HS2

October 2018

High Speed Rail (Crewe to Manchester and West Midlands to Leeds)

Working Draft Environmental Statement

Alternatives Report

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Alternatives Report

Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

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A report prepared for High Speed Two (HS2) Limited:

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1 Introduction

1.1 Overview of High Speed Two

1.1.1 High Speed Two (HS2) is a new high speed railway proposed by the Government to connect major cities in Britain. New stations in London, Birmingham, Leeds, Manchester and East Midlands would be served by high speed trains running at speeds of up to 360 kilometres per hour (kph) (225 miles per hour (mph)). HS2 trains would also run on the existing network to serve destinations including Crewe, Preston, Liverpool, Sheffield, Newcastle, York, Glasgow and Edinburgh.

1.1.2 In January 2012, following a consultation exercise, the Government announced its intention to develop a Y-shaped high speed rail network, which would be brought forward in two phases. The 2012 decision confirmed the Government's preferred route for a high speed line between London and the West Midlands, called Phase One. In November 2013, HS2 Ltd deposited a hybrid Bill in Parliament to seek powers for the construction and operation of Phase One. The High Speed Rail (London – West Midlands) Act[1] received Royal Assent in February 2017 and pre-construction work on Phase One commenced in July 2017.

1.1.3 In January 2013, the Government announced its 2013 initial preferred scheme for Phase Two between the West Midlands, Leeds and Manchester. Following some minor amendments, the 2013 proposed scheme for consultation was subject to a seven-month public consultation from July 2013 until January 2014.

1.1.4 In two reports, *HS2 plus* (2014)[2] and *HS2 rebalancing Britain* (2014)[3], Sir David Higgins recommended accelerating the section of the Phase Two route between the West Midlands and Crewe to deliver some of the benefits that HS2 would bring to the region and the North sooner. In the Command Paper, *The next steps to Crewe and beyond report* (2015)[4], the Government announced its intention to bring forward the route between the West Midlands and Crewe, and set out the preferred route for what is known as Phase 2a. Phase 2a would involve the construction of the first approximately 58km of the western leg of Phase Two from the end of the Phase One route to a connection with the West Coast Main Line (WCML) at Crewe. In July 2017, HS2 Ltd deposited a hybrid Bill to Parliament to seek powers for the construction and operation of Phase 2a. A subsequent ES deposited with an Additional provision to that Bill followed in March 2018. The High Speed Rail (West Midlands - Crewe) Act is expected to receive Royal Assent in 2019.

[1] *High Speed Rail (London - West Midlands) Act 2017*. Available online at: http://www.legislation.gov.uk/ukpga/2017/7/contents/enacted
[2] HS2 Ltd., (2014), *HS2 Plus – A report by David Higgins*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374695/HS2_Plus_-_A_report_by_David_Higgins.pdf
[3] HS2 Ltd., (2014), *Rebalancing Britain – From HS2 towards a national transport strategy*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374709/Rebalancing_Britain_-_From_HS2_towards_a_national_transport_strategy.pdf
[4] Department for Transport (2015), *High Speed Two: East and West: The next steps to Crewe and beyond.* Cm 9157. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf

1.1.5 On 15 November 2016, the Government set out the majority of its 2016 preferred route[5] between Crewe and Manchester and between the West Midlands and Leeds, referred to as Phase 2b and completing what is known as the 'Y network'. Alongside the 2016 preferred route to Manchester and Leeds, the Government also announced a consultation on seven route refinement areas. On 17 July 2017, the Government announced a decision on these refinements and confirmed the remaining areas of the preferred route for Phase 2b.

1.1.6 Phase 2b, referred to as 'the Proposed Scheme', is the subject of this working draft Environmental Statement (ES). The working draft ES is an interim report presenting preliminary environmental information for consultation. The design and assessment of the Proposed Scheme are at an early stage of development and are presented to enable the public and stakeholders to provide comments, which will be taken into account, as appropriate. Nothing included at this stage is intended to limit the form of the final scheme that will be presented in the hybrid Bill and formal ES in light of further scheme development and the ongoing discussions with stakeholders such as Transport for the North and Midlands Connect. The Environmental Impact Assessment (EIA) and design of the Proposed Scheme will continue to be refined during and following this consultation and reported in the formal ES.

1.1.7 The Proposed Scheme comprises the route from Crewe to Manchester with a connection onto the WCML (referred to as the 'western leg'), and from the West Midlands to Leeds via the East Midlands and South Yorkshire with a connection onto, and part electrification of, the Midland Main Line (MML) and a connection onto the East Coast Main Line (ECML) (referred to as 'the eastern leg'). Since the Government announced the 2017 preferred route for Phase 2b in July 2017, the Proposed Scheme was amended to include the electrification of a section of the MML between Clay Cross and Sheffield Midland Station[6]. This would enable high speed trains to connect to Chesterfield and Sheffield as part of the Proposed Scheme. The design of the proposed electrification of this section of the MML is at an early stage of development (as reported in the MML01 and MML02 Volume 2: Community area reports) and the outcome of the environmental assessment of the likely significant effects of the electrification works will be reported in the formal ES.

1.1.8 The powers for Phase 2b will be sought through a hybrid Bill ('the Bill') that is expected to be deposited in Parliament in 2020. Construction of Phase 2b is anticipated to commence in approximately 2023, with operation planned to start around 2033.

[5] Department for Transport (2016), *High Speed Two: From Crewe to Manchester, the West Midlands to Leeds and beyond*. Moving Britain Ahead. Cm9355. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568208/high-speed-two-crewe-manchester-west-midlands-leeds-web-version.pdf

[6] HS2 Ltd. (2018). Press release: HS2 Ltd to undertake development works for electrification of the Midland Main Line. Available online at: https://www.gov.uk/government/news/hs2-ltd-to-undertake-development-works-for-electrification-of-the-midland-main-line

1.2 Purpose of this report

1.2.1 The consideration of reasonable alternatives forms a statutory requirement of EIA reporting. The Town and Country Planning (Environmental Impact Assessment) Regulations 2017[7] require an ES to include:

"A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects."

1.2.2 Further, as part of a requirement of the Bill, Parliamentary Standing Order 27A[8] requires:

"A report which identifies, describes and evaluates reasonable alternatives to the works authorised by the bill, taking into account the objectives and geographical scope of the bill."

1.2.3 This report describes the evolution of the Proposed Scheme to date, summarising its objectives and requirements, and identifies the strategic alternatives, route-wide rail and route corridor alternatives, and reasonable alternatives to the main elements of the Proposed Scheme which have been studied. In each case, this report indicates the main reasons for selecting the chosen option over another, which ultimately resulted in the Proposed Scheme.

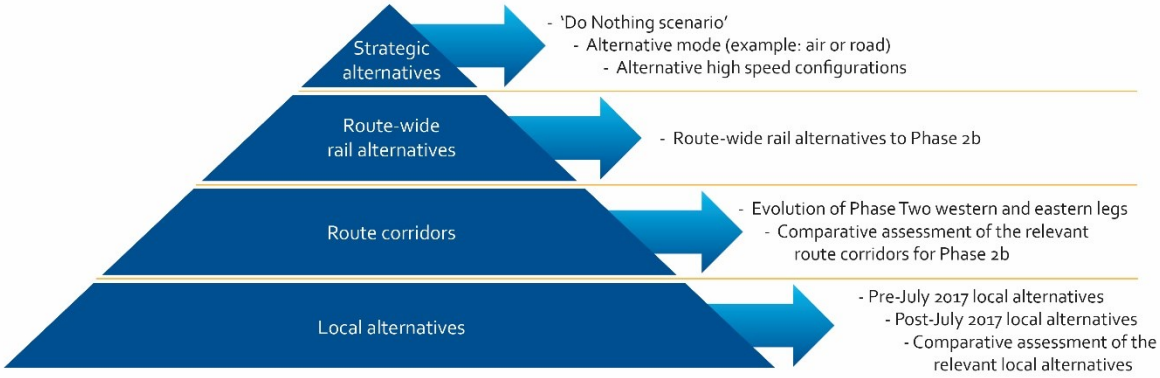
1.2.4 This report has been developed for the Proposed Scheme taking into account relevant information provided within existing reports including the *Phase One alternatives report* (2013)[9], *Phase 2b strategic alternatives report* (2016)[10] commissioned by the Department for Transport (DfT) on strategic alternatives and Government reports, such as the *Strategic case for HS2 report* (2015)[11].

[7] *The Town and Country Planning (Environmental Impact Assessment) Regulations 2017* (S.I 2017 No. 571), London, Her Majesty's Stationery Office. Available online at: http://www.legislation.gov.uk/uksi/2017/571/pdfs/uksi_20170571_en.pdf
[8] House of Commons (2017) *Standing Order 27A relating to private business (environmental assessment)* House of Commons. Available online at: https://publications.parliament.uk/pa/cm201719/cmstords/Nov2017/pb2017v12.pdf
[9] HS2 Ltd, (2013), *London - West Midlands Environmental Statement – Volume 5 Technical Appendices, Alternatives report (CT-002-000).* Available online at: https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-5-alternatives-report
[10] Atkins, (2016), *Strategic Alternatives to HS2 Phase 2b. A report for the Department for Transport*. Available online at: https://www.gov.uk/government/publications/strategic-alternatives-to-hs2-phase-2b https://www.gov.uk/government/publications/strategic-alternatives-to-hs2-phase-2b https://www.gov.uk/government/publications/strategic-alternatives-to-hs2-phase-2b
[11] Department for Transport (2015), *Supplement to the October 2013 Strategic Case for HS2*. Available online at: https://www.gov.uk/government/publications/hs2-supplement-to-the-october-2013-strategic-case

1.3 Structure of this report

1.3.1 The reasonable alternatives studied by Government and HS2 Ltd are set out in accordance with the hierarchy shown in Figure 1.

Figure 1: Hierarchy of reasonable alternatives studied



1.3.2 Part I of this report presents a brief summary of the strategic alternatives to the high speed rail network (the full Y network incorporating Phase One and Phase Two) that are outlined in more detail in the *Phase One alternatives report* (2013). Part I then discusses the reasonable strategic alternatives to the Proposed Scheme including the consideration of a 'do nothing' scenario (i.e. not constructing the Proposed Scheme) and the strategic alternatives to the Proposed Scheme, including consideration of alternative modes of transport (i.e. road and air). The report then sets out the route-wide rail alternatives to the Proposed Scheme, including consideration of high speed and conventional rail options.

1.3.3 Part II of this report explains the consideration of the reasonable route corridor alternatives to the Proposed Scheme studied by Government and HS2 Ltd, and the reasoning behind the decisions taken on the preferred route presented for public consultation in 2013/2014 and 2016/2017, including a comparison of environmental impacts. It also describes the reasonable local alternatives considered and the reasons for the decisions taken both before and, as far as possible at this stage of design, after the announcement of the 2017 preferred route to Manchester and Leeds.

Part I

2 Strategic alternatives

2.1 Strategic alternatives to high speed rail previously studied

2.1.1 The Government has concluded that action is needed to meet the future travel needs of Britain and 'doing nothing' is not an option. The Government's case for HS2 is set out in Volume 1: Introduction and methodology, Section 2.

2.1.2 Before deciding to proceed with HS2, a wide range of options to address Britain's inter-urban transport challenges were reviewed. These included domestic aviation, new motorways, a new conventional speed railway as well as upgrades to existing roads and railways.

2.1.3 The potential for capacity upgrades to the existing conventional rail network has been explored. The Government rejected this option as further upgrades would not provide the scale of capacity increase and connectivity benefits needed to fulfil the Government's objectives[12]. This option would also fail to meet Government objectives for future performance of the conventional rail network and would cause considerable disruption to existing train services during construction.

2.1.4 Carbon emissions from air travel are significantly greater than from high speed rail. The capacity of London's airports is limited and providing for future growth in international travel will be a significant challenge without also serving additional demand from domestic air services. The Government's policy therefore is to enable and encourage more people to take the train instead of air for domestic and short-haul journeys, to achieve environmental benefits and to release capacity at airports for longer journeys.

2.1.5 The Government also decided not to give further consideration to major new motorways as an alternative to HS2, as high speed rail is preferable in terms of both capacity and journey times and also has lower carbon emissions and environmental effects.

2.1.6 The cost of a new conventional speed railway would be almost as high as that of high speed rail without delivering the reduced journey times and would have only marginally fewer environmental impacts. For these reasons, a new conventional railway option was rejected.

2.1.7 Prior to the introduction of the Phase One hybrid Bill into Parliament in November 2013, the Government considered and reported on alternative configurations of the proposed high speed rail Y network. The Government's conclusion and reasons for promoting the Y network were reported in the Command Paper, *High Speed Rail: Investing in Britain's Future report* (2012)[13] and subsequently in the *Phase One*

[12]Department for Transport (2017) *High Speed Two Phase Two Strategic Case. Moving Britain Ahead*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629393/high-speed-two-phase-two-strategic-case.pdf

[13] Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3648/hs2-decisions-and-next-steps.pdf

alternatives report (2013) deposited in Parliament alongside the Phase One hybrid Bill. The Phase One hybrid Bill was enacted in February 2017 and pre-construction works on Phase One have commenced.

2.2 Strategic alternatives to Phase 2b

Doing nothing

2.2.1 As referenced in paragraph 2.1.1 of this report, consideration of 'doing nothing' for the whole of the Y network is provided in the *Phase One alternatives report* (2013).

2.2.2 For Phase 2b, the 'do nothing' scenario implies not delivering the Proposed Scheme between Crewe and Manchester and between the West Midlands and Leeds, nor connections to the WCML, ECML or MML. This scenario would therefore not provide:

- additional new rail network capacity;
- increased train services;
- reduced journey times;
- improved rail connectivity to the northern cities and Scotland from and to the Midlands and London; and
- support for economic growth in the East Midlands and the North.

2.2.3 The Government has, however, concluded that action is required to meet the rising demand for inter-city travel, reduce crowding, to address the growing rail congestion on Britain's inter-city rail network and to support economic growth. 'Doing nothing' is therefore not considered an option.

Alternative modes – air or road

2.2.4 As referenced in paragraphs 2.1.4 and 2.1.5, consideration of alternative modes of transport to high speed rail is provided in the *Phase One alternatives report* (2013).

2.2.5 The Government considers that a continuing increase in demand will create a need over the next 20 to 30 years for additional capacity to cater for inter-city journeys between London and the major conurbations in the Midlands and the North. It does not, however, believe transferring rail demand to road or domestic aviation to be an appropriate solution. Rather, the Government considers that it is the rail network which needs to be in a position to play the lead role in delivering new capacity and that a clear case exists for this new capacity to be a new high speed rail network.

3 Route-wide rail alternatives

3.1 Rail alternatives to Phase 2b

Background

3.1.1 In line with the requirements of the HM Treasury *Green Book*[14], the DfT has considered alternatives to the Proposed Scheme throughout its development to ensure the case for the Proposed Scheme is robust. As part of the development of a strategic outline business case for Phase 2b, the DfT commissioned Atkins to develop and appraise potential route-wide rail alternatives. The study, as reported in the *Phase 2b strategic alternatives report* (2016), was completed in November 2016 and updated previous work completed on route-wide rail alternatives by Atkins in 2013[15], taking account of design updates including the decision by Government to construct Phase 2a ahead of the remainder of Phase Two.

3.1.2 The DfT specified that the appraisal of rail alternatives be undertaken against the Government's strategic objectives for HS2, and in particular, Phase 2b. In addition to the consideration of costs, the following was considered at a high level:

- generation of additional network capacity that could be used for other future services;
- on train/seating capacity and crowding;
- reliability and punctuality;
- disruption during construction; and
- environmental impacts.

3.1.3 Within the scope of the remit above, the rail alternatives were required to represent a range of costs and solutions.

Alternatives studied

Study assumptions

3.1.4 To appraise the route-wide rail alternatives to Phase 2b, Atkins developed five options that all tried, to various degrees, to overcome capacity and journey time limitations on the WCML, ECML and MML. The options considered required a range of different combinations of infrastructure upgrades and sections of new track to deliver improved journey times and similar train frequencies to the 2016 preferred route to Manchester and Leeds, as far as practicable using the existing conventional rail network. Design development work by Network Rail on the conventional rail network, including 225 kph (140 mph) running on the ECML and new rail schemes or upgrades to the existing conventional rail network assumed to be 'committed' to by Government, were taken

[14] Appraisal and Evaluation in Central Government – latest edition released 2018. Available online at: http://webarchive.nationalarchives.gov.uk/20080305121602/http://www.hm-treasury.gov.uk/media/3/F/green_book_260907.pdf
[15] Atkins (October 2013), *HS2 Strategic Alternatives: Final Report*. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/253456/hs2-strategic-alternatives.pdf

into consideration. As such, the findings and conclusions reported here are based on the conventional network at the time of the study including any committed schemes.

3.1.5 A train service specification (TSS) was produced for the operation of the route-wide rail alternatives, as considered in the *Phase 2b strategic alternatives report,* which delivered a comparable level of connectivity to the proposed Phase 2b TSS. This allowed a consistent approach between the route-wide rail alternatives and the methodology applied to the Proposed Scheme[16].

3.1.6 On the western leg to Manchester, it was assumed that Phase 2a will have been built. As a result, the sections of the route-wide rail alternatives proposed as alternatives to the western leg of the Proposed Scheme were constrained to a single, similar option along the WCML north of Crewe.

3.1.7 Train services from Birmingham could only be accommodated at Manchester Victoria Station, not Manchester Piccadilly Station. It was necessary to utilise Manchester Victoria Station to deliver sufficient capacity and to provide the same number of services as the Phase 2b service pattern, which could not otherwise be accommodated on the approach to, or at, Manchester Piccadilly Station.

3.1.8 On the eastern leg to Leeds, all of the route-wide rail alternatives would require a new link from Phase One to the existing conventional Birmingham to Derby Railway. The Birmingham to Derby Railway would need to be electrified and upgraded.

3.1.9 On the eastern leg to Leeds, all of the route-wide rail alternatives would serve the East Midlands via Derby and Nottingham and not via East Midlands Hub (near Toton), as for the Proposed Scheme. Each option was designed as far as possible to be comparable to the Phase 2b service pattern, to ensure that each destination retained a similar service provision, particularly in terms of frequency. The rail alternative options, however, could not precisely replicate the Phase 2b service pattern in all instances and the service levels at Derby and Nottingham were combined and designed to be comparable with the Phase 2b service pattern at the East Midlands Hub.

3.1.10 The sections of the route-wide rail alternatives proposed as alternatives to the eastern leg of the Proposed Scheme would provide a number of different ways of reaching Edinburgh, Leeds and Nottingham via upgrades to existing conventional railway infrastructure. All the alternatives examined would serve Sheffield Midland Station via upgrading the existing conventional Derby to Sheffield line.

[16] Following the route-wide rail alternatives options study completed by Atkins in 2016, the Phase 2b service pattern was revised. The service pattern produced for the route-wide rail alternatives is considered not to be materially affected by the revision to the Phase 2b service pattern. As a result, the route-wide rail alternatives options can be compared to both the 2016 preferred route to Manchester and Leeds and the Proposed Scheme.

3.1.11 The route-wide rail alternatives were discussed and agreed at a series of workshops with the DfT, Network Rail and HS2 Ltd. High level analysis of the journey times, costs, capacity and disruption was undertaken for the different options as outlined above. The analysis used models and methodologies similar to those used for analysis of the 2016 preferred route to Manchester and Leeds as far as practicable, acknowledging that the route-wide rail alternatives were comparatively less developed. The route-wide rail alternatives were compared to the 2016 preferred route to Manchester and Leeds and a 'do minimum' (with Phase 2a) scenario[17].

Options description

3.1.12 As part of the route-wide alternatives to Phase 2b considered by Atkins in 2016, five options (Option 1, Option 2S, Option 2L, Option 3 and Option 4) were developed and assessed, which comprised various infrastructure upgrades and interventions. For the eastern leg to Leeds, the five options reflected the different ways of reaching Edinburgh, Leeds and Nottingham, whereas for the western leg to Manchester, one single infrastructure option was considered based on infrastructure upgrades to the WCML north of Crewe, with slight TSS variations to take into account the options considered for the eastern leg to Leeds. Option 1 was based on upgrading the ECML and elements of WCML, whilst Options 2 to 4 were based on constructing a section of high speed line between Sheffield and Leeds, with Option 2S and Option 2L representing different lengths of high speed line. Option 2, which would require upgrades principally to facilitate faster and more frequent trains to Edinburgh, was similar to Option 1, except Leeds would be served from a spur from the HS2 main line. Option 3 would be similar to Option 2, apart from Edinburgh would be served via a joint Glasgow service from London Euston, like the Proposed Scheme TSS. Option 3 would require the least number of upgrades to the ECML as Edinburgh would be served via HS2 and the WCML. Option 4 would be the same as Option 2, although Nottingham would be served by the MML rather than by the HS2 main line.

3.1.13 A summary of the five options is provided below, with further details given in the *Phase 2b strategic alternatives report* (2016).

Option 1

3.1.14 Option 1 would require upgrades to the WCML north of Crewe and would provide (as would Option 4) one additional service to Manchester relative to Options 2S, 2L and 3.

3.1.15 Upgrades to the ECML would be required in order to reach Leeds, York and Newcastle. Option 1 would require the most investment and upgrades along the ECML compared to the other route-wide rail alternatives considered. The line speed along the ECML would be increased from a current maximum speed of 201 kph (125mph) to 225 kph (140 mph) for this option to broadly match journey times along the eastern leg of the Proposed Scheme. City centre stations at Nottingham and Sheffield would be reached via an improved MML route from Trent Junction, which would connect to Phase One via an upgrade of the existing conventional railway

[17] The 'do nothing' scenario provides a model for the operation of train services from 2033 assuming the Proposed Scheme does not go ahead and provides a reference against which the 'do something' options can be compared. The 'do minimum' operational train timetable assumptions are based on future committed schemes only and assumes that Phase One and Phase 2a will have been built. Further information is available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/574740/Planet_Framework_Model_Assumptions_Report.pdf

via Burton and would involve mainly four tracking and a new connection to Phase One near Birmingham.

3.1.16 The key elements of this option are summarised as follows:

- western leg to Manchester:
  - partial four tracking of the Crewe (Wilmslow) – Weaver Junction on the WCML and provision of an alternative freight route via Sandbach;
  - substantial grade separation between Crewe and Preston on the WCML and some platform lengthening so trains can split and join at both stations; and
  - a chord from Phase One that would allow two trains per hour to connect with the WCML Stoke branch via Stone to Manchester Piccadilly Station.
- eastern leg to Leeds:
  - four tracking of the existing two track ECML through Welwyn North and modifications to local signalling;
  - replacement of the existing flat crossing at Newark with a grade separated junction to allow movement of trains to, and from, Nottingham;
  - provision of a grade separated junction in the Doncaster area to allow for the east-west running of trains and the north-south running of freight services;
  - upgrades, to the eastern side of the HS2 main line at Darlington, including the provision of loops, to provide extra capacity for the running of trains along the ECML;
  - grade separation of the Trent and Stenson junctions on the MML;
  - upgrades to the MML to improve capacity and speed between Derby and Sheffield; and
  - upgrades to the MML between Trent Junction and Nottingham, and connection to Phase One via mainly four tracking of the existing conventional railway via Burton.

Option 2S and Option 2L

3.1.17 Like Option 1, both Options 2S and 2L western leg train services would run along the WCML, although the Stoke via Stone chord would not be required as only one conventional train per hour would operate via Stoke between Manchester and London Euston Station. The WCML services would broadly match those designed for the Proposed Scheme, albeit at a lower speed and sometimes with less capacity per train.

3.1.18 Like Option 1, both Options 2S and 2L eastern leg train services would run along the ECML to York, Newcastle and Edinburgh, but Leeds would be served via a spur from Phase One, an upgraded section of the existing conventional railway, the MML (assumed to be electrified) and a section of new track that would broadly follow the M18 route of the Proposed Scheme between Leeds and the MML near Sheffield. This new section of track would allow high speed trains to Leeds to operate from London

Euston Station and would remove the need for extra capacity on the ECML and in particular in the Welwyn area.

3.1.19 For Option 2S, this section of new track would be approximately 41.8km long and would be constructed between Leeds and just south of Mexborough, where the HS2 main line would then divert away to connect to the existing conventional railway between Sheffield and Leeds (via Moorthorpe) near Rawmarsh. For Option 2L, the section of new HS2 main line would be approximately 62.6km long and would be built as far south as Killamarsh before diverting to connect to the same existing conventional railway further south between Sheffield and Leeds. Options 2S and 2L were considered in order to compare whether a shorter or longer section of new HS2 main line at this location would perform better.

Option 3

3.1.20 Option 3 would require the least upgrades to the existing conventional railway lines when compared to the other route-wide rail alternatives. It would be the same as Option 2S except that Edinburgh, like Glasgow, would be reached via a joint service from London Euston Station, as per the Proposed Scheme, except the WCML would be joined north of Crewe. Since the ECML would not be required to serve Leeds or Edinburgh, upgrades to increase line speeds would not be required. The flyover and associated grade separation works at Newark would therefore not be required to allow for faster trains running on the ECML. As a result, a slightly different running pattern for Cross Country services would be required that would revert back to using Doncaster as the main ECML route.

Option 4

3.1.21 Option 4 was the same as Option 2S except that Nottingham would be served via the MML. The MML would be upgraded north of Kettering while upgrades in the Trent area would not be required.

Appraisal of alternatives

Journey Times

3.1.22 The route-wide rail alternatives would deliver significantly faster journey times than the 'do minimum' (with Phase 2a) scenario to many of the key destinations included within the study. However, the Proposed Scheme would offer the fastest journey times between London and Leeds, Manchester, Newcastle, the East Midlands and Sheffield. The differences in journey times to other destinations such as Edinburgh and Glasgow were less pronounced. To compensate for slower running speeds, the route-wide rail alternatives would rely on changes to the stopping pattern and/or the removal of splitting and joining[18] of high speed services. The Proposed Scheme would deliver substantially faster journey times between cities in the North and the Midlands compared to existing journey times. The route-wide rail alternatives would not match this connectivity, and the longer journey times would not meet the Government's

[18] A splitting train separates into two trains partway along its route, so as to serve two destinations. The services will usually 'join' on the return journey

strategic objectives for HS2 to the same extent in terms of the level of economic benefits that the Proposed Scheme would bring.

Additional network capacity

3.1.23 In most cases, 'spare' network capacity would be generated where the route-wide rail alternatives provide upgrades or infrastructure to facilitate the running of extra trains or line speed improvements. In addition, the route-wide rail alternatives would provide an extended freight route on the ECML (and a much shorter freight route on the WCML) which would release further capacity. In comparison, the Proposed Scheme would generate 'spare' capacity both on its own high speed network and on the conventional rail network. This is because the number of conventional trains on existing intercity routes would be fewer than is currently run, as services switch to using the high speed railway.

3.1.24 In summary, therefore, both the Proposed Scheme and the route-wide rail alternatives would create extra capacity on the national conventional rail network for other services. However, only the Proposed Scheme would create extra capacity for potential additional high speed services on the eastern and western legs north of Birmingham and would therefore better meet the Government's strategic objectives for HS2.

Train seating capacity and crowding

3.1.25 The route-wide rail alternatives would provide more train seating than the 'do minimum' scenario, but fewer seats than the Proposed Scheme to some key destination cities.

3.1.26 The route-wide rail alternatives would change the service offered and the frequency of destinations served and therefore could either approximately meet or slightly exceed the train frequencies of the Proposed Scheme. The Proposed Scheme would, however, operate significantly longer trains (400m in length) than the route-wide rail alternatives to the destinations of Manchester, Leeds and the East Midlands, and therefore, would provide more seating overall to these destinations.

3.1.27 In order to provide extra capacity, further infrastructure investment would be required to lengthen trains running on the route-wide rail alternative options, although it would be possible to run 260m trains on certain sections of the alternatives. The Proposed Scheme would operate shorter trains (200m long) than the route-wide rail alternatives to other destinations including York, Newcastle, Liverpool, Glasgow and Edinburgh.

Reliability and punctuality

3.1.28 Network resilience would be less for the route-wide rail alternatives than for the Proposed Scheme. This is because the route-wide rail alternatives would require less new railway line to be constructed compared to the Proposed Scheme which would benefit from having a new high speed line designed and built to modern standards of resilience.

3.1.29 No benefits were identified for the punctuality and reliability on the existing conventional rail network from infrastructure investment proposed for the route-wide rail alternatives or from the released capacity generated by the Proposed Scheme

for new train paths on the congested WCML and ECML. Further, no benefits were identified for any increase or reduction in the splitting or joining of services. The route-wide rail alternatives would typically be less punctual and less reliable than the Proposed Scheme as the alternatives would require 10 more trains per hour from London and Birmingham in each direction from Phase One and Phase 2a and onto the conventional rail network.

Disruption

3.1.30 Network Rail undertook an assessment of the disruption impact of constructing the route-wide rail alternatives and in summary concluded that across the existing conventional rail network, the route-wide rail alternatives would each require:

- between approximately 1,500 and 2,000 week night closures;
- approximately 360 'equivalent Sunday'[19] closures; and
- approximately 100 full weekend or extended weekend closures.

3.1.31 Overall, no route-wide rail alternative was identified on the western leg to Manchester that could connect Manchester to Phase 2a, or serve Leeds on the eastern leg, that would not be substantially disruptive. Atkins concluded, however, that the total disruption impact associated with the construction of the route-wide rail alternatives would not necessarily make them undeliverable. The cost of disruption and compensation were taken into account in the capital and operational expenditure forecasts for the route-wide rail alternatives.

Environmental impacts

3.1.32 A high level appraisal of environmental impacts was undertaken. The route-wide rail alternatives would be delivered primarily through upgrades and alterations to sections of the existing conventional rail network within or adjacent to existing railway land. As a result, the works to construct the different elements of the route-wide rail alternatives would not always require further land. The route-wide rail alternatives would therefore have fewer environmental impacts overall than the Proposed Scheme.

3.1.33 The most notable works requiring land to construct the route-wide rail alternatives would include:

- the Newark chords (connections from flyover to ECML only);
- the Doncaster and Barnby Dun freight chords;
- the Trent Junction flyover;
- the Stone to Phase One chord; and
- the provision of new track following the M18 route.

