Selecting an initial preferred scheme for phase two: Refinement work since March 2012

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Contents

Executive Summary

1. This report sets out the work HS2 Ltd has carried out since March 2012 and our further advice to Government. It describes the further options for refinement following engagement with Government about the route and station options presented in March. In some cases this report describes our preliminary advice which would be subject to further work if Government wishes to take them forward.

2. We also describe the further work we have undertaken refining the route and station option to serve Heathrow T5 since reporting in March 2012. As set out in the Command Paper, the Government has announced its intention to suspend any further work on the spur to Heathrow until after the Airports Commission has reported and it has had the opportunity to consider the Commission's recommendations. The refinements recommended in this report represent the last activity HS2 Ltd will undertake on the route and station option for Heathrow T5 until we receive a formal remit from Government in the future.

3. This report also sets out the further discussions we have held with Natural England (NE) and the Environment Agency (EA), and the additional studies we have carried out, to be able to advise Government on Pasturefields SAC, the River Mease SAC and the South West London Water Bodies Special Protection Area (SPA) and Ramsar site. In summary this report covers:

West Midlands to Manchester

- A description of the further work we have undertaken with NE and the EA about route options in the proximity of Pasturefields SAC. Following discussion and additional investigation, we describe a proposed route option that is acceptable in principle to NE and the EA;

- Our consideration of the potential impacts of the route alignment at Swynnerton with the explanation that the current alignment remains the best solution at this stage;

- A description of the further work we have carried out on a section of the route from Whitmore Heath to Madeley via Crewe and our proposed refinements in this area;

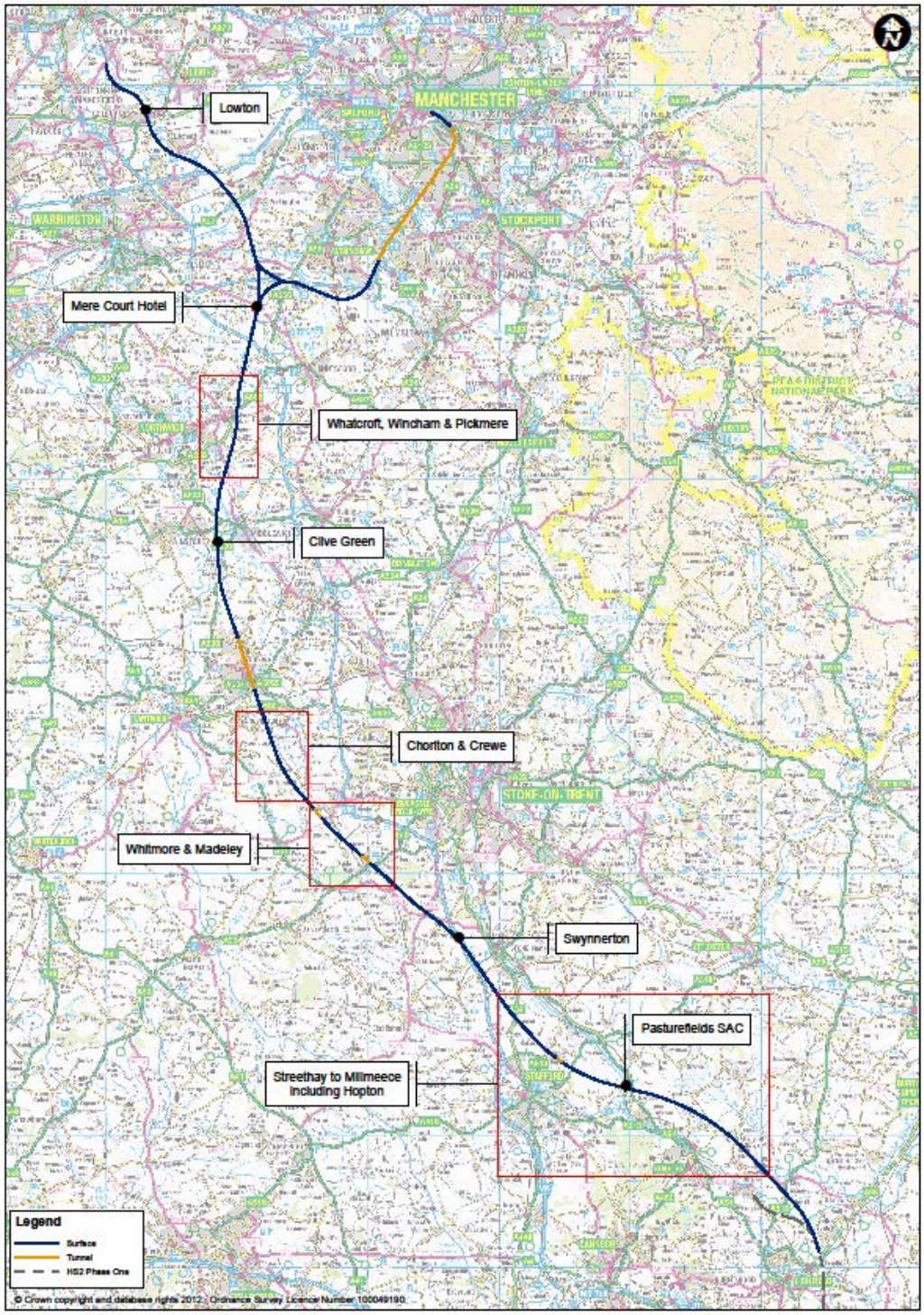
- Our consideration of the potential to improve the route option at Clive Green Lane where we are not making a recommendation to Government at this stage in the design process;

- Our consideration of the alignment of the route at Whatcroft, Wincham and Pickmere concluding that there is not a viable and cost-efficient solution at this stage of the design process;

- An explanation of the further work we did examining how to avoid the direct impact on the grounds of the Mere Court Hotel and why we have been unable to find a feasible alternative option; and

- Our consideration of the route as it passes Lowton and our conclusion that we continue to work on the existing alignment and explore how further mitigation might be applied at the next stage of design.

Figure 1.1: West Midlands to Manchester



- A description of the further work we have undertaken in communication with NE and the EA about the proposed route options that would cross the River Mease SAC. Following additional investigation and appraisal we describe a route option that is not likely to have an adverse effect on the integrity of the River Mease SAC and is likely to be acceptable to NE and the EA;

- Our proposal to alter the alignment of the tunnel beneath East Midlands Airport which would reduce the length of the tunnel, visual and noise impacts and the earthworks and enable a better crossing of the M1 motorway;

- Our proposal to modify the station option at Toton which would reduce the complexities of the associated road bridges and would reduce the number of residential and light industrial demolitions;

- Our consideration and assessment of the risks, particularly mining, associated with the engineering of both the route broadly following the M1 and the alternative route following the Erewash Valley and our advice to Government on how this affects route selection;

- Our proposal to change the alignment of the route through Strelley which would pass closer to the motorway and which we believe would reduce the impact on Strelley Village and Conservation Area and the reservoir at the top of Catstone Hill;

- Our proposal to alter the alignment in the vicinity of Hardwick Hall to reduce the visual impacts from the Hall and the need for some major highways works in this area;

- Confirmation that we believe we have identified the best possible route option around Rother Valley Country Park at this stage of the process but that we will continue to explore options as our engineering design process continues;

- A description of the further work we carried out looking at the route alignment at Hoyland and the impacts in this area. Due to the impacts resulting from the alternative options considered we have not progressed them further at this stage;

- The further work we have done to explore options to alter the alignment as it would pass Royston. We have identified options that would avoid the impact on McKenzies Coking Plant and will carry out further investigation of options to reduce and mitigate the route through this area in advance of formal consultation;

