreases as a standard and Ash and Field Maple (Acer campestre) increase. In the Southern half of the wood the dominance of Bluebells decreases and is replaced by Wood anemone (Anemone nemorosa) as the vernal dominant. Here the vegetation is W8b Fraxinus excelsior-Acer campestre- Mercurialis perennis woodland, Anemone nemorosa subcommunity (Ash-Field Maple-Dogs Mercury woodland, Wood Anemone sub community), this vegetation occurs on heavy clay soils of impeded drainage. Notably some veteran Midland Hawthorn (Crataegus laevigata) trees contribute to the canopy and Wild Service Tree and Small Leaved Lime (Tilia cordata) are present. In this area of the wood there are several small shaded pools. Fallen dead stems of Ash and Birch are scattered throughout. Regeneration of Ash saplings is taking place sporadically, over most of the wood. Invasive non native trees and shrubs are not a major problem, though Cherry Plum (Prunus cerasifera), Snowberry (Symphoricarpos rivularis) and Sycamore (Acer pseudoplantus) are present. A small part of the wood has under-planting of cypress trees.

There is a good diversity of ancient woodland indicator species including Moschatel (Adoxa moschatellina), Wood anemone, Wood Sedge (Carex sylvatica), Enchanters Nightshade (Circaea lutetiana), Ground Ivy (Glechoma hederacea), Bluebell, Wood Sorrel (Oxalis acetosella), Wild Service Tree, Yellow Archangel (Lamiastrum galeobdolon) Small Leaved Lime and the Butterfly, White Admiral (Ladoqa camilla).

Other notable historic records include breeding nightingales (Last record 1980) and abundant Purple Hairstreak butterflys (*Quercusia quercus*).

The woodland has been designated as a Local Wildlife Site. The Evaluation against the criteria is as follows (Habitat criteria applied: Woodland): SCIENTIFI Elements of the criteria COMMUNITY Elements of the criteria applying to the site CRITERIA applying to the site **CRITERIA** 6 Diversity Physical & Visual Access Rarity Educational Value Size Community & Amenity Value **Naturalness** Aesthetic Appeal & Landscape Fragility Geographical Position **Typicalness** Recorded History Ecological Continuity of Position Landuse Significant Populations Potential Value

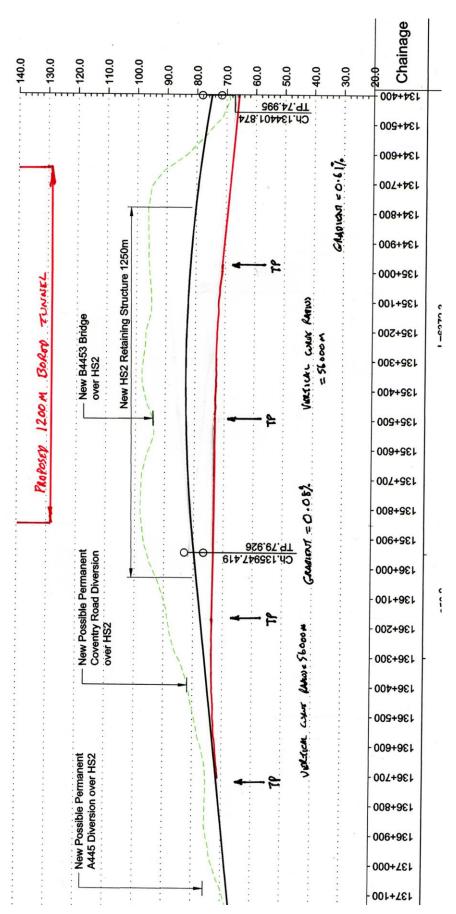
## Why this site qualifies as a Wildlife Site: Summary of assessment

South Cubbington Wood scores very highly, meeting 19 scientific and 14 sociological criteria. Notably it meets all the diversity criteria and other important naturalness and rarity criteria. The woodland is obviously ancient as demonstrated by its evidence of traditional management and indicator species. The W8b woodland sub community is locally rare in Warwickshire. The wood contains several locally rare species notably the Butterfly's White Admiral and Purple Hairstreak and several ancient woodland indicator plant species. The area of the wood is not large in itself, but it is connected to two other woods of the Princethorpe Woods Complex, comprising a large area of woodland.