3.1.34 The high level appraisal identified:

[19] The closure of a service for a day in order for maintenance/ improvement work on the track

- the potential for adverse impacts on wetland habitat associated with Potteric Carr, a Site of Special Scientific Interest (SSSI), in proximity to one of the proposed Doncaster chords;
- that the Stone to Phase One chord (Options 1 and 4), while avoiding the Pasturefields Salt Marsh Special Area of Conservation (SAC)/SSSI, may have an adverse impact on the complex water table in the area; and
- the potential for adverse environmental impacts on the River Trent associated with the Trent Junction flyover viaduct (Options 1-3, and also passed through by the Proposed Scheme).

Conclusions

3.1.35 Compared with the conventional rail network at the time of the study by Atkins in 2016, the route-wide rail alternatives could provide significant improvements in journey times. However, the Proposed Scheme would deliver substantially faster journey times between cities in the North and the Midlands, which could not be matched by the route-wide rail alternatives. As a result, the route-wide rail alternatives would not meet the Government's strategic objectives for HS2 to the same extent in terms of the level of economic benefits that the Proposed Scheme would bring.

3.1.36 Additional network capacity would be generated by the route-wide rail alternatives where infrastructure or upgrades would be provided to facilitate the running of extra trains or line speed improvements and through the extension of freight routes. The Proposed Scheme would, however, generate greater capacity both on the high speed line and also on the conventional rail network and would therefore better meet the Government's objectives for HS2.

3.1.37 The route-wide rail alternatives would change the service offered and the frequency of destinations served and therefore could either approximately meet or slightly exceed the train frequencies of the Proposed Scheme. However, the Proposed Scheme would operate significantly longer trains (400m in length) than the route-wide rail alternatives to key destinations and would therefore provide more seating overall to these destinations, thus better meeting the Government's objectives for HS2. The route-wide rail alternatives would require substantially less new railway lines to be constructed compared to the Proposed Scheme, however, as a result, network resilience would be less for the route-wide rail alternatives because HS2 would be built to a higher resilience standard than existing conventional railways. The route-wide rail alternatives would typically be less punctual and less reliable than the Proposed Scheme and would require 10 more trains per hour from London and Birmingham in each direction to use the existing conventional rail network. The route-wide rail alternatives would not meet the Government's strategic objectives for HS2 in regard to punctuality and reliability.

3.1.38 The route-wide rail alternatives would be delivered primarily through upgrades and alterations to specific sections of the existing conventional rail network, within or adjacent to, existing railway land. The route-wide rail alternatives would therefore have fewer environmental impacts overall than the Proposed Scheme.

3.1.39 Overall, the effectiveness of the different sections of the route-wide rail alternatives as alternatives to the Proposed Scheme varied. On the western leg to Manchester, which utilised the WCML for all the route-wide rail alternatives, no other conventional alternative option was identified that could connect to Manchester Piccadilly Station that would not be substantially disruptive to the existing conventional rail network. It would be difficult to increase train speeds sufficiently for the route-wide rail alternatives along the WCML. Train services for the route-wide rail alternatives from Birmingham could only be accommodated at Manchester Victoria Station, not Manchester Piccadilly Station. The alternatives relied on using the existing routes into Manchester which are highly capacity constrained and would not offer the levels of reliability that high speed passengers might reasonably expect. On the eastern leg to Leeds, the route-wide rail alternatives journey times would be notably better than that provided by the existing conventional rail network. However, no route-wide rail alternative could be found to serve Leeds that was not substantially disruptive, or that could deliver sufficient benefits in terms of speed when compared to the Proposed Scheme.

3.1.40 Midlands Connect and Transport for the North propose to use additional capacity created by the Proposed Scheme as a first step to transforming and connecting the economies of the Midlands and the North. This would rely, in particular, on some sections of the Proposed Scheme that would not be built as part of the route-wide rail alternatives. It follows, therefore, that the aspirations of Midlands Connect and Transport for the North would be more expensive, disruptive or difficult to achieve utilising the route-wide rail alternatives.

3.1.41 In conclusion, the study identified that there is no alternative that could deliver the same level of benefit for Britain, stand the test of time and provide the same level of capacity, connectivity and service that the Proposed Scheme would in pursuit of the Government's strategic objectives for HS2. As these alternatives did not meet these strategic objectives, they were not taken forward. Consequently, Phase 2b emerged as the preferred scheme as it best meets the Government's objectives for HS2.

Part II

4 Route corridor alternatives

4.1 Background

4.1.1 Part II of this report describes the development of the Phase Two route since autumn 2010.

4.1.2 This section describes the evolution of the Proposed Scheme and the reasonable route corridor alternatives that have been studied, focussing on the appraisal of sustainability process and sifting.

4.1.3 Consideration of sustainability (including environmental impacts) has been integral to the Proposed Scheme throughout the appraisal process. Since the initial option development, HS2 Ltd has continued to develop route and station proposals that seek to reduce environmental and community impacts within the engineering and financial constraints of the scheme development.

4.1.4 The proposed routes presented for public consultation in 2013/2014 and in 2016/2017 have emerged from many combinations of route options. The 2017 preferred route to Manchester and Leeds, and subsequently the Proposed Scheme, that emerged from this process was on balance considered the best to meet objectives for passenger demand, ease of construction, journey time, sustainability and cost.

4.2 Sifting of options

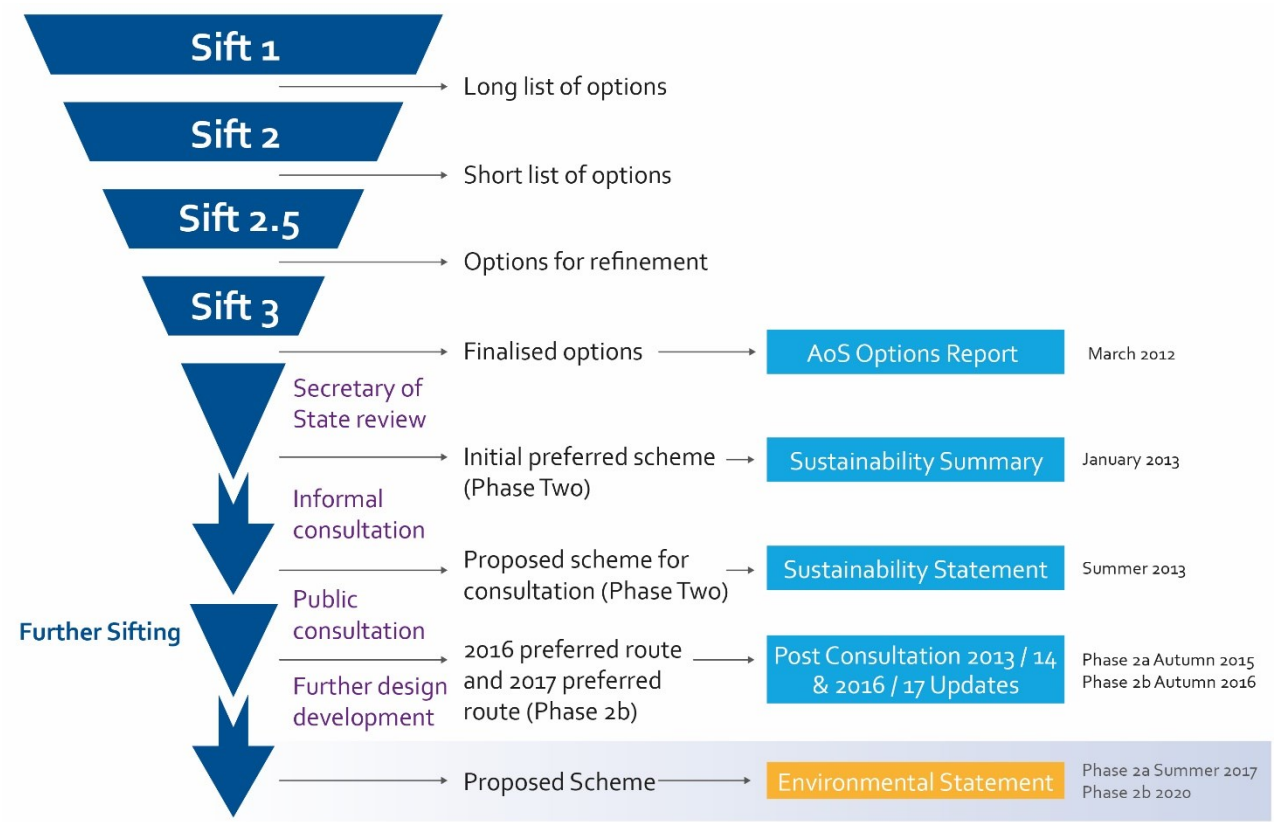
4.2.1 The scheme has evolved through a refinement process resulting in the development of the Proposed Scheme. This process is referred to as sifting. The sifting process consisted of a sequentially more detailed appraisal of route options. At the end of each appraisal stage or sift, sustainability performance was formally studied alongside other cost, operational and engineering information by HS2 Ltd, who identified preferred options for progression to the next level of design. The selected options then entered the next sift for more detailed appraisal.

4.2.2 As part of the consideration of sustainability performance, the following environmental factors were considered: climatic factors and adaptability; greenhouse gases; landscape; townscape and cultural heritage; biodiversity and geodiversity; water resources; flood risk; air quality; noise and vibration; community integrity; accessibility; health and well-being; security and safety; economic prosperity; economic welfare; soil and land resources; waste generation; and resource use.

4.2.3 A summary of the sifting process and outputs is shown in Figure 2. The process started with a long list of potential options. The sequence of subsequent sifts was aimed at reducing the number of options under consideration (e.g. by avoiding centres of population and/or key environmental features). In the later sifts, the predicted impacts of the remaining options were further mitigated by refining the vertical and/or horizontal alignments and by introducing certain structures, such as viaducts or cuttings with retained walls, where appropriate. In this way, the route development

process has ensured that mitigation, so far as reasonably practicable, is inherent within the design from the outset.

Figure 2: The sifting process

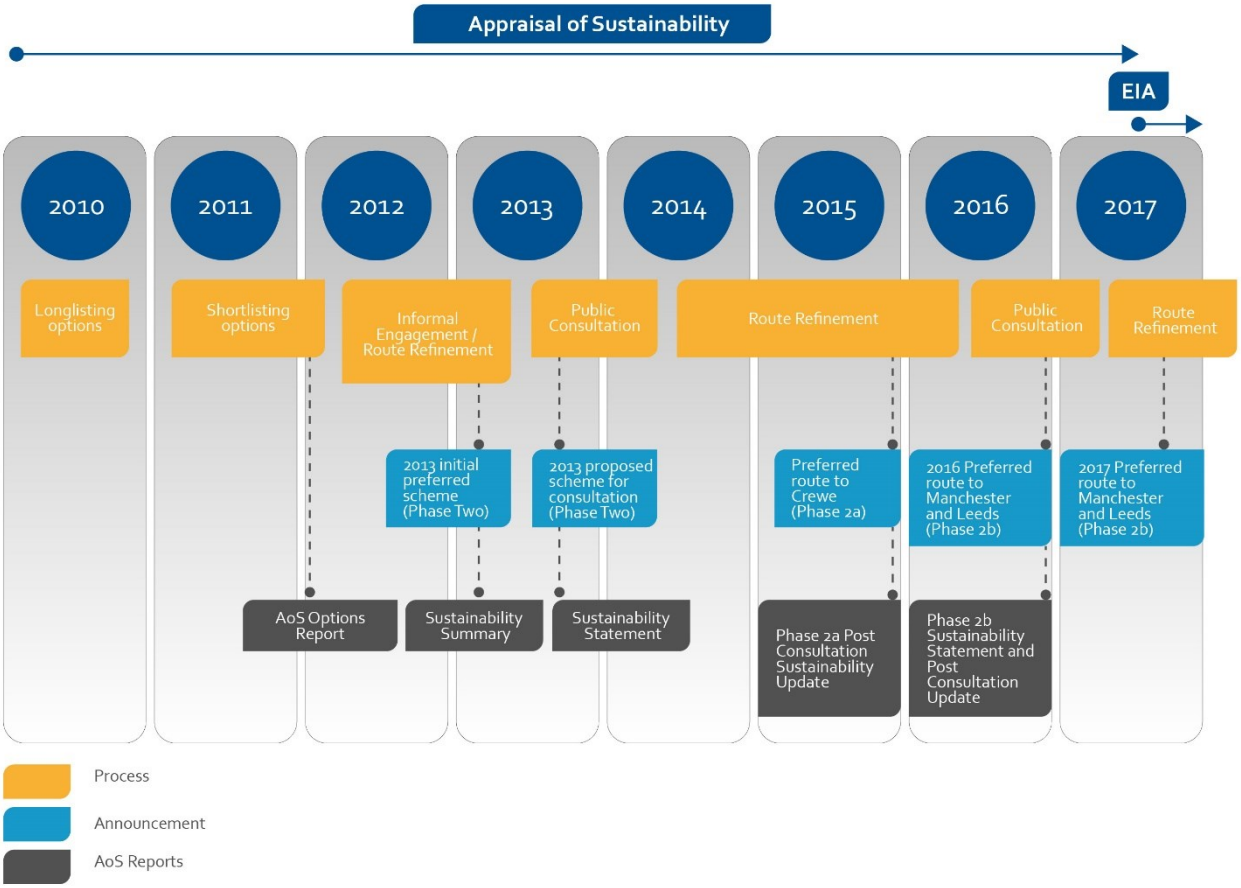


4.3 Route development

Overview

4.3.1 This section provides a summary of the sift process key milestones, consultation process and outputs produced as part of the development of alternatives and the preferred options over time, leading up to the EIA process. This is illustrated by Figure 3. A summary of the development of the western and eastern legs to Manchester and Leeds respectively is also provided.

Figure 3: Milestones and outputs from the sustainability appraisal sifting



Options for Phase Two of the high speed rail network (March 2012)

4.3.2 In January 2012, the Government announced its decision to deliver a new national high speed rail network and its preference for a Y-shaped high speed rail configuration. The *Options for Phase Two report* (2012)[20] documents the first step in the development of Phase Two of the high speed rail network.

4.3.3 The report sets out options and the refinement process undertaken for the routes between the West Midlands to Manchester and Leeds with stations in South Yorkshire and East Midlands and a direct high speed line serving a station at Heathrow. The report also describes options for serving cities beyond the network, direct trains serving cities such as Liverpool, Newcastle, Glasgow and Edinburgh. The report provided Government with choices for the future development of the Phase Two network and the underpinning evidence to facilitate future engagement and decision making.

[20] High Speed 2 Ltd (2012) *Options for Phase Two of the high speed rail network.* A report to Government by HS2 Ltd. Available at: https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network

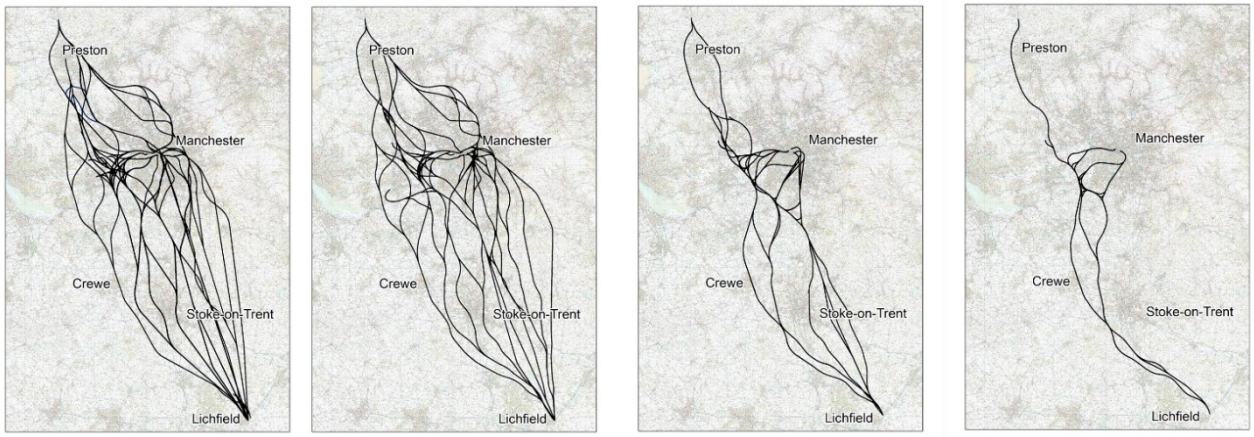
Appraisal of sustainability options report (March 2012)

4.3.4 Following the announcement of the Government's preference for a Y-shaped high speed rail configuration, further work was undertaken to investigate various route, station and depot options that could deliver the western and eastern legs of the network (i.e. Phase Two). A process of sifting (see Section 4.2) was utilised to refine a long list of options and route combinations, as shown in Figure 4 and Figure 5.

4.3.5 The initial route options appraisal for the western leg to Manchester of Phase Two focussed on the sifting of route corridors from the West Midlands (connecting with Phase One near Lichfield) through to Manchester, and connecting with the WCML. On the eastern leg to Leeds, the initial route options appraisal focussed on the sifting of route corridors from the West Midlands through to Leeds via stations within the East Midlands and South Yorkshire, and connecting with the ECML.

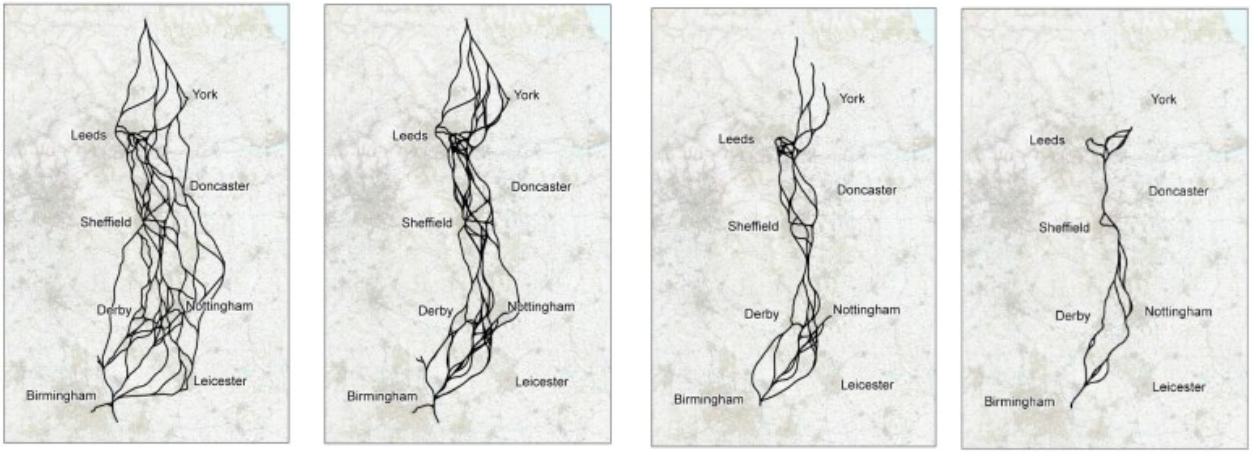
4.3.6 The *Options for Phase Two – appraisal of sustainability report* (2012)[21] describes the output from the initial sifting process and describes the performance of those options that were considered to best meet the remit set by Government[22]. The report focused on 42 separate route sections for the western leg to Manchester and 32 for the eastern leg to Leeds, which could be used to create up to 144 and 112 possible route combinations respectively. The 74 route sections presented in the report had been sifted down from several hundred through the earlier route options appraisal process described previously.

Figure 4: The evolution of the options for the western leg



[21] Temple – ERM (2012) Options for Phase 2 of the high speed network – Appraisal of Sustainability. Available online at: https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network-appraisal-of-sustainability
[22] Department of Transport (2010) Remit for HS2 Ltd. A letter from the Secretary of State to the Chairman of HS2 Ltd. Available online at: http://assets.hs2.org.uk/sites/default/files/inserts/HS2%20Ltd%20remit%20170310.pdf

Figure 5: The evolution of the options for the eastern leg



4.3.7 The report did not make any recommendation as to a preferred route option but provided information on the sustainability performance of different possible route options between common node points on a comparable basis to help Government identify the 2013 initial preferred scheme[23].

4.3.8 Following the submission of advice to Government published within *Options for Phase Two report* (2012), the Secretary of State met with council leaders to discuss station options, and separately visited areas potentially affected by the route.

4.3.9 This led to further refinement and route development. A number of design reviews were undertaken by HS2 Ltd to consider whether improvements could be made in terms of cost, simplification of construction and sustainability, often prompted by requests from the Secretary of State following the informal engagement and site visits. From these design reviews, alternatives to route sections emerged and were subject to a further level of appraisal. Following this work, the Government selected the 2013 initial preferred scheme, as published in *High speed rail: investing in Britain's future – Phase Two report* (2013)[24] and as outlined in the *Phase Two initial preferred scheme sustainability summary* (2013)[25].

Sustainability summary (January 2013)

4.3.10 The *Phase Two initial preferred scheme sustainability summary* (2013) described the potential impacts of the 2013 initial preferred scheme on people and the environment. It presented the findings of the ongoing appraisal of sustainability work at that point in time.

[23] The recommendations for a preferred route option are provided within: HS2 Ltd (2012) Options for Phase Two of the High Speed Rail Network - A report to Government by HS2 Ltd. Available online at : https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/68965/options-for-phase-two-of-the-high-speed-rail-network.pdf

[24] Department of Transport (2013) High Speed Rail: Investing in Britain's Future – Phase Two: The route to Leeds, Manchester and beyond. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69738/hs2-phase-two-command-paper.pdf

[25] Temple-ERM (2013) *HS2 Phase Two Initial Preferred Scheme - Sustainability Summary*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/68971/hs2-phase-two-initial-preferred-scheme-sustainability-summary.pdf

4.3.11 The western leg of the 2013 initial preferred scheme to Manchester would ultimately connect with the WCML at two locations (Crewe and Golborne). It would include a terminus high speed station in Manchester city centre as well as a further high speed station at Manchester Airport. An infrastructure maintenance depot (IMD) at Basford, south of Crewe, and rolling stock depot (RSD) near Golborne were also identified as being required[26].

4.3.12 The eastern leg of the 2013 initial preferred scheme to Leeds would connect with the ECML north-east of Church Fenton. It would include a terminus high speed station in Leeds city centre, and interchange stations at Toton, midway between Derby and Nottingham (referred to as the East Midlands Hub) and at Meadowhall, Sheffield. An IMD at Staveley and RSD near Crofton were also proposed [27].

4.3.13 Following publication of the *Phase Two initial preferred scheme sustainability summary* (2013), engagement took place with a number of key stakeholders and MPs, particularly those potentially affected by the route. As a result, a small number of further refinements were made to the route. These refinements culminated in the development of the 2013 proposed scheme for consultation. The sustainability appraisal of the 2013 proposed scheme for consultation is described in the *Phase Two sustainability statement* (2013)[28].

Sustainability statement (July 2013)

4.3.14 The *Phase Two sustainability statement* (2013) was prepared to assist with public consultation by explaining the potential sustainability benefits and adverse impacts of the 2013 proposed scheme for consultation. It also reported on the alternatives studied, as well as to explain how sustainability has helped support the Phase Two selection and design process.

4.3.15 The western leg to Manchester of the 2013 proposed scheme for consultation included a new high speed station near Manchester Airport, a new city centre high speed station adjacent to the existing station at Manchester Piccadilly and a connection to the WCML at Golborne. Two depots were proposed at sites south of Crewe (Basford) for the IMD, and near to the WCML connection at Golborne for the RSD. On the eastern leg to Leeds, the 2013 proposed scheme for consultation included the East Midlands Hub station, located to the south-west of Nottingham at Toton, a high speed station in South Yorkshire at Meadowhall, a high speed station in Leeds city centre, accessed from the south-east of the city, and a connection to the ECML at Church Fenton. Two depots were proposed, an IMD near Staveley and a RSD south of New Crofton.

4.3.16 The public consultation ran from July 2013 to January 2014, with a series of information events providing an opportunity for engagement with local communities, stakeholders and statutory bodies running between October 2013 and January 2014.

[26] The IMD at Crewe has subsequently been relocated near to Stone in the form of an infrastructure maintenance base- rail. The rolling stock depot at Golborne has subsequently been relocated to Crewe north.
[27] The rolling stock depot near Crofton has subsequently been relocated to Leeds East.
[28] Temple-ERM (2013) *High Speed Rail: Consultation on the route from the West Midlands to Manchester, Leeds and beyond - Sustainability Statement*. Available online at: https://www.gov.uk/government/publications/hs2-phase-two-consultation-sustainability-statement

Refinements to the 2013 proposed scheme for consultation

4.3.17 In response to the feedback received during consultation and as a result of the experience gained from Phase One, HS2 Ltd investigated a number of areas for possible refinements (termed local alternatives) to the 2013 proposed scheme for consultation. Further revisions were driven by an initiative to improve the technical performance of the design and to consider cost efficiencies.

4.3.18 In support of the ongoing Phase One design, HS2 Ltd prepared a series of updated standards that the design of both Phase One and Phase Two were required to meet. The requirements took into consideration developing industry best practice, optimal passenger comfort, and long-term operational considerations such as maintainability, safety and durability. The requirements applied to Phase Two were principally concerned with the camber and gradient of the track alignment, as well as the structural clearance over or under roads, other railways, watercourses and floodplains.

4.3.19 The consultation process and a summary of the issues raised are documented in the independent *High speed rail: investing in Britain's future – consultation report* (2014)[29] that was published alongside the decision document *HS2 from Crewe to Manchester, the West Midlands to Leeds and beyond report* (2016)[30] and the *Summary of route refinements report*[31] in November 2016. Options were developed to address the issues that were raised during consultation. These were then appraised and those that were feasible when considered alongside other scheme requirements were progressed. In addition, other minor scheme revisions arose from the need to incorporate these geographically specific route refinements (arising from both the consultation process and application of design requirements) back into the overall scheme design.

Sustainability report, Phase Two post-consultation update: West Midlands to Crewe (November 2015)

4.3.20 In March 2014, Sir David Higgins, the Chairman of HS2 Ltd, recommended bringing forward development of a section of the Phase Two route between the West Midlands and Crewe by 2027 thus separating the route of the 2013 proposed scheme for consultation on the western leg to Manchester in two.

4.3.21 In November 2015, the Government, having considered a number of options for accelerating part of the route, announced its intention to bring forward the construction of the section of route connecting the West Midlands to Crewe, known as the 2015 preferred route to Crewe.

[29] Ipsos MORI Social Research Institute (2014) *High Speed Rail: Investing in Britain's future. Consultation on the route from the West Midlands to Manchester, Leeds and beyond*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480397/P2L0R_Ipsos_MORI_FINAL_REPORT.pdf

[30] Department for Transport (2016) *High Speed Two: From Crewe to Manchester, the West Midlands to Leeds and beyond*. Moving Britain Ahead. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/568208/high-speed-two-crewe-manchester-west-midlands-leeds-web-version.pdf

[31] HS2 Ltd (2016) *High Speed Two Phase 2b Crewe to Manchester West Midlands to Leeds Summary of Route Refinements*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/569186/D13_HS2_PHASE_2b_Summary_Report_web_FINAL.pdf

4.3.22 The *Sustainability report, Phase Two post-consultation update: West Midlands to Crewe* (2015)[32] was published in November 2015, documenting the post consultation updates and changes. The 2015 preferred route to Crewe subsequently became Phase 2a.

4.3.23 The announcement of the 2015 preferred route to Crewe, Phase 2a, in November 2015, included a connection with Phase One north of Lichfield through to a connection with the WCML near the A500 south of Crewe, and included an IMD at Basford.

Sheffield and South Yorkshire report (July 2016)

4.3.24 In July 2016, Sir David Higgins published the *Sheffield and South Yorkshire report* (2016)[33]. HS2 Ltd also published the *Sheffield and South Yorkshire options report* (2016)[34] in support of the Sir David Higgins report.

4.3.25 The *Sheffield and South Yorkshire report* (2016) reviewed locations for the high speed station in South Yorkshire and how best to serve the region based on five factors. These factors included demand, the needs of Sheffield and the wider region, connectivity with the existing conventional rail network and wider transport, consideration of topography, urban density and environment, and consideration of cost. The 2013 proposed scheme for consultation provided for an elevated high speed station at Meadowhall in Sheffield, adjacent to the M1. However, the *Sheffield and South Yorkshire report* (2016) recommended a change to how HS2 served Sheffield and South Yorkshire by utilising the existing Sheffield Midland Station in Sheffield city centre. This station would be accessed by running conventional compatible high speed trains into Sheffield via a dedicated link that would run off the HS2 main line onto the existing Erewash Valley Line and then onto the existing MML that runs into Sheffield Midland Station. This would better reflect the demand in South Yorkshire, enable direct city centre to city centre services and open up the possibility of running high speed trains from Sheffield to Leeds by building a link back onto the HS2 main line north of Sheffield (and thereby providing better alignment with emerging Northern Powerhouse Rail aspirations).

4.3.26 This *Sheffield and South Yorkshire report* (2016) also recommended that the HS2 main line route be moved further east to run parallel to a section of the M18 (the M18/Eastern route). This route avoided some of the complexities and risks associated with the previous route to serve a high speed station at Meadowhall and would provide journey time savings for services to Leeds, York and Newcastle.

[32] Temple-RSK (2015) *High Speed Rail: Preferred Route to Crewe Sustainability Report - Phase Two Post-Consultation Update*: West Midlands to Crewe. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480667/Sustainability_Report_Phase_Two_Post-Consultation_Update_West_Midlands_Crewe.pdf

[33] High Speed 2 Ltd (2016) *Sheffield and South Yorkshire Report 2016*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/535307/CS550A_South_Yorkshire_Report_WEB.pdf

[34] High Speed 2 Ltd (2016) *HS2 Phase Two - Sheffield and South Yorkshire Options Report*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/536075/South_Yorkshire_Station_Options_Report_07072016.pdf.