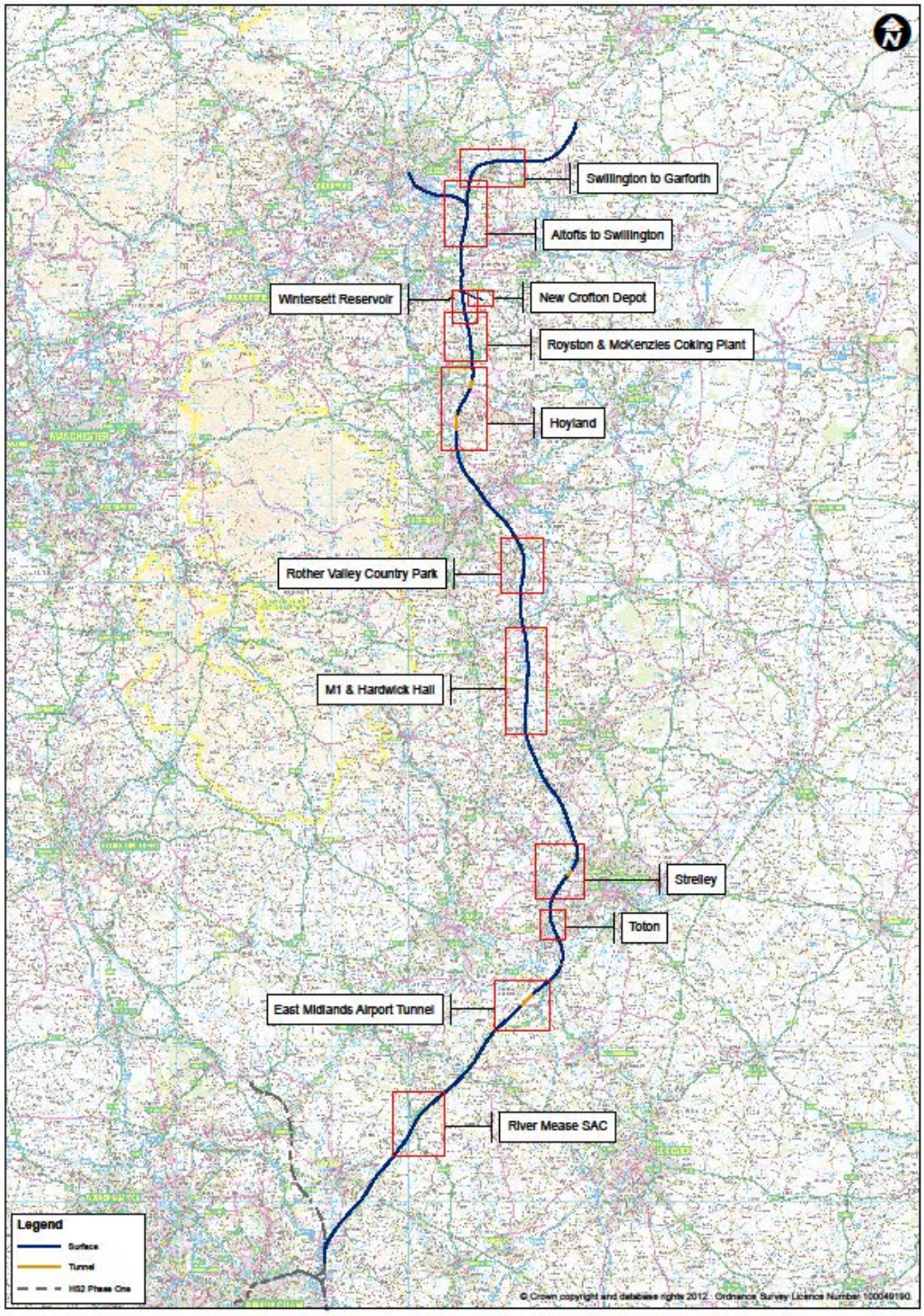
- Our proposals to mitigate the impacts of the route as it passes Wintersett Reservoir where through further work we may be able to improve the alignment through this area;

- Subject to further information, we will investigate whether it is possible to reduce the height of the grade separated structures in the vicinity of the proposed New Crofton Depot;

- A proposal to alter the alignment between Altofts and Swillington to reduce impacts and to improve the configuration of the junction in this area; and

- A proposed change to the alignment between Swillington and Garforth which we believe reduces impacts, including the number of potential residential demolitions.

Figure 1.2: West Midlands to Leeds



Heathrow

4. As set out in the Executive Summary the Government has announced its intention to suspend work on the proposed spur to Heathrow T5 until after considering the report by the Airports Commission. The proposed refinements below reflect the further work we undertook on the final option we described in our March 2012 reports. We will undertake no further activity on this proposition until we receive a new formal remit from Government.

- Our proposals to modify the spurs on both the London and Birmingham facing sections of the alignment to improve the engineering of the route option;

- Our proposals to refine the alignment to the south of Denham where the Birmingham and London facing spurs emerge from tunnel which, from initial appraisal, improves the engineering and sustainability performance, whilst reducing potential impacts on Denham;

- An update on the HRA screening undertaken on the South West London Water Bodies Special Protection Area / Ramsar site. The conclusion that there is no likely significant effect which has been agreed with NE and the EA; and

- A proposed modification of the north-south station option that was described in our report in March, which reduces the highway and hydrological infrastructure impacts and the number of residential demolitions but would be around 150m further away from Terminal 5 than the option we described in March.

1 Introduction

1.1.1 At the end of March 2012 HS2 Ltd submitted a number of reports to Government on line of route and station options and associated infrastructure for phase two of the high speed rail network[1]. They represented the first stage in reporting on the development of options for phase two. The reports set out all the options we considered and described our process of analysing and refining them until a small number of final options remained. In our reports we also described the areas that we believed warranted further work to ensure that we could advise Government fully as it selected its initial preferred route and station options.

1.1.2 This report sets out the work we have carried out since March and our further advice to Government. It describes the further options for refinement following engagement with Government about the route and station options. It also describes the outcome of the further work that we said we would need to undertake, after submitting our March reports, to be able to advise the Government fully in a small number of outstanding areas. In some cases this report describes our preliminary advice which would be subject to further work if Government wishes to take them forward.

1.1.3 This is an early stage in the development of our route and station options with the design and mitigation of the whole scheme continuing through to, and beyond, public consultation. The refinement of the scheme is not just limited to the areas covered in this report. So in some areas described below we have been unable to find and recommend any changes at this stage but we will continue to explore possible options going forwards and may be able to recommend improved options to Government in the future.

1.1.4 This report also sets out the further discussions we have held with NE and the EA, and the additional studies we have carried out, to be able to advise Government on Pasturefields SAC, the River Mease SAC and on the South West London Water Bodies SPA / Ramsar site.

[1] Our March reports are:

- Options for phase two of the high speed rail network
- Options for phase two of the high speed rail network – approach to design
- Engineering options report – West Midlands to Manchester
- Engineering options report – West Midlands to Leeds
- Engineering options report – Heathrow
- Options for phase two of the high speed rail network – Appraisal of Sustainability
- HS2 Cost and Risk Model Report
- Record of stakeholder engagement for phase two of the high speed rail network

2 West Midlands to Manchester

2.1.1 This section of the report describes the further work we have done since March exploring potential refinement to the route between the West Midlands and Manchester and our further advice to Government. Our advice reflects preliminary investigation and will be subject to further development and appraisal as we work towards advising Government on a preferred scheme for future public consultation. We identify where further work will be necessary. We noted in our March reports that we needed to engage NE and the EA and carry out further work on the potential impacts on Pasturefields SAC. This section describes the outcome of those discussions and our advice on an appropriate route option.

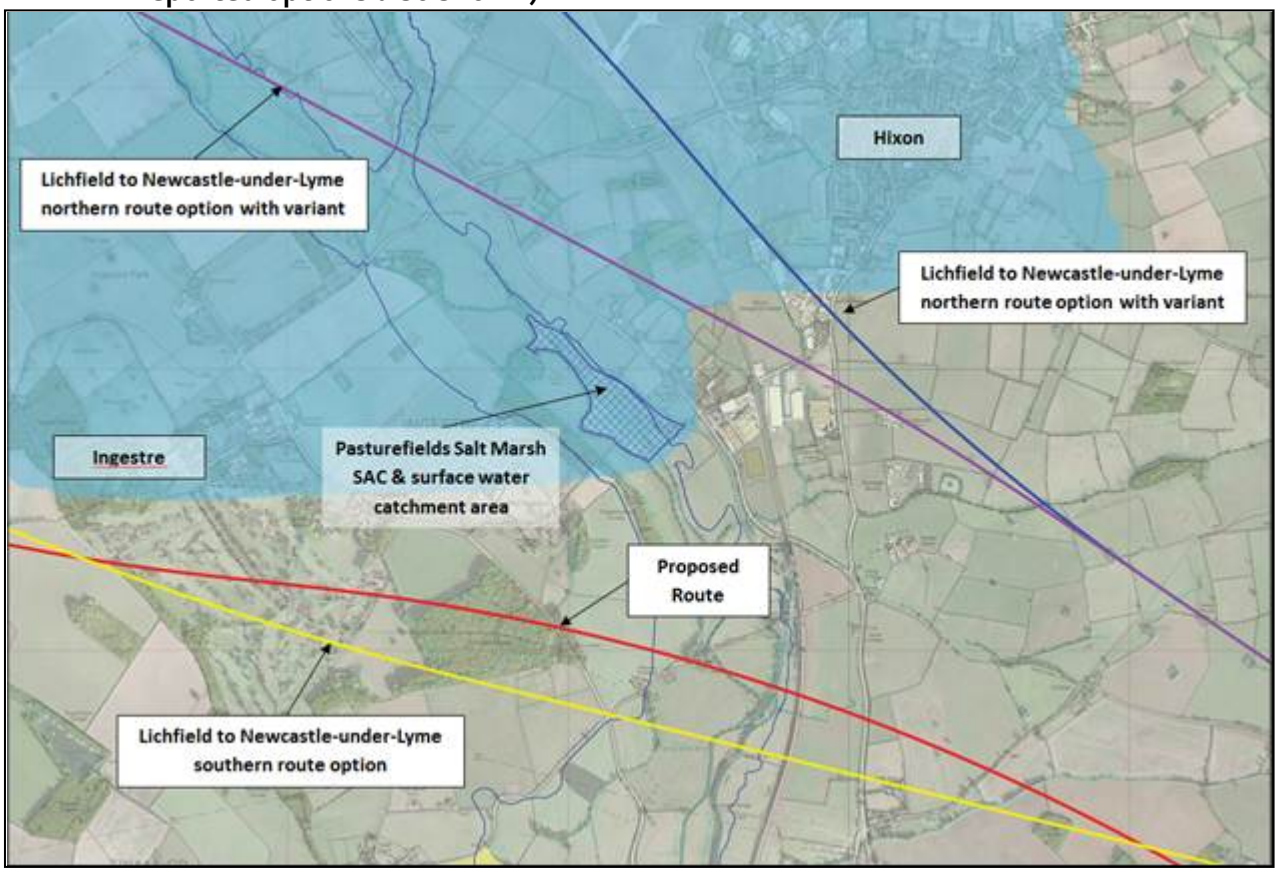
2.2 Pasturefields SAC

2.2.1 In our March reports, we noted that our route options would pass in close proximity to Pasturefields Special Area of Conservation (SAC). Pasturefields SAC is a protected European site of particular importance because it is one of only two known extant inland salt meadows (or salt marsh) remaining in the British Isles. Inland salt meadow is identified as a priority habitat in Annex 1 of European Council Directive 92/43/EEC Conservation of natural habitats and of wild fauna and flora (the "Habitats Directive"). This means that there are particularly stringent criteria that must be met before a project that would cause potential adverse effect can be approved.