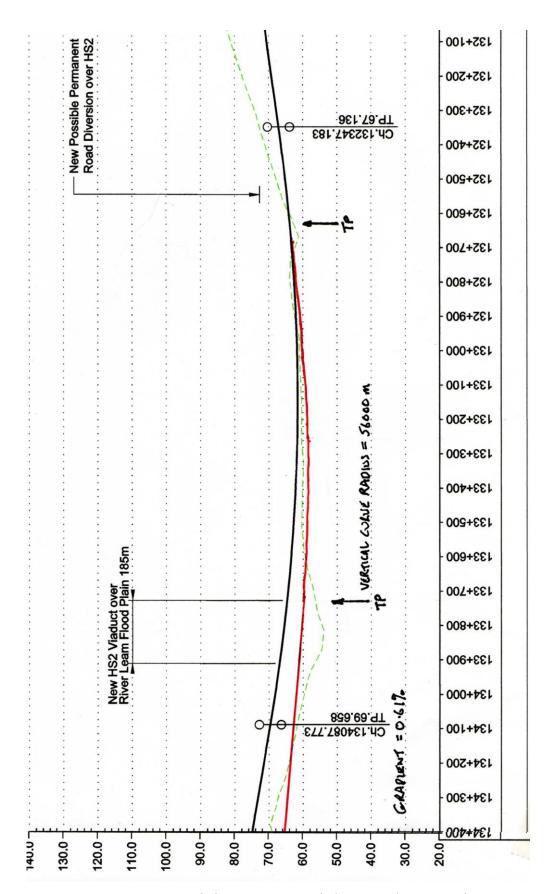
The wood is in quite a natural state with the NVC types W8b and W10 recognisable; regeneration of native trees; presence of dead wood and a low abundance of non native invasive species. Cypress has been underplanted and represents a threat to the wood. There is a good potential for the value of the wood to be increased as the landowner is interested in managing the wood for conservation.

Sources of Information : WSproject, WBRC, HBA

APPENDIX 3 – Proposed vertical alignment changes (indicative)
The proposed new vertical alignment is indicated by the red line.



**Figure A.3.1** - Proposed change to vertical alignment between chainages 134+400 and 137+100 (indicative only) – source of original drawing HS2 Ltd



**Figure A.3.2** - Proposed change to vertical alignment between chainages 132+100 and 134+400 (indicative only) – source of original drawing HS2 Ltd

#### APPENDIX 4 - Calculations of volumes (and areas, where required) of features

In this Appendix 4 estimates of the volumes (and surface areas, where required) of the features, such as cuttings and embankments, specified for the post-consultation design and the alternative proposed by this paper have been made using an Excel spreadsheet. These calculations have been employed in section 6.2 of this paper to enable some basic comparisons of the costs of the two alternative designs to be made. In addition, the same calculations have been utilised in section 6.3 of this paper to assess the spoil that would be generated by each of the two proposals.

In order for these calculations to be made, it has been necessary to employ some simplifying assumptions and these are identified below.

#### General assumptions:

- That the volume of a cutting or embankment may be estimated by summing the
  estimated volume of separate sections between adjacent one hundred metre
  chainage points (e.g. 133+300 to 133+400) and using "cut" or "fill" values for these
  one hundred metre chainage points only, without any consideration of the values
  within these chainage points.
- That the cut or fill at each one hundred metre chainage point of the postconsultation design may be taken from the row of values designated as "cut and fill" on drawings HS2-ARP-00-DR-RW-05021 (issue 3.0) and HS2-ARP-00-DR-RW-05022 (issue 4.0).
- That the cut or fill at each one hundred metre chainage point of the alternative alignment may be scaled off from the red line marked on the drawings in Appendix 3 to this paper.
- That where the end of a cutting or embankment does not approximately align with a one hundred metre chainage point, the volume of a section of less than one hundred metres, between the nearest one hundred metre chainage point and the chainage of the end of the cutting or embankment, may be estimated and added to the sum of other relevant sections.
- That the cut or fill of any required chainages that are intermediate between one hundred metre chainage points may be scaled off drawings HS2-ARP-00-DR-RW-05021 (issue 3.0) and HS2-ARP-00-DR-RW-05022 (issue 4.0) or the from the red line marked on the drawings in Appendix 3 to this paper, as appropriate.
- That expansion of excavated spoil and compaction of embanked spoil may be ignored.