Sustainability statement including post-consultation update Phase 2b (November 2016)

4.3.27 In November 2016, the Government announced the 2016 preferred route to Manchester and Leeds (from Crewe to Manchester including a connection to the WCML and from the West Midlands to Leeds including a connection to the ECML). This was based on updated design standards and refinements made to the route following the 2013/2014 consultation, and the recommendations outlined within the *Sheffield and South Yorkshire report* (2016). In some locations, substantial changes had been made to the route previously presented in the 2013 proposed scheme for consultation.

4.3.28 The *Phase 2b preferred route sustainability statement* (2016)[35] was published documenting the post-consultation changes to Phase 2b, together with the associated potential sustainability performance.

4.3.29 As a result of these changes, a further period of public consultation between November 2016 and March 2017 was launched alongside the announcement of the preferred route for Phase 2b in November 2016. The consultation focused on seven sections of route across both the eastern and western legs to Leeds and Manchester respectively. On the western leg between Crewe and Manchester, these route refinement consultation areas consisted of:

- moving the proposed western leg RSD from a site near Golborne to a site north of Crewe;
- changing the route over approximately 26km between Middlewich and Pickmere; and
- changing the alignment of the route on the approach to Manchester Piccadilly Station, including the location of the tunnel portal, and as a result, the alignment of the Manchester tunnel.

4.3.30 On the eastern leg between the West Midlands and Leeds, these route refinement consultation areas consisted of:

- moving the route to the east of Measham in Leicestershire;
- avoiding the need to tunnel under East Midlands Airport by moving the route to the east of the A42, M1 and airport runway;
- amending the alignment and height of the route where it would pass through Long Eaton on the approach to the East Midlands Hub station; and
- moving the alignment of the route from Derbyshire to West Yorkshire to reflect the change in proposals for serving Sheffield, as recommended by Sir David Higgins in the *Sheffield and South Yorkshire report* (2016) (the M18 /Eastern route) including consideration of a northern junction near Clayton.

[35] Temple-RSK (2016) *High Speed Rail: Phase 2b Preferred Route - Sustainability Statement including Post Consultation Update*. Available online at: https://www.gov.uk/government/publications/hs2-phase-2b-sustainability-statement-2016.

From Crewe to Manchester, West Midlands to Leeds and beyond – Phase 2b route decision (July 2017)

4.3.31 A period of public consultation on the seven sections of route was held between November 2016 and March 2017. This was followed by route refinement work to address specific consultee concerns raised during the consultation period[36] and subsequently HS2 Ltd provided advice on the different options considered to the Government[37]. In July 2017, the Government announced the 2017 preferred route to Manchester and Leeds (*HS2 from Crewe to Manchester, the West Midlands to Leeds and beyond report* (2017)[38]) .

4.3.32 Decisions were made for six of the seven proposed changes. The exception was the consulted change to the route at Measham, which would have seen the route move to the east of Measham, away from the A42. Following the consideration of responses to consultation, the Government confirmed a modified version of the 2013 proposed scheme for consultation to the west of Measham, which would be slightly further east than the 2013 proposed scheme for consultation, and would include a longer viaduct to mitigate commercial property impacts. These decisions drew on previous work to look in detail at the route in this area, on consultation responses and on further analysis undertaken in light of these responses.

4.3.33 The July 2017 announcement also launched a separate consultation on a proposal to relocate the eastern leg RSD from New Crofton to a site within the Aire Valley, east of Leeds, adjacent to the M1 (Leeds East). This consultation was held between July 2017 and October 2017. The Government confirmed the location of the eastern leg RSD at the Leeds East site in July 2018.

[36] Dialogue by Design (2017) *High Speed Two Phase 2b: Crewe to Manchester & West Midlands to Leeds Route Refinement Consultation 2016, a summary of consultation responses*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/629018/HST10_RR2016_SummaryReport_140717.pdf

[37] High Speed 2 Ltd (2017) *High Speed Two Phase 2b Crewe to Manchester West Midlands to Leeds Route refinements - HS2 Ltd's advice to Government*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/628605/CS848_Phase_2b_201617_Route_Refinement_Advice_FINAL_WEB_170713.pdf

[38] Department for Transport (2017) *High Speed Two: From Crewe to Manchester, West Midlands to Leeds and beyond – Phase 2b Route Decision*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/668511/high-speed-two-from-crewe-to-manchester-west-midlands-to-leeds-and-beyond-phase-2b-route-decision-web-version.pdf

4.4 Establishment of the Proposed Scheme between the West Midlands and Manchester

Manchester routes –options short listing

Introduction

4.4.1 The initial short list of route options to Manchester undertaken between 2010 and 2012 was broken down into 11 groups, based on the geography and functionality offered. The groups are described within the *Options for Phase Two – appraisal of sustainability report* (2012) and within *Options for Phase Two report (2012),* which would commence with a connection with Phase One north of Lichfield, through to central Manchester, with connections on the existing WCML as far north as Preston. Each group contained a number of individual route sections that could be aggregated together in a variety of combinations to form longer routes. These are outlined in the following sections and illustrated in Figure 6, together with the reasons why they were or were not progressed further.

4.4.2 Within each group, individual route options were either recommended for further refinement, or discounted on the basis of sustainability, cost, engineering and/or operational concerns. At each phase, new options were also considered within the groups as the understanding of the key constraints increased and viable solutions increased.

Short listed options

Peak District group

4.4.3 The group comprised three routes (at the most easterly part of the route corridor) which would connect Lichfield with Dunkinfield, south-east of Manchester. The group would have had a direct impact on the Peak District National Park, which would have been crossed for a substantial distance by all three routes. Opportunities for mitigation would have been limited, and to avoid the National Park, would have required a section of tunnel of at least 20km in length. The northern half of the group would have had a direct impact on: one Grade II* registered park and garden (Lyme Park); 14 SSSI; one Special Protection Area (SPA) (Peak District Moors – South Pennine Moors Phase 1); two SAC (South Pennine Moors, Peak District Dales); and over 20 Grade II listed structures. The southern half of the group would have had significant landscape and visual impacts. Due to these environmental impacts, no corridors were progressed for further refinement from the Peak District group. In addition, these routes would not perform favourably compared to more westerly options in terms of cost and journey time.

Churnet Valley group

4.4.4 The group would connect east of Cheadle with Macclesfield. It would have had a direct impact on three SSSI (Churnet Valley, Dimmings Dale and Ranger). The group would have required a large viaduct to cross the Churnet Valley SSSI resulting in significant landscape and visual impacts. Opportunities for mitigation would have been limited. The section of route crossing the Churnet Valley from the Peak District was not taken forward. This was because there was an alternative option from Lichfield that would pass to the west of Uttoxeter which performed more favourably in terms of cost and

sustainability impact. One corridor was progressed for further refinement from the Churnet Valley group.

Central (power) corridor group

4.4.5 The corridor comprised one route which would connect Lichfield with south of Macclesfield. The corridor would have crossed one Ramsar site (Midland Meres and Mosses Phase 1); one SAC (West Midlands Mosses); one SSSI and National Nature Reserve (NNR) (Chartley Moss); and would have had a direct impact on two scheduled monuments (Blithewood Moated Site and Paynsley Hall Moated Site). The southern half of the route would have had significant landscape and visual impacts. This corridor was progressed for further refinement from the central (power) corridor group.

East of Stoke group

4.4.6 The group comprised a single corridor that would connect the north-east side of Stoke-on-Trent with Brereton Heath, just west of Congleton. This group would have required a high number of residential property demolitions, mainly at Biddulph and Norton Green. The group would have had a direct impact on one SSSI (Roe Park Woods) and indirect impacts on six SSSI (Bagmere, Brookhouses Moss, Ford Green Reedbed, Gannister Quarry, Holly Banks, River Dane); and two Ramsar sites (Midland Meres and Mosses Phase 1 and 2). This corridor was progressed for further refinement.

West of Stoke group

4.4.7 The group comprised a single corridor that would connect north of Stone with Over Peover, which would pass partly in tunnel west of Stoke-on-Trent. The group would have required a comparatively high number of residential property demolitions and a significant number of properties would have experienced noise impacts; particularly at Stone and Stoke-on-Trent. The group would have required six crossings of, and had a potential impact on, the River Trent (a major river) and would have crossed the Trent and Mersey Canal. It would have also had a direct impact on one SSSI (River Dane); two Grade II registered parks and gardens (Rode Hall, Peover Hall); and an indirect impact on three scheduled monuments; five Grade II* listed structures; and one Grade II* registered park and garden (Trentham Gardens). No corridors were progressed for further refinement from the west of Stoke group due to the substantial number of demolitions and noise impacts at Stone and Stoke-on-Trent, in addition to the high costs associated with the tunnel to the west of Stoke-on-Trent.

Eastern approaches group

4.4.8 The group comprised a number of approaches connecting core route options at Macclesfield with high speed stations in east Manchester. Some of the approaches split to the north to connect with city centre station options. The surface routes would have required a high number of residential property demolitions and significant numbers of properties would have experienced noise impacts in south and east Manchester. The group would have crossed the Peak District National Park (two eastern-most routes only) and Reddish Vale Country Park and would have had an impact on two scheduled monuments; three Grade II* listed structures; one Grade II*

registered park and garden (Adlington Hall); and two Grade II registered parks and gardens (Philips Park, Philips Park Cemetery). All surface route options into eastern stations were not shortlisted due to high cost and poor sustainability performance, including high numbers of demolitions required. Only tunnel options were taken into the next stage.

Western approaches group

4.4.9 The group comprised five approaches, which would connect core route options with high speed stations in the west of Manchester. These approaches would extend north from either Lymm (two approaches), Altrincham (two approaches), or north-east of Holmes Chapel (eastern-most approach), to connect with St. George's. The group would have required a high number of residential property demolitions (Urmston, West Didsbury and Newall Green). As such, some options were also re-designed as tunnel approaches for further refinement in the next development stage. It would have crossed one SSSI (Dunham Park). It would have also had an impact on the Dunham Massey National Trust site; two Grade II* registered parks and gardens (Tatton Park, Dunham Massey); three Grade II registered parks and gardens (Alexandra Park, Wythenshawe Park, Manchester Southern Cemetery); one Grade II* listed structure (Barton Bridge), one Grade I listed structure (Church of All Saints) and one scheduled monument (Bowl Barrow). A number of route sections from the different approaches of this group were progressed for further refinement. Three core western approach options were not progressed because alternative routes within this group performed more favourably on all accounts.

South Manchester spine group

4.4.10 The group connected Wilmslow (south of Manchester) with Wigan and would link routes from Birmingham to Manchester and the WCML via a long tunnel under Manchester Airport. The group would have crossed one SAC (Manchester Mosses, which includes Risley Moss SSSI), a SSSI (Brookheys Covert); and would have crossed the Manchester Ship Canal resulting in landscape and visual impacts. The group would have also had landscape and visual impacts where it crossed the Pennington Flash Country Park on viaduct. Mitigation considered included bypassing the country park (the southern-most spine route). However, a high number of residential properties would have experienced noise impacts and there would have been a high number of residential property demolitions at Golborne. Given the substantial cost of tunnelling and the potentially poor sustainability performance further north, these route options were not taken forward. Other groups provided better route corridor options.

WCML, Warrington and Wigan connections group

4.4.11 The group connected Warrington, Wigan and the WCML with the core Birmingham to Manchester routes. The group was from Northwich to the south, and Altrincham and Knutsford to the south-east, north to Preston. The group would have required residential property demolitions in numerous built-up areas including at Euxton, Coppull, Orrell, Abram, Hartford, and Warrington. The group would have crossed two SSSI (Abram Flashes, Woolston Eyes); and would have had impacts on two Grade II registered parks and gardens (Tabley House, Avenham Park); and three Grade II*

listed structures (Lower House Farmhouse, Lightshaw Hall, Church of All Saints). No route sections from this group were progressed for further refinement.

West Pennine Hills group

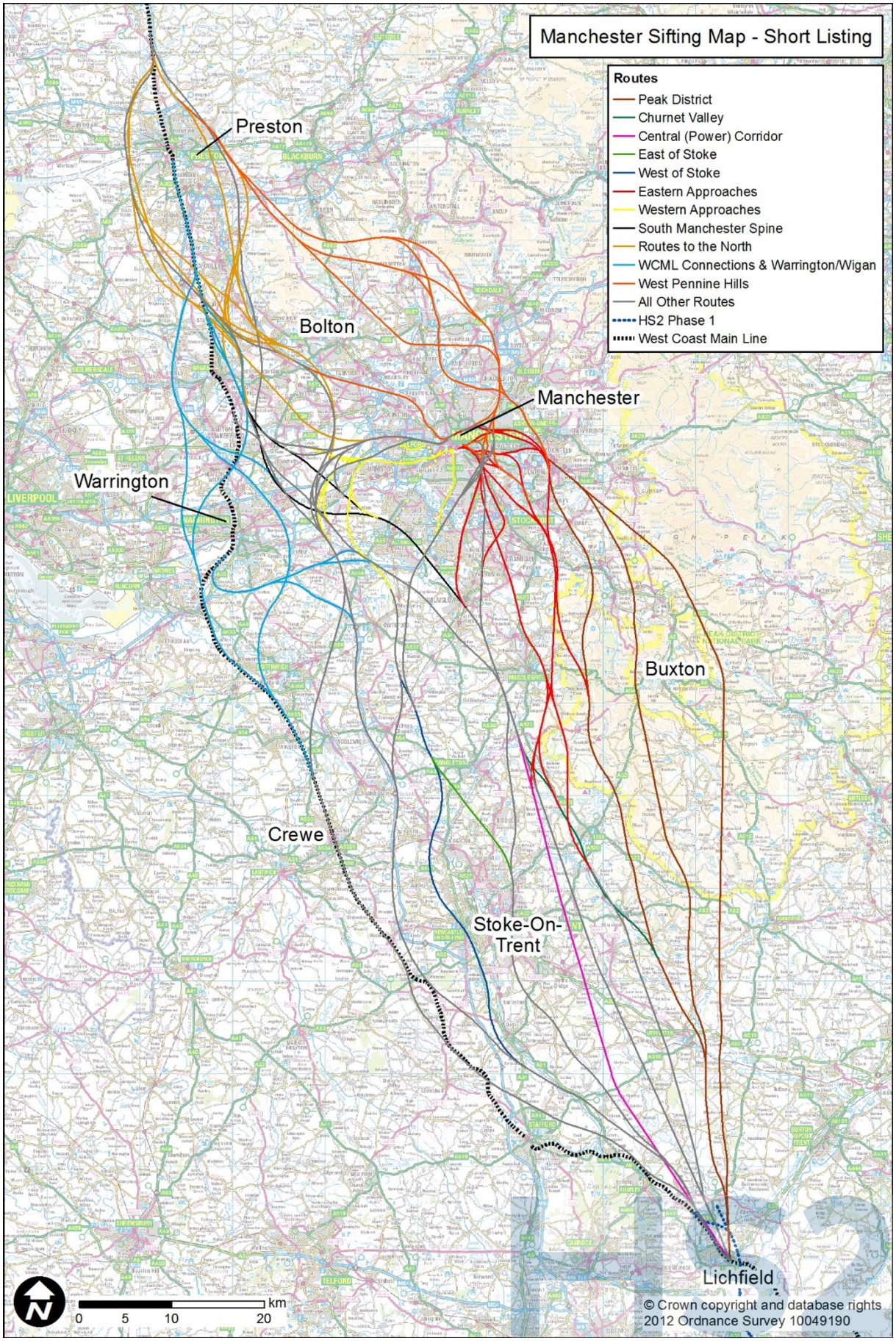
4.4.12 The group connected Manchester with north-east of Preston, with the exception of one route which would have followed the M61 corridor to Westhougton. The group would have required a high number of residential property demolitions, particularly to the north of Manchester. It would have had a direct impact on two SSSI, (Rochdale Canal, Red Scar and Tunbrook Woods); one SAC (Rochdale Canal); two Grade II registered parks and gardens (Hoghton Tower, Heaton Park); and a National Trust site (Stubbins Estate). Opportunities for mitigation would have been limited in urban areas without extensive tunnelling. The group would require substantial lengths of tunnels and structures and also performed poorly from a sustainability perspective, with significant demolition numbers and impacts on an SAC and two SSSI. Options from this group were not progressed for further refinement.

Routes to the north of Preston group

4.4.13 The group connected routes from Golborne and west Manchester to the WCML north of Preston, with some routes skirting around east and west of Preston. The group would have had a direct impact on three scheduled monuments (the Moat House, Bretters Farm, Moated Site at Arley Hall). It would have crossed the River Ribble, at a point approximately 2.2km upstream of the Ribble and Alt Estuaries Ramsar site. It would also have crossed several other major rivers and canals (River Yarrow, Bridgewater Canal, Leeds and Liverpool Canal, Lancaster Canal, Millennium Ribble Link), resulting in visual impacts on users of waterway footpaths. It would have had an indirect impact on one SSSI (Red Moss); one Grade I listed structure; and 13 Grade II* listed structures.

4.4.14 The options that would connect to the WCML south of Preston performed less favourably when compared to the options connecting to the north of Preston in terms of engineering complexity, sustainability and journey time and so were also not progressed. A number of route sections from this group were progressed for further refinement.

Figure 6: Manchester routes short listing options



Manchester routes – options for further refinement

Introduction

4.4.15 Manchester route options that were subject to further refinement are shown in Figure 7. These were either route sections that were progressed from the initial sifting process or new options identified. The geographical grouping of options was not used beyond this next phase of optioneering. Those individual route sections that were progressed beyond this stage and further refined are presented in *Options for Phase Two – appraisal of sustainability report* (2012). This section briefly describes the route corridors subject to further refinement and the reasons they were or were not further progressed.

Churnet Valley group

4.4.16 This comprised a single corridor connecting Lichfield with Macclesfield that would pass to the west of Leek. The corridor would have crossed one SSSI (Churnet Valley), one area of National Trust land (Hawksmoor), two canals (Trent and Mersey Canal, Caldon Canal); and three major rivers (rivers Dane, Team and Blithe), which may have also required works. The corridor would have had major landscape and visual impacts on the surrounding area (which includes the Peak District National Park and Churnet Valley). This route corridor was not progressed predominantly due to the cost of structures and tunnels required to negotiate the Churnet Valley and surrounding hills, and also due to the likely environmental impacts associated with this route.

Central (power) corridor group

4.4.17 The group, which would broadly follow the overhead power lines between Lichfield and a point in Manchester city centre, comprised a short corridor that would pass to the east of Stoke-on-Trent, connecting Gratwich (west of Uttoxeter) to Bradshaw (west of Leek). The corridor would have had direct impacts on several floodplains including crossing the Caldon Canal and River Blithe. It would have had visual impacts on open landscape at its southern extent where it would pass through rural countryside.

East of Stoke group

4.4.18 The group comprised a single corridor connecting Lichfield with Macclesfield that would pass in tunnel through Stoke-on-Trent (on the east side). The corridor would have had impacts on three conservation areas (Hilderstone, Trent and Mersey Canal, Macclesfield Canal); seven biodiversity action plan (BAP) habitats; and five ancient woodlands, and indirect impacts on seven Natura 2000 sites (within 10km). It would have also crossed one abstraction site (at Moddershall; 3,500 cubic metres/day). The corridor would have had major visual impacts on a National Trust site (Congleton Cloud), a Grade II* registered park and garden (Gawsworth Old Hall); three scheduled monuments (Gawsworth Hall Gardens, Hilderstone Hall, Moated Site at Great Hartwell Farm) and over 40 Grade II listed structures. Although this route performed better compared to other routes in this group, it was not taken forward primarily due to higher costs compared to other options.

Eastern approaches group

4.4.19 The group comprised five approaches into east Manchester. All approaches diverged from a core route option between Macclesfield and Altrincham to terminate at one of three eastern city-centre station options. All of the approaches would have required tunnels from the outskirts of Manchester. The group would have required a high number of residential property demolitions at Mottram St Andrews and Dean Row and at Alderley Edge, a significant number of properties would have also experienced noise impacts. There would also have been landscape and visual impacts at Alderley Edge. The group would have crossed a National Trust site (Hare Hill), and there would have been impacts on the setting of a Grade II* registered park and garden and scheduled monument (Gawsworth Old Hall). The approach routes that served the high speed station options at Baird Street and Manchester Victoria were not taken forward as those station options were not taken forward. The other eastern approaches were not progressed because of the substantial cost associated with sections of tunnel being required.

Western approaches group

4.4.20 The group comprised six approaches[39] to terminus station options located in the west of Manchester. The group diverged from the main route at one of four locations: near the M6 crossover (west of Tatton Park); south-west of Altrincham (north of Rostherne Mere); to the north-east of Lymm; or east of Culcheth. Although all routes in this group would include approximately 4-6km tunnels on the approach to the terminals, the group would have required a high number of residential property demolitions including some at Eccles (in an area of high deprivation).

4.4.21 The group would have crossed a National Trust site (Dunham Massey) and would have had a visual impact on the associated Grade II* registered park and garden (Dunham Massey). The group would have had impacts on one scheduled monument (a promontory fort), one Grade II* listed structure (Barton Bridge); and would have passed in proximity to two SAC (Manchester Mosses, Rixton Clay Pits). The group would have also had indirect impacts on two Ramsar sites (Rostherne Mere – also an NNR, and Midland Meres and Mosses Phase 1); and eight SSSI (Abram Flashes, Rixton Clay Pits, Risley Moss, Holcroft Moss, Astley and Bedford Mosses, Rostherne Mere, Bryn Marsh and Ince Moss, Dunham Massey). Three approach options (the western-most three) would have crossed, and had a major visual impact on, the Manchester Ship Canal.

4.4.22 Of the western approaches, the route furthest to the west was not progressed due to it performing poorly from a cost and sustainability perspective with no balancing journey time benefits. The western approach option furthest to the east was not progressed as it would include a tunnel underneath Urmston and would have a particularly high cost attached to this when compared to alternative options.

[39] Five approaches were originally considered. However, more approaches were added as the optioneering process evolved.

4.4.23 Two new approach routes were proposed and developed to the same level as the others at this stage. One was a route via the River Mersey Valley corridor and then a tunnel to the Manchester Piccadilly high speed station options; this was assessed to perform better overall than alternatives to Piccadilly. The other was a route via the M62 corridor that would serve options in Salford, which would mainly run on the surface and have a comparatively short section of tunnel. In total, four approach routes were taken forwards for finalisation, all of them would be in tunnel from the city outskirts.

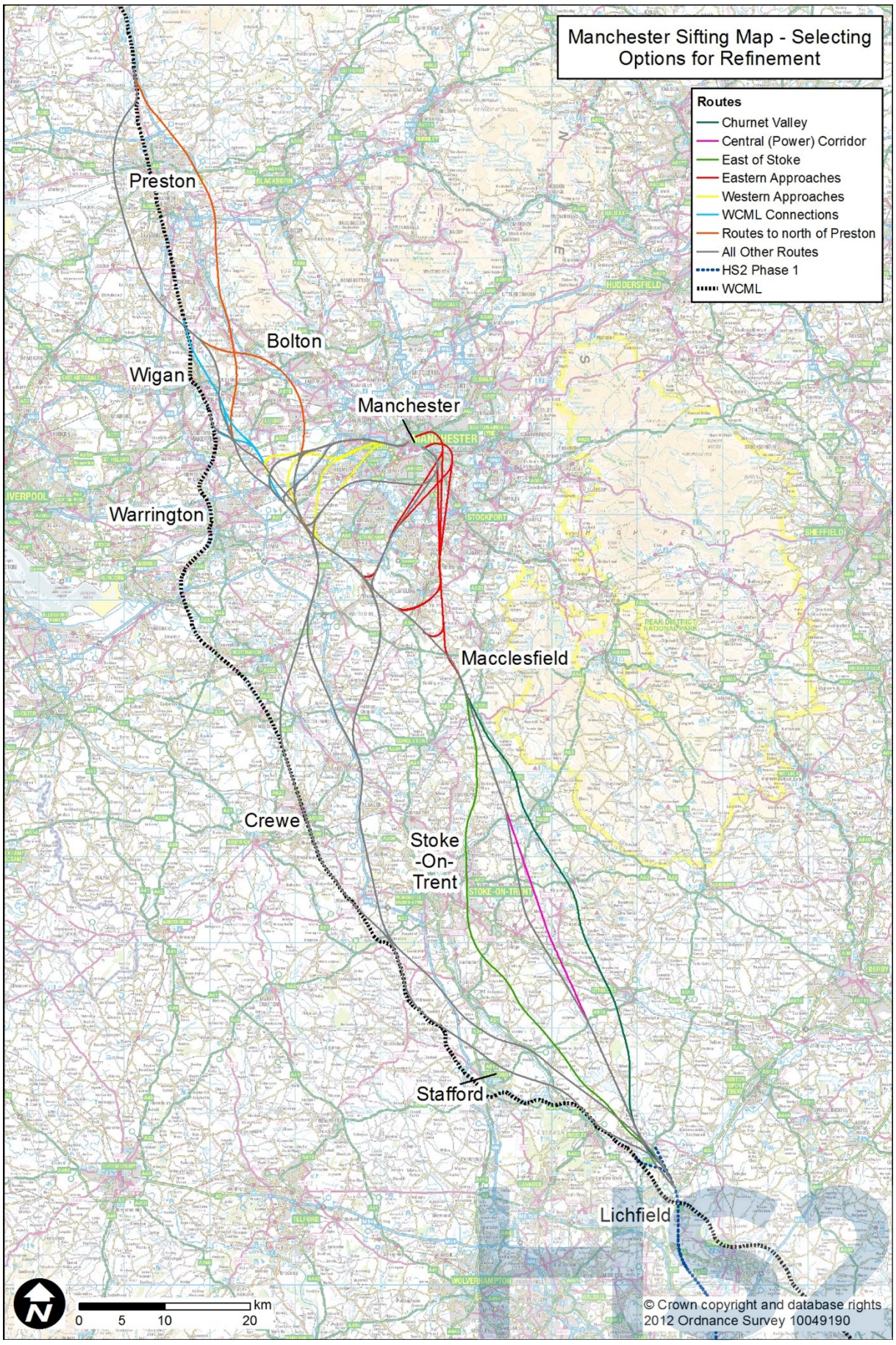
WCML connections group

4.4.24 The group would be from east of Warrington to south of Coppull and would connect the Birmingham to Manchester line of route to the WCML. The group would have crossed the Pennington Flash Country Park on viaduct and would have had a major impact on the landscape. A number of properties would have experienced noise impacts. The group would have required residential property demolitions at Hollins Green and would have had a direct impact on one scheduled monument (Haigh Sough); and indirect impacts on two SAC (Manchester Mosses, Rixton Clay Pits); and five SSSI (Abram Flashes, Bryn Marsh and Ince Moss, Holcroft Moss, Risley Moss and Rixton Clay Pits).

Routes to north of Preston group

4.4.25 The group comprised three routes connecting with the WCML. Two of the routes originated to the south-west of Altrincham to terminate to the east and west of Aspull. The third route connected Golborne to the WCML north of Preston that would run east of the M61. The group would have required residential property demolitions at Tyldesley, Horwich, Crankwood and Wheelton. The group would have had direct impacts on one SSSI (Red Scar and Tunbrook Woods); a National Trust site (Dunham Massey); Worthington Lakes Country Park; and would have had indirect impacts on two SAC (Manchester Mosses, Rixton Clay Pits); and an Area of Outstanding Natural Beauty (Forest of Bowland). The group would have also had visual impacts on the Ribble Valley, Dunham Park SSSI and Dunham Massey Grade II* Registered Park and Garden. Of the remaining options from the west of Manchester to the north of Preston, only one route, running to the west of Preston, was progressed for further development. The routes to the west of Bolton and the east of Preston were not taken forward due to costly lengths of tunnels and structures and also relatively poor sustainability performance.

Figure 7: Manchester routes sifting map – selecting options for refinement



Options not progressed to finalised option stage

Introduction

4.4.26 The two groups outlined below were alternatives to the preferred route within each of the spine and central (power) corridor groups that emerged at the end of the selection process detailed above. These groups were not progressed to a full sift (i.e. to the highest level of engineering design detail and appraisal at this stage of the process) due to the notably better performance of the final options. The routes are shown in Figure 8.

Central (power) corridor route

4.4.27 This route was the most easterly route remaining at the final options stage and is commonly referred to as the Eastern route option. As this was the only remaining route option to the east it was investigated in some detail, but was not fully developed as a final option. The route would run from Lichfield to Mobberley and would pass to the east of Stoke-on-Trent and to the west of Leek and Macclesfield. The route would require a mixture of high embankments and cuttings, some lengths of high viaduct, and several short sections of tunnel to pass through the hilly landscape.