2.2.2 We therefore noted in our reports that we would need to advise Government further on acceptable route options following further studies and engagement with NE and the EA. Since March we have held those discussions and undertaken further work on route alignment options. As well as considering the potential impact of route options on the SAC we also considered other important infrastructure and sustainability issues in the surrounding area; these include Sandon Park Registered Park and Garden, the River Trent, the Trent and Mersey Canal and its associated Conservation Area and listed structure, the West Coast Main Line and the A51. As a result of further work, potential impacts on Weston, Hopton, Great Haywood, Hixon and Salt nearby were also avoided and/or limited as far as possible at this stage of the design process.

2.2.3 Our further work concentrated on understanding the SAC and its hydraulic setting through appraisal of existing data and through discussion with NE and the EA. Our sustainability consultants, Temple ERM, have carried out further site appraisal, data gathering and desk top analysis enabling HS2 Ltd to confirm with NE and the EA that, subject to formal submission of the HRA Screening Report, routes to the south of Pasturefields SAC can be screened out of requiring a Habitats Regulations "Appropriate Assessment".

Figure 2.1: New proposed route alignment avoiding Pasturefields SAC (March 2012 reported options also shown)



2.3 Streethay to Millmeece including Hopton

2.3.1 Whilst the main driver for considering alternative route options was Pasturefields SAC, the implications of the route refinements extended from Streethay to Millmeece. This presented an opportunity to address some of the other key sustainability and engineering challenges. The new route that we have developed would avoid impacts on Pasturefields SAC and would also have fewer demolitions, less potential noise impacts and would avoid conflict with the Norton Bridge existing rail network junction remodelling and the Ministry of Defence Stafford development site. We noted though that this route would consequently pass in close proximity to the village of Hopton, but would avoid Hopton Historic Battlefield.

2.3.2 We therefore carried out further work on improving the alignment at Hopton. We recommend lowering the route alignment to minimise noise and line of sight from the residential properties at the top of the adjacent hill. This would result in a 2.4 miles (3.8km) cutting of which 510m would be in a green tunnel mitigating the visual and noise impacts on the houses close to the route during operation.

2.3.3 The proposed cutting would be located between 50m to 150m outside the main settlement of Hopton and the views from properties are unlikely to be affected due to the distance, the depth of the route and the position of the route relative to the general line of sight.

Recommendation

2.3.4 HS2 Ltd recommends to Government the route option described in paragraphs 2.2.1 to 2.3.3 above and shown on figure 2.1 which will not impact on Pasturefields SAC and is acceptable in principle to NE and the EA.

2.4 Swynnerton

2.4.1 Moving north from Hopton, we described in our March reports how the proposed route would pass Swynnerton to the east on an embankment and then run in a deep cutting and underneath the A51 and A519. The embankment would be around 400m in length at a height of up to 10m. In addition, Tittensor Road would need to be realigned and lowered by 3m at the crossing with the route.

2.4.2 Since March, we have considered whether there was the potential to lower the alignment beneath Tittensor Road and to find a solution that would not require the embankment, in order to reduce the noise, visual and landscape impact in this locality. However, at this stage in our design process the alternative option that we explored created new complexities.

Recommendation

2.4.3 HS2 Ltd recommends to Government that the current alignment remains the best solution at this stage.

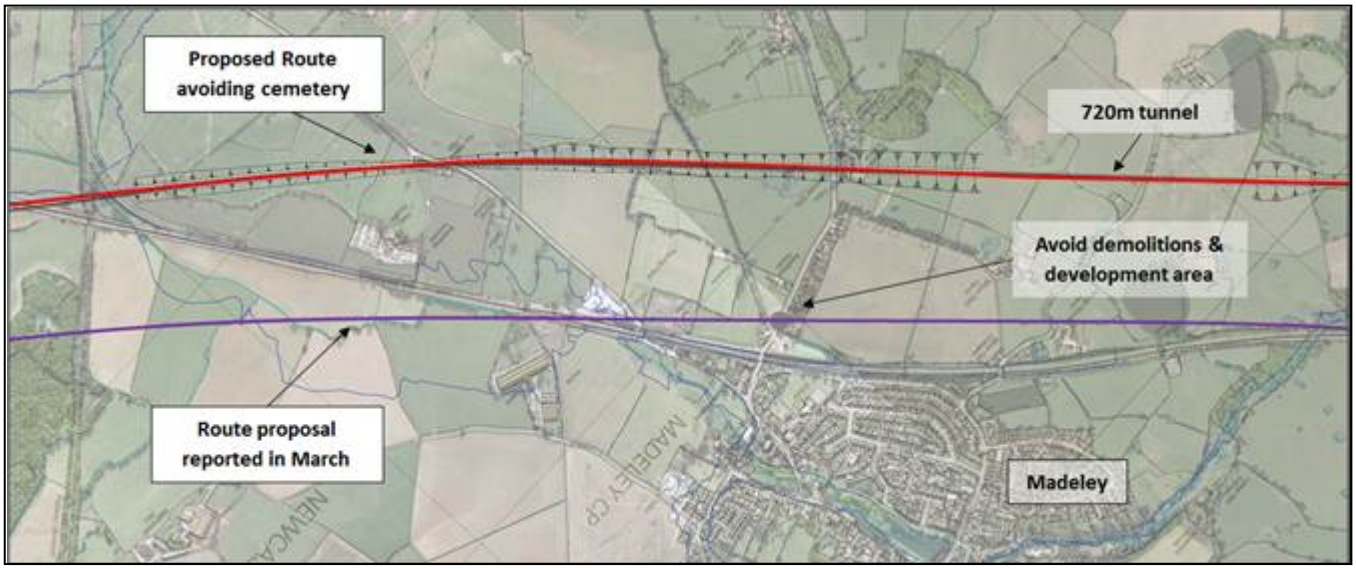
2.5 Whitmore Heath to Madeley via Crewe

2.5.1 Since developing our line of route options in March we have carried out further work on a 12.4 miles (20km) section of route from Whitmore Heath (west of Newcastle-under-Lyme) via Madeley to Crewe. Our further work has explored the options for reducing the number of potential demolitions, noise and visual impacts around Whitmore Heath, and the landscape impacts resulting from the height of the proposed viaduct passing to the south west of Madeley Conservation Area. Our work to consider these issues has also highlighted an opportunity to avoid a complex and costly crossing of the West Coast Main Line (WCML) north of Madeley, staying on the west side of the WCML up to the proposed depot and tunnel south of Crewe.

2.5.2 At Whitmore Heath we would propose moving the alignment further west, with a 710m tunnel under the Heath, compared to 300m in our March reports, which would avoid the demolition of Limpits and also reduce the extent of the earthworks required further north along the valley approaching Madeley. This would also reduce the length and height of the viaduct over both the floodplain and the WCML and would remove an impact on Hey Spink Ancient Woodland though it would increase the impact on Whitmore Wood. We would continue to look at options to mitigate any potential noise disturbance at Whitmore Heath from the tunnel portal as part of on-going design development.

2.5.3 At Madeley we propose a route refinement that would reduce the height of the viaduct as the route crosses the WCML; the optimised route option would also move the crossing point 0.9 miles (1.5km) further south away from Madeley Conservation Area, and pass further west into the hillside adjacent to Madeley. This would result in a 720m tunnel but also a reduction of potential demolitions at this location (Bar Hill and Moss House Farm). The result of moving west and lowering the route would also reduce potential noise and visual impacts on Madeley.

Figure 2.2: Route refinement reducing the potential impact on Madeley



2.5.4 Overall, our appraisal indicates that this refined option at Whitmore Heath and Madeley would be an improved route option which would reduce visual and noise impacts, reduce the number of demolitions and improve the crossing of the WCML relocating it 0.9 miles (1.5km) further south away from Madeley. Lower and shorter viaducts across the floodplains would also be achievable.