Additional assumptions employed for cuttings with sloping sides:

- That the cross-section of a cutting described as of having "sloping sides" has a flat base of 22 metres width and uniformly sloping sides that extend a further distance at natural ground level of twice the cutting depth (i.e. the "cut" depth).
- That the cross-sectional area of such a cutting at any point may be calculated from the expression (22c + 2c<sup>2</sup>), where "c" is the depth of cut at that point.

• That the volume of a section of the cutting between two points, A and B, which are a distance "d" apart may be estimated from the expression d((cross-sectional area at A) + (cross-sectional area at B))/2.

Additional assumptions employed for the retained cutting (proposed for the post-consultation design between chainages 134+800 and 136+030):

- That the cutting has vertical sides. We have been unable to find any confirmation
  of this, or whether the wall would be constructed with a batter, in the documents
  that have been published.
- That the trackbed width within the cutting will be the standard width of 22
  metres, less 4 metres saved by removing the access road. A further 2 metres of
  excavation has been allowed on either side to allow the retaining walls to be
  constructed, leading to a minimum width of excavation of 22 metres.
- That the cutting is a uniform 22 metres wide and that the cross-section of the retained cutting is, therefore, a rectangle with base of 22 metres and side equal to the cutting depth.
- That the volume of a section of the retained cutting between two points, A and B, which are a distance "d" apart may be estimated from the expression 35d((depth at A) + (depth at B))/2.
- That the retaining structure extends for the full depth of the cutting.
- That the area of the retaining structure on each face of the cutting between two
  points, A and B, which are a distance "d" apart may be estimated from the
  expression d((depth at A) + (depth at B))/2.

Additional assumptions employed for embankments:

- That all sections of embankment have a level top of 22 metres width and uniformly sloping sides that extend a further distance at natural ground level of twice the embankment height (i.e. the "fill" height).
- That the cross-sectional area of such an embankment at any point may be calculated from the expression (22f + 2f<sup>2</sup>), where "f" is the height of fill at that point.
- That the volume of a section of the embankment between two points, A and B, which are a distance "d" apart may be estimated from the expression d((cross-sectional area at A) + (cross-sectional area at B))/2.

Additional assumptions employed for the tunnel:

• That tunnel bores have a circular cross-section.

## Calculation of Volumes (and Areas)

#### HS2 Ltd proposed route (post-consultation with retained cutting)

#### Section 1 - embankment between 133+900 and 134+550

Assumed trackbed width (metres)

22

Section (A to B)		Fill at A	Fill at B	Cross- sectional area at A	Cross- sectional area at B	Mean cross- sectional area of section	Volume of section
Α	В						
133+900	134+000	10.6	8.5	457.9	331.5	394.7	39471
134+000	134+100	8.5	8.0	331.5	304.0	317.8	31775
134+100	134+200	8.0	7.4	304.0	272.3	288.2	28816
134+200	134+300	7.4	6.0	272.3	204.0	238.2	23816
134+300	134+400	6.0	5.8	204.0	194.9	199.4	19944
134+400	134+500	5.8	3.0	194.9	84.0	139.4	13944
134+500	134+550	3.0	0.0	84.0	0.0	42.0	2100

Total volume 159866

#### Section 2 - cutting between 134+550 and 134+800

Sloping sides assumed

Assumed trackbed width (metres)

22

Section (A to B)		Cut at A	Cut at B	Cross- sectional area at A	Cross- sectional area at B	Mean cross- sectional area of section	Volume of section
Α	В						
134+550	134+600	0.0	4.9	0.0	155.8	77.9	3896
134+600	134+700	4.9	14.9	155.8	771.8	463.8	46382
134+700	134+800	14.9	15.9	771.8	855.4	813.6	81362

Total volume

131640

Section 3 - retained cutting between 134+800 and 136+030

Uniform cutting width assumed throughout (metres)

22

Section (A to B)		B) Cut at A Cut at B		Average depth	Area of side	Volume	
Α	В						
134+800	134+900	15.9	14.8	15.4	1535	33770	
134+900	135+000	14.8	13.6	14.2	1420	31240	
135+000	135+100	13.6	12.4	13.0	1300	28600	
135+100	135+200	12.4	13.7	13.1	1305	28710	
135+200	135+300	13.7	14.4	14.1	1405	30910	
135+300	135+400	14.4	14.2	14.3	1430	31460	
135+400	135+500	14.2	11.0	12.6	1260	27720	
135+500	135+600	11.0	12.9	12.0	1195	26290	
135+600	135+700	12.9	15.9	14.4	1440	31680	
135+700	135+800	15.9	16.9	16.4	1640	36080	
135+800	135+900	16.9	16.8	16.9	1685	37070	
135+900	136+000	16.8	14.8	15.8	1580	34760	
136+000	136+030	14.8	13.2	14.0	420	9240	

