High Speed Two Limited

High Speed 2

Optimisation of Route 3
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1 Introduction

1.1 The December 2009 Report

In December 2009, Arup prepared a report for High Speed Two Limited (HS2 Ltd).

That report presented the findings of a route engineering and alignment study for a potential new high-speed rail line from London to the West Midlands. It described the processes for generating a large number of route options, and the “sifting” process by which a Preferred Route (Route 3) was chosen, and how some other route options were “parked”.

HS2 Ltd presented its findings to the Secretary of State for Transport on December 31st, 2009.

1.2 This Report - August 2010

The previous Government announced Route 3 as its Preferred Route in March 2010. That announcement was the first public exposure of the scheme, and led to a number of suggestions for route amendments.

The sections of route subject to reassessment are:

- Calvert to Stoneleigh;
- Burton Green to the proposed station at Birmingham Interchange (Airport / International area);
- Water Orton Delta Junction to Lichfield.

HS2 Ltd therefore asked Arup to re-visit these areas to identify what might be achieved in an alignment review.

This report describes the findings of that review.

1.3 Layout of this Report

This report is laid out as follows:

- Chapter 1, this chapter, is introductory.
- Chapter 2 addresses the alignment options;
- Chapter 3 captures the conclusions and recommendations;

There is only one Appendix:

- Appendix A contains the Drawings.

1.4 Drawings

The table below lists the drawings relating to those lengths of route where HS2 Ltd adopted alignment changes. These are contained in Appendix A.
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<td>Route 3 Plan and Profile, Optimisation</td>
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<td>Sheet 1 of 7 to Sheet 7 of 7</td>
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Table 1  Route 3 Optimisation Drawings
2 Alignment Options

2.1 Areas of Concern

This report considers route alignment options in the following areas, with commentary on the issues giving rise to concern:

- Calvert to Finmere / Mixbury:
  - Direct effect on Grebe Lake
  - Proximity to Twyford;
  - Proximity to Chetwode;
- Brackley and Turweston:
  - Visual impact in the valley between Turweston and Brackley, and proximity to both settlements;
- Brackley to Wormleigh:
  - Proximity to Greatworth;
  - Proximity to Thorpe Mandeville;
  - Difficult topography around Lower Thorpe;
  - Proximity to Chipping Warden;
- Wormleigh to Southam / Ufton:
  - Proximity to Ladbroke;
  - Visual impact of long viaduct near Ladbroke;
- Crackley to Birmingham Interchange:
  - Severance at Burton Green, together with proximity to housing and adverse community effects;
  - Proximity to and visual effects on Berkswell;
- Middleton to Lichfield:
  - Visual impact on Hints.

Although not in geographical order, this report first considers the Brackley and Turweston area, because the logic of the alignment development required consideration of this section first, before the discussion on the Calvert to Brackley section. The Calvert to Brackley considerations could not have arisen without a prior view on whether the route should be moved at Brackley / Turweston.
2.2 Brackley and Turweston

The Preferred Route, approaching this area from the south, followed the alignment of the former Great Central Railway (GCR) from Calvert (see Blue Line on Figure 1). The disused railway passed through Brackley, an option no longer available to the HS2 alignment. The HS2 alignment therefore deviated from the railway near Mixbury, passing a little to the east in order to pass between Brackley and Turweston. In doing so, it would cross the A43 Brackley Bypass at Turweston Road, on a high viaduct over the River Great Ouse, visible from large parts of both settlements. The alignment was reviewed in this area, to identify if there had been too much adherence to the concept of following the GCR.

A revision of the route was found which would deviate from the Preferred Route near Mixbury, and would then pass to the east of Turweston (see Purple Line on Figure 1). To the south-east of Turweston, this alternative would be in a deep cutting, up to 17m deep. The route would still cross the valley of the River Great Ouse, but at a much lower elevation in relation to the crossing point and the local topography. The route would then pass under the A43 near Ilett’s Farm, before returning to the Preferred Route near Greatworth. About 12km of route could be realigned.

Subject to environmental overview, this alternative would appear to have merit.

2.3 Calvert to Brackley

If the suggested realignment at Turweston were to be considered acceptable, there would appear to be a much more direct route from Calvert to newly-aligned alternative in the Turweston area (see Orange Line on Figure 2). This would take the route away from the “GCR” concept, and the route would be on a virtually straight alignment between Calvert and Finmere. The lateral move would be in the order of 1.5km.
The move would have an advantage in that the straight-line projection of the route north from Calvert would avoid any impact on Grebe Lake Figure 3 but would bring the route close to Preston Bissett, a village that was at some distance from the GCR route. The move would benefit Twyford, moving the route from about 50m from the village edge to 600m, while Chetwode would also benefit. It is this effect on Preston Bissett that would be of concern, but not in an engineering sense – both route options would be acceptable in alignment terms, albeit that a straight is to be preferred to a minimum radius curve near Chetwode.