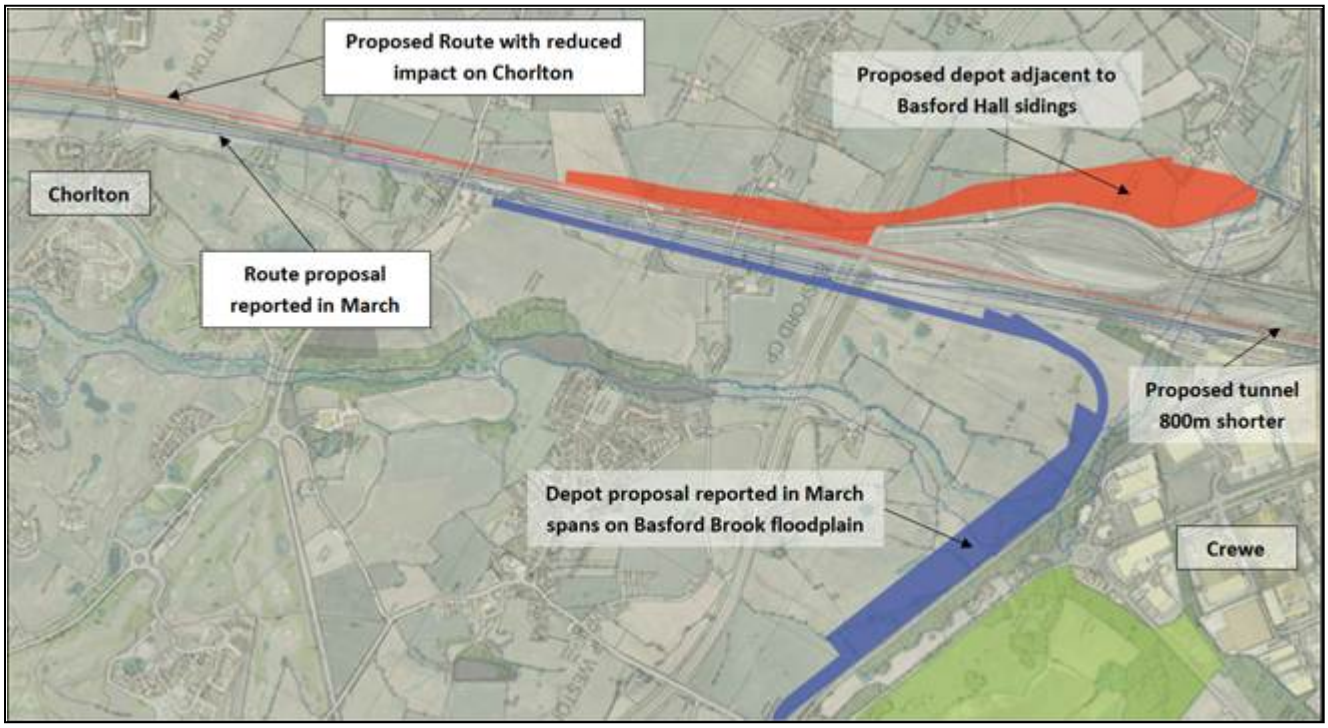
2.6 Chorlton and Crewe

2.6.1 As we progressed the proposed alignment change at Whitmore Heath and Madeley described above, it became apparent that potentially running the route on the west side of the WCML, to the tunnel portal south of Crewe, would be simpler in engineering terms and would have fewer sustainability impacts.

2.6.2 Compared to the alignment we described in our March reports, this revision would remove a complex skewed crossing of the WCML at Wrinehill. It would reduce the impact at Chorlton by moving the route to the opposite side of the WCML, where previously it would have passed between 60m and 130m from the western edge of the village. Although the new route on the west of the WCML would be elevated north from Chorlton, the WCML is similarly elevated so it is considered at this stage that the visual impact on Chorlton would likely be minimal. This revised alignment would also reduce the tunnel length under Crewe by 800m and would move the depot to the west side of the WCML adjacent to the current Basford Hall railway sidings, thus avoiding a potential impact on the floodplain. It would also avoid

potential impacts on the setting of Crewe Hall Grade II Registered Park. We believe this refinement will simplify the depot layout and access arrangements and would reduce the number of potential residential demolitions. This new simplified depot layout and access arrangements would offset the additional cost of an elevated mainline approach from Chorlton.

Figure 2.3: Route refinement reducing the impact on Chorlton and with new depot lay out



2.6.3 This revised alignment would require alteration to the existing layout at Basford Hall sidings. We have held initial discussions with Network Rail and, subject to this new alignment being selected by Government for further development, we would need to develop further the connections to the HS2 depot, existing freight lines and sidings.

Recommendation

2.6.4 When taken collectively the changes at Whitmore Heath, Madeley and Crewe would increase costs, compared to the costs included in March, by £100m. Government will wish to consider this additional cost on top of the costs HS2 Ltd reported in March. However, as paragraphs 2.5.1 to 2.6.3 set out, there are clear benefits from adopting the changes we have described.

2.7 Clive Green Lane

2.7.1 Continuing further north, the proposed route we described in March would cross over the Shropshire Union Canal on an embankment up to 5m high. The elevated approach to the canal would require an embankment each side and would also

require Clive Green Lane to be realigned and lifted vertically by 8m above the proposed phase two route.

2.7.2 During our further design work we have considered whether the visual impact could be further mitigated in this area. We also examined a revised vertical design where the route would pass underneath the canal. We identified that a depth of 10m would be required to pass beneath the canal, allowing for canal depth, possible sediments and railway structural clearance. This would also generate cuttings of just over half a mile (1km) either side of the canal. This design would then also cross beneath Clive Green Lane with the lane being lifted 3m (rather than the 8m described in paragraph 25 above) at the crossing point.

2.7.3 The effect of this realignment would be to slightly reduce visual impacts from properties at Clive, Clive Green and Middlewich along with views locally along the canal itself. The cuttings would reduce potential noise impacts, particularly to the south of the canal where the alignment is currently on embankment. This revised design would add around £20m to costs.

Recommendation

2.7.4 HS2 Ltd is not making a recommendation to Government at this stage in the design process.

2.8 Whatcroft, Wincham and Pickmere

2.8.1 Since March we have considered further the proposed alignment through Whatcroft, Northwich, Lockstock Green, Wincham and Pickmere. Through this 6.2 miles (10km) section the route would be mainly elevated on embankment and viaduct resulting in potential visual and noise impacts, albeit with mitigation potential as the scheme develops. The route is constrained in this area by three major roads, the A530, A556 and A559, a railway line and several flood plains.

2.8.2 Whilst we have considered, at a high level, options for mitigating the route through this area, we have been unable to find a viable solution at this stage that would provide worthwhile mitigation and would come at a reasonable proportionate cost. As our designs develop, we would discuss whether there are options for lowering the viaduct height with the EA to ensure that any potential alterations would be consistent with the EA's flood risk policy.

Recommendation

2.8.3 HS2 Ltd is not making a recommendation to Government at this stage in the design process.

2.9 Mere Court Hotel

2.9.1 During our further work we have examined whether there was an alternative alignment that would not encroach so significantly on the Mere Court Hotel near

Knutsford. At a high level we developed a revised design which would move the alignment and junction east, but this would encroach the boundaries of Holly House Farm and Bowden View Farm and would also require the realignment of Bowden View Lane.

2.9.2 This option would still have significant noise and visual impacts on the Mere Court Hotel with the spur to Manchester still encroaching on part of the hotel boundary as well as impacts on the farms and potentially on several properties in the surrounding area. With both options there would also need to be associated work to the A50 which runs adjacent to the hotel. This road would require raising by 8m to cross the high speed line and would have potential visual and noise impacts on the hotel and would therefore also impact on the hotel's setting.

Recommendation

2.9.3 HS2 Ltd does not believe that the alternative alignment described above would provide any improvement compared to the alignment we reported in March.

2.10 Lowton

2.10.1 The route option we described in March would broadly follow a disused railway corridor through Lowton. The corridor is currently developed with residential and light industrial buildings, and the proposed alignment would affect some of those properties.

2.10.2 At a high level, our further work considered a possible alternative route option which would move the alignment east. We have concluded that at this stage of the design, this alternative option would offer some mitigation to properties on the west but also bring additional impacts to properties on the east and that further design and mitigation on the March route option would potentially offer as effective a solution as moving the route.

Recommendation

2.10.3 HS2 Ltd recommends retaining the existing March 2012 alignment at this stage.

3 West Midlands to Leeds

3.1.1 This section of the report describes the further work we have done since March exploring potential refinement to the route between the West Midlands and Leeds and our further advice to Government. The refinements we propose below take as their starting point the final route options described in our March reports. We noted in our options report in March that we needed to continue to engage with NE and the EA, and carry out further studies, about our route options that would potentially cross or impact on the River Mease SAC. This section describes the outcome of those discussions and our advice on an appropriate route option and solution.

3.2 River Mease SAC

3.2.1 The River Mease Special Area of Conservation (SAC) is a protected European site of importance because of its valued species which are mainly aquatic. Of particular concern is the effect of bridge shading on a light-sensitive plant which is a qualifying feature of the SAC. In our March reports we indicated that we needed to advise Government, following further analysis, of the most appropriate route to reduce any impacts on the River Mease SAC. As with the base proposition described in March, we concentrated on route options between Water Orton and the proposed station at Toton in the East Midlands.