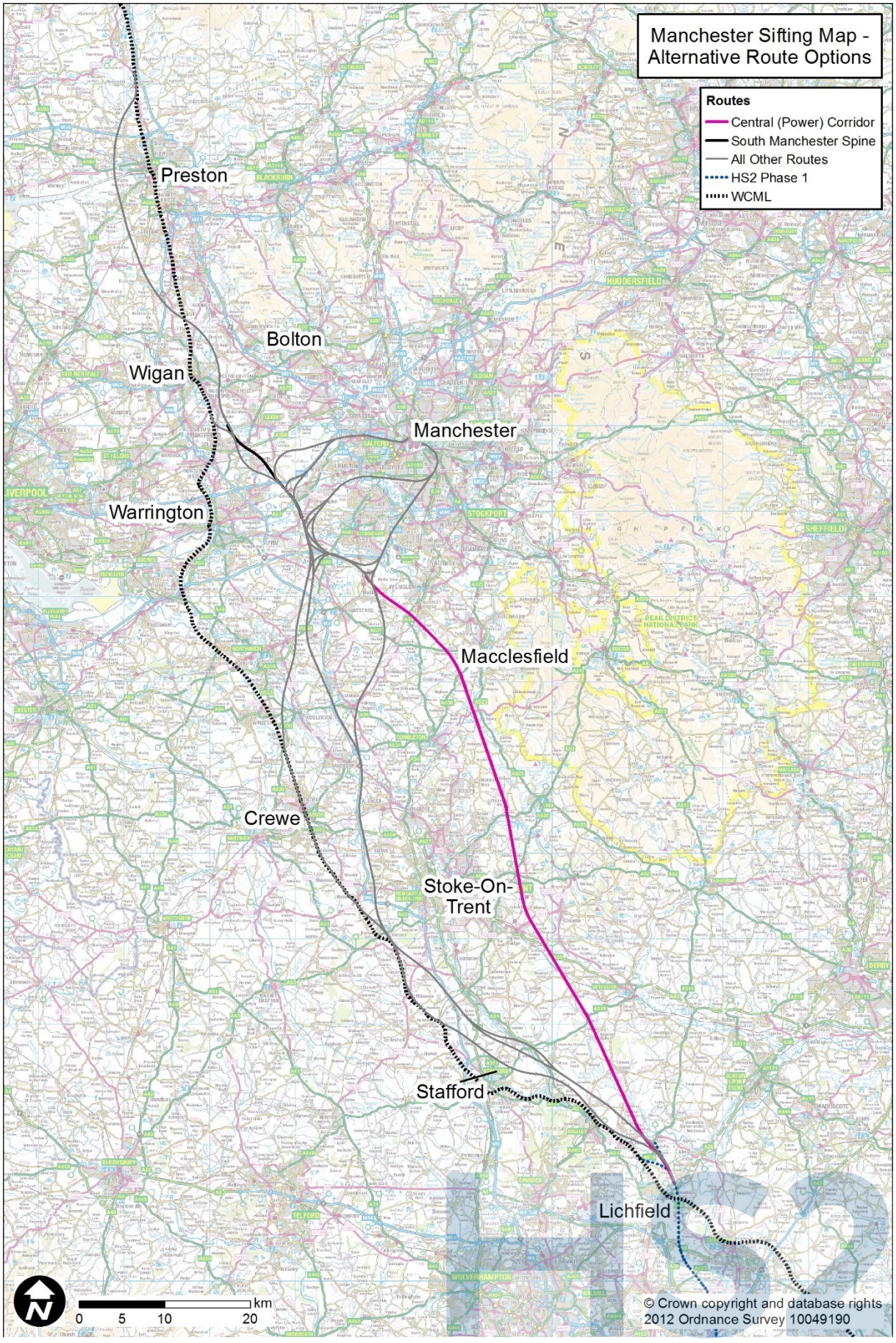
4.4.28 The route would have passed within 2km of the Peak District National Park impacting on views from higher ground. There would have been five major river diversions (four affecting the River Blithe, and one affecting the River Dane) and approximately 17km of the route, in cut or tunnel, would have crossed important aquifers. The route would have had direct impacts on approximately 20 ancient woodlands. It would also have required some residential property demolitions (with approximately 13 at Key Green). There would have been noise impacts on some residential properties; a visual impact on Dane Valley; and indirect impacts on three scheduled monuments, four Grade II* listed structures and two Grade II* registered parks and gardens (Gawsworth Old Hall, Tatton Park).

4.4.29 The considerable number of structures and earthworks required for this route would be a costly route option. This option would also present a number of sustainability impacts, including potential water and ecology impacts on Blithfield Reservoir, landscape and heritage impacts in relation to Congleton Cloud and landscape and heritage impacts on Gawsworth Old Hall. This option was not developed primarily because of its higher cost compared to the final options.

Spine route (tunnel under Lowton)

4.4.30 This route would be located to the north-east of Lymm and would run north-west past Pennington Flash Country Park to terminate at Crankwood, north-east of Golborne. The route would have had a direct impact on a groundwater zone 1 source protection zone (SPZ) and public borehole at Lowton Common. It would have required residential property demolitions and there would have been vibration impacts for residents at Lowton Common. It would have had an indirect impact on Manchester Mosses SAC (part which is Holcroft Moss SSSI).

Figure 8: Manchester routes sifting map – alternative route options (not progressed to finalised option stage)



Preferred route from Crewe to Manchester – route corridor appraisal

Establishment of the preferred route from Crewe to Manchester

4.4.31 Route options appraisal between 2010 and 2012 focused on establishing a preferred route from the West Midlands to Manchester. In 2013, the Government announced the 2013 proposed scheme for consultation which proposed a route to Manchester via Crewe as the best overall option to meet the Government's objectives.

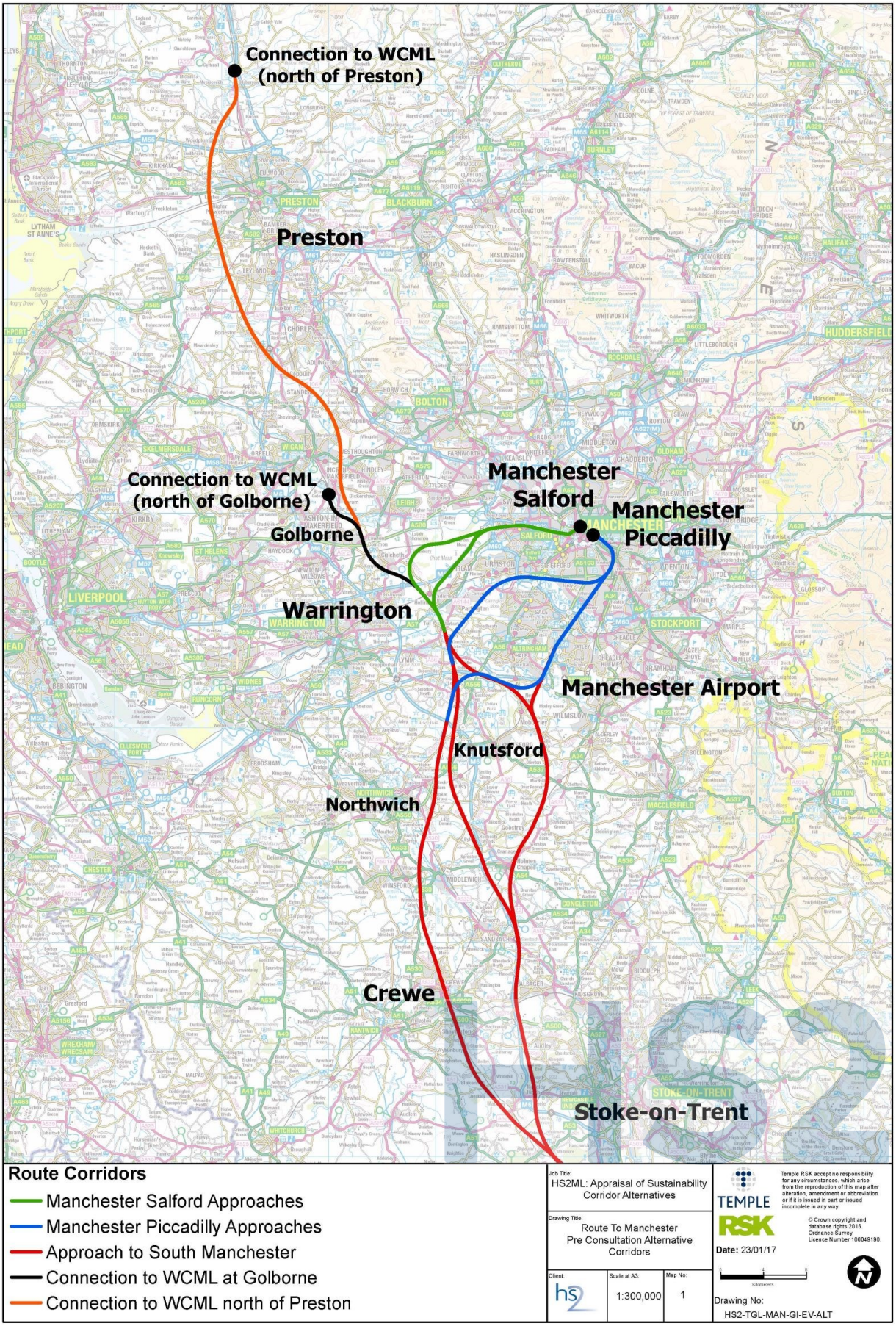
4.4.32 In March 2014, Sir David Higgins recommended bringing forward the construction of the Phase Two route from the West Midlands to Crewe, splitting the route into two sections (Phase 2a and Phase 2b).

4.4.33 The Phase 2b route would include a tunnel under Crewe and would head north through Cheshire to a junction at Hoo Green. This junction would have provided a spur to a terminus station at Manchester Piccadilly, via a new high speed interchange station near Manchester Airport, and a route north to a connection with the WCML at Golborne.

4.4.34 Whilst the route via Crewe had emerged as the preferred route, considerations prior to 2013 within the *Options for Phase Two – appraisal of sustainability report* (2012) included routes that bypassed Crewe to the east and provided alternative approaches into Manchester. Those routes comprised three groups of alternative corridors from a common point south of Crewe (near Swynnerton) through to Manchester and Golborne. These comprised the following (as shown in Figure 9):

- approaches to south Manchester;
- approaches to a high speed station at Manchester Piccadilly; and
- approaches to a high speed station at Manchester Salford.

Figure 9: Reasonable alternative route corridors to Manchester (pre-consultation 2013/2014)



Reasonable alternative route corridors from Crewe to Manchester

Approaches to south Manchester

4.4.35 Three main corridor approaches (A, B and C) to the south-eastern outskirts of Manchester were considered (Figure 10). Each was an aggregation of individual route sections that were developed to the same set of engineering standards and subjected to an equivalent level of appraisal.

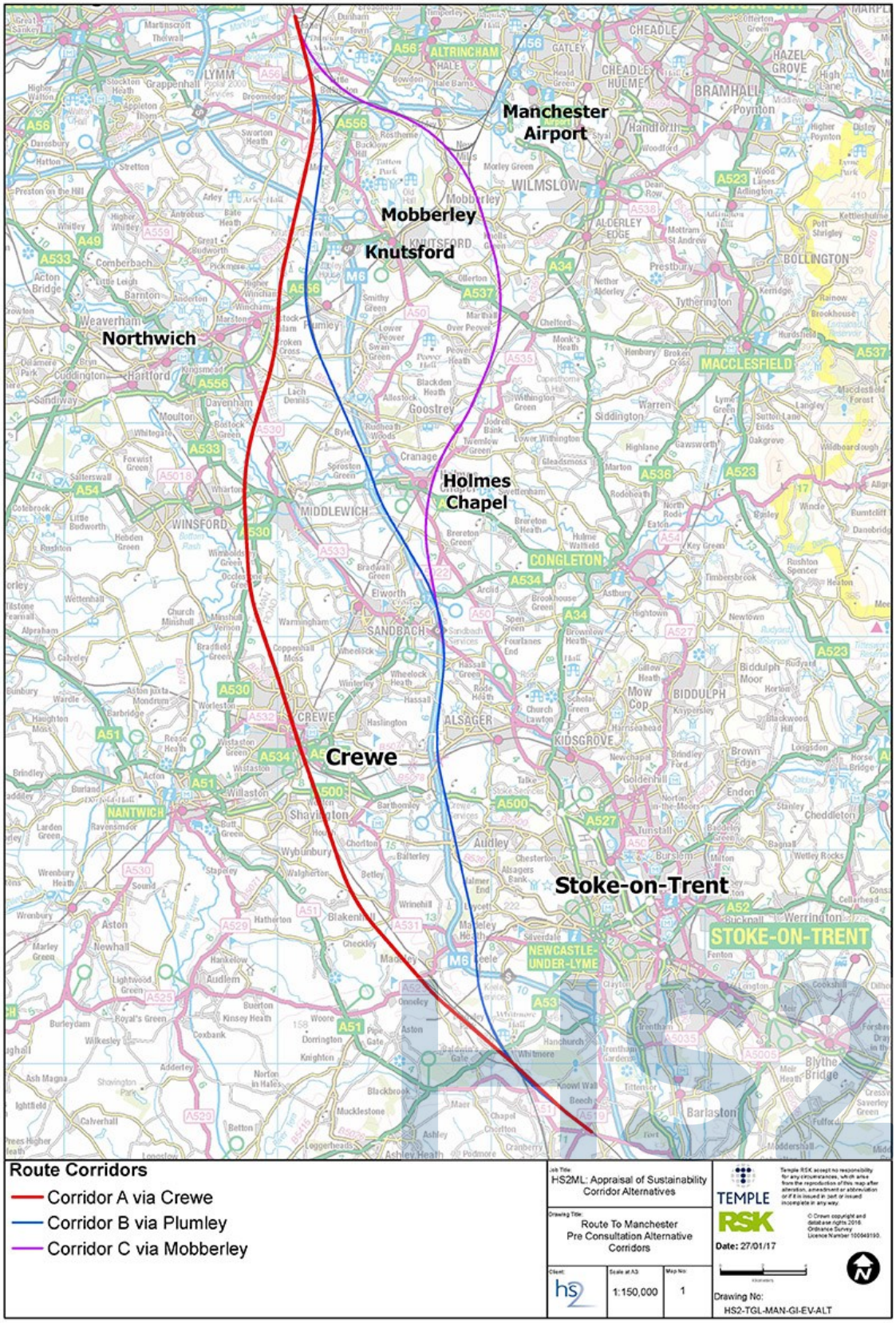
4.4.36 All three route corridors commenced at a common node point at Swynnerton. From there each would head north, taking different routes across the Cheshire Plains and covering up to 50km in length. Approaching south Manchester, each corridor would provide connectivity with alternative approaches into both Manchester Piccadilly and Manchester Salford, as well as onward connectivity with the WCML at Golborne. All options would provide the opportunity for a high speed interchange station to the north of Manchester Airport. The route corridors are described in more detail in *Options for Phase Two – appraisal of sustainability report* (2012).

4.4.37 Corridor A via Crewe would pass Swynnerton to the west of Madeley and would approach Crewe from the south alongside the existing WCML. A junction onto the WCML would be provided near Chorlton, whilst the HS2 main line would continue north in a bored tunnel under Crewe. The route would emerge from tunnel north of Crewe, continuing to follow the WCML before diverging and would head north between Winsford and Middlewich. Continuing north, the route would cross the A556 east of Lostock Gralam, cross the M6 and then M56 to the north-east of High Legh.

4.4.38 Corridor B via Plumley would also commence at Swynnerton but would take a route to the east of Madeley and would roughly follow the M6 north to the west of Newcastle-under-Lyme and close to the western edge of Alsager. Heading north it would continue to broadly follow the M6 corridor, would pass between Middlewich and Holmes Chapel before heading north-west to the east of Knutsford and converging with Corridor A to the east of High Legh.

4.4.39 Corridor C via Mobberley would follow a similar route to Corridor B, east of Madeley and would broadly follow the M6 east of Alsager. East of Sandbach, this route would diverge from Corridor B, taking a route to the east of Holmes Chapel and would approach Manchester from the east close to the village of Mobberley. Here the route would skirt the south of Manchester, and head west, to the north of Rostherne Mere before converging with Corridor A to the north-east of Lymm.

Figure 10: Approaches to south Manchester



Selection of the preferred approach to South Manchester

4.4.40 As described in *High speed rail: investing in Britain's future – Phase Two report* (2013), the Government's initial preferred option for this route was Corridor A via Crewe. This was due to the greater strategic benefit of connecting with the WCML near Crewe, as this would provide connectivity to north-west England and north Wales (including Chester, Liverpool and Warrington). This route would also perform more favourably from a sustainability perspective compared with the other alternatives, as it would require fewer demolitions and would be further away from a number of settlements across the Cheshire Plains.

4.4.41 Corridors B and C were not progressed due to a combination of cost, engineering and/or sustainability concerns. From a sustainability perspective, this included impacts on communities (noise, visual and property impacts given the proximity to a number of high population areas (including Alsager, Sandbach, Holmes Chapel and Mobberley) and rural settlements), as well as direct impacts and impacts on the setting of a number of heritage assets (listed buildings and scheduled monuments). These, and further sustainability considerations are detailed within the *Options for Phase Two – appraisal of sustainability report* (2012).

4.4.42 These options also included potential provision for a high speed station near to Stoke-on-Trent alongside the M6 which would serve the dispersed rail demand around Stoke-on-Trent and Crewe. However, it would be unlikely to attract a high proportion of passengers to or from the urban areas of Stoke-on-Trent and Crewe themselves, where people would be likely to continue using existing conventional rail connections to London. Further, analysis at that time, suggested that the benefits this would generate would be less than the costs to construct the high speed station. Stoke-on-Trent City Council developed a further option in this area and suggested that a new high speed station could be built as an addition to the WCML connection to the south of Crewe. Analysis identified that, although it would generate additional benefits for Stoke-on-Trent and its surrounding area, these would fall short of the additional cost required to construct a high speed station in this location.

Establishing a preferred terminus station

4.4.43 As described in *High speed rail: investing in Britain's future – Phase Two report* (2013), the Government's initial preferred option was for a terminus station at Manchester Piccadilly. Manchester Piccadilly was identified as the preferred terminus station on the basis of a combination of engineering, sustainability, cost and/or operational factors.

4.4.44 Following on from an initial sifting process, three options were considered in more detail for the provision of a city centre terminus station (Figure 11). The options considered were Manchester Piccadilly platform 1 (Option 1a), Salford Central Middlewood (Option 9b) and Salford combined station (Option 19). These options, and those considered as part of the sifting process, are described in more detail within the *Options for Phase Two – appraisal of sustainability report* (2012).

Manchester Piccadilly platform 1 (Option 1a)

4.4.45 The Manchester Piccadilly platform 1 station option (Option 1a) would consist of four elevated platforms parallel with, and alongside, platform 1 of the existing Manchester Piccadilly Station. High speed concourse facilities would be located at ground level, beneath the elevated platforms. Passengers would be able to transfer directly between the existing conventional rail and high speed concourses. A new combined conventional rail and high speed forecourt and car park was proposed. The station option would be constructed in phases owing to the constrained nature of the site and to reduce disruption.

4.4.46 The station is served by six train operating companies serving intercity routes, the south coast of England and northern England on the conventional rail network. The station provides interchange for existing Metrolink tram services and bus services, and benefits from good connections to major highways.

4.4.47 Construction of the station option would require the demolition of approximately 47 residential dwellings within one building on Chapel Town Street. It would have a major adverse impact on the setting of the existing train shed at Manchester Piccadilly Station (Grade II listed), a minor impact on the setting of the Grade II former goods office and would affect the setting of the Whitworth Street and Stevenson Square conservation areas. Provision of a high speed station at this location would support strategic growth in the area.

Salford Central Middlewood (Option 9b)

4.4.48 This station option (Option 9b) would be located adjacent to the western side of the existing Salford Central Station on a brownfield site known as Middlewood Locks. Salford Central Station would be retained in its original configuration. The station option would require four elevated platforms with concourse facilities located beneath. A new multi-storey car park would be located directly opposite the concourse. Passenger interchange between the existing conventional rail services at Salford Central Station and the station option would require a walk of up to 500m. The high speed station would be constructed in stages to reduce disruption.

4.4.49 Salford Central Station provides regional rail services to the north and west and connects with Manchester Victoria Station to the east. Future planned works could include Salford Central Station in the Manchester loop which would link Manchester Victoria, Manchester Piccadilly and Manchester Airport. The site benefits from good connections to major highways and local bus services, but has poor connectivity to existing Metrolink services and to Manchester city centre, with the nearest Metrolink stop at Deansgate, approximately a 15 minute walk away.

4.4.50 The station option and throat would result in the demolition of approximately 225 residential dwellings, of which 211 are within one apartment block on Middlewood Street. The station option would have some visual intrusion on Middlewood Locks and may affect views from a high-rise development in Rodney Street. The Grade II listed former Royal Bank of Scotland building would be demolished and there would be a potential impact on the views and setting of a Grade I listed railway bridge. The station option would support the strategic growth of Greater Manchester due to its location. However, the orientation of the proposed options, in a west-east direction,

would have the potential to sever those parts of central Salford to the north of the station option from the main areas of economic activity in central Manchester/Salford. This would not be consistent with the aim of developing the area and joining the two cities. It would also remove a section of the Bury Canal. However, the station option would support proposals for a riverside park by relocating Trinity Way.

Salford combined station (Option 19)

4.4.51 This station option (Option 19) would provide for a combined high speed and existing conventional rail interchange station situated on the footprint of the existing Salford Central Station. The combined station arrangement would deliver four high speed platforms and either two or four conventional rail platforms. A new combined high speed and rail concourse facility and multi-story carpark would be located beneath the elevated platforms, to the east of Trinity Way. The combined station would be constructed in phases to reduce disruption.

4.4.52 This station option would offer access to the same regional conventional rail services as for the Salford Central Middlewood station option (Option 9b). The combined station option would offer quicker interchange between high speed and conventional rail services. The proposed combined station option would provide good connections to major highways and local bus services. Metrolink services would be approximately a 15 minute walk away.

4.4.53 This station option and throat would result in the demolition of approximately 363 residential dwellings located on Rodney Street, Chapel Street and Middlewood Street and a section of existing brick arched viaduct. Chapel Street Hope and United Reform Church and the Chester's Salford Brewery, both Grade II listed buildings, would be demolished. The combined station would adversely affect views from high rise flats in Rodney Street and the adjacent conservation areas and impact the historic townscape character. The station option would support the strategic growth of Greater Manchester due to its location. As with Salford Central Middlewood Station option, this option has the potential to sever those parts of central Salford to the north of the existing station from the main areas of economic activity in central Manchester/Salford.

Options appraisal

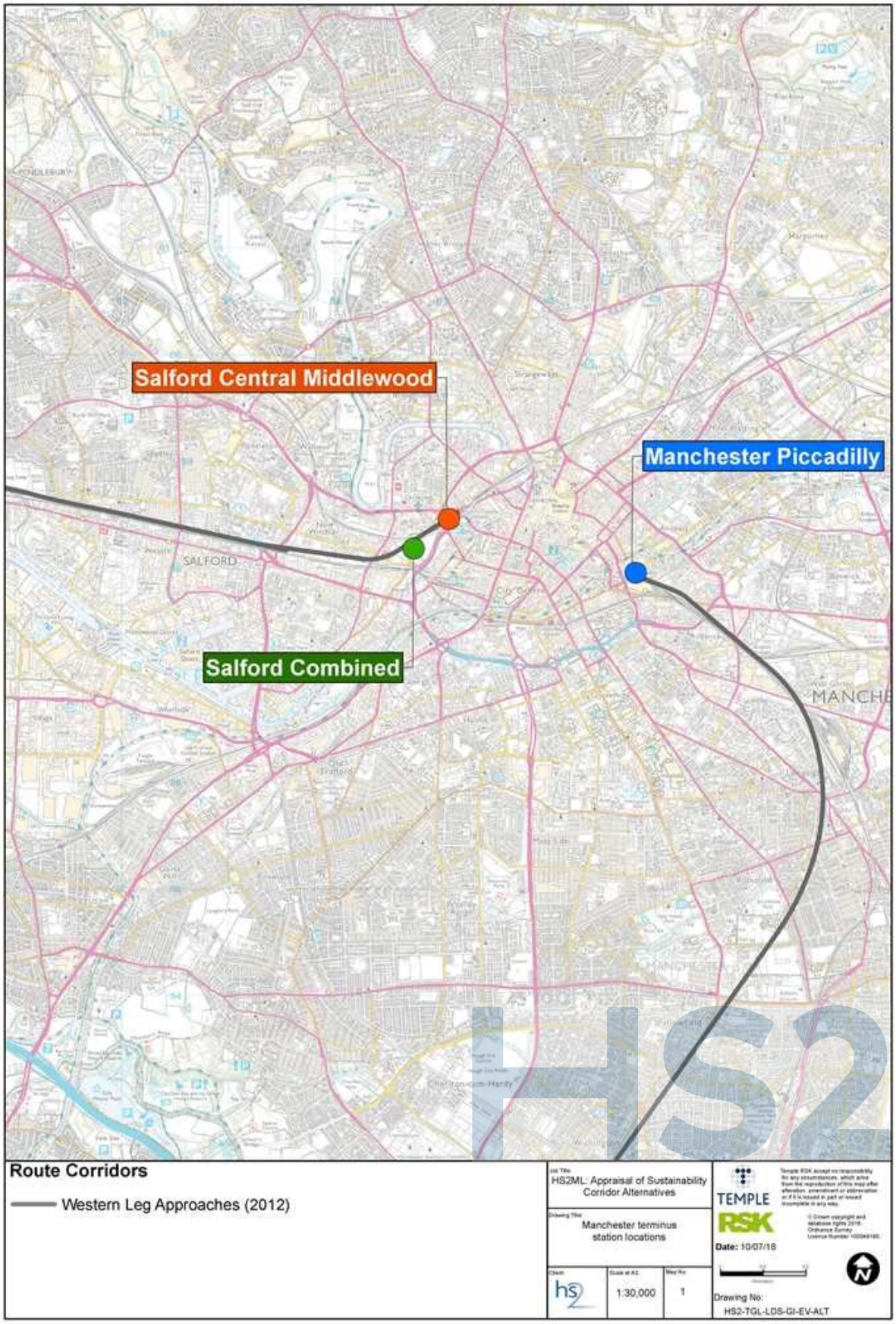
4.4.54 The locations of demand in Manchester are such that either the Salford or Piccadilly locations would be suitable locations. However, overall Manchester Piccadilly would provide connectivity to a wider range of public transport links, including interchange with the existing conventional railway, allowing the wider region to be served, including Manchester Airport, and would attract demand from the whole of the Manchester area. As a result, a high speed station at Manchester Piccadilly offers the best potential benefits and revenue. Whilst the station and approach combined would be marginally more costly to construct than the two Salford options, the additional cost would be substantially outweighed by the benefits it would deliver.

4.4.55 All three options would have an impact through demolitions. The potential demolitions would be higher for the two Salford options.

4.4.56 Approaching Manchester from the west would also mean that a high speed interchange station serving Manchester Airport would not be viable. The consideration of connectivity with principal airports was part of the Government's original remit for HS2 and a station here would also enable the capture of the Stockport and south Manchester demand markets.

4.4.57 Overall, Manchester Piccadilly, with its city centre location and its connectivity to the wider region, was considered to be the best location for a high speed city centre station. The selection of Manchester Piccadilly as the preferred location for a high speed station has informed the approach options into central Manchester.

Figure 11: Manchester terminus stations



Approaches to a high speed station at Manchester Piccadilly

4.4.58 Two main approaches (Corridors D and E) to a new high speed station at Manchester Piccadilly were considered. Both would approach the terminus at Piccadilly from the east side of the city centre. Each has compatibility with all three corridor approaches from south Manchester and is illustrated in **Error! Reference source not found.**. The oute corridors are described in more detail in the *Options for Phase Two – appraisal of sustainability report* (2012).

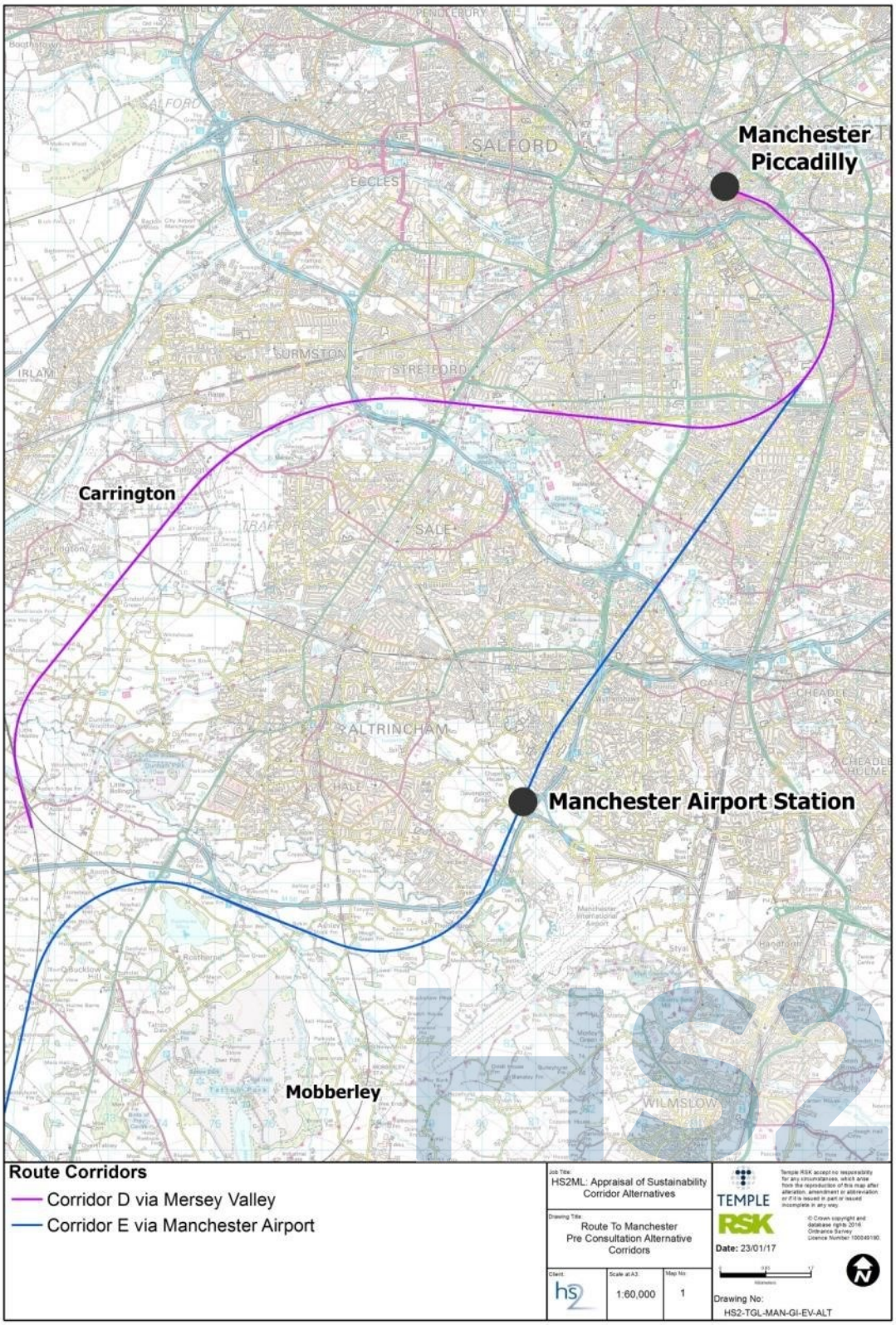
4.4.59 Corridor D via the Mersey Valley would commence to the east of High Legh. A junction close to Mossbrow would provide an onward connection with the WCML at Golborne and a spur in to Manchester via the Mersey Valley. This would take a route from Mossbrow north-east, skirting the southern edge of Partington and Carrington before heading directly east following the River Mersey south of Stretford. The route would be in tunnel approaching Chorlton, after which the tunnel would turn north beneath Rusholme and emerge at West Gorton alongside the existing conventional rail line into Piccadilly. The new high speed station would be located parallel to, and immediately north of, the existing Manchester Piccadilly Station.