2.4 Greatworth to Wormleighton

Over this 15km length, a move of about 100-150m north-eastwards would reduce the adverse effects on the settlements of Greatworth, Thorpe Mandeville, and Chipping Warden, but would place the route nearer Aston-le-Walls by that amount, albeit that Aston-le-Walls is set back at a greater distance than the closer settlements listed (Orange line Figure 4). The move would similarly place the route nearer Sulgrave and Culworth, but these villages would still lie about 1.5km from the route.
There is a particularly challenging piece of topography (in high-speed railway alignment terms) near Lower Thorpe (shown in Figure 5). Finding an acceptable route through this area is challenging no matter what alignment is adopted. The move suggested would place the route through the ponds at Lower Thorpe and require the acquisition of property in this area.

There is a Scheduled Monument near Edgcote House (brown outline Figure 4). This would be directly impacted by the lateral move being described. There would be two options to overcome the Scheduled Monument issues:

- Retention of the Preferred Route alignment, but this would then not achieve the alignment move objectives at Chipping Warden, and other ways of reducing the adverse effects of the route would need to be considered, such as false tunnelling and mounding;
- An even greater move east by about 400m, but this would mean a greater impact on Aston-le-Walls, which would then be at virtually the same distance from the route as is the concern at Chipping Warden.

The decision on the alternative between Greatworth and Wormleighton is not clear cut, but in engineering terms, there is nothing to choose between the Preferred Route and the alternative. The alignment at Chipping Warden could be lowered, and the route placed in a “false tunnel”.

### 2.5 Wormleighton to Boddington

In this area, the Preferred Route is ideally located for engineering purposes, avoiding the steepening hillside running east towards Stoneton. The route would avoid the Fox Covert woodland and Berryhill plantation.
Significant optimisation of the vertical alignment in the Lower Boddington area reduced embankment heights from approximately 19m to 5m (Figure 6).

The Preferred Route position near Wormleighton was therefore taken as a fixed point before considering alignment options in the Ladbrooke area.

### 2.6 Wormleighton to Southam / Ufton

The main concern in this area is Ladbrooke. The Preferred Route would pass within about 100m of the edge of the village, and there would be an approximate 4000m length viaduct over the A423, the flood plains of tributaries to the River Itchen, and the B4451 to Deppers Bridge (blue line Figure 7).

A move northwards (of about 500m) away from the village would eliminate most of the viaduct, and would involve only simple bridge crossings over the A423 and the B4451. The move would clearly increase the lateral distance between Ladbrooke and the route to about 600m, and this separation would also allow the incorporation of landscape planting and noise mitigation measures (purple line Figure 7).
The move would however bring the route a corresponding distance closer to Southam. It is noted that the nearest properties in Southam are an industrial estate, and other individual property and sports facilities. The move could adversely affect the Dallas Burston Polo Grounds located to the north west of Southam.

Both routes would have acceptable alignment parameters, but the moved route would be less costly, resulting from reduced structural requirements.

This move is recommended on engineering grounds.

2.7 Southam / Ufton to Crackley

On this section of route, generally in the Stoneleigh area, a number of alternative alignments were considered.

These options considered various ways of lessening the direct effects on Stoneleigh village, as well as lowering the route and minimising the lengths of viaduct over the River Leam. The options had differing effects on the National Agricultural Centre (NAC). Effects on properties within South Cubbington Wood and at Stareton were also considered. One of the options was found to be the most direct, shortest and most cost-effective route, as it would cross the River Avon only once. It would pass through the NAC to the west of the Stare bridge.

This option was preferred on engineering grounds.

2.8 Crackley to Birmingham Interchange

The main concerns on this length are Burton Green and Berkswell.

The Preferred Route would cross Finham Brook, the Leamington to Coventry railway, and the A429 before following the dismantled rail corridor towards Burton Green. At Burton Green, the route would require widening and deepening the cutting, probably with retaining walls on the approaches, to pass through a gap in property (purple line Figure 8). At Berkswell Station, the route would cross the existing railway in the station car park area, passing just north of the station on elevated structure.
Burton Green, and much of the development in the area, is “ribbon development” alongside the historic road network. Finding an alternative gap through this locality is difficult. Northwards from the proposed gap, the development is continuous, and a move north would offer no advantages. A move about 300m south would place the route clear of property on Cromwell Lane, but would bring it in close proximity to the rear of properties on Red Lane (Blue Line Figure 8).