3.2.2 As described in our March reports, we considered a number of alternatives to a new crossing of the River Mease SAC but these were ruled out because of concerns over engineering complexity and costs. One alternative that would avoid crossing the river was retained. Design measures would seek to avoid any significant hydrology impacts and the HRA screening report concluded that this route option, that would avoid crossing the river, would have no likely significant effect on the River Mease SAC. However, we believe this option would generally have greater sustainability impacts than options crossing the river.

3.2.3 We would design options that cross the river to avoid or mitigate any impact on the river as far as possible. Due to the narrow width of the river, we envisage that it could be protected from any significant impact through good bridge design and best practice construction and operation of HS2. However, in March 2012, the Habitats Regulations Assessment (HRA) screening report undertaken by our consultants was unable to conclude that the river crossing option would not be likely to have a significant effect on the integrity of the SAC, due largely to the potential shading of aquatic vegetation under a bridge crossing.

3.2.4 We therefore agreed with NE and the EA that an Appropriate Assessment (under the UK Habitats Regulations and EU Directive) was required to determine whether proposals for the new crossing of the river would have an adverse effect on the integrity of the SAC.

3.2.5 As part of the Appropriate Assessment further work has been carried out on variations to the design of a bridge crossing that would seek to minimise the

shading effect on the light-sensitive plant and to better understand the shade tolerance of the key plant species. Field surveys have been undertaken to relate the distribution of the plant to variations in natural lighting levels and to determine whether it grows in shaded areas. Other work was carried out on the effect of a new bridge crossing on the hydrology of the river. We have continued to discuss findings with NE and the EA.

3.2.6 As we described in March, of the two options via Measham that would cross the River Mease, impacts would be generally similar. However, the route that would pass Measham to the north has a slightly higher cost whereas the route that passes to the south of Measham would potentially affect a larger number of people from noise. Whilst the bridge design, shading and hydrology work has focussed on the route to the north of Measham, as a result of informal discussion with NE and the EA, the conclusions of this work are considered to be broadly applicable to other route options crossing the River Mease.

3.2.7 This would be subject to agreement in further discussions with NE and the EA, and it should be noted in particular that the southern route has a longer and less favourable crossing of the Mease, and this may require more mitigation than the crossing for the route north of Measham.

3.2.8 Based on current design data, our Appropriate Assessment has reached the provisional conclusion that the River Mease crossing would not have an adverse effect on the SAC. NE has agreed with this. The Appropriate Assessment process will continue through the design to ensure no adverse effects.

Recommendation

3.2.9 Following our further work with the NE and the EA, HS2 Ltd is able to confirm that the Government can select a route option that would cross the River Mease SAC. Our work has particularly focussed on the route option that would cross the River Mease to the north of Measham.

3.3 East Midlands Airport

3.3.1 South of the proposed Toton station option, the high speed route would pass under East Midlands Airport. The route we described in our March reports would require a 1.6 miles (2.5km) tunnel. Following a design review we are able to recommend an option that would reduce the tunnel length to 1 mile (1.6km) on a slightly revised alignment to the north of the route proposed in March. This would also move the crossing of the M1 just to the north of Junction 24 from a position immediately south of it.

3.3.2 This new alignment would sit more naturally in the landscape with a reduced amount of earthworks and a more straightforward crossing of the motorway. This alignment would reduce the noise impacts on Kegworth although it would potentially increase the noise impacts at Lockington.

Recommendation

3.3.3 HS2 Ltd believes that this alignment change would be an improvement whilst also potentially delivering some beneficial cost savings. We would however also have to consider any potential conflicts with the proposed East Midlands Strategic Gateway Freight Interchange site to ensure that the two plans are compatible.

3.4 Toton

3.4.1 Beyond East Midlands Airport, the corridor north and south of the proposed station at Toton would cause potentially significant impacts. We have taken the opportunity since reporting in March to review the design of the station. By moving the station 350m to the south, and by reducing the length of the station loops on the exit to the north, we believe that impacts to the north of the station in the Sandiacre and Stapleford areas could be reduced.

3.4.2 We have considered whether there would be any operational impacts from shortening the station loops. Our conclusion is that there would be no material impact. By moving the station southwards the loops could fit onto the length of straight enabling the halving of their length.

Recommendation

3.4.3 HS2 Ltd recommends this change to Government as it would reduce construction complexities. This change would also reduce the number of residential and light industrial/commercial properties demolished in the Sandiacre and Stapleford area and bring a small reduction to overall costs.

3.5 Erewash Valley and M1 route choices

3.5.1 On the exit from Toton, our March reports presented two route options towards South Yorkshire, one broadly following the line of the M1 corridor and the other via the Erewash Valley railway corridor. Further north, the two routes would start to come together beside the M1 west of Bolsover to become a single route option that would follow the Rother Valley towards Sheffield and the Meadowhall area.

3.5.2 We reported in March that the route option following the M1 was around £280m more expensive than the Erewash Valley route. We also noted though that there are difficult sustainability and engineering issues with the routes, especially in terms of mining hazards and risks. We highlighted that as part of the ongoing design process we needed to continue to assess the risks around route development. We believed that this was likely to lead to both routes being of a similar cost which would potentially have a bearing on route choice.

3.5.3 From an alignment perspective, the route following the Erewash Valley would be potentially more straightforward than the M1 route option which would cross more

difficult terrain and would have some potentially complex interfaces with the M1 motorway. The differences in construction were reflected in the cost differences we set out in our March reports.

3.5.4 Since March our further work has enabled us to establish that the Erewash Valley route would be potentially far more affected by the legacy of ground hazards presented by outcropping coal seams and past opencast extraction and shallow underground mining activities.

3.5.5 We have also looked further at the landfill issues on both routes and through our further design work have been able to avoid many sites. There would still be a number of remaining landfill sites on the proposed Erewash Valley route option which we could not avoid and one of which presents a high risk. In contrast the proposed M1 route option has only one landfill site which is considered a medium risk.

3.5.6 The potential complex motorway crossings and other interfaces between the high speed line and the national motorway network is a further significant factor we considered. On this issue, the route that would broadly follow the M1 would have seven major interfaces, including crossings with the M1 route, compared to three for the Erewash Valley route (with two common to both). We have made an allowance to cover contractual agreements for the cost of motorway disruption associated with major crossings but this cannot fully capture any potential impact on motorists.

3.5.7 In addition to the consideration of the engineering and mining risk associated with both routes, there are also significant sustainability considerations. There would be more potential demolitions along the M1 route option than along the Erewash Valley route. Both routes would pass a number of cultural heritage features but with the Erewash Valley option directly affecting a greater number of conservation areas.

3.5.8 Our noise assessment of both routes concluded that there would be a significant difference with the change in population annoyed by noise estimated around two thirds higher for the Erewash Valley route compared to the M1. As mitigation is applied as the design develops it is expected that noise impacts for both route options would be likely to reduce significantly.

3.5.9 Finally, our further work on the M1 route past Hardwick Hall (paragraphs 3.7.1 to 3.7.5) has identified scope to reduce the visual impact of the route in a way that would not be possible with the Erewash Valley route.

Recommendation

3.5.10 As described above there are complex issues with both route options through this area. Our assessment of mining risk has led to a levelling of the cost difference we previously reported between both options in March. Therefore, Government will wish to consider the engineering, sustainability and cost issues and the wider issues such as the benefits of the M1 route option broadly following an existing transport corridor.

3.6 Strelley

3.6.1 The village of Strelley lies approximately a mile to the east of the M1 between Junctions 25 and 26. So if the M1 route option described above is chosen the route would pass through Strelley, which includes several listed structures and a conservation area. In particular, the route would pass through parkland to the east of All Saints Church (Grade I Listed) in a cut and cover tunnel. Despite the cut and cover tunnel, we have noted, in our further work since March, that the impact through this area would remain significant.

3.6.2 Our further work has considered the viability of moving the alignment to the west side of the church and closer to the motorway. The new alignment that we have developed would follow the route as previously described in our March reports from Stapleford up to the crossing of the route over the Nottingham Canal. From there, the new alignment would run more closely to the M1 corridor, so that it would be directly adjacent to the M1 on the east side at a distance of just over half a mile (1km) south of Strelley.

3.6.3 The new alignment would be closer to the M1 Trowell service area than reported in March but neither would require the demolition of this service area. The proposed cutting would be moved away from the reservoir at Catstone Hill and Shaw's plantation avoiding impacts and bringing a small cost saving on earthworks.

3.6.4 After running adjacent to the M1 for approximately 500m, the new alignment would then enter Strelley Conservation Area in a 600m long cut and cover tunnel under Main Street, just west of the Grade I Listed Church and Grade II Listed Strelley Hall.

3.6.5 This new alignment would then emerge as open shallow cutting to the north-east of the conservation area and continue north towards Nottingham Business Park. The new alignment would potentially involve fewer demolitions and would sever less of the business park.

3.6.6 Overall this new alignment would pass much closer to the M1 through this area. We have been unable to find major sustainability improvements but we believe the new alignment is better because it is between Strelley Hall and the M1 and would no longer separate the conservation area from the village. The new alignment would also move the cutting away from the reservoir at Catstone Hill, reducing impacts there and bringing about some cost savings.