4.4.60 Corridor E via Manchester Airport would commence at Hoo Green and would branch off to the east and would pass to the north of Rostherne Mere and Tatton Park before turning north near Thorns Green and Davenport Green where provision would be included for a high speed interchange station to the north of Manchester Airport. An approximately 12km tunnel would then take the route below Wythenshawe and Withington before surfacing near West Gorton and would run parallel to the existing conventional rail line approaching Piccadilly. Similar to Option D, the new high speed station would be located parallel to, and immediately north of, the existing station. The HS2 main line would continue north from Hoo Green and would provide onward connectivity with the WCML near Golborne.

Selection of a preferred approach to Manchester Piccadilly

4.4.61 As described in *High speed rail: investing in Britain's future – Phase Two report (2013)*, the Government's initial preferred option for this route was Corridor E via an high speed station interchange station serving Manchester Airport. The approach via the Mersey Valley (Corridor D) had a number of engineering and sustainability constraints, particularly around the Mersey Valley itself and the associated floodplain. These included a potential diversion of the River Mersey and landscape and visual impacts along the associated valley. This corridor would also require construction through a number of active and historic landfill sites. The approach via Manchester Airport (Corridor E) would be comparatively faster into Manchester Piccadilly and while it would be more costly to construct, would provide more benefits associated with serving Manchester Airport.

Figure 12: Approaches to Manchester Piccadilly



Approach into a high speed station at Salford

4.4.62 As described above, Salford was considered as the most reasonable alternative to a high speed terminus station at Manchester Piccadilly, with two station options proposed at Salford Central Middlewood and as part of a remodelled Salford Central Station. Both would be located in a similar geographical area and could align with Corridor F via Erlam or Corridor G via Chat Moss, as illustrated in Figure 13. The approaches into a high speed station at Salford are described within the *Options for Phase Two – appraisal of sustainability report* (2012).

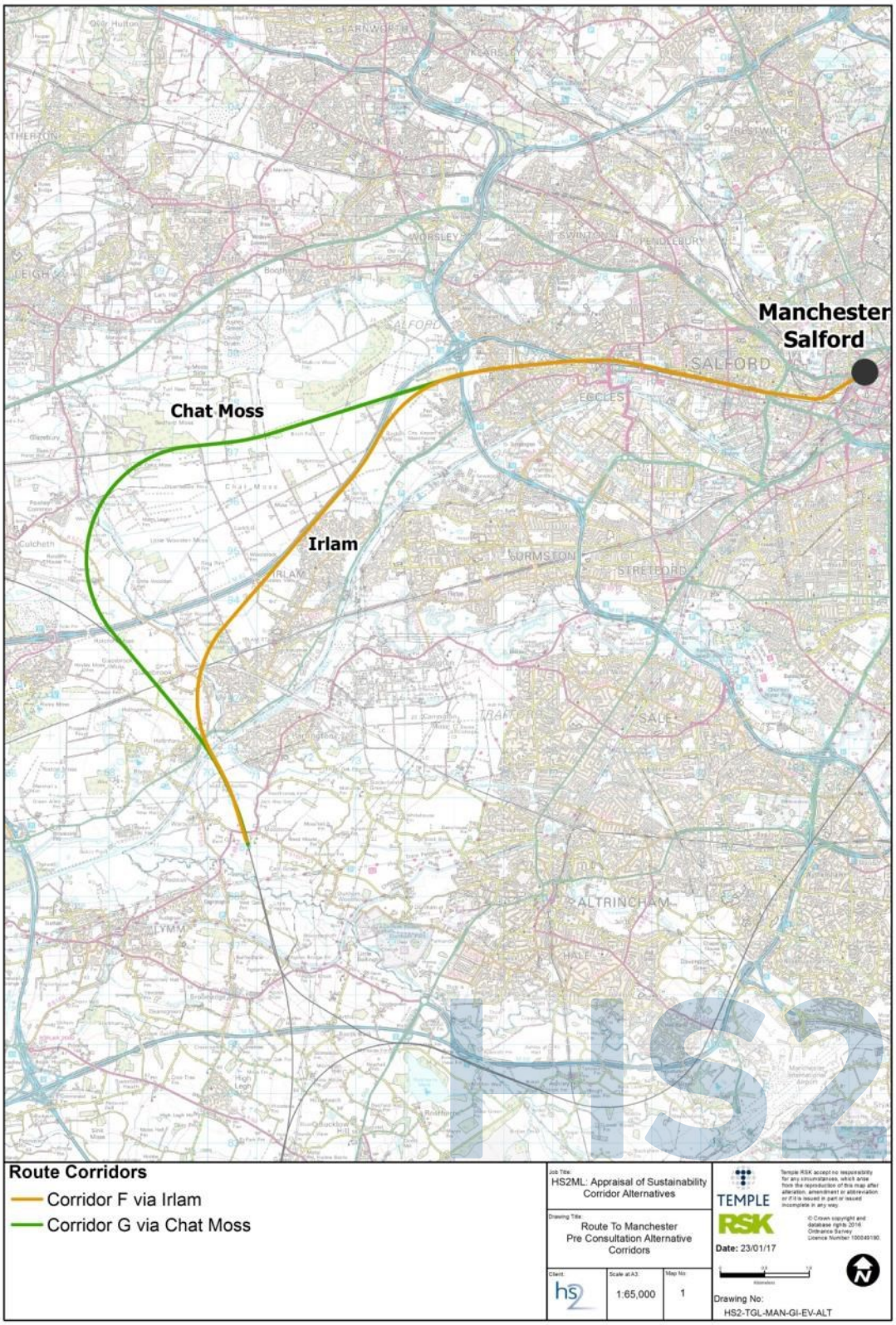
4.4.63 Whilst still providing an onward connection to the WCML near Golborne, a high speed station at Salford would require an approach from the west of Manchester. A junction between the HS2 main line to Golborne (and connection with the WCML) and spur to Manchester would be required to the north of the Manchester Ship Canal.

4.4.64 There were two main corridor alternatives for an approach into a high speed station at Salford. Corridor F via Irlam would require a junction immediately north of the Manchester Ship Canal crossing, and then the Manchester spur would head east and to the north of Cadishead and follow the M62 approaching Eccles. The route would remain at surface through Eccles alongside the existing conventional rail line into Manchester before entering a tunnel to pass under Albert Road and would emerge to the west of the existing Salford Central Station.

4.4.65 The second alternative, Corridor G via Chat Moss, would require a junction further north to the south of Culcheth close to where the HS2 main line would cross the M62. The spur into Manchester would then head east alongside the existing conventional Liverpool to Manchester Line (Chat Moss) on the northern side before crossing the M62 for a second time. The route would then adopt a similar approach to Corridor F into Salford from Eccles, using a tunnel to approach a high speed station at either Salford Central or Salford Central Middlewood.

4.4.66 The high speed station at Salford and the corresponding approach corridors were not taken forward. This is because the high speed station at Manchester Piccadilly was selected as the preferred terminus station. Further, the approach corridors to a high speed station at Salford would not serve a high speed interchange station at Manchester Airport, and would therefore not capture the demand from Stockport and south Manchester.

Figure 13: Approaches to Manchester Salford



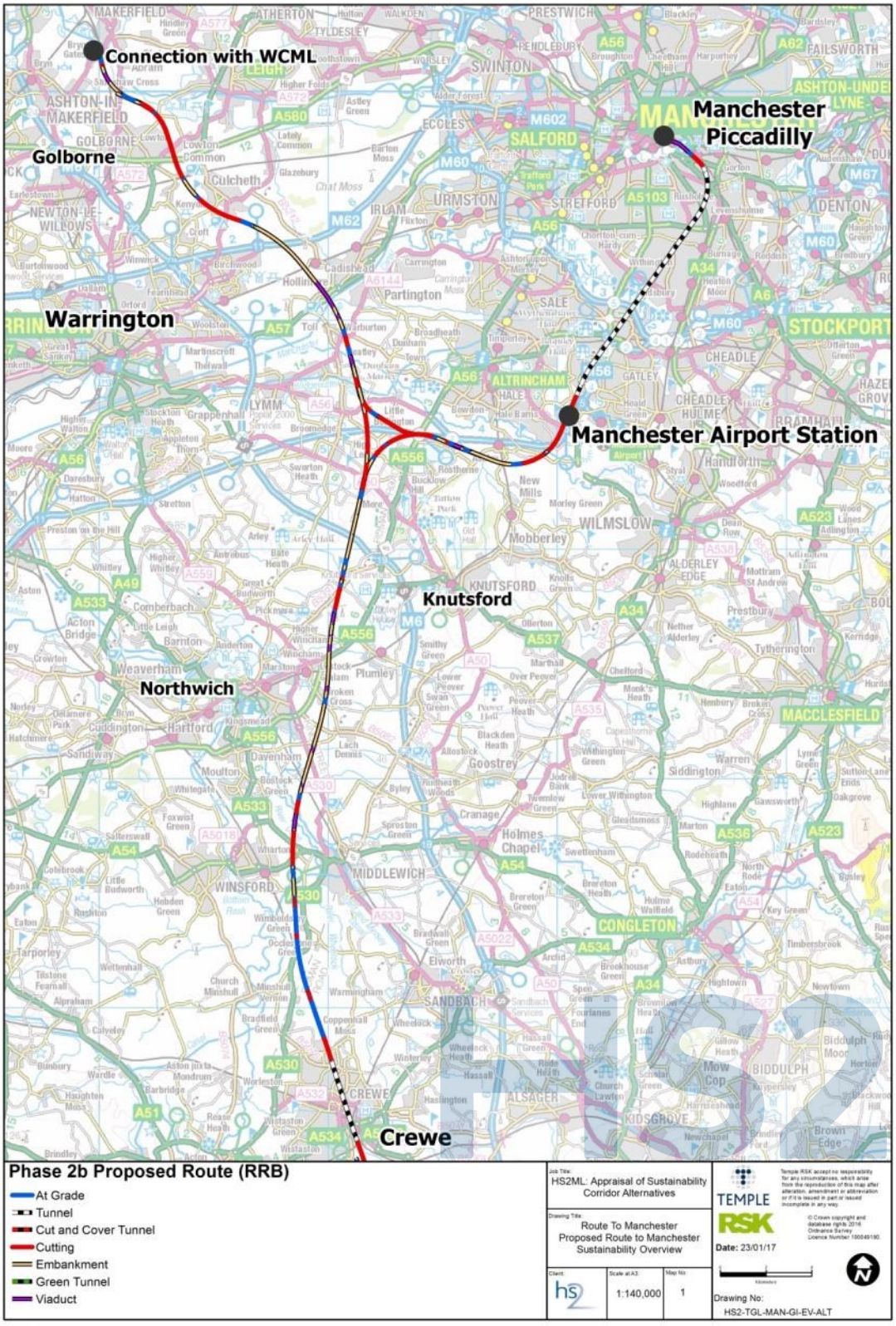
Proposed route to Manchester Piccadilly (from the connection with Phase 2a)

4.4.67 The proposed route to Manchester, comprising Corridor A via Crewe, Corridor E via Manchester Airport, together with a connection on to the WCML at Golborne, was published for consultation in 2013 within the *Phase Two initial preferred scheme sustainability summary* (2013). A number of changes have since been made to the 2013 proposed scheme for consultation on the basis of a number of factors including consultation feedback, engineering and/or environmental reasons.

4.4.68 In addition to the consideration of local alternatives along the western leg to Manchester, further work was also undertaken to re-visit the previous alternative approach to Manchester Piccadilly via the Mersey Valley. This was in response to consultation feedback and further design and assessment work to ensure that, on balance, the best possible options were progressed.

4.4.69 The following sections describing the proposed route to Manchester Piccadilly, and the alternative via a Mersey approach, provide further detail on the development of this alternative corridor and the comparisons made against the preferred option at the time of appraisal (Figure 14). The Mersey approach alternative was treated the same way as any other post-consultation refinement and compared against the preferred route for the equivalent sections.

Figure 14: Proposed route to Manchester Phase 2b (July 2013)



Proposed route to Manchester Piccadilly – route description

4.4.70 The description below provides a review of the 2013 proposed scheme for consultation. This route was compared with an alternative corridor approach into Manchester Piccadilly (see Figure 15). Further refinements were made to the route as part of subsequent design development described later in the report.

4.4.71 The route to Manchester would commence north of the A500, immediately south of Crewe and would connect to Phase 2a[40]. The route would approach the existing Crewe Station below ground in a bored tunnel and would continue under central Crewe before surfacing north of Bradfield Road. The route would emerge from tunnel through the town's northern outskirts, on the east side of the WCML, maintaining this alignment as far as Walley's Green.

4.4.72 Near the A530 the route would move away from the WCML and would continue north across the Cheshire Plains. The route would pass between Winsford and Middlewich and continue north on a series of embankments and viaducts and would cross the River Dane and Trent and Mersey Canal Conservation Area.

4.4.73 The route would continue north and would pass to the east of Lostock Green and Lostock Gralam on a mix of viaduct and embankment. The route would be on embankment for several kilometres across the farmland east of Higher Wincham and Pickmere before crossing over the M6 to Hoo Green, where the Manchester junction would be located. The HS2 main line would continue north and a spur to Manchester would bear east towards Manchester Airport high speed station.

4.4.74 From the Manchester junction at Hoo Green, the spur into Manchester would pass east and to the north of Rostherne Mere in cutting before crossing Blackburn Brook, Birkin Brook and the River Bollin to the south of Ashley.

4.4.75 The route would then head north-east in cutting through the settlements of Thorns Green, Halebank and the edge of Warburton Green approaching the proposed high speed station at Manchester Airport. The Manchester Airport high speed station would be located within green belt land close to Davenport Green. Immediately north of the proposed high speed station, the route would enter a bored tunnel approximately 12km long beneath much of southern Manchester before re-surfacing at West Gorton. The route would then rise onto embankment and viaduct approaching Manchester Piccadilly Station.

4.4.76 The terminus station would be built alongside the existing station at Manchester Piccadilly. The high speed station would provide for interchange with existing public transport, and improved pedestrian access in the area as well as offering substantial potential for supporting local economic activity and development.

[40] The connection with Phase 2a changed following a decision to extend the tunnel under Crewe by 2.55 km further south as part of the Phase 2a hybrid Bill process.

Figure 15: Proposed route to Manchester Piccadilly and reasonable alternative

Reasonable alternative – Mersey approach

4.4.77 An alternative route approaching Manchester Piccadilly centred principally on the Mersey approach, a corridor initially considered as part of the *Options for Phase Two – appraisal of sustainability report* (2012), which was reviewed again following the 2013/2014 consultation.

4.4.78 The Mersey approach was refined and focused on variations in tunnel length and route under south Manchester, the location of the tunnel portal, and how to reduce interaction with a series of landfill sites along and around the Mersey Valley area as well as the River Mersey itself. A review was also conducted into the possibility of including a high speed interchange station in the south Manchester area.

4.4.79 A direct comparison was made between the 2013 proposed scheme for consultation and the Mersey approach. As the Mersey approach shares the same route with the 2013 proposed scheme for consultation from Crewe to the Manchester Ship Canal, the route section directly south of the Manchester junction was removed from the comparison. Figure 16 shows both routes and the extents of comparison.

4.4.80 The Mersey approach included a similar HS2 main line connection to the WCML at Golborne as that of the 2013 proposed scheme for consultation. However, the junction for the spur towards Manchester would be positioned further north, directly after the crossing of the Bridgewater Canal, east of Lymm. At this location, the spur would branch north-east to the south of Mossbrow on a mix of viaduct, embankment and cutting before again rising onto embankment south of Partington, which would run within the northern boundary of National Trust land. A double viaduct crossing of the River Bollin would be required causing landscape and visual impacts east of the village of Heatley.

4.4.81 A short viaduct crossing of the Red Brook would be followed by a long stretch of embankment where the route would continue north-west bisecting a development site at Carrington. In an attempt to reduce the impacts associated with the Mersey Valley, the refined alternative approach would pass into tunnel on the edge of the main urban area approaching Trafford, thus avoiding the Mersey Valley and associated flood risk, landscape and visual impacts further north. The route would continue to head east in bored tunnel for just under 14km, below the urban areas of Sale, Chorlton and Fallowfield before heading north under Rusholme and emerging from tunnel at West Gorton, on the eastern side of the existing conventional rail line approaching Manchester Piccadilly Station.

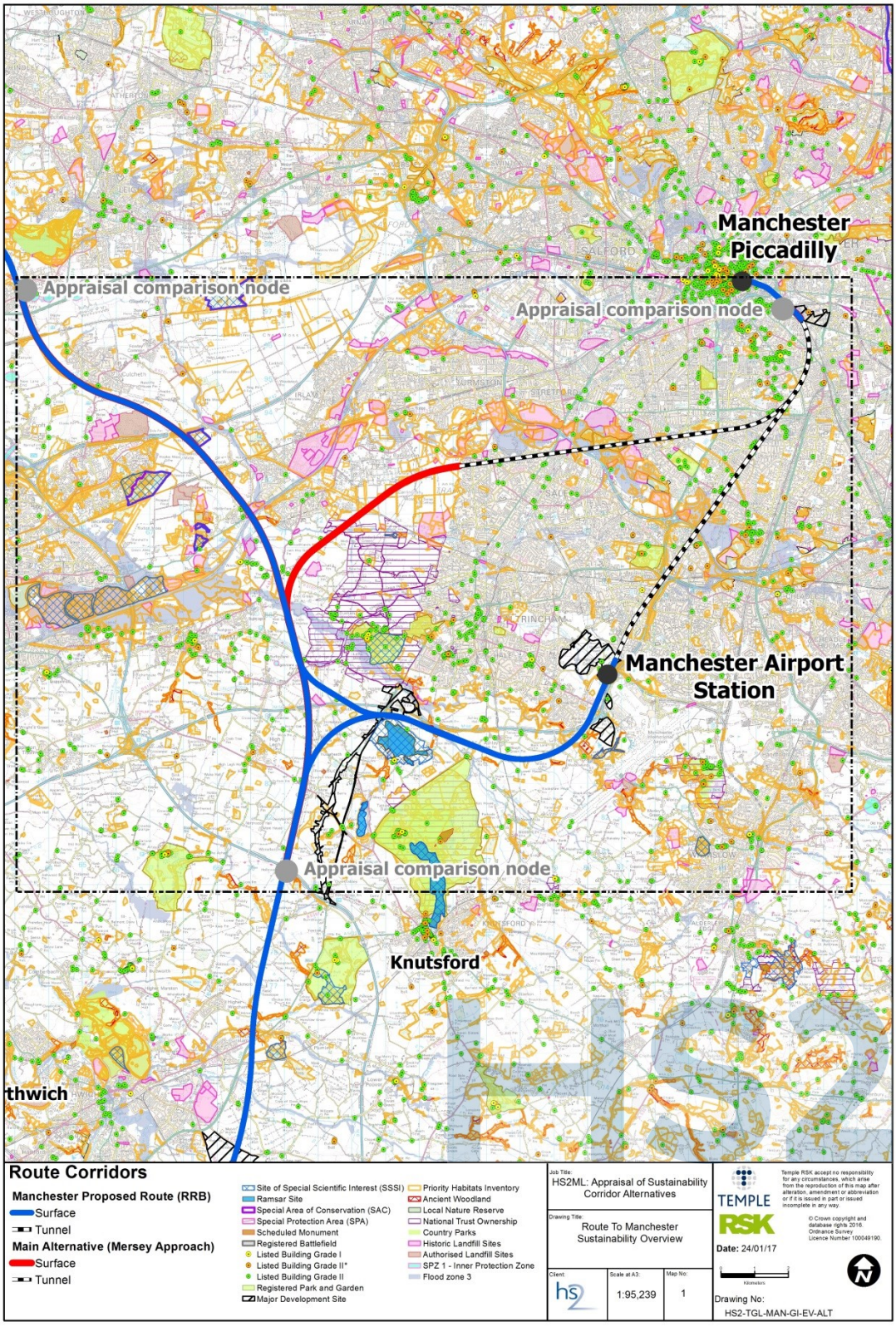
4.4.82 Approaching Manchester Piccadilly Station, the alternative would follow a similar horizontal and vertical profile of the 2013 proposed scheme for consultation, with the same impacts at West Gorton and the station.

4.4.83 The Mersey approach alternative also provided opportunity to explore a depot at Carrington as an alternative to depot options at Golborne and north Crewe (considered as part of the of the 2013 post-consultation local refinements). The Carrington depot would be situated to the north of the spur into Manchester, within the development site at Carrington. A connection onto the existing conventional network would be achieved by re-opening a disused rail line east of Partington and connecting onto the existing conventional network at Glazebrook. This connection

would also require the reinstatement of an additional crossing of the Manchester Ship Canal, with additional land required from Coroners Wood Ancient Woodland on the approach to the crossing. Visual impacts from the depot itself would be limited due to the industrial nature of the existing land, although re-establishing the disused rail line for connectivity with the existing conventional network would introduce new visual impacts at Partington.

4.4.84 Options for a high speed interchange station as part of the Mersey approach were considered near the M6 crossing south of Hoo Green, as well as north and south of the M56, east of High Legh. However, an interchange station in these locations did not perform well in regard to demand, cost and benefits.

Figure 16: Proposed Manchester Piccadilly station approach and reasonable alternative



Summary of sustainability impacts

4.4.85 Table 1 summarises the sustainability impacts of the proposed route into Manchester Piccadilly via Manchester Airport and the alternative via the Mersey Valley as appraised following the 2013/2014 consultation. The key sustainability constraints are shown on the route comparison map (Figure 16), together with the route sections compared for this appraisal. The summary table includes a full appraisal of impacts of both routes between the node points highlighted on the figure.

Table 1: Proposed route and alternative route via Mersey approach comparison table

Topic Area	**Proposed route to Manchester via Manchester Airport consultation route with updated design standards applied**	**Alternative route via Mersey approach**
Property and Community Integrity	Demolitions (approximately) 54 residential 46 commercial One community Two industrial **Approximate Total: 103**	Demolitions (approximately) 35 residential 41 commercial One community Two industrial **Approximate Total: 79**
Noise (annoyance)	Approximately 160	Approximately 190
Landscape and Visual Impacts	Major landscape and visual impacts crossing the Manchester Ship Canal Moderate visual impacts at Ashley and Hale Barns	Major landscape and visual impacts crossing the Manchester Ship Canal Moderate to major landscape in the Bollin Valley
Planning and Development	Direct impact on two development sites (West Gorton, Davenport Green)	Direct impact on two development sites (West Gorton, Carrington)
Cultural Heritage	Direct impact on two Grade II listed buildings (Newchurch Old Refectory, Buckhall) Major impact on the setting of one Grade II listed building (Mere Court) Moderate impact on the setting two Grade II listed buildings (Ovenback Cottage, The Chapel House)	Direct impact on one Grade II listed building (Newchurch Old Refectory) Major impact on the setting of one Grade II listed building (Mere Court) Moderate impact on the setting one Grade II listed buildings (Bank Cottage)
Biodiversity and Wildlife	Two ancient woodlands directly affected (Coroners Wood and Hancock's Bank) 31 Habitats of Principal Importance intersected for approximately 1.9km	One ancient woodland directly affected (Coroners Wood) 31 Habitats of Principal Importance intersected for approximately 2.7km

Topic Area	Proposed route to Manchester via Manchester Airport consultation route with updated design standards applied	Alternative route via Mersey approach
Water Resources and Flood Risk	Four diversions of minor watercourses Two crossing where HS2 main line could be at risk of fluvial flooding Approximately 800m of route in cut/tunnel through source protection zone 2	Two diversions of minor watercourses Two crossing where HS2 main line could be at risk of fluvial flooding Approximately 800m of route in cut/tunnel through source protection zone 2
Land use resources	One active landfill site intersected One historical landfill site intersected 41km of green belt land intersected	One active landfill sites intersected One historical landfill sites intersected 26km of green belt land intersected

Proposed route and alternative route via the Mersey approach summary

4.4.86 The Mersey approach performed comparatively better from a sustainability perspective, including fewer demolitions and fewer impacts on heritage assets, although this approach would bring the route closer to larger population areas and thus increase potential noise impacts. The Mersey approach option also provided an initial cost saving, owing to its shorter route length, when compared with the route via Manchester Airport. However, the key driver for the recommended continued progression of the route via Manchester Airport was the opportunities afforded by the provision of a high speed station at Manchester Airport.

4.4.87 Having a high speed station at Manchester Airport on the high speed network was seen by Government and key stakeholders as vital for maximising connectivity to international markets and also for unlocking further development potential, building upon the success of the Airport City Enterprise Zone.

Interchange stations

4.4.88 As per the remit set by Government, options for interchange stations including access to major airports were considered. A long list of options was developed.

4.4.89 Following on from the initial sifting process, five options were considered in more detail for the provision of a high speed interchange station (see Figure 17). The options considered were Manchester Airport Davenport Green (Option 4e), Manchester Airport north-south (Option 4c), Manchester Airport east-west (Option 4d), Knutsford - Sandbach to Golborne M6 route (Option 5) and Knutsford - Crewe to Golborne western route (Option 5a). These options and sifting process are described in more detail within the *Options for Phase Two report* (2012).

Manchester Airport Davenport Green (Option 4e)

4.4.90 This option would provide a connection to Manchester Airport, but only if the terminating station in Manchester was at Piccadilly. It would be located underground, on the airport and south Manchester tunnelled approach. The cost of serving the

station (not including the station cost itself) would add substantial costs compared to the alternative, lower cost approach (Mersey and tunnel), to Manchester Piccadilly. Trains would not be able to call at this station before heading north on the through route to the WCML connection, as is possible with the Knutsford options, for example.

4.4.91 The high speed station would have one central platform to serve the two stopping HS2 main lines. The concourse facilities for the high speed station would be at surface, above the platform. A four storey car park would be constructed adjacent to the southern half of the platforms to the west. The high speed station would be accessed from all highway routes via a new section of link road. This option is the closest to the airport out of a number of locations in the area that were looked at. Bus services or a people mover would be needed to transfer people between the station option and the airport.

4.4.92 This high speed interchange station option would be constructed within green belt land. However, development proposals associated with the airport in this area would be complementary to the development of this option. Approximately 300 jobs could be supported by a station in this location. At the time of the appraisal, it was assessed that this option would give rise to a moderate visual impact on residential areas nearby. Three demolitions of residential dwellings would potentially be required for the station and its related infrastructure.

4.4.93 This option and all necessary supporting infrastructure was estimated to be the lowest cost of the five options developed at this stage. It was estimated that 300 jobs could be supported by the high speed station in this location.

Manchester Airport north-south (Option 4c)

4.4.94 As for Option 4e above, this interchange station option would provide a link to Manchester Airport, and would be located on the airport and south Manchester tunnel approach to Manchester Piccadilly. Trains would not be able to call at this high speed station before heading north on the through route to the WCML connection.

4.4.95 This option would be located approximately 2km (1.2 miles) to the south-west of the Manchester Airport terminal area, just to the south-west of junction 6 of the M56. This station option would provide two platforms on either side of the HS2 main lines. It would be constructed in cutting, with the platforms approximately 10m below ground. The concourse would be at ground level and a four storey car park would be located above ground to the east of the station. A people mover would be needed to transfer people between the station option and the airport. Alternatively, a conventional rail connection from the nearby Chester to Altrincham Railway Line could be built, although this was not factored into the design or costing for this station option. The site would have good access to the road network, although new connections to the M56 would be required along with capacity increases. The nearest existing station would be Ashley approximately 2.6km (1.6 miles) away.

4.4.96 The proposed location would be in green belt; however, it is immediately to the west of the proposed extension areas of the Airport Development Area shown in Manchester City Council's draft core strategy (also known as Airport City in other plans), which is identified for release from green belt. The station would also support

the Enterprise Zone status of the airport. It is estimated that 600 jobs would be supported by a station at this location.

4.4.97 Approximately nine residential dwellings would need to be demolished for the construction of the station option and its related infrastructure. In addition, a Grade II listed building (Yew Tree House) would also need to be demolished. Due to the relatively flat nature of the surrounding area, the station option at ground level and the four storey car park would mean visual impacts for those living in the Halebank area, but this is in context of the station option being on the other side of the motorway from the settlement. The station option and its associated infrastructure would impact on Sunbank Wood, which is an ancient woodland and BAP habitat. The four tracks required to accommodate the station option would impact a small area of Flood Zone 3 (land with a high probability of flooding).

4.4.98 This station option was not the lowest cost option for the approach to Manchester Piccadilly. The Manchester Airport north-south option would cost substantially more to build than the Manchester Airport Davenport Green option.

Manchester Airport east-west (Option 4d),

4.4.99 This station option would provide a link to Manchester Airport. It would be located on the Sandbach to Golborne route option. Trains could call at this station before serving Manchester city centre or before heading northwards to connect with the WCML. The other two main route options north of Crewe/Sandbach could not serve this station option. The Mersey approach would be used after calling at this option to access a station near Manchester Piccadilly. Either of the approaches to a Salford station could also be used.

4.4.100 The station option would be located adjacent to the existing conventional Chester to Altrincham Line, approximately 1.5km (1 mile) south of the M56 and approximately 4km (2.5 miles) to the south-west of the Manchester Airport terminal area. The station option would be elevated approximately 3m above ground level. The high speed station concourse would be at surface level underneath the platforms and tracks. A crossover between platforms would be required above the platform level. The distance between the concourse and terminal one at the airport would be approximately 7km (4.4 miles). An above ground car park to the east of the station option would be provided. A connection to Manchester Airport would be provided via a people mover system, as with the two above options. A conventional rail link could be provided as an alternative with a connection to the existing conventional rail network and to the airport.

4.4.101 To provide access to the road network, a new motorway junction would need to be constructed to the M56. A new road would be constructed to link between the station option and the new motorway junction. A new bus service would need to be introduced to serve the station option. Traffic related to the station option would require capacity enhancement on the M56.