A further effect is that the route engineering would also imply that the route would move between 100m - 200m closer to Berkswell, contrary to the concerns there. At Station Road, Berkswell, the route would enclose property between itself and the existing WCML and station area. It would be on an elevated structure there. The route would then pass only 40m from recently-constructed housing in the Balsall Common area.

A tunnelled route would be able to pass under Burton Green, but not emerge east of Berkswell. Conversely, a tunnel under Berkswell would not be able to be accommodated with a surface solution at Burton Green. The only realistic tunnelled option would therefore run from a point about 1.5km east of Burton Green to a point about 1.5km north of Berkswell, a length of about 7km, on a 400kph section of route.

Another option would be to lower the vertical alignment a little in the Burton Green area, and then enclose the route in a “false tunnel” extending some distance both east and west of property. This option would involve the creation of a “box” constructed in open cut, or the construction of plied retaining walls to form the sides of the structure. In both cases, a “lid” would be created on which Cromwell Lane could be situated. It would be possible create the permanent structure to the west, divert Cromwell Lane temporarily onto it, create the Cromwell Lane section, then allowing the Lane to revert to its present position, on the lid.

There is no clear engineering answer in this area, but all options would meet the 400kph design speed requirement. More detailed exploration of mitigation design opportunities in the Burton Green area is needed.
2.9  **Middleton to Lichfield**

The Preferred Route would run east of Middleton, and pass west of Hints to avoid the area of higher ground and quarry to the north-east (shown in Figure 9). Bourne Brook passes to the south of Hints, and the route would be carried over it on a 170m bridge. A 320m retaining wall would be required to prevent the railway embankment footprint infringing on the flood plain.

This alignment was reviewed, particularly to review how the HS2 route would be threaded through the old A5 (Watling Street) and the new, dual-carriageway A5. A move to the west was considered, but this would result in an alignment on the limits of acceptable design parameters for 400kph operation. This would invoke an on-going maintenance liability. It would also result in greater earthworks volumes and some increased impacts on the topography and woodland.

![Figure 9 View of Hints Hill from Watling Street](image)

Lowering the vertical alignment to lessen the impact on Hints was also investigated. It would appear that this would be possible, with some alterations to Watling Street that need to be investigated in more detail. A lowering by about 7m to 10m would allow the route to pass over the brook and under Watling Street. More topographical detail is needed, but the lowering would seem to be achievable in engineering terms.
3 Conclusions and Recommendations

This report aims to present engineering recommendations, and it is not about concluding whether an alignment alternative should be adopted.

These engineering conclusions are:

- Brackley and Turweston. There is an engineering preference for a move to the north and east of Turweston;

- Calvert to Brackley. If the move at Turweston were to be considered acceptable, the direct route from Calvert to Turweston would be acceptable in engineering terms, indeed it is marginally preferable as a straight alignment is preferable to a curved alignment. Both alignments would be within standards.

- Greatworth to Wormleighton. In engineering terms, there is nothing to choose between the Preferred Route and the alternative.

- Wormleighton to Southam / Ufton (Ladbroke). A move of the route by about 500m away from Ladbroke is recommended on engineering grounds.

- Crackley to Birmingham Interchange (Burton Green and Berkswell). There is no clear engineering answer in this area, but all options would meet the 400kph design speed requirement. More detailed exploration of mitigation design opportunities in the Burton Green area would be needed to identify if there is a better solution.

- Middleton to Lichfield (Hints). More topographical detail is needed, but lowering the vertical alignment would seem to be achievable in engineering terms.

Following a meeting with HS2 on the 5th of August 2010, Arup were instructed to create an alignment (Figure 10), which incorporated the following changes:

- Turweston / Brackley: Horizontal and vertical change such that the route would pass to the north eastern side of Turweston.

- Chipping Warden: The route is to maintain the same horizontal position. The vertical alignment is to be lowered at Chipping Warden to allow the construction of a green tunnel.

- Boddington to Wormleighton: Vertical optimisation is to be incorporated into the route hereby minimising embankment lengths and reducing embankment height.

- Southam: Incorporate change to move HS2 away from Ladbroke.

- Stoneleigh: Incorporate route to pass through grounds of the National Agricultural Centre.

- Burton Green: Vertical alignment to be lowered to allow the construction of a green tunnel in this area.
• Hints: The vertical alignment is to be lowered to minimise embankment heights.

All changes were captured and are shown in Figure 10.

Figure 10 Route 3 Optimisation
Appendix A

Drawings
A1 Drawings for Route 3 Optimisation