Recommendation

3.6.7 Should the proposed M1 route option be selected, HS2 Ltd recommends this new alignment to Government as it would provide a number of benefits described above compared to the route we described in our March reports.

3.7 Hardwick Hall

3.7.1 The proposed M1 route would pass through the National Trust land associated with Hardwick Hall south of Bolsover. Between the villages of Tibshelf and Heath the

alignment would also run very close to the M1 on the west side of the motorway, the opposite side of the Hall.

3.7.2 The alignment we described in our March reports would require a series of complex and potentially expensive engineering solutions at the interfaces with the highway network. This would include a crossing beneath the M1 at Tibshelf, remodelling of Junction 29 at Heath, two further crossings over the M1 and a difficult interface with the A623 Chesterfield Road at Long Duckmanton. Our work since March has therefore explored making improvements at each of these locations in tandem with a desire to lower the alignment through the National Trust land past Hardwick Hall in order to reduce the visual impact.

3.7.3 We have developed a new alignment that would simplify the crossing of the M1 north of Tibshelf at an angle that would reduce the length of temporary diversion and avoid the realignment of the bridge that carries the Mansfield Road over the M1. The new crossing angle would allow the high speed alignment to run closer to the M1 on its west side and to sit lower in the landscape past the Hall as far as Junction 29 at Heath.

3.7.4 As the new alignment passes Long Duckmanton the interface with the A623 would be simplified and by being further away from the M1 at this point the crossing of Junction 29A would also be simpler.

Recommendation

3.7.5 HS2 Ltd recommends this new alignment to Government. We believe that it would reduce the scope for major highways works on the M1 and its junctions bringing about an overall cost reduction of around £90m. The alignment would also help reduce the visual impacts of the route past Hardwick Hall.

3.8 Rother Valley Country Park

3.8.1 The route we described in our March reports would enter the Sheffield City region from the South at the Rother Valley Country Park, passing between the park and the suburb of Beighton. The western edge of the park is bounded by several railway corridors, only one of which is currently in use.

3.8.2 The design in our March reports proposes to re-align the existing rail corridor towards Beighton so that the HS2 corridor could sit between the existing rail corridor and the embankment of the redundant rail corridor on the boundary of the park, which would serve as a visual and noise screen between HS2 and the park.

Recommendation

3.8.3 Due to the constraints in this area from the Country Park, existing rail lines and nearby settlements, HS2 Ltd believes that it has proposed the best engineering solution in this area at this stage of the design process.

3.9 Hoyland

3.9.1 The route alignment we proposed in our March reports would include a tunnel beneath Hoyland which would emerge into the valley to the east of Blacker Hill. Our further work in this area has explored whether the route could be moved onto the redundant rail corridor which is occupied by a supplier of an excavating plant.

3.9.2 At a high level we explored two options for reducing the length of tunnel beneath Hoyland and simplifying the crossing of the M1 further south towards Chapeltown. These options would also move the alignment closer to the redundant rail corridor. The first option would be to follow the existing redundant corridor whilst maintaining a 360kph speed profile. This would however potentially result in the demolition of multiple properties at Swaithe, some of which are Grade II listed. The second option, avoiding the demolitions at Swaithe, would require a speed reduction to 330kph.

Recommendation

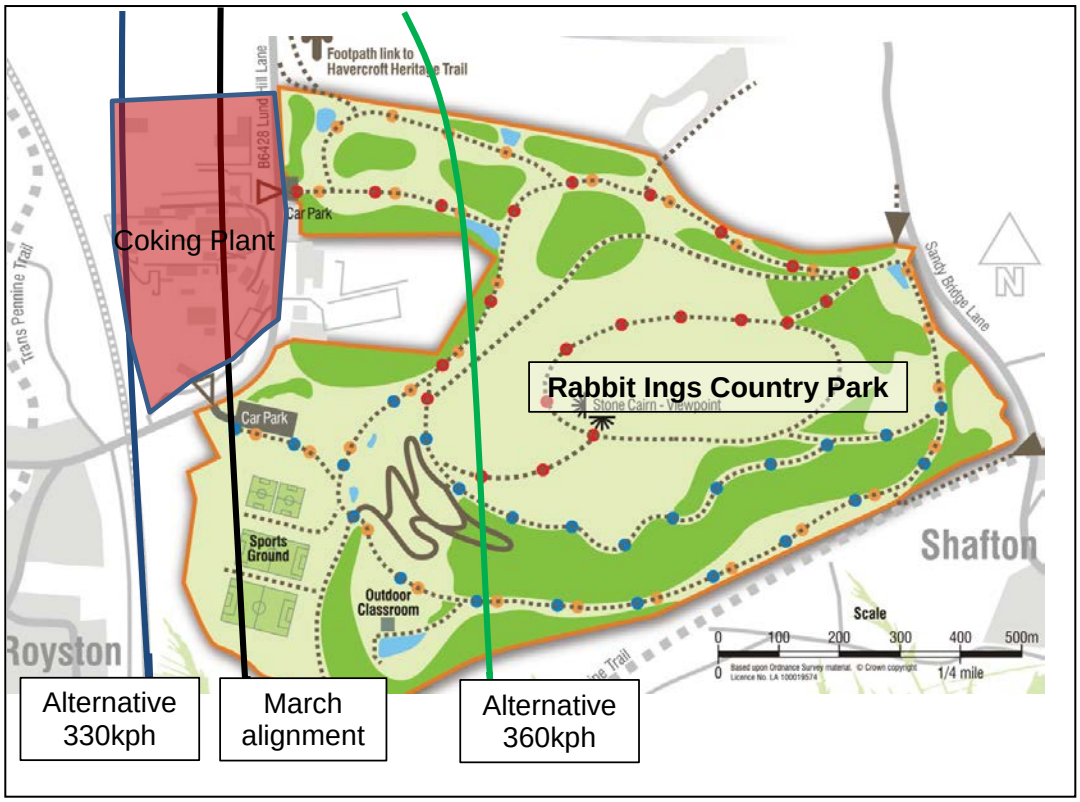
3.9.3 At this stage of the design process, we believe we have the best solution and are therefore not recommending a refinement.

3.10 Royston and McKenzies Coking Plant

3.10.1 Heading north the route we described in March would pass through an area constrained by the town of Royston, McKenzies Coking Plant and the Rabbit Ings Country Park. Our further work in this area has explored whether we can avoid directly impacting McKenzies Coking Plant whilst balancing this with any potential impacts on Rabbit Ings Country Park to the east of Royston.

3.10.2 Our further work has concentrated on two alternative options at this stage of the design process. The first new alignment would dissect the western edge of the Coking Plant and would be in close proximity to the town of Royston operating at a speed of 330kph. This option would sit within the existing rail freight corridor immediately adjacent to the town. The second new alignment would avoid the Coking Plant altogether but would dissect Rabbit Ings Country Park operating at a speed of 360kph and would clip the eastern boundary of a timber recovery yard. This would be to the east of both the March alignment and the first alternative option above.

Figure 3.1: Route options passing through Royston



3.10.3 We looked further at what the dissection of the Coking Plant would mean in practice noting the significant investment recently made in this business. The first new alignment would dissect the gas storage area and associated pipelines and infrastructure. We believe that this could be moved but would be at high risk. Risks included whether there would be a suitable alternative location and the costs, as yet unidentified, of relocating the infrastructure. We would need to understand further whether the site could still operate with a high speed line isolating the west of the plant. We would also need to undertake further investigation about operating a high speed line in such close proximity to a coking plant. These risks potentially present an unfavourable argument for locating the high speed line within the footprint of the plant.

3.10.4 Whilst the alternative alignment we developed on the east side would not directly affect the Coking Plant, it would dissect the length of Rabbit Ings Country Park. There may be possible opportunities to mitigate the direct impact on the park and thereby limiting impacts from HS2 at the construction stage. We could develop this option further as the design of the route continues. This would include undertaking further assessment to establish the exact locations of the specific features and habitats within the park.

3.10.5 We will also continue to look at options for reducing the impact of the alignment including potentially moving it westwards towards the B6428 which runs alongside the Coking Plant and between the Country Park. This may require the relocation of the timber recovery yard but would potentially reduce the direct impact on the park by reducing the amount of land taken. Any further move in the alignment would also need to assess potential impacts on Wintersett Reservoir to the north and to

establish whether the potential demolitions by Shaw Dike Bridge would be unavoidable.

3.10.6 Noise impacts for the alignment we described in our March reports and the two alternatives described here could be potentially mitigated through scheme design, as it develops.

Recommendation

3.10.7 In summary, all the options HS2 Ltd has looked at in this area are not without particular impacts. Nevertheless the route option that would avoid McKenzies Coking Plant looks preferable and through further work we may be able to identify further alignment improvements.

3.11 Wintersett

3.11.1 Heading north from Royston, the alignment, as described in our March reports, would pass between the Cold Hiendley and Wintersett reservoirs. Our current proposal is that the tracks would sit on a viaduct that would bridge the east and shallow end of the Cold Hiendley reservoir close to the dam wall of the deeper and much larger Wintersett Reservoir. Immediately to the north-east of Wintersett reservoir is the Anglers Country Park, now a lake. This former opencast mine was one of the deepest in the country at 80m.

3.11.2 We have considered several alignments through this area seeking to balance sustainability, engineering risk, operation and cost. We believe that the route we described in our March reports offers the most appropriate balance even when the engineering difficulties and sustainability issues associated with the reservoirs are considered.

3.11.3 We have carried out some very high level further work mainly seeking to identify possible options for improving the vertical alignment and particularly the potential impacts on Wintersett Reservoir which we would propose taking forwards.

Recommendation

3.11.4 HS2 Ltd believes that through further work we may be able to improve the alignment through this area.

3.12 New Crofton Depot

3.12.1 Since our report in March we have looked again at the proximity and height of the alignment and the connections to the proposed New Crofton depot site, as the route passes Walton Country Park (a former opencast colliery). A number of rail corridors would cut across the proposed HS2 route with some in deep cutting.

3.12.2 We have carried out a preliminary assessment and believe that it may be possible to reduce the height of the grade separated structures subject to understanding in

more detail the height of the existing rail alignment over which we cross. This modification would reduce the overall footprint of the junction and bring a modest reduction in construction costs and a reduction in the impact upon the country park.

3.12.3 We have also looked at refining the connections to the proposed depot with the result that the south facing connection has been removed, leaving only the north facing connection. Due to the scale of the refinements there would be little difference in sustainability performance between the alternative and the March design for the New Crofton depot.

Recommendation

3.12.4 HS2 Ltd believes that through further work we may be able to improve the alignment through this area.

3.13 Altofts to Swillington

3.13.1 As the route we described in our March reports passes between Altofts and Swillington it would pass close to the Scheduled Henge on Birkwood Common, through the Moss Carr BAP habitat and Ancient Woodland and would potentially put at risk Grade II listed buildings at Clumpcliffe. The route would then pass close to Woodlesford as it continues north past Swillington.

3.13.2 Following further work on the route through this area, we believe that the impacts described above can be mitigated by moving the alignment eastwards. This also would have the additional benefit of improving the configuration of the grade separated junction for the spur to the proposed Leeds New Lane station by reducing its footprint, land-take and costs.

3.13.3 From a sustainability perspective this change in alignment would result in the route being further from the Scheduled Henge at Birkwood, whilst avoiding Moss Carr BAP habitat and ancient woodland and the listed buildings at Clumpcliff.

Recommendation

3.13.4 HS2 Ltd recommends that this change in the alignment is adopted by Government.

3.14 Swillington to Garforth

3.14.1 From Swillington the route we described in our March reports heads on towards Garforth. We have undertaken some further work in this area to look specifically at the potential to mitigate the possible demolitions at Swillington Common and simplify the crossing at Barwick Road.

3.14.2 The spur connection to the ECML that we reported in March would follow the M1 corridor past Swillington and Garforth before crossing beneath the A1(M) to the north of Micklefield. The alignment we reported in March would pass beneath the

A63 Selby Road in a cutting up to 23m deep with its depth and width resulting in a number of potential demolitions in the Swillington Common area.

3.14.3 Our further work on the route at Swillington Common has modified the alignment to move it closer to the motorway and raise it to create a shallower cutting with a bridge crossing over the A63. The alignment would fit more naturally into the landscape as a result and would also reduce residential demolitions at Swillington Common. When combined with the previously described route change between Altofts and Swillington described above there would also be a cost saving of around £75m.

3.14.4 As the proposed alignment from Swillington Common heads east, parallel with the M1, it would run on a low embankment at a similar height to the motorway to pass beneath Barwick Road, lengthening that bridge. We believe this would be a better solution than putting the HS2 alignment on a higher embankment above the Barwick Road, as this would result in major visual intrusion and create technical difficulties with the crossing beneath the A1(M) further east.

Recommendation

3.14.5 HS2 Ltd recommends that this change in the alignment is adopted by Government.

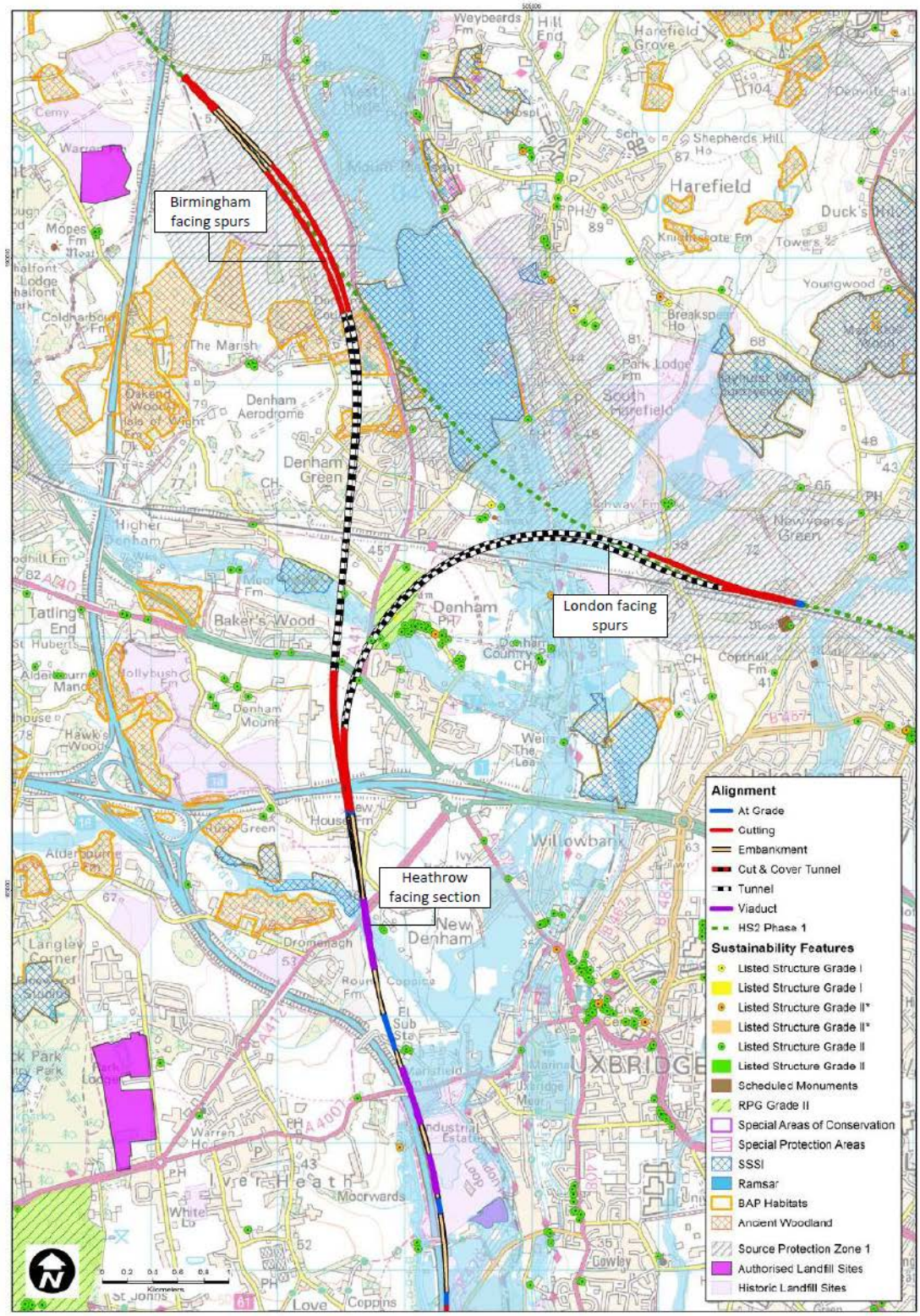
4 Heathrow

4.1.1 The Government has announced its intention to suspend any further work on the spur to Heathrow until after the Airports Commission has reported and it has had the opportunity to consider the Commission's recommendations. The refinements described below, covering the further work we carried out since March exploring potential route refinement to the proposed spur to Heathrow T5, represent the last activity HS2 Ltd will undertake on the route and station option until we receive a formal remit from Government in the future.

4.2 Heathrow route alignment

4.2.1 Since reporting in March we have undertaken further work to refine the route between Heathrow T5 and the junction with the HS2 phase one alignment in the vicinity of the Colne Valley. In this section of the report, we split the route into four sections; the London facing spurs, the Birmingham facing spurs, the Heathrow facing section where the two spurs come out of tunnel and merge and the central section adjacent to the M25 leading to the station approach. For each of the sections identified, apart from the central M25 section where we are not presenting a change from our March reports, we describe how our proposed alignment compares to the options we described in March.

Figure 4.1: Spur to Heathrow T5



4.3 London facing spurs

4.3.1 The route we reported in March was designed so that the London facing spurs would pass into tunnel almost immediately after leaving the HS2 phase one alignment to avoid the impacts on the village of Denham. Our further work has modified this alignment, broadly following the same approach but with some modifications.

4.3.2 Our further design work has reduced the spacing between tunnels from around 500m to less than 100m, negating the need for multiple surface intervention shafts through the Denham area. Our design work since March has reduced engineering complexity, for example by removing the skewed crossing under the Chiltern Line and ensuring adequate cover for construction of the tunnel portals. Our proposed alignment changes would also avoid two historical landfill sites previously intersected by our March report alignment. We have also increased the proposed alignment speed from 160kph to 230kph when joining with the phase one alignment so as to not have a detrimental effect on phase one journey times and capacity. This would improve times by approximately one minute.

4.3.3 We believe that our further work on the London facing spurs would generally improve the engineering of this section of the route. It would however have a greater direct impact on Source Protection Zone 1 used to abstract drinking water (an SPZ1 is an Environment Agency category relating to the immediate groundwater abstraction area). The route would intersect 2.2 miles (3.5km) of SPZ1 instead of 1.4 miles (2.3km) as set out in our March reports. One tunnel portal would also be within an area of SPZ1 and would be likely to require additional protection from flooding given the high water table in this location.

4.3.4 Should Government wish to take forward this route option in the future, we would need to undertake further work with Thames Water and the EA and consider what specialist construction methods would potentially be required. We would also need to carry out detailed monitoring, potentially over a number of years, accompanied by detailed mitigation designs and a construction phasing plan. Given the nature of the ground through this area we would also need to consider specialist construction techniques which may increase costs.

Recommendation

4.3.5 Should Government wish to progress this route option in the future, we recommend that the changes to the London facing spurs described here are adopted.

4.4 Birmingham facing spurs

4.4.1 As with the London facing spurs, the Birmingham facing spurs were designed to pass into tunnel almost immediately after leaving the HS2 phase one alignment to avoid impacts on the village of Denham. As with the London facing spurs, we have reduced the tunnel spacings, which we believe would reduce the landscape impacts on the Colne Valley, and increased the turnout speeds providing a journey time

saving of one minute. The revised alignment would also intersect two historical landfill sites rather than three as described in our March report option.

4.4.2 We believe that these are beneficial changes but, as with the London facing spurs, this would result in an increase in the intersection with the SPZ1 to 2 miles (3.2km) rather than 1.7 miles (2.7km) as we reported in March. As with the London facing spurs, should Government wish to progress this route option in the future, we would need to carry out additional detailed assessment and monitoring to secure consent from the EA and Thames Water and would need to consider specialist construction methods.

Recommendation

4.4.3 Should Government wish to progress this route option in the future, we recommend that the changes to the Birmingham facing spurs described here are adopted.

4.5 Heathrow facing section

4.5.1 Our further work has also examined the route to the south, where the Birmingham and London facing spurs emerge from tunnel to the south of Denham and prior to the approach to Heathrow.

4.5.2 Our revised design would move the tunnel portals north of the M40 resulting in a shortening of the tunnels overall by approximately 1000m and negating the need for multiple intervention shafts. We would also propose moving the alignment westwards by approximately 100m to provide a simpler crossing of the M40, reduce the impacts on the A412 and provide a reduction in the length of four-track railway. This would also result in the tunnels not passing directly under the village of Denham.

4.5.3 We believe that this revised alignment would improve the performance of this section of the route. It would reduce the number of potential demolitions and avoid the direct impact on a Grade II listed structure. This revised alignment would affect one fewer inactive landfill sites compared to our March alignment (four rather than five). However, the changes would potentially result in a greater impact on Kingcup Meadows & Oldhouse Wood SSSI due to the revised route being closer to this site. We believe that through further design it may be possible to mitigate the impact on this site. There would also be a need to move a section of high voltage power cables.

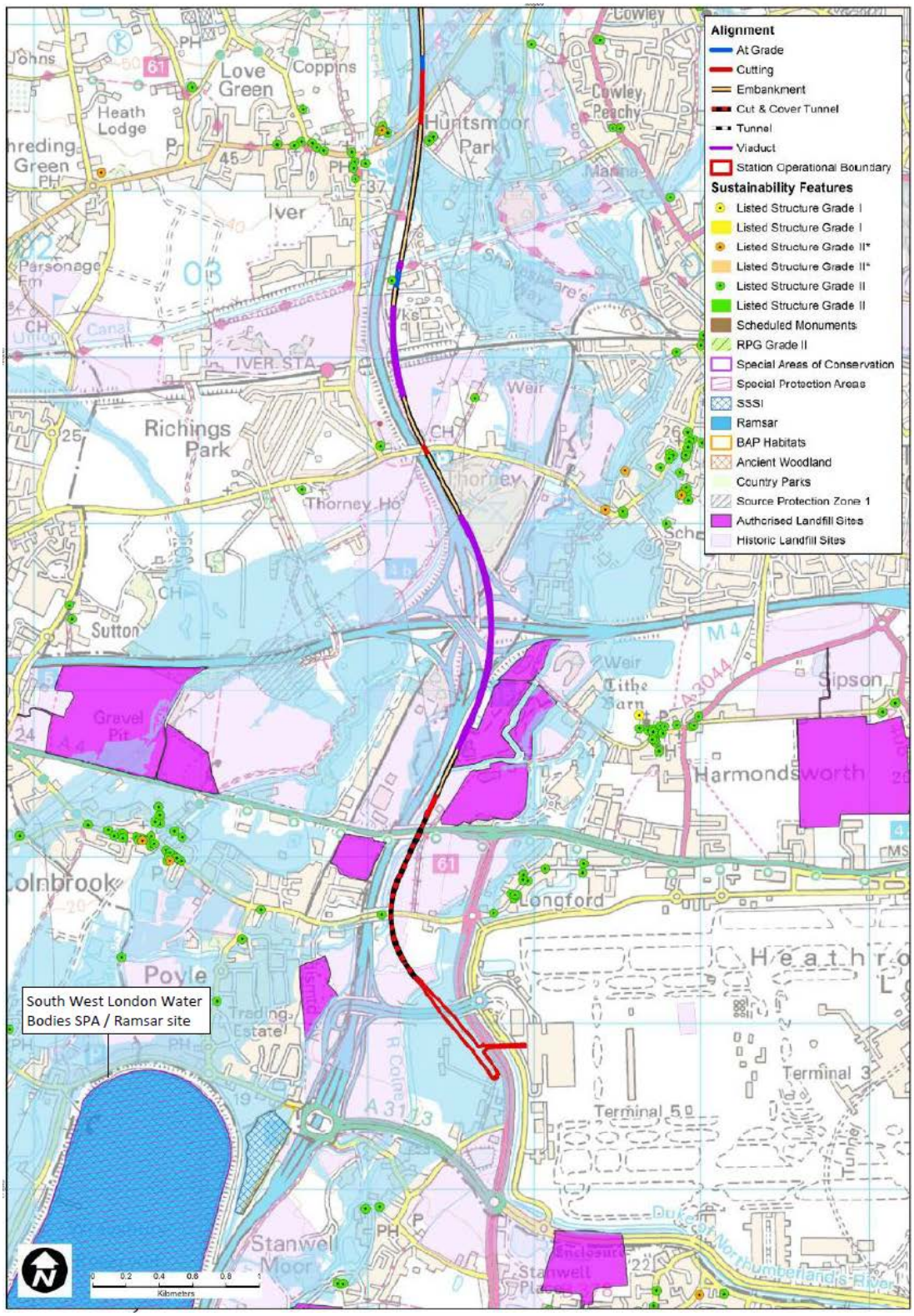
Recommendation

4.5.4 Should Government wish to progress this route option in the future, we recommend that the changes to the Heathrow facing section are adopted.

4.6 South West London Water Bodies SPA / Ramsar site

4.6.1 In our March reports we noted the particular importance of the South West London Water Bodies (SWLWB) Special Protection Area (SPA) and Ramsar site. The proposed Heathrow spur would be located just over half a mile (1km) from the South West London Water Bodies SPA / Ramsar site. We highlighted that there could be potential for in-combination effects from the phase one route and proposed phase two Heathrow spur. Since March, the HRA screening reports have been completed in consultation with the NE and EA. The reports conclude that there is no likely significant effect and this has been agreed with NE and EA.

Figure 4.2: Spur to Heathrow T5 showing South West London Water Bodies SPA / Ramsar location



4.7 Heathrow T5 station – North/South station

4.7.1 In our March reports we described a station option at Terminal 5 which would be broadly orientated north-south. Our further work has explored whether we could reduce the impact on the surrounding infrastructure. We also examined whether we could reduce the number of potential demolitions by modifying the station option. We also looked at the implications of our further hydrological assessment.

4.7.2 Our further design work has looked therefore at moving the station option further west from T5. This station would provide the same functionality as the previous station but would avoid the highway and hydrological infrastructure modifications resulting in a cost saving of around £80m. There would still need to be some modifications required to the surrounding infrastructure although these would be limited to a 650m permanent diversion of the River Colne and temporary diversion of the M25 spur. There would also be a significant reduction in the amount of the construction zone within the floodplain. Due to the reduced construction zone there would also be a reduced number of demolitions.

4.7.3 This revised design would locate the station further from T5 increasing the walking distance between the high speed station and terminal by around 150m, about an additional one minute walk time.

Recommendation

4.7.4 Should Government wish to progress this route option in the future, we recommend that HS2 Ltd would need to work with BAA on further developing this station option. Overall though, given the improvements in provides to cost, constructability and sustainability we would recommend this revised alignment.