4.4.102 The site is a greenfield site within the green belt. This station option and associated infrastructure would likely require the demolition of 11 residential dwellings. A Grade II listed structure would also need to be demolished. Given the green belt location and distance from the Enterprise Zone around the airport, this option is unlikely to support

associated developments and job creation. Given the elevated nature of the station option, it would impact on views from the surrounding hamlets and countryside which is relatively flat. In addition, the beginning of the section of four tracked route approaching the station option from the south would be within the Mobberley Conservation Area. The station option would directly affect two ancient woodlands, which are also wet woodland BAP habitats – Arden House Wood and Hancocks Bank.

4.4.103 The Manchester Airport east-west option would be the most costly of the five interchange options to the south of Manchester, substantially more costly than the Manchester Airport Davenport Green option.

Knutsford - Sandbach to Golborne M6 route (Option 5) and Knutsford - Crewe to Golborne western route (Option 5a)

4.4.104 Two very similar station options in close proximity to each other were considered, located to the west of Knutsford. These two station options were developed in the area to serve the two main route options that would pass through this area. Option 5 would be located on the Sandbach to Golborne M6 route. Option 5a would be located on the Crewe to Golborne western route. Services heading into any station option in Manchester, via any of the approaches or heading north to connect to the WCML would be able to call at both station options. This would include any conventional compatible services continuing north after connecting to the WCML.

4.4.105 Option 5 would be approximately 1km (0.5 miles) to the south of junction 19 of the M6 on a greenfield site. Option 5a would be slightly to the north-west of Option 5, on a greenfield site approximately 1.4km (1 mile) to the west of junction 19 of the M6. The platforms for both options would need to be elevated above ground level by approximately 4m as the route would be elevated, with an elevated concourse area above the tracks. A four storey above ground car park to the east of both of the station options would be provided.

4.4.106 Highway access to both of the station options would be via a new road constructed to connect with the A556. This road would link to junction 19 of the M6 and further north to the M56. Both motorways can be congested at peak times and traffic to the station options would potentially create further congestion. Currently, bus services run along the A556 would be diverted to serve either station option. There would not be access to the existing rail conventional network at either location, as the nearest station would be Plumley, approximately 4km (2.5 miles) away on the Chester to Altrincham Line.

4.4.107 Both options would lie within the green belt and would conflict with the local planning strategy as there are no plans to release the land for development. Option 5 would require the demolition of approximately three residential dwellings. Given the relatively flat nature of the surrounding landscape and that the station option and approaching sections of four tracks would be elevated, there would be some visual intrusion on the Grade II Tabley House Registered Park and Garden as well as views from Knutsford and surrounding hamlets. The four tracked section to the south of the station option would cut through Round and Rinks Wood, an ancient woodland.

4.4.108 Option 5a would require the demolition of approximately four residential dwellings. This station option is a little further away from Tabley House Registered Park and Garden and the outskirts of Knutsford than Option 5. There would be visual intrusion of views from surrounding hamlets. The station option and the four tracks required to accommodate it would impact on a small area of Flood Zone 3 (land with a high probability of flooding).

4.4.109 The cost of both Knutsford options would be more than the Manchester Airport Davenport Green option.

Options appraisal

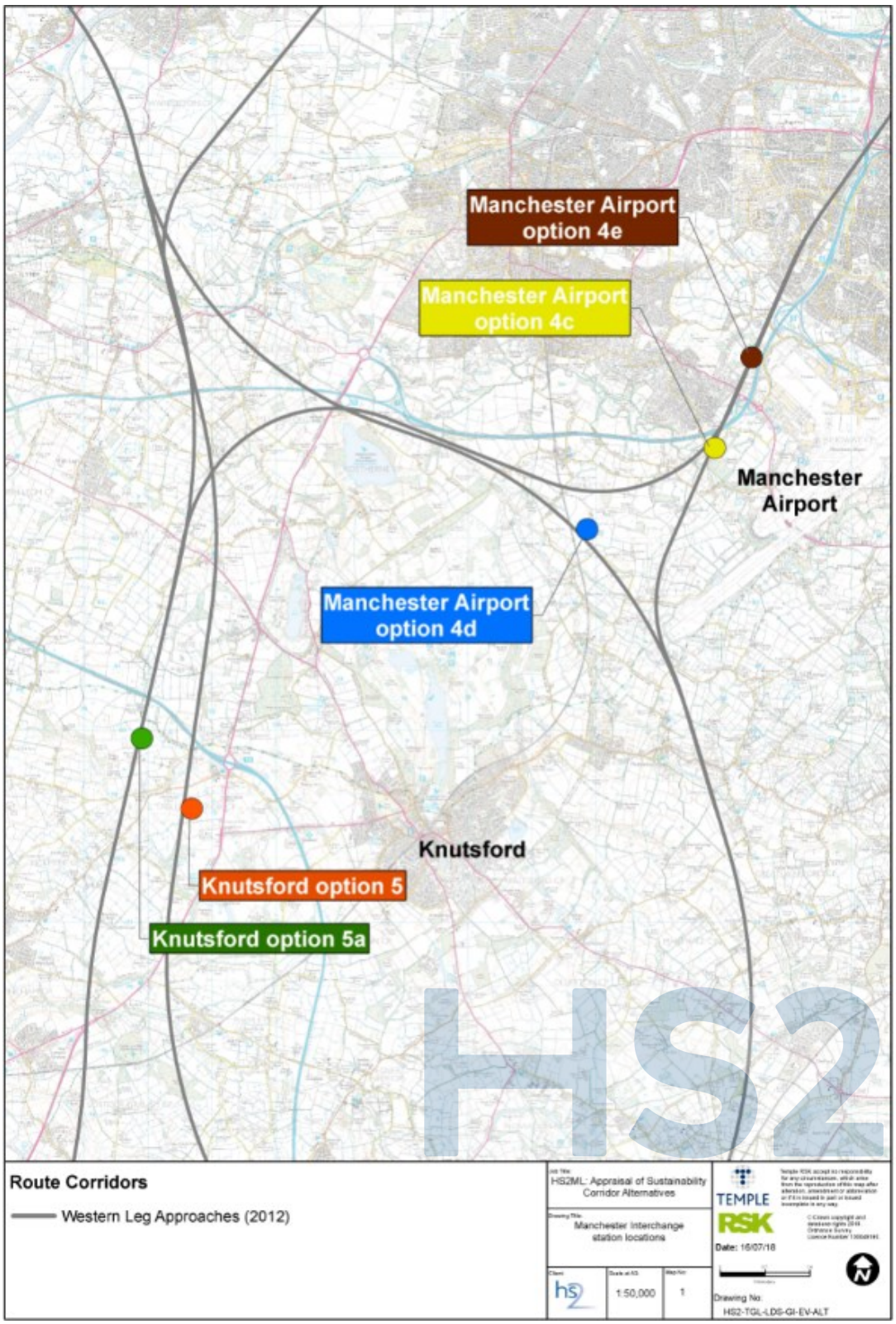
4.4.110 An interchange station on the outskirts of Manchester would give the benefit of time savings for passengers from the Manchester area. Services which stop at the interchange station, however, would take longer to reach the city centre station.

4.4.111 A key consideration in determining the optimum location for a Manchester interchange station was the relative access times from the key target markets of south Manchester, Trafford, Stockport and north Cheshire. A station located towards the northern extent of this catchment would offer better access to the core market than one further south at a location such as Knutsford. However, the station options in Knutsford would benefit from connectivity to the M6.

4.4.112 In terms of the station options, Manchester Airport Davenport Green offered the best connectivity and proximity to Manchester Airport and could be delivered at the lowest cost. This station option could be accessed from all three main route options, but only from one approach, the airport and south Manchester tunnel.

4.4.113 The combination of a high speed station at Manchester Piccadilly and an interchange station to the south of Manchester in the vicinity of Manchester Airport would attract the largest number of passengers compared to other combinations of station options.

Figure 17: Manchester interchange station



Proposed route to the WCML

4.4.114 From the junction with the Manchester spur at Hoo Green, the HS2 main line would pass under the M56 and would rise onto embankment and viaduct across the Bollin Valley. It would then cross the farmed former moss land around the southern edge of Greater Manchester and would continue across the Bridgewater Canal.

4.4.115 The HS2 main line route would then bear north-west in a shallow cutting before rising onto a viaduct over Coroners Wood Ancient Woodland and the Manchester Ship Canal, close to the settlements of Hollins Green, Cadishead and Glazebrook. The route would continue on embankment for several kilometres across farmland between Warrington and Irlam, avoiding Risley Moss and Holcroft Moss SAC and SSSI. It would cross the M62 before bearing west towards Culcheth, intersecting the edge of Risley landfill, although not impacting any of the active deposition cells.

4.4.116 Entering cutting, the route would pass to the south side of Culcheth, through the Taylor Business Park. The HS2 main line would then continue northwards through Culcheth Linear Park before rising to cross over the Liverpool to Manchester Line.

4.4.117 The route would descend into cutting to pass beneath the A580, between Lowton St Mary's and Lowton Common, before rising onto a low embankment and bearing west to the north of Golborne. It then would continue northwards where it would converge with the WCML at Bamfurlong, south of Abram Flashes SSSI and Pennington Flash Country Park. The junction with the WCML would allow onward connection with conventional rail stations further north including Wigan, Preston, Lancaster, Glasgow and Edinburgh.

4.4.118 Further to the long and short listing stages described earlier in this report, the main alternative considered for a connection to the WCML was a route running north of Preston (as shown on Figure 9). As described in the *Options for Phase Two – appraisal of sustainability report* (2012), despite having benefits in terms of shorter journey times to Scotland, it would mean HS2 trains would not be able to call at stations on the existing rail network between Bamfurlong and Brock (e.g. Wigan and Preston). Extending the WCML connection further north would also carry a substantial additional cost and would introduce additional sustainability impacts. It was considered that the benefits gained from the further journey time savings and markets captured would need to outweigh these substantial costs.

4.5 Establishment of the Proposed Scheme between the West Midlands and Leeds

Leeds routes – options short listing

Introduction

4.5.1 The initial short list of route options to Leeds undertaken between 2010 and 2012 was broken down into nine groups, based on the geography and functionality of the various options offered. The eastern leg to Leeds route corridor options appraised were defined by four broad geographical sections, within which different corridor options were considered (Nottingham and Derby, South Yorkshire, Leeds city centre and ECML connection). The groups are described within the *Options for Phase Two – appraisal of sustainability report* (2012). These are illustrated in Figure 18 and are outlined below, together with a high-level commentary on the sustainability constraints. Within each group, individual route options were either recommended for further refinement or discounted on the basis of sustainability, cost, engineering and/or operational concerns. At each phase of development, new options were also considered within some of the groups as the understanding of the key constraints increased and potential viable solutions were identified.

River Mease group

4.5.2 The group comprised four routes that would run north-east between the north of Tamworth and Ashby-de-la-Zouch. Three of these routes would cross the River Mease SAC/SSSI. The most western route would also have a direct impact on Alvecote Pools SSSI, north of Tamworth. The remaining route would have avoided direct impacts to the River Mease SAC/SSSI. The group would have had a direct impact on two Grade II listed structures.

West of Derby group

4.5.3 The group comprised a small number of routes which would have bypassed Derby and run from Burton-upon-Trent to south of Belper. The group would have intersected the Derwent Valley Mills World Heritage Site for approximately 2km (1.2 miles). It would have also crossed the River Dove, the River Derwent and the Trent and Mersey Canal and had impacts on the setting of two scheduled monuments (Mackworth medieval settlement and Monks Bridge), Kedleston Hall Grade I Registered Park and Garden and a number of listed structures.

4.5.4 Routes around the western edge of Derby would not serve the wider East Midlands market, the centre of Derby, provide an interchange with existing conventional rail services or serve the Nottingham area. These route options would also have potentially affected the Derwent Valley Mills World Heritage Site. Route options that would pass via the former Friargate Station would have a low design speed whilst a combination of the western Derby bypass and Derby Friargate loop would require substantially more additional railway construction. For these reasons a number of route options in this group were not taken forward beyond this stage.

Elvaston Castle group

4.5.5 The group comprised a single route between south-east Derby and Ilkeston. The routes within this group would have required some residential demolitions in West Hallam and Borrowash. The group would have had a direct impact on Elvaston Castle Grade II* Registered Park and Garden as the route would have intersected the start of a tree-lined avenue forming the major sightline from the house. It would also have a direct impact on a scheduled monument (Heavy Anti-Aircraft Gunsite, 340m south-east of Gardens Farm). It would not have been feasible to avoid the registered park and garden as the route would run through the site, with approximately 1km (0.6 miles) of the site on either side of the route, and the route could not be feasibly realigned to avoid the site. It was decided not to develop the route primarily because of the impact it would have on the Elvaston Castle Grade II* Registered Park and Garden.

Through Nottingham group

4.5.6 The group comprised a number of routes that would connect Kegworth with east Sheffield. The routes would run north-east from Kegworth, pass east of Nottingham city centre before running north to the east of Sheffield. The eastern route option (between Burton Joyce and Rainworth) would have required some residential demolitions at Carlton, Burton Joyce and Lowdham. The group would have crossed two SSSI (Sherwood Forest Golf Course, and Hills and Holes and Sookholme Brook) and would have had direct impacts on three scheduled monuments (a Romano-British settlement at Glebe Farm, Ash Tree Cave, and Palaeolithic and prehistoric sites at Cresswell Gorge), and one Grade II* listed structure (Church of the Holy Rood, West Bridgford).

4.5.7 Analysis showed that, in benefit terms, Nottingham and Derby as through stations would both offer slower journey times to their respective city centres, but slower journey times to markets further north, when compared against the East Midlands Hub station option. A Nottingham through station would be substantially worse than other options in terms of cost, and poorer still in revenue and benefit terms. Derby as a through station would be better value for money compared to Nottingham on a through route or a spur. The development of Nottingham through route options was taken no further. The route option around Nottingham, which included a proposed station on a greenfield site at Clifton, was not taken forward beyond this stage as it would be substantially more costly and result in slower journey times to Nottingham and markets further north than the alternative options.

West of Chesterfield group

4.5.8 The group comprised a single route that would connect Ripley with Sheffield that would run west of Chesterfield. The group would have had a direct impact on one scheduled monument (Smelt Mill in Linacre Wood) and one Grade II listed structure (The Crown Inn, Heeley). A large number of properties would have experienced noise impacts, mainly on the approach into Sheffield. This route would pass through challenging topography at the foothills of the Derbyshire Peak district with a long section of new tunnel making this route comparatively more expensive than other alternatives.

Doncaster group

4.5.9 The group comprised routes that would run between the eastern outskirts of Sheffield and Leeds. The routes would pass west of Doncaster and provide a connection onto the ECML at Ulleskelf. The group would have required a number of potential residential demolitions, mainly in Rothwell, Mickletown and Castleford. It would have had direct impacts on two SSSI (Cadeby Quarry and Sprotbrough Gorge), two scheduled monuments (a Romano-British enclosure in Pot Ridings Wood and Steeton Hall) and two Grade II listed structures. These route options would not serve the more densely populated parts of South Yorkshire and would provide no connection to a South Yorkshire station (based on work that was emerging at that time on potential station locations). Construction through Doncaster would also have been complex and disruptive.

West of Barnsley (M1) group

4.5.10 The group comprised routes along the most westerly corridor that would run between the northern outskirts of Sheffield and west of Leeds, joining the Transpennine approach into Leeds city centre. The group would have had direct impacts on two Grade II registered parks and gardens (Bretton Hall and Wortley Hall); one scheduled monument (Middleton Park Shaft Mounds); five Grade II listed structures and would require demolitions of residential dwellings. This group would run through hilly terrain and would require the extensive use of steep gradients, earthworks and tunnels, including large sections of tunnel for all options to avoid residential areas west of Barnsley and Wakefield, and on the southern approach into Leeds. In addition to this the route north of the M1 corridor would run at a reduced speed because of the urban nature of the area near the Junction of the M1 and M62 to the south of Leeds. For these reasons, this group was not developed beyond this stage.

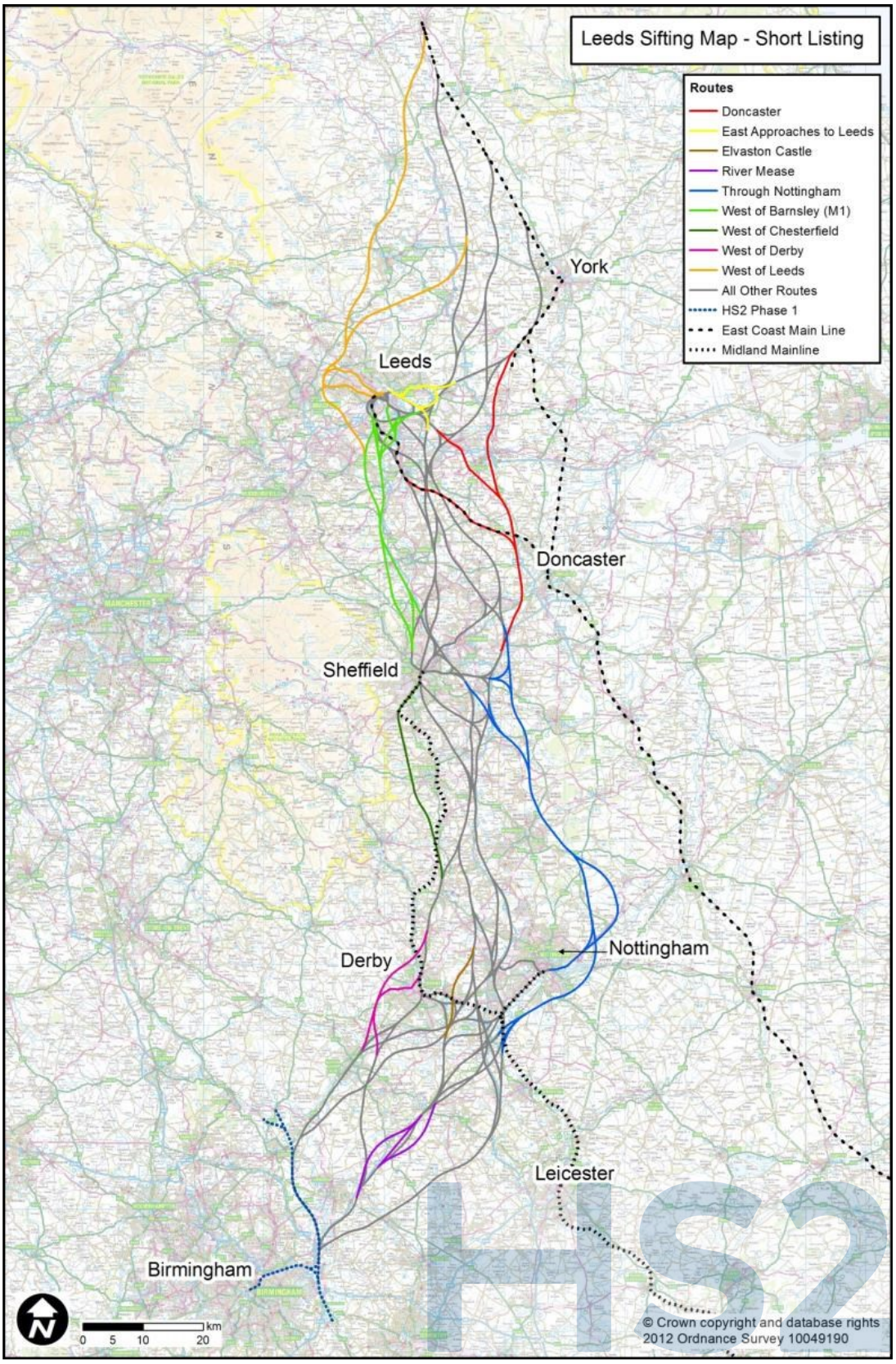
West of Leeds group

4.5.11 The group comprised routes to the west of Leeds that would run north to Northallerton, and north-east to east of Knaresborough, before joining the ECML connection group. The group also included spurs into Leeds following the existing conventional Pudsey or Wharfedale lines. The group would have required a substantial number of potential residential demolitions and a substantial number of properties would have experienced noise impacts, particularly on the western side of Leeds. The group would have had direct impacts on a large number of Grade II listed structures, predominantly on the western side of Leeds, and would have crossed a SSSI twice (Leeds and Liverpool Canal). The routes into Leeds from the west would be through challenging topography, were substantially longer and would have had a greater journey time compared to other groups. In addition, routes to the west of Leeds would also not serve York or have the opportunity to connect with the ECML further south. For these reasons, it was therefore decided not to develop the route options to the west of Leeds beyond this stage.

East approaches to Leeds group

4.5.12 The group comprised two spur options into an east facing Leeds Station. The group would have had a direct impact on one Grade II registered park and garden (Temple Newsam) and indirect impacts on several listed structures in Leeds (Grade I, II* and II). As a result of the decision taken not to develop the Leeds city centre station option to the east, the development of eastern route options into Leeds at this stage was not progressed.

Figure 18: Leeds route short listing options



Leeds routes – options for further refinement

4.5.13 Following the initial short listing and grouping of route options it was possible to further refine and regroup the options for progression through the options appraisal process. A high level commentary of these options is provided below and illustrated on Figure 19.

Lichfield connection group

4.5.14 The group comprised three routes connecting Water Orton with south Derby, via Burton upon Trent and Swadlincote. The two most westerly options would have required some residential demolitions and would have led to noise impacts at Burton upon Trent as they ran along existing rail corridor. They would also have had a direct impact on three scheduled monuments. Mitigation would have been difficult due to the size of the scheduled monument designation and the proximity of the A38 and Burton upon Trent. The group would have crossed and potentially required works to the River Trent, Trent and Mersey Canal, and River Dove and led to a potential noise impact on the National Memorial Arboretum. In addition, these options would result in difficult constructability issues along the railway corridor through Burton and have a potentially significant impact on Hints. The route which diverged to the north-east would have had a direct impact on two further scheduled monuments (Bretby Castle Fortified Manor and settlement sites north-east of Sittles Farm), Bretby Hall Grade II Registered Park and Garden, and would have crossed the River Mease SAC/SSSI at Croxall.

4.5.15 Considering the route options for serving Derby, the option that would follow the A38 from Lichfield along the existing conventional railway corridor through Burton-upon-Trent was not taken forward. This would have served as an alternative to following the M42/A42 corridor. This option would result in difficult constructability issues along the railway corridor through Burton-upon-Trent and have a potentially significant impact on Hints. This option would also have a potential noise impact on the National Memorial Arboretum. The decision not to take forward this option meant that there was no option for serving central Derby which would avoid the River Mease SAC/SSSI.

East of Coalville group

4.5.16 This group formed the most eastern route corridor between Water Orton and Nottingham. The routes would diverge north, to the east of Coalville, and would follow the M1 to the south-east of Nottingham. The group would have had direct impacts on two Grade II registered parks and gardens (Garendon and Whatton House) and four scheduled monuments. Opportunities for mitigation would have been limited due to the proximity of existing transport corridors. The group would have crossed the Ashby Canal SSSI, the River Derwent and River Trent, which may have required works as a result. The group may have also had indirect impacts on a large number of SSSI. This group of routes would pass through hilly terrain in this area requiring a large number of tunnels, embankments and cuttings as well as steep gradients and complex motorway crossings. In addition, passing to the east of Coalville would add to the overall length of the route and have a journey time impact. This group of routes was not taken forward beyond this stage.

Spurs into Derby and Nottingham

4.5.17 The two spurs into Derby would have approached the city from the west, via Borrowash and Spondon. Both spurs would have had a direct impact on Elvaston Castle Grade II* Registered Park and Garden, although the impact from the more northerly spur would have been greater. Both spurs into Derby would also have resulted in multiple crossings of the River Derwent, high noise impacts, and residential demolitions. However, the more southerly spur would have resulted in a higher number of residential demolitions (as the route would not have followed an existing conventional rail corridor).

4.5.18 The Nottingham spurs comprised:

- a sub group of two routes which would converge at Beeston (to approach Nottingham from the south-west);
- a delta junction at Aston-on-Trent (would also converge with the Beeston group to approach Nottingham from the south-west); and
- a spur from Trowell (approaching Nottingham from the west).

4.5.19 The Beeston sub group and the delta junction would have had direct impacts on two SSSI (Lockington Marshes and Attenborough Gravel Pits) and have required a major crossing of the River Trent. The Trowell spur would have crossed a conservation area at Attenborough and have required a significant number of residential demolitions. The spur would also have had a direct impact on one scheduled monument (Iron Age settlement and cursus).

4.5.20 The spur options would be costly to construct due to the additional length of route that would require construction and would result in substantial disruption to the existing conventional railways. They would also provide little journey time benefit compared to through route options. The time penalty for passengers heading northwards would also be significant. In addition, both the spur to Derby and the spur to Nottingham would have a high number of potential demolitions with the spur options to Nottingham incurring substantial additional cost. For these reasons, this group was not taken forward beyond this stage.

East of Bolsover

4.5.21 The group comprised one route from south-west of Kirkby in Ashfield to Killamarsh via Bolsover that would pass on the eastern side of Hardwick Hall. The group would run through Annesley Woodhouse SSSI (on the western edge) and adjacent to Bogs Farm Quarry SSSI. It would have been difficult to avoid the SSSI due to the proximity of the M1 and the town of Selston. The group would have also required residential demolitions at Killamarsh.

Nottingham Derby gap group

4.5.22 The group comprised three routes through the Nottingham and Derby gap between Ashby-de-la-Zouch and Heanor/Eastwood. The group would have had a direct impact on Elvaston Castle Grade II* Registered Park and Garden, which would have been difficult to avoid given the proximity of Ambaston and other villages. There would also

have been an impact on Shipley Country Park, the associated surrounding ancient woodland and a conservation area, and a direct impact on Carnfield Hall Conservation Area and Carnfield Hall Ancient Woodland. Opportunities for mitigation at Shipley and Carnfield would have been limited due to the proximity of the motorway and neighbouring towns. The group would have also crossed the River Derwent and the River Trent.

4.5.23 A number of routes that would effectively serve stations in the area between Derby and Nottingham were considered. These routes offered the fastest journey times. However, the decision not to take forward the associated stations at Breaston, Lockington and Draycott, with the concern about developing through this sensitive area, meant that these routes were not taken forward.

North of Nottingham group

4.5.24 The group comprised one route that would run north of Toton and Nottingham, connecting Stapleford with south-west of Kirkby. The group would have had a direct impact on one scheduled monument (Beauvale Carthusian Priory), surrounding ancient woodland, a BAP habitat, and one SSSI (Bogs Farm Quarry). The group would have also required several crossings of the River Erewash (between Stapleford and Eastwood). Residential properties would have experienced noise impacts at Eastwood, Kimberley, Ilkeston and Awsworth.

Serving Sheffield

4.5.25 The group comprised routes into Sheffield, serving Sheffield Midland Station and Sheffield Victoria Station. The group would approach Sheffield from west of Bolsover in the south, departing Sheffield and would run north towards the east of Barnsley, largely in tunnel.

4.5.26 The group would have given rise to landscape and visual impacts and would have affected the setting of a scheduled monument and several listed structures at Sutton Scarsdale and had a direct impact on a conservation area. The group would have also had a direct impact on large areas of ancient woodland and multiple BAP habitats. The more easterly route (via Eckington) would have had a greater impact, directly crossing Moss Valley SSSI and a direct impact on number of listed structures. The routes through Sheffield Midland Station would have required residential demolitions on the northern approach to the station.

4.5.27 The Sheffield Victoria Station loop would have required residential demolitions at Darnall, and would have had a direct impact on a SSSI at Neepsend Railway Cutting.

East of Rotherham group

4.5.28 The group comprised long routes that would extend from west of Bolsover in the south and would closely follow the M18 to Bramley where the route would split east and west of Mexborough and continue north to Normanton. The group also comprised a delta junction into Sheffield at Aughton. Both routes, east and west of Mexborough, would have had indirect impacts on a scheduled monument and several listed structures at Sutton Scarsdale, and a direct impact on a conservation area. Residential properties would have experienced noise impacts at Bramley (where the route would have been in cutting) and in Swinton and Mexborough. In addition,

the route west of Mexborough would have had potential hydrological impacts at Wintersett Reservoir.

Wakefield tunnel group

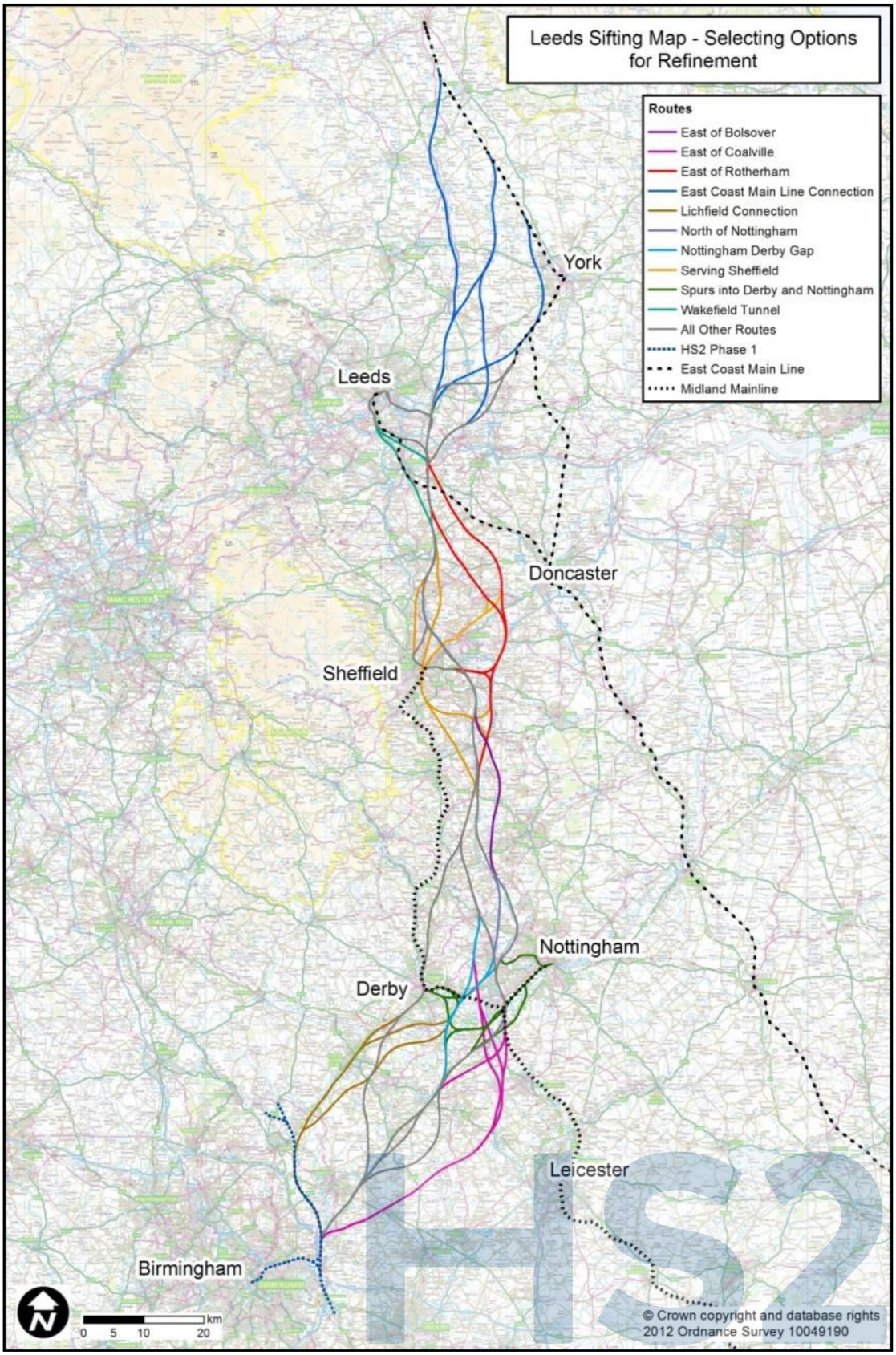
4.5.29 The group comprised two routes that would approach Leeds from the south-west, both predominantly in tunnel. The northern route would be mainly on embankment and viaduct around Stanley. This would have required residential demolitions at Stanley Ferry, crossing and possible diversion of the River Calder, and would have had landscape and visual impacts. The southern route would have had impacts on a number of Grade II listed structures, and would have affected the setting of Grade I and a Grade II* listed structures.

ECML connection group

4.5.30 The group comprised four route options north of Leeds, each would connect into the ECML at different points to the west and north-west of York. The group would have had landscape and visual impacts on Woodlesford and Swillington, and for users of the Trans Pennine Trail and Aire and Calder Navigation Canal. In addition, the group would have had impacts on a Grade I registered park and garden (Bramham Park) and surrounding ancient woodland, and on the settings of a number of battlefields (including Boroughbridge, Marston Moor and Towton). It may also have required the diversion of the River Nidd, would have an impact on areas of high tranquillity (Bolton Percy and outside of Linton-on-Ouse and Tholthorpe) and on several scheduled monuments including a Roman Fort at Boroughbridge, Aberford Dyke, and a cluster of Roman structures west of Newton Kyme.

4.5.31 Having considered these options, a further five potential connections all at more southerly points were identified. The most southerly connection was at Normanton, the next at Castleford, followed by Church Fenton, an option which bypassed Church Fenton and Colton Junction. Connecting too far south would have a substantial journey time penalty to services to York and beyond of between nine and 15 minutes. These options would also require substantial works to the existing rail network as this is a heavily used freight line with some passenger services. One option from this group, with a connection point at Church Fenton, was taken forward on the basis of it offering a reasonable journey time saving for services northwards at a proportionate cost.

Figure 19: Leeds route options for further refinement



Route to Leeds – route corridor appraisal

4.5.32 Based on the initial options appraisal undertaken (described above) prior to the establishment of the 2013 initial preferred scheme, the eastern leg to Leeds could be split into four broad geographical sections, within which different reasonable alternative route corridor options were considered: Derby and Nottingham, South Yorkshire, Leeds city centre and ECML connection. These route sections and the corridors are considered in the *Options for Phase Two – appraisal of sustainability report* (2012) and are shown in Figure 20.

4.5.33 The Derby and Nottingham corridors would run between Birchmoor in the south and Killamarsh or Tibshelf in the north. In broad terms, this section contained a corridor to the west to serve a high speed station in Derby city centre and a corridor to the east which would serve a high speed station at Toton to the south-west of Nottingham. The eastern corridor in this section had several alternative route options which are discussed further below.

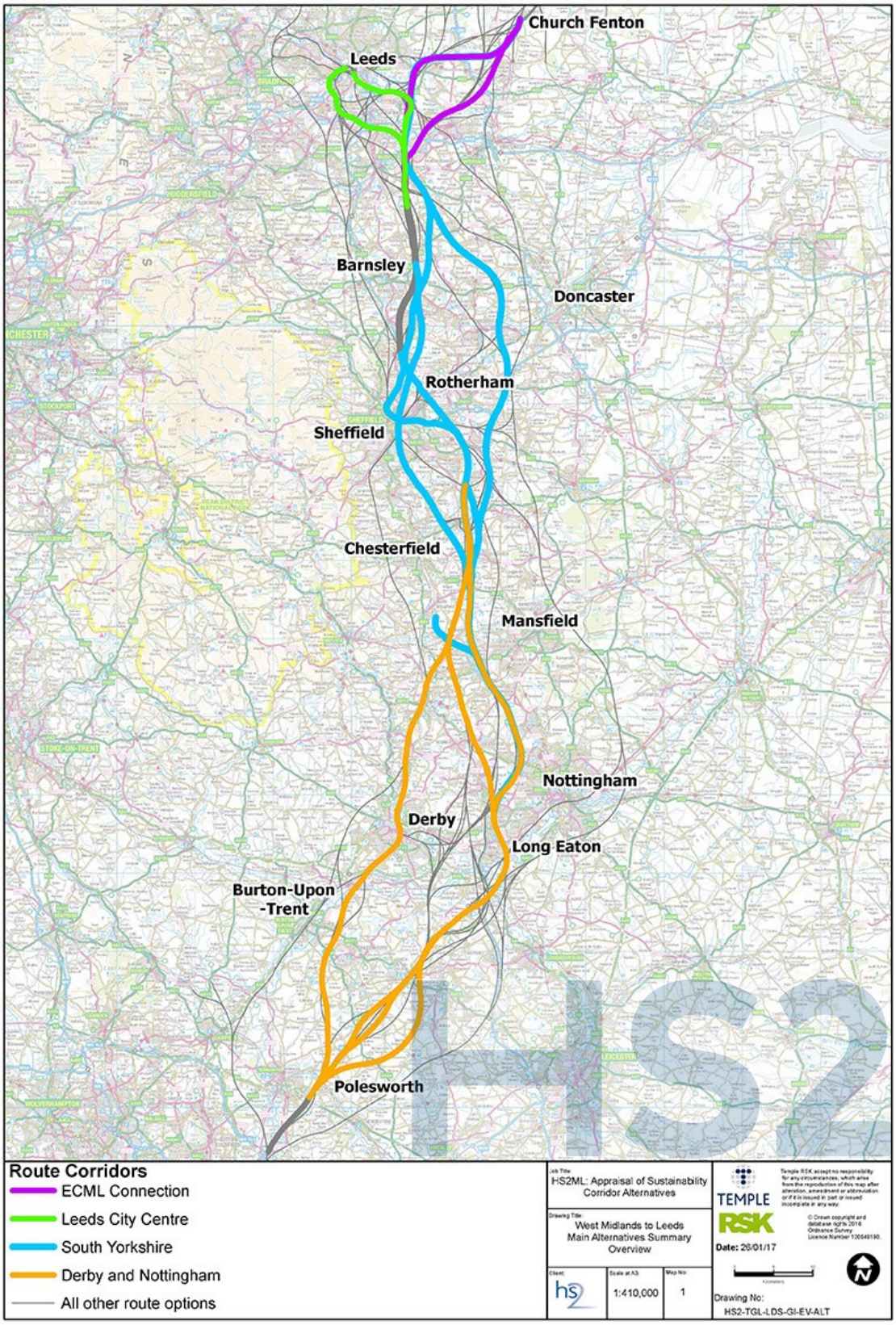
4.5.34 The South Yorkshire route corridor options would run within the geographical section between Kirkby in Ashfield in the south and Altofts in the north. Corridor options within in this section extended as far west as Sheffield and as far east as the M18 corridor near Bramley.

4.5.35 The Leeds city centre corridor options would run broadly within the geographical section between Wakefield and Leeds city centre, offering station approaches from the west, east and south.

4.5.36 The ECML connection corridor options would run within the geographical section north of Altofts to the ECML connection at Church Fenton via corridors as far north as the M1 north of Garforth.

4.5.37 On the eastern leg to Leeds there would be an approximately 11km long common route section from Phase One at Water Orton, which would follow the M42 corridor, to Birchmoor. This section would require a central elevated section for several kilometres in order to cross the River Tame, Kingsbury Water Park, the A51, the Birmingham to Derby Railway, and the M42.

Figure 20: Eastern route options for the 2013 initial preferred route



Derby and Nottingham corridors

4.5.38 Between Birmingham and Sheffield, there were two main route corridors through the East Midlands. The corridor options are described within the *Options for Phase Two – appraisal of sustainability report* (2012) and are shown in Figure 21 below.

4.5.39 The corridor via Derby would run from the east of Tamworth following the M42 corridor, and would cross the motorway, the River Anker and the River Mease on viaduct, before passing between Swadlincote and Burton-upon-Trent. It would curve eastwards and would cross the River Trent and Trent and Mersey Canal on viaduct, until picking up the Birmingham to Derby Railway leading to the outskirts of Derby. The route would continue to follow the existing conventional rail into Derby Midland Station. To the north of the station, the route would continue over the River Derwent and the A61 before crossing the rivers north of Alfreton and the Erewash Valley Line (Nottingham to Sheffield railway) east of Stonebroom on viaducts and finishing north of Tibshelf.

4.5.40 The corridor via Nottingham would broadly follow the M42/ A42 until Measham/Ashby-de-la-Zouch, where it would diverge from the M42 for approximately 2.3km and would continue north to pass through a high speed interchange station at Toton. North of Toton, this route corridor would either follow the Erewash Valley or the M1 corridor. The selection of the preferred corridor north of Toton is described further below in this section.

East Midlands station

4.5.41 In evaluating the route corridors between Birmingham and Sheffield, HS2 Ltd considered a number of station options for serving the East Midlands. Two reasonable station options were identified by 2012, one in Derby and one on the outskirts of the Nottingham urban area at Toton, referred to as the East Midlands Hub station. The site in Derby would be located at the existing Derby Midland Station.

4.5.42 The high speed station at Toton would be situated within the Erewash Valley on the eastern part of the existing Toton railway sidings, which form part of Toton Yard (an existing rail freight and logistics facility).

4.5.43 The station option at Derby would be accessed by high speed trains using existing conventional rail corridors into Derby Midland Station. Existing conventional rail lines would need to be realigned within the existing rail corridor and Derby Midland Station would need to be rebuilt immediately to the east of its current location. The station at Toton would also be accessed via existing rail corridors and would similarly require substantial reconfiguration of existing conventional rail infrastructure.

4.5.44 A station at Derby would serve the immediate city centre catchment area, but not the wider East Midlands region. The East Midlands Hub station, by comparison, would be better placed to serve the wider region and would attract greater passenger numbers. Given its proximity to the M1 and existing conventional railway and tram connections, a high speed station at Toton would facilitate interchange with other transport modes.

Selection of the Nottingham corridor and the East Midlands Hub station at Toton

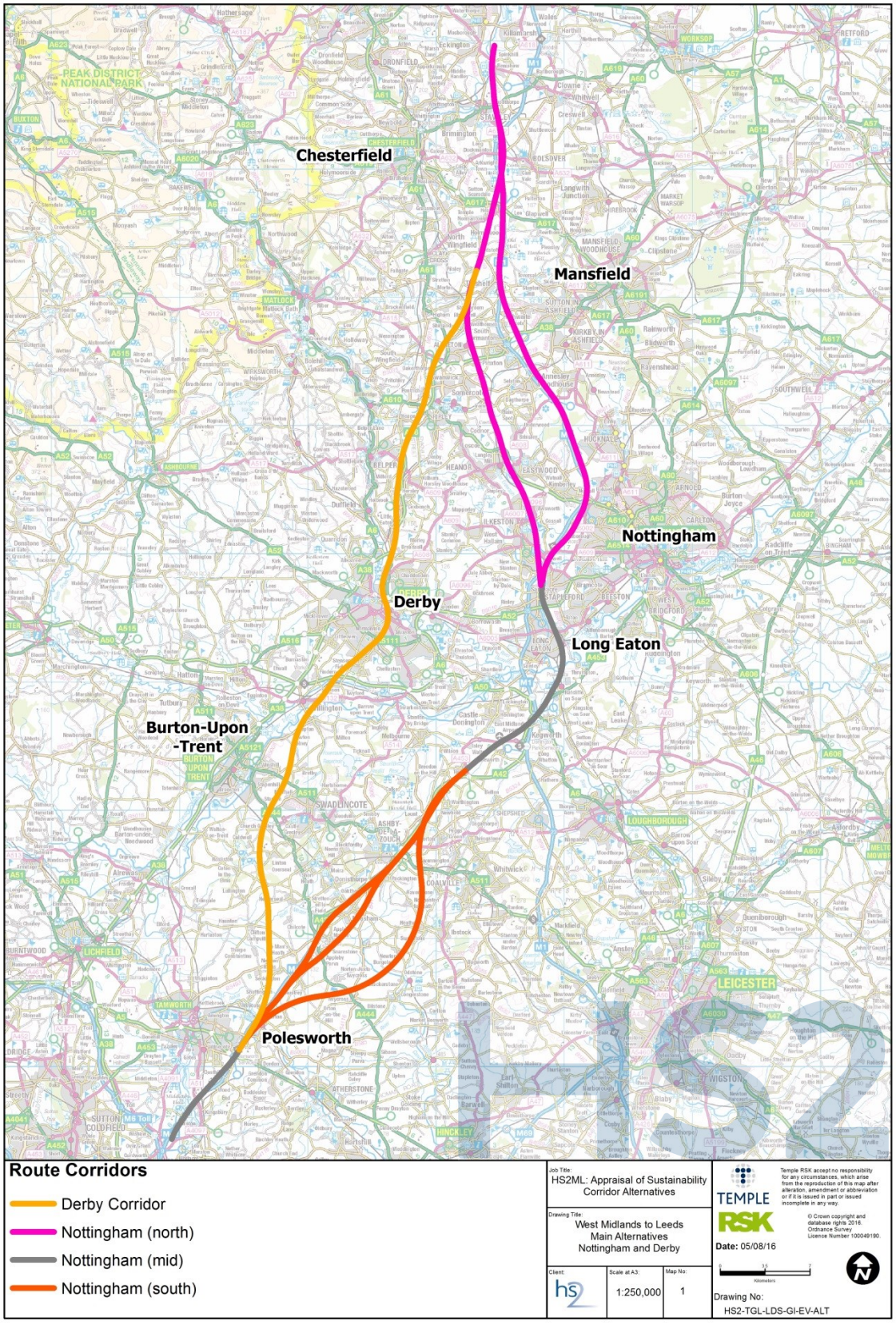
4.5.45 As described in *High speed rail: investing in Britain's future – Phase Two report* (2013), the Government's preference for a station serving the East Midlands region was to construct a new high speed station on existing railway land in the south-western suburbs of Nottingham. The rationale was based on a station in this location could be readily accessible by public transport from both Derby and Nottingham but also from much of the wider East Midlands region.

4.5.46 The station at Toton would be located alongside the existing conventional rail network and would incorporate platforms to accommodate potential connecting rail services from across the East Midlands. The integrated high speed and conventional rail station would mean that passengers would be able to benefit from quick and efficient interchanges.

4.5.47 The proximity of the Toton site to the A52 also offers the possibility of good connectivity by local bus to a range of destinations in the Derby, Nottingham and Erewash Valley areas. In addition, the proximity to junction 25 of the M1 offers the potential for a range of regional coach feeder services to operate to the station.

4.5.48 For these reasons, the route corridor via Nottingham was selected and the corridor via Derby was not progressed further. Having selected the route option via Nottingham, the corridor was further refined to select the most appropriate route to cross the River Mease SAC/SSSI and the most appropriate route between Toton and South Yorkshire. The selection of the preferred route is described in the following sections.

Figure 21: Derby and Nottingham corridors



Nottingham corridor - crossing the River Mease SAC

4.5.49 The River Mease SAC stretches from the village of Packington, south of Ashby-de-la-Zouch, to just north of Croxall, a village north-east of Lichfield. Within the Nottingham corridor between Birchmoor and Tonge, two route section alternatives were evaluated as options to cross the River Mease SAC and one was designed specifically to avoid the SAC. The west of Measham option would run broadly parallel to the A42 corridor and would pass Measham to the west where it would cross the River Mease SAC. The east of Measham option would pass Measham to the east where it would cross the River Mease SAC and then rejoin the A42 corridor at Packington.

4.5.50 The River Mease SAC avoiding option would run approximately 6km from the A42 to avoid crossing the River Mease SAC, but would instead cross the Ashby Canal SSSI to the west of Shackerstone. The east of Measham option would require the least number of overall property demolitions of the three options, while the River Mease SAC avoiding option would require the most. However, the east of Measham option would generate the greatest potential noise impacts. All three options would generate indirect impacts on the setting of conservation areas, but the River Mease SAC avoiding option would also cross over the Ashby Canal (a conservation area) on viaduct. In terms of ecology, all three options would have the potential to indirectly affect two SSSI as a result of bird strike. All three options would also give rise to air quality impacts during construction. The River Mease SAC avoiding option would also cross over the Ashby Canal SSSI with the potential for impacts as a result of shading.

Selection of the preferred option to cross the River Mease SAC

4.5.51 A study to inform the Habitats Regulations Assessment (HRA)[41] was undertaken for the River Mease SAC in 2012. This was undertaken in consultation with Natural England and the Environment Agency. The HRA screening report concluded that there was a potential significant effect on the SAC due to shading of the river caused by crossing the SAC on viaduct. A draft Appropriate Assessment was then undertaken, which included a detailed study of shading impacts on the river habitats. This concluded there would be no adverse effects on the River Mease SAC arising from the construction or operation of the Proposed Scheme. HS2 Ltd will continue to consult with these bodies (and other relevant key stakeholders) as the design develops to ensure that the submitted design in the hybrid Bill and its construction comply with the Habitats Regulations 2017[42]. Where required, further assessment will be undertaken and an appropriate design will be developed through an iterative process. Any studies to inform the required assessments will be completed and the outcomes agreed with Natural England prior to submission of the hybrid Bill.

4.5.52 The route to the west of Measham was considered more favourably than the other options and was taken forward for consultation in 2013/2014 as it would cross a narrow part of the floodplain and would take a more direct crossing of the river requiring a shorter viaduct structure. It would also follow an existing transport corridor

[41] HS2 (2012) *HRA Screening Report for the River Mease SAC*
[42] The Conservation of Habitats and Species Regulations 2017 (S.I. 2017 No.1012) London, Her Majesty's Stationery Office. Available online at: http://www.legislation.gov.uk/uksi/2017/1012/made

more closely and would island less land and fewer communities. The east of Measham option, by comparison, would likely affect a larger number of people with noise and would also result in more communities being islanded between the HS2 main line and the motorway corridor. Beyond this, the routes were otherwise comparable. The River Mease SAC avoiding option, while avoiding the SAC designation directly, would have the greatest sustainability impacts and would directly affect BAP habitats, ancient woodlands and a conservation area.

Nottingham corridor - route options to the north of Nottingham

4.5.53 Beyond Tonge, the route corridor via Toton would pass north-east in tunnel under East Midlands Airport and on a bridge over the M1, before crossing the River Soar and River Trent on long viaduct sections. It would enter Long Eaton where it would run within the existing Erewash Valley Line railway corridor.

4.5.54 Two alternative routes were considered north of Toton; an eastern route and a western route to Killamarsh, which are shown in Figure 22. The western route would run broadly alongside the Erewash Valley Line before running parallel to the M1. The eastern route would largely follow the M1 corridor from the edge of Nottingham to Staveley. These routes are described in more detail below.

4.5.55 The western route via the Erewash Valley would run from the proposed high speed station at Toton. North of Tibshelf, the route would pass under the M1 at Stanton Gate before crossing the Erewash Canal and the River Erewash and its floodplain on viaduct. To the east of Ilkeston, the western route would pass between the piers of the Grade II* listed Bennerley Viaduct and would then pass onto a viaduct over the River Erewash and its floodplain.

4.5.56 Further north, the western route would return to ground level and would deviate from the existing conventional railway corridor to run alongside the A610. North of the A608 junction, the western route would run on viaduct to cross the River Erewash again, its floodplain and the disused Cromford Canal. The route would then cross over the Erewash Valley Line to its eastern side where the existing conventional rail line is in cutting on the approach to the existing Alfreton Tunnel before passing under the A38.

4.5.57 Continuing north, the western route would then briefly follow the Erewash Valley Line on its eastern side, rising to cross over the Normanton Brook and out of the Erewash Valley east of Pilsley. At Tibshelf, the route would travel north towards Killamarsh and would rejoin a common route via the M1 corridor.

4.5.58 The eastern route via the M1 corridor would be broadly the same as the route via the Erewash Valley as far as Toton. North of Toton, the route would pass to the west of Astwith, emerging from cutting at the northern fringe of the village. A series of embankments and viaducts would follow before the route would pass under the A6175, through a cut and cover tunnel, and would emerge north of the A617 and north-west of the village of Heath. The eastern route would continue to the east of Sutton Scarsdale before crossing over to the east of the M1. The route would then run broadly at ground level past the Markham Vale Environment Centre.

4.5.59 The eastern route would again cross over the M1 to its western side. Further north, this route would be on a viaduct to cross over the River Doe Lea and its floodplain and the A619 before the route would pass to the west of Renishaw. The route would rise to cross over the River Rother and floodplain on a viaduct.

Selection of the preferred option between the East Midlands Hub station and South Yorkshire

4.5.60 As described in *High speed rail: investing in Britain's future – Phase Two report* (2013), the Government's 2013 initial preferred route was via the M1. The route option to serve Sheffield Meadowhall via the M1 was (after taking account of potential mitigation) of comparable cost to the alternative Erewash Valley option. However, the latter posed greater risk in terms of capital and maintenance costs, and programme with regards to mining issues and historic landfills. The Erewash Valley route also performed less favourably in terms of sustainability, including potentially higher noise impacts than the M1 route.

Summary of sustainability impacts

4.5.61 Table 2 summarises the sustainability impacts of route corridors through Nottingham via either the M1 or Erewash Valley corridors. The key sustainability constraints are shown on the route comparison map (Figure 22), together with the route sections compared for this appraisal as described within the *Options for Phase Two – appraisal of sustainability report* (2012).

4.5.62 The western route via the Erewash Valley would have a greater community impact than the M1 route, which would pass much closer to large urban areas including Ilkeston, Eastwood, Langley Mill, Somercote and Alfreton. Additionally, landscape impacts would likely to be major and disruptive in the Erewash Valley.

4.5.63 The choice between routes was also partly influenced by potential impacts on Hardwick Hall (National Trust and English Heritage properties and listed structures, Grade I registered park and garden). Both routes would have an impact on the setting of Hardwick Hall, the associated National Trust land, Sutton Scarsdale and Bolsover Castle. Despite being substantially closer to Hardwick Hall, the eastern route would have less of an overall impact due to its close proximity to the motorway and its setting lower in the landscape. The eastern route would follow the M1, reducing its overall visual impact from Hardwick Hall, and at the same time, would have less of an impact on the National Trust land. Despite the Erewash Valley route being over approximately 2km from Hardwick Hall, the impact would be greater due to the route forming a new transport corridor within the landscape on viaducts over approximately 30m high that would result in visual impacts and fragmentation of the National Trust land.

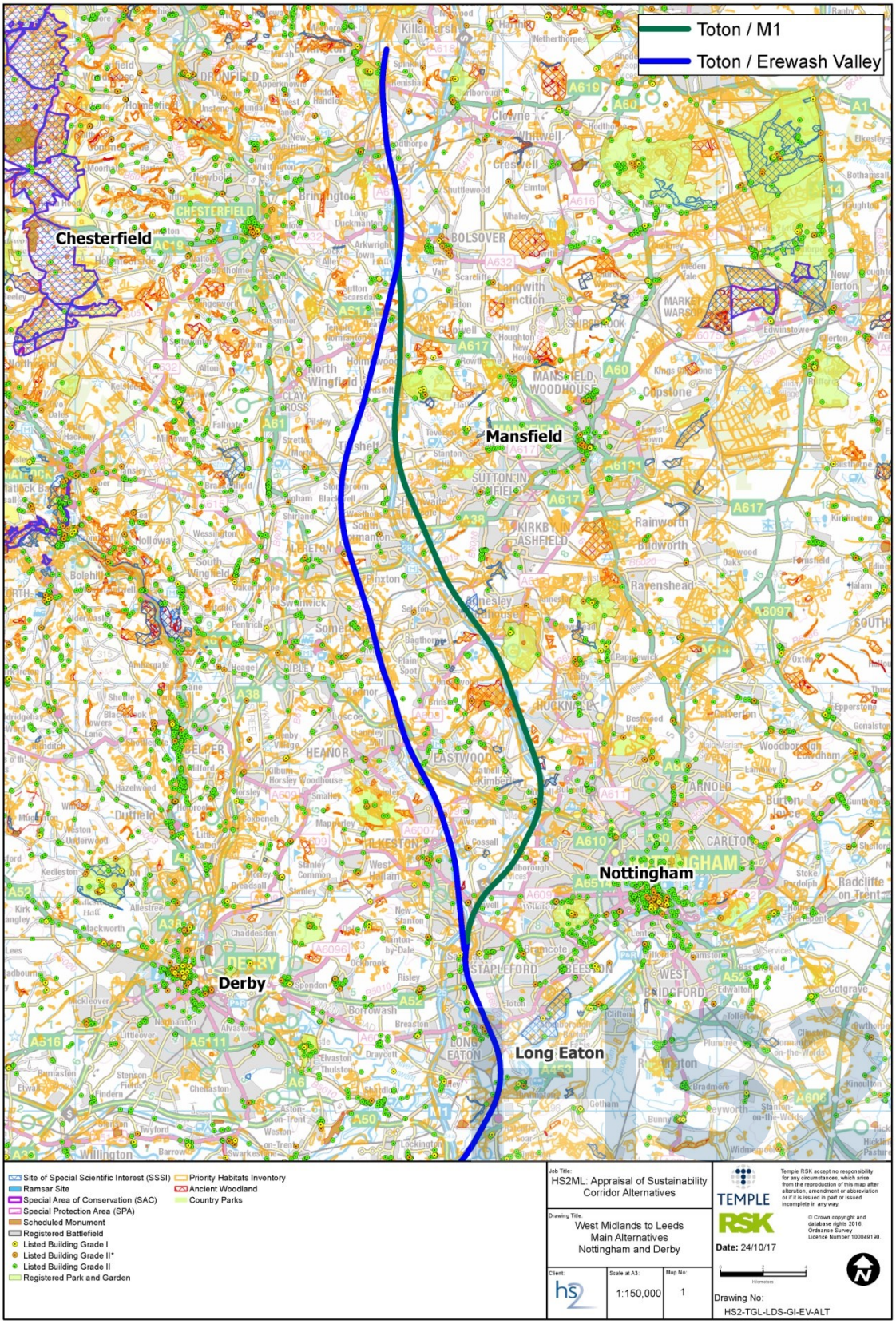
4.5.64 The Erewash Valley route would have greater noise impacts (more than double) than that of the M1 alternative. The Erewash Valley route would also potentially require a total of five major river diversions (three of the River Erewash, one of the River Doe Lea and one of the River Rother), as well as three diversions of the Erewash Canal, compared to two major river diversions for the M1 route. The Erewash Valley route would also directly affect nine landfills compared to one landfill for the M1 route option.

4.5.65 Another factor between the two options was cost. The western route option via the Erewash Valley would cost substantially less to construct than the more complicated eastern route via the M1 corridor. However, the sustainability issues associated with the western route, particularly the terrain it would run through, would necessitate extensive mitigation to reduce impacts on people and heritage assets. There was also added risk of passing through a greater number of landfill sites. Therefore, it is likely that the requirement for additional mitigation on the western route would potentially lead to both route options ultimately being of a similar cost.

Table 2: Routes north of Nottingham via Erewash Valley and via M1 corridors comparison table

	Nottingham corridor via the Erewash Valley	**Nottingham corridor via the M1 corridor**
Property and Community Integrity	Demolitions (approximately) 15 residential 27 commercial **Approximate Total: 42**	Demolitions (approximately) 39 residential 17 commercial **Approximate Total: 56**
Noise (annoyance)	Approximately 4,312	Approximately 1,486
Key sustainability impacts (direct)	Nine landfill sites Two Grade II* listed buildings (Bennerley Viaduct, which has two listings) Three Grade II (Hallam Fields Lock, Hallam Fields Bridge, Lock to Cromford Canal) National Trust land intersected (Hardwick Hall) One Grade II* registered park and garden (Renishaw Hall) Eight conservation areas (Sandiacre Cloud Side, Langley Mill Great Northern Basin, Carnfield Hall, Astwith, Hardstoft, Heath, Sutton Scarsdale, Eckington and Renishaw) Four BAP habitats Three ancient woodlands Five major river diversions (River Erewash x3, River Doe Lea and River Rother)	One landfill site One Grade II listed building (ruins of Health Old Church) National Trust land intersected (Hardwick Hall) One Grade II* registered park and garden (Renishaw Hall) Two SSSI (Bulwell Wood, Bogs Farm Quarry) Three conservation areas (Stainsby, Strelley, Eckington and Renishaw) Six BAP habitats Three ancient woodlands Two major river diversions (River Doe Lea and River Rother)

Figure 22: Nottingham routes via Erewash Valley and M1 corridors (2013) comparison map



Further refinement of the preferred option between the East Midlands Hub station and South Yorkshire

4.5.66 The Erewash Valley corridor was revisited following the 2013/2014 public consultation and updates to design standards. This appraisal sought to determine if there was an alternative route through the Erewash Valley compared to a route via the M1 corridor. The refinement options responded to concerns raised during consultation that a route via the Erewash Valley may be preferable as it would avoid the complexities associated with landfills and mining that would be encountered along the route via the M1 corridor. A total of four options were proposed, all of which were progressed to full sift. The key sustainability constraints are shown on the route comparison map (Figure 23), together with the route sections compared for this appraisal.

4.5.67 Option 00 would run to the east of Stapleford, then alongside the M1 (on its eastern side) until it would cross underneath the motorway at Tibshelf. From here, the route would cross the M1 and would follow the western side of the motorway past Hardwick Hall and Heath, before once again crossing back over the M1 and would then run to the west of Bolsover, ending in Markham Vale, to the south-east of Staveley. Option 00 would cross the operational Erin landfill site, the Blackwell Tip (partly crossed on viaduct) and a deep cutting through Markham Vale Tip north-west of Bolsover.

4.5.68 Option 01 would be to the west of Option 00, to the west of Stapleford, and would cross both the M1 and the Erewash Valley on viaduct. The route would be predominantly on viaduct to the east of Ilkeston and west of Eastwood. Option 01 would leave the Erewash Valley at Ironville, would pass east of Somercote, then through Clover Nook Industrial Estate in cutting, then under the A38 and through Charnfield Hall Conservation Area. Option 01 would continue north, to the west of Blackwell and between Stonebroom and Tibshelf, before heading north-west, passing Pilsley and Hardstoft, then Heath Conservation Area and the A617 in tunnel. It would then cross Sutton Scarsdale Conservation Area before passing over the M1 and rejoining the route of Option 00 west of Bolsover. Option 01 would cross the Erin landfill site and eight historic landfills (six sites crossed on viaduct).

4.5.69 Option 02 would be similar to Option 01 in that it would also branch to the west of Option 00, west of Stapleford, but would then follow the curve of the River Erewash (slightly to the east of Option 01) at a lower level and would then cross under the M1 in tunnel. Option 02 would then largely follow the route of Option 01, but at a lower level. Option 02 would cross Erin landfill site and six historic landfills (three sites crossed on viaduct).

4.5.70 Option 03 would be similar to Option 02 until where the route would reach the east of Somercote, where it would pass further to the east within Clover Nook Industrial Estate and within the Charnfield Hall Conservation Area, before the route would rejoin Option 02 (and Option 01) to the west of Tibshelf. Option 3 would cross Erin landfill site and four historic landfills (with two sites crossed on viaduct).

4.5.71 HS2 Ltd determined that Option 00 should be retained as the preferred option as, although Option 03 had reduced landfill impacts, Options 01, 02 and 03 had a higher cost risk range than Option 00 and did not performed as well from a sustainability perspective (partly due to the large number of diversions of the River Erewash that would be required, as well as landfill and mining risks).

4.5.72 The preferred option, Option 00, would have moderate landscape impacts, with localised major impacts. This option would also have direct impacts on Strelley Conservation Area, Stainsby Conservation Area and impacts on the setting of the Grade I listed Hardwick Hall Registered Park and Garden. Option 00 would also have a direct impact on Bogs Farm Quarry SSSI, which would have otherwise been avoided by Options 01, 02 and 03.

4.5.73 Option 01 would have major landscape and visual impacts on the conservation area in Sandiacre as a result of a large viaduct, deep cutting sections near Hardstoft and Astwith, and intrusive structures bisecting Carnfield Hall Conservation Area and between Stonebroom and Tibshelf. This option would intersect five conservation areas (Carnfield Hall, Heath, Astwith, Hardstoft and Sutton Scarsdale), the Erewash Meadows Nature Reserve and Carnfield Wood Ancient Woodland, Heath Wood and Owlcotes Wood. The Grade II* listed Bennerley Viaduct would also be affected, although there would be opportunity for this structure to be retained with suitable mitigation.

4.5.74 Option 02, similar to the preferred option, would have moderate to localised major landscape impacts. Compared to Option 00, this option would have increased impacts south of Eastwood where the route would diverge from the existing conventional rail corridor and would be on a long viaduct. This option would cross the five conservation areas and the Grade II* listed Bennerley Viaduct, which would also be affected by Option 01. A direct impact on Bogs Farm Quarry SSSI would be avoided by this option. However, three ancient woodlands would be directly affected (Carnfield Wood, Heath Wood and Owlcotes Wood).

4.5.75 Similar to the preferred option and Option 02, Option 03 would have moderate to localised major landscape impacts. As this option would follow a similar route to Option 02, this option would have increased landscape impacts when compared to the preferred route due to the long viaduct south of Eastwood. Option 03 would also have an impact on the same five conservation areas and the Grade II* listed Bennerley Viaduct affected by Options 01 and 02. This option would also avoid a direct impact on Bogs Farm Quarry SSSI, but would introduce impacts to the three ancient woodlands also affected by Option 02.

4.5.76 All options would require demolitions of residential dwellings, commercial and industrial premises. The preferred option would result in the greatest number of demolitions.

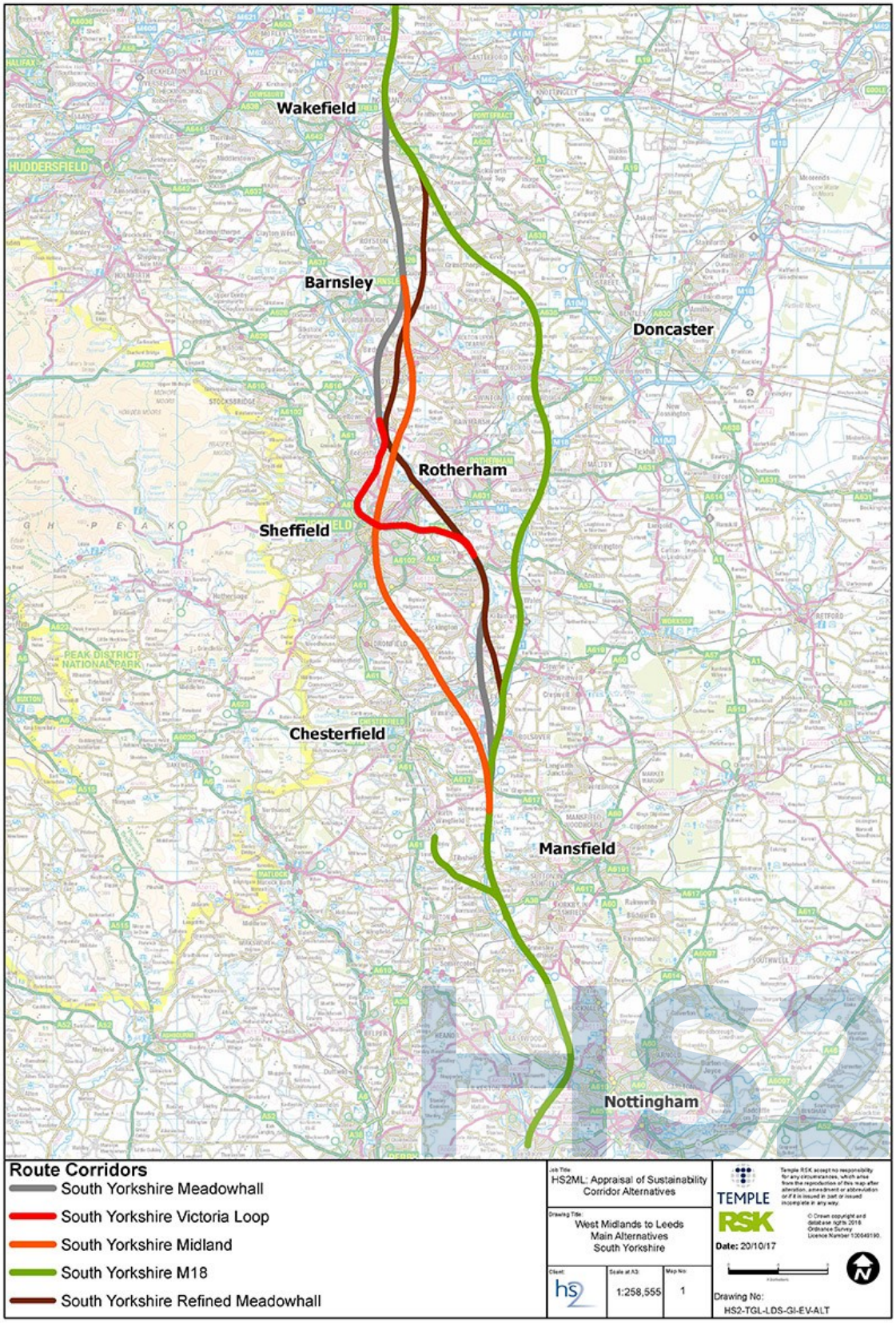
Figure 23: Nottingham routes via Erewash Valley and M1 corridors (following 2013/2014 consultation) comparison map

South Yorkshire corridors

4.5.77 Throughout the route development process, a number of corridors were explored to determine the optimal route through South Yorkshire, taking into consideration the location of a potential high speed station in the region. The route corridors considered as reasonable alternatives are shown in Figure 24.

4.5.78 These route corridors have been considered at various points throughout the route development process between 2010 and 2016. This section describes the consideration of these reasonable route corridor alternatives to the Proposed Scheme and the reasons they were not taken forward.

Figure 24: South Yorkshire reasonable route corridor options



Sheffield Victoria

4.5.79 The Sheffield Victoria route options would allow high speed trains to serve the currently disused Victoria Station, located on the north-east side of Sheffield city centre, to the north of the A61 inner ring road (Derek Dooley Way) and over the River Don and Sheffield and Tinsley Canal. Due to limited space, the platforms and tracks for high speed trains would be on a new viaduct above the existing viaduct. This would enable the new structure to be built without physically impacting the Grade II* Wicker Arch.

4.5.80 Options to serve Sheffield Victoria via a through route, a loop and a spur were considered.

4.5.81 The first of these corridors would see HS2 serve Sheffield Victoria as a main line station, with the entire HS2 main line routed through the high speed station. Whilst this option could deliver substantial benefits, particularly with some further investment to improve connectivity within Sheffield, the route through Sheffield would be significantly slower for all high speed trains to Newcastle, York and Leeds than other route corridors considered for serving this station[43].

4.5.82 The option of a spur following the Sheffield to Worksop Railway into Sheffield city centre was also considered with a Sheffield Victoria terminating station. The footprint for this route option would not impact on the west side of the Sheffield Victoria Station area compared to the through or loop variant. However, the spur option to Sheffield Victoria would not perform as well as the loop through Sheffield Victoria in terms of onward connectivity, as it would not facilitate the delivery of improved journey times from Sheffield northwards.

4.5.83 The loop option for serving Sheffield Victoria would also follow the corridor of the existing Sheffield to Worksop Railway into Sheffield. The high speed station and northern section of route would broadly be in line with those considered for the Sheffield Victoria through route options, albeit with the ability for trains not serving Sheffield to continue on the HS2 main line adjacent to the M1. North of Sheffield Victoria Station, the route would be in tunnel for approximately 4km to avoid the built-up area to the north of Sheffield.

4.5.84 At this stage of the design process, it was concluded that, whilst potentially having a greater impact than the spur and through route options, and having a greater cost, the best way to serve Sheffield Victoria would be on a loop to avoid substantial journey time impacts to markets further north, including Leeds.

4.5.85 When compared to the Proposed Scheme, the loop alternative via Sheffield Victoria (indicated on Figure 24) would cost substantially more as a result of, among other reasons, the considerable tunnel infrastructure that would be required. The loop option would also have significant sustainability impacts and would potentially conflict with a development site at Waverley. The potential economic benefits of a

[43] The Sheffield and South Yorkshire Report in July 2016 re-considered a Sheffield Victoria through route. However, this reached a similar view to previous work in concluding that this was not a viable option compared to other alternatives given the longer route and time penalties for markets further north, poor connectivity, highly constrained nature of the local area, disruption to rail services during construction, and cost.

city centre high speed station accessed by a loop option would not outweigh the additional costs.

Sheffield Midland

4.5.86 Four route options were assessed for accessing a high speed station at Sheffield Midland; a through route option, two loop options and a spur option with a terminus station. All the station options considered would require substantial construction works to the existing Sheffield Midland Station.

4.5.87 The through route option (indicated in orange on Figure 24) would require the entire Sheffield Midland Station and its approaches to be rebuilt with a tunnel required to the south of the station which would be at risk of flooding due to being within the floodplain of the River Sheaf and Porter Brook. There would potentially be major disruption at Sheffield Midland Station with this option and it was anticipated that it would entail a significant reduction in train services over several years during construction.

4.5.88 Two loop options for Sheffield Midland Station were assessed; one with a loop to the east and one with a loop to the west of the existing station. The loop option to the east would require realignment of the existing tram line and remodelling of platforms 7 and 8 within Sheffield Midland Station, which would necessitate the alteration of the Grade II listed elements of the existing station concourse. The loop option to the west would require the total remodelling of Sheffield Midland Station, including its listed concourse and approach tracks. This option would have similar impacts to the Sheffield Midland through route option, including potential flood risks and disruption to train services and passengers during construction.

4.5.89 A terminus station was also considered. The option for a terminus station, accessed via a spur, would be constructed to the east of Sheffield Midland Station. This would require realignment of the existing tram line and works to platform 8, and the concourse and entrance areas within the existing station. It would also require works to the station throats to the north and south of Sheffield Midland Station. The spur option would be less disruptive to Sheffield Midland Station and adjacent roads than the other options and have less impact on the floodplain. It would potentially require more demolitions of dwellings than the through option.

4.5.90 Despite the anticipated impacts as a result of its construction, it was considered that taking the entire route through Sheffield Midland Station would deliver the largest amount of benefits when compared to the Sheffield Midland loop and spur options.

4.5.91 In terms of local demand, Sheffield Midland Station would better serve the city centre and the south-west of South Yorkshire than the other options considered. Sheffield Midland Station would have the greatest potential for employment growth in the city centre. It could also support the aspiration set out by TfN for fast, frequent services between Sheffield and Leeds city centres.

4.5.92 However, topographical and urban density constraints along the route to, and around, Sheffield Midland Station would result in severe disruption, and therefore, substantial additional cost. In addition, construction of the HS2 main line to Sheffield city centre would require several sections of bored tunnel, adding to project costs and

engineering complexity. Works would also be required to the existing conventional rail and road infrastructure to the north of Sheffield Midland Station, potentially causing substantial disruption to rail and road users for several years.

4.5.93 It was estimated that building a new high speed line into Sheffield Midland Station and a high speed station would cost substantially more when compared to the other route corridors, and was therefore not considered further[44].

Provision of a new high speed station in Sheffield city centre

4.5.94 For the reasons set out above, serving Sheffield Midland Station directly with a through route, and constructing a loop to Sheffield Victoria from the HS2 main line adjacent to the M1, were not considered to perform better than other options and were therefore not taken forward for further consideration. The other main alternative that was considered was a route adjacent to the M1, with a station next to Meadowhall Shopping Centre. This was referred to as the refined Meadowhall route.

Refined Meadowhall route

4.5.95 In 2013/2014, HS2 Ltd consulted on a route through South Yorkshire which included a high speed station adjacent to the M1 at Meadowhall (referred to as the Meadowhall route, and shown in grey in Figure 24).

4.5.96 Following the 2013/2014 consultation, changes to the 2013 proposed scheme for consultation through South Yorkshire were made in two sections:

- the route would run further to the east past Bolsover and Markham Vale to avoid crossing landfill and development sites at Markham Vale. This would bring the route closer to Bolsover Castle, and included an alternative approach to the Staveley IMD. It would also enable the route to avoid the Chesterfield Canal restoration; and
- the route would run further to the east, north of Sheffield. This would avoid one of the tunnels that was proposed in the 2013 proposed scheme for consultation, reducing project cost and on balance, reducing sustainability impacts.

4.5.97 These refinements were presented to Government between 2015 and 2016. These individual refinements resulted in what was referred to as the 'refined Meadowhall route'. The route took an altered route through the region, but retained the previous proposition of serving the high speed station at Meadowhall.

4.5.98 The refined route via Meadowhall (indicated in brown on Figure 24) would run to the west of the M1 and north of Heath, before crossing the M1 towards Bolsover. The route would then pass back over the M1, where it would bear north-east, passing Mastin Moor to the east and continue north through the Rother Valley. The route would continue along the Rother Valley for several kilometres past Renishaw,

[44] The Sheffield and South Yorkshire Report in July 2016 re-considered a Sheffield Midland through route. This reached similar conclusions to our previous work, starting that, whilst Sheffield Midland station would better serve the main areas of demand in Sheffield city centre and to the south-west, and is well positioned to meet the NPR strategic ambitions, the construction of a new line into and out of the city would include several long tunnels to the south and multiple impacts on the city's existing railway and road infrastructure to the north. This work also concluded that serious issues with topography and urban density would result in severe disruption and additional cost.

Killamarsh and the south-eastern suburbs of Sheffield. Where the Rother Valley widens around Orgreave, the route would again follow the corridor of the M1 and would pass through the industrial corridor between Sheffield and Rotherham. This route would link to a high speed station at Meadowhall which would be elevated and located alongside the M1.

4.5.99 North of Meadowhall, the route would continue alongside the M1 before crossing north of junction 35, where it would continue to the east of Harley. The route would then pass beneath Hoyland in a tunnel and would continue northwards, east of Ardsley and Cudworth. The route would then continue towards the village of Crofton, passing to the east of the village, before continuing northwards towards Leeds and the ECML connection.

4.5.100 The refined Meadowhall route performed better in terms of costs and overall sustainability than the Meadowhall route presented in the 2013/2014 consultation. This route was therefore used for the comparison with the M18 / Eastern route.

M18 / Eastern route

4.5.101 The *Sheffield and South Yorkshire report* (2016) reviewed locations for the high speed station in South Yorkshire and how best to serve the region based on five factors. These factors included demand, the needs of Sheffield and the wider region, connectivity with the existing conventional rail network and wider transport, consideration of topography, urban density and environment, and consideration of cost.

4.5.102 The M18 / Eastern route (indicated in green in Figure 24) sought to address the issues of providing a high speed service to South Yorkshire, whilst maintaining the integrity of the service to Leeds, York and Newcastle by separating out the services to these destinations.

4.5.103 In order to serve Sheffield city centre, the M18 / Eastern route included a spur from the HS2 main line, south-east of junction 28 on the M1, connecting to the conventional rail network on the Erewash Valley Line. This spur would allow high speed conventional compatible trains to utilise the existing conventional railway lines to serve Sheffield Midland Station while enabling trains to continue to run along the HS2 main line to serve Leeds and other destinations further north.

4.5.104 The advantage of this approach would be that demand would be met within and around Sheffield city centre without affecting services to the areas of greater demand further north in Leeds, York and Newcastle. Connectivity to the wider South Yorkshire region would also be improved by utilising the existing conventional rail network allowing easy interchange in Sheffield with regional rail services. This option also opened up the possibility of serving Chesterfield with HS2 services.

4.5.105 The use of Sheffield Midland Station for high speed services also opened up the possibility of running high speed trains from Sheffield to Leeds via a link north of Sheffield Midland Station to the HS2 main line. This link would support the Northern Powerhouse Rail project ambition for a frequent 30 minute journey time between Leeds and Sheffield city centres.

4.5.106 Use of the existing conventional rail network would also avoid many of the cost and environmental impacts associated with the construction of a new HS2 main line and new high speed station in an urban area. Heading north from Hilcote, the M18/Eastern route would pass to the east of Sutton-in-Ashfield, before crossing under the M1 in a cut and cover tunnel. It would closely follow the western side of the M1 and would pass the Grade I registered park and garden, scheduled monument and listed buildings at Hardwick Hall and the scheduled monument at Stainsby. Modification to the M1 and some of its junctions may be required at certain locations.

4.5.107 The route would continue alongside the M1 and would cross over the motorway, and would then run east near Bolsover. The route would diverge briefly from the M1 before crossing the motorway once again and then following the motorway on its west side past Barlborough.

4.5.108 The route would continue north and would diverge briefly from the M1 at Woodall and then again near Aston, before crossing the junction of the M1 and M18 on viaduct near Thurcroft. Continuing to the western side of the M18, the route would pass between Bramley and Hellaby and would diverge north away from the M18 towards Conisbrough Park. The route would pass between Mexborough and Conisbrough over the A6023 and to the east of Barnburgh. North of Barnburgh, the route would head in a north-west direction passing near Clayton, Frickley, South Kirby and Hemsworth. A RSD was proposed east of Wakefield, south of Crofton, on former industrial land adjacent to the exiting conventional railway line. Access to the RSD from the HS2 main line would be via a flyover junction that would pass underneath the HS2 main line to the south-east of Crofton. Following consultation in July 2017, the RSD to the south-east of Crofton was moved to a location to the east of Leeds in the Aire Valley (further information on this is provided in Section 5.3).

4.5.109 Other options for the location of the spur were considered as an alternative to this spur. Consideration was given to spurs in the Wales and Killamarsh areas, both of which ultimately connected onto the Sheffield to Worksop Line. These were not progressed as trains would have to enter Sheffield Midland Station from the north, resulting in capacity issues. Accessing Sheffield Midland Station from the north would introduce the requirement for services to turn-back to access areas to the north of Sheffield. There would also be implications of this from an operational point of view at Sheffield Midland, with likely requirements for extra platforms due to additional services approaching from the north and longer platform occupation times. These alternatives were therefore not considered as preferable to the spur onto the Erewash Valley Line. Further detail on alternatives considered to the Sheffield spur are available in the post 2016/2017 consultation refinements on the Sheffield spur, and in the post-July 2017 local alternatives for the relevant Community area.

Summary of sustainability impacts

4.5.110 A sift comparison was undertaken which compared the M18 / Eastern route with the refined Meadowhall route. The sustainability impacts identified as part of that assessment are summarised in Table 3. The key sustainability constraints are shown on the route comparison map (Figure 25).

4.5.111 The M18 / Eastern route would avoid not only the site specific complexities associated with the Meadowhall viaduct, but also the problems of air quality and road congestion and access at the shopping centre. It would avoid the demolition of businesses in the Meadowhall area. The M18/Eastern route would run through the comparatively less populated, and geologically less challenging, eastern part of South Yorkshire. There would be a substantial reduction in potential demolitions along the M18/Eastern route when compared against the refined Meadowhall Route, a reduction in noise impacts and fewer potential watercourse diversions. There would, however, be an increase in landscape and heritage impacts. Use of a section of the existing conventional rail network into Sheffield city centre would also avoid many of the environmental impacts associated with the construction of a new high speed line and station within an urban area.

4.5.112 The separation of services to South Yorkshire from those which would run further north via the M18 / Eastern route would better address existing passenger demand and the needs of Sheffield and the wider region both in the South Yorkshire area and at destinations further north than the route via Meadowhall station.

4.5.113 The use of Sheffield Midland Station for HS2 services would also open the possibility of running high speed trains from Sheffield to Leeds via a link to the north of Sheffield Midland Station to the HS2 main line. This link would deliver the Northern Powerhouse Rail ambition for a frequent 30 minute journey time between Leeds and Sheffield. It would also allow cross-platform interchange to places across the city region by rail, and across the city on the tram network. It would also create the possibility of conventional compatible services running through Sheffield Midland Station to other destinations, including Barnsley, Meadowhall and Rotherham. The M18/Eastern route would also be less costly to construct than the refined Meadowhall route option.

4.5.114 For these reasons, together with the sustainability considerations (presented within Table 3 below), the M18 / Eastern route was recommended to form part of the preferred Phase 2b route by HS2 Ltd for consultation in 2016 and, following a period of public consultation, was endorsed by the Secretary of State for Transport in 2017.

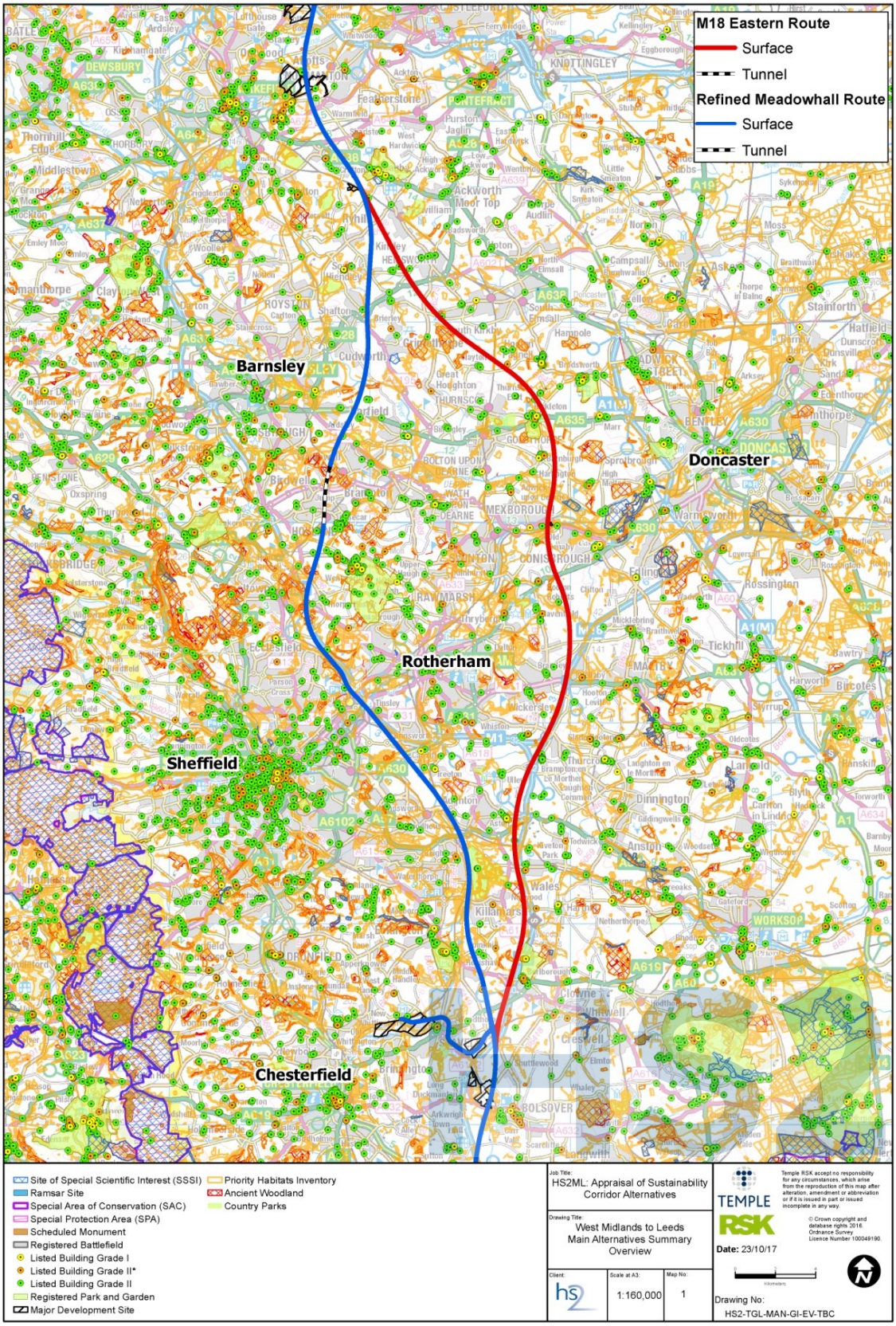
Table 3: M18/Eastern route and the refined Meadowhall route comparison table (comparison made between Tibshelf and Altofts in 2016)

	M18/Eastern route	**Refined Meadowhall route**
Property and Community Integrity	Demolitions: Approximately 35 residential[45] 13 commercial 0 community Three industrial **Approximate Total: 51**	Demolitions: Approximately 80 residential Approximately 44 commercial 0 community Three industrial **Approximate Total: 127**
Noise (numbers of properties potentially qualifying for noise insulation)	Approximately 100	Approximately 285
Landscape and Visual Impacts	Major landscape and visual impacts at 15 locations along the route	Major landscape and visual impacts at eight locations along the route
Planning and Development	Three development sites affected Impact on the now completed Shimmer housing estate (that was a development site at the time of the appraisal).	Five development sites affected
Cultural Heritage	Major impact on four Grade II listed buildings Moderate impact on the setting of five Grade II listed buildings Major impact on Stainsby Conservation Area due to physical change and changes within the setting from embankment and viaduct Major/moderate impact on the setting of a Grade II registered park and garden (Hickleton Hall) Moderate impact on the setting of five scheduled monuments	Major impact on two Grade II listed buildings Moderate setting impact on five Grade II listed buildings Major impact on Stainsby Conservation Area due to physical change and changes within the setting from embankment and viaduct. Moderate impact on setting of three scheduled monuments

[45] This figure includes an estimated 16 residential demolitions at the now completed Shimmer housing estate (that was a development site at the time of the appraisal).

Biodiversity and Wildlife	77 Habitats of Principal Importance intersected for approximately 5.6km Four ancient woodlands directly affected One Local Nature Reserve directly affected	98 Habitats of Principal Importance intersected for approximately 7.2km Four ancient woodlands directly affected
Water Resources and Flood Risk	0 diversion of a major watercourse 16 diversions of minor watercourses 3.3km of Flood Zone 3 intersected 4.3km of Flood Zone 2 intersected	Three diversions of major watercourses 14 diversions of minor watercourses 5.8km of Flood Zone 3 intersected 9.9km of Flood Zone 2 intersected.
Land use resources	Three active landfill sites intersected Seven historical landfill sites intersected 56km of green belt land intersected	Two active landfill sites intersected Eight historical landfill sites intersected 44km of green belt land intersected

Figure 25: M18/Eastern route and the refined Meadowhall route sustainability map



ECML connection

4.5.115 A connection to the ECML would be required to serve York and the markets to the North East of England. At the culmination of the 2010-2012 optioneering stage, two main route options were considered for the ECML connection (as shown on Figure 26); a northern option via Garforth and southern option via Castleford, both of which would connect to the existing conventional network and then on to the ECML at Church Fenton.