Twice by total area of side 3523
Total volume

35230 Total volume 387530

#### Section 4 - cutting between 136+030 and 136+700

Sloping sides assumed

Assumed trackbed width (metres)

22

Section (A to B)		Cut at A	Cut at B	Cross- sectional area at A	Cross- sectional area at B	Mean cross- sectional area of section	Volume of section
Α	В					55511511	
136+030	136+100	13.2	12.0	639	552	595.4	41681
136+100	136+200	12.0	11.1	552	491	521.3	52131
136+200	136+300	11.1	9.1	491	366	428.2	42822
136+300	136+400	9.1	6.6	366	232	299.1	29907
136+400	136+500	6.6	5.6	232	186	209.1	20912
136+500	136+600	5.6	4.2	186	128	156.8	15680
136+600	136+700	4.2	3.6	128	105	116.4	11640

Total volume 214773

Additional item - B4453 road bridge

Assumed span (metres) Assumed road width (metres)

22 9.3

(Road width is in accordance with the single-carriageway example in figure 4-3a in Volume 6 Section 1 Part 2 of the Design Manual for Roads and Bridges)

Area of road surface (square metres)

205

# Cubbington Action Group alternative proposal (vertical realignment with bored tunnel)

Note that cut and fill for the alternative route, proposed by this paper, have been scaled off from the red line drawn on figures A.3.1 and A.3.2 in Appendix 3

#### Section 5 - embankment between 133+900 and 134+150

Assumed trackbed width (metres)

22

Section	n (A to B)	Fill at A	Fill at B	Cross- sectional area at A	Cross- sectional area at B	Mean cross- sectional area of section	Volume of section
133+900	134+000	4.7	2.1	147.6	55	101	10130
134+000	134+100	2.1	1.1	55.0	27	41	4082
134+100	134+150	1.1	0.0	26.6	0	13	666
					Т	otal volume	14878

## Section 6 - Cutting between 134+150 and 134+650 (tunnel portal)

Sloping sides assumed

Assumed trackbed width (metres)

22

Section (A to B)		Cut at A Cut at B		Cross- sectional area at A	Cross- sectional area at B	Mean cross- sectional area of section	Volume of section	
	Α	В					Section	
134	4+150	134+200	0.0	1.0	0.0	24.0	12	600
134	4+200	134+300	1.0	2.6	24.0	70.7	47	4736
134	1+300	134+400	2.6	4.2	70.7	127.7	99	9920
134	4+400	134+500	4.2	7.4	127.7	272.3	200	20000
134	1+500	134+600	7.4	15.8	272.3	846.9	560	55960
134	1+600	134+650	15.8	22.1	846.9	1463.0	1155	57748

Total volume 148964

#### Section 7 - Bored tunnel between chainages 134+650 and 135+850

(Circular cross-section assumed for simplicity)

Twin-bore, assumed diameter of each bore (metres)

10.5

Assumed length of tunnel (metres)

1200

Volume of tunnel, both bores

207816

Section 8 - retained cutting between 135+850 and 136+030

Uniform cutting width assumed throughout (metres)

22

Section (A to B)		Cut at A	Cut at B	Average depth	Area of side	Volume	
Α	В			1.77			
135+850	135+900	24.2	23.7	24.0	1198	26345	
135+900	136+000	23.7	19.5	21.6	2160	47520	
136+000	136+030	19.5	18.9	19.2	576	12672	

Twice by total area of side

7867	
otal volume	86537

#### Section 9 - cutting between 136+030 and 136+700

Sloping sides assumed

Assumed trackbed width (metres)

22

Section (A to B)		Cut at A	Cut at B	Cross- sectional area at A	Cross- sectional area at B	Mean cross- sectional area of section	Volume of section
Α	В						
136+030	136+100	18.9	15.8	1130	847	989	69199
136+100	136+200	15.8	14.2	847	716	781	78128
136+200	136+300	14.2	11.6	716	524	620	62000
136+300	136+400	11.6	7.4	524	272	398	39832
136+400	136+500	7.4	6.3	272	218	245	24515
136+500	136+600	6.3	5.3	218	173	195	19538
136+600	136+700	5.3	3.6	173	105	139	13895

Total volume 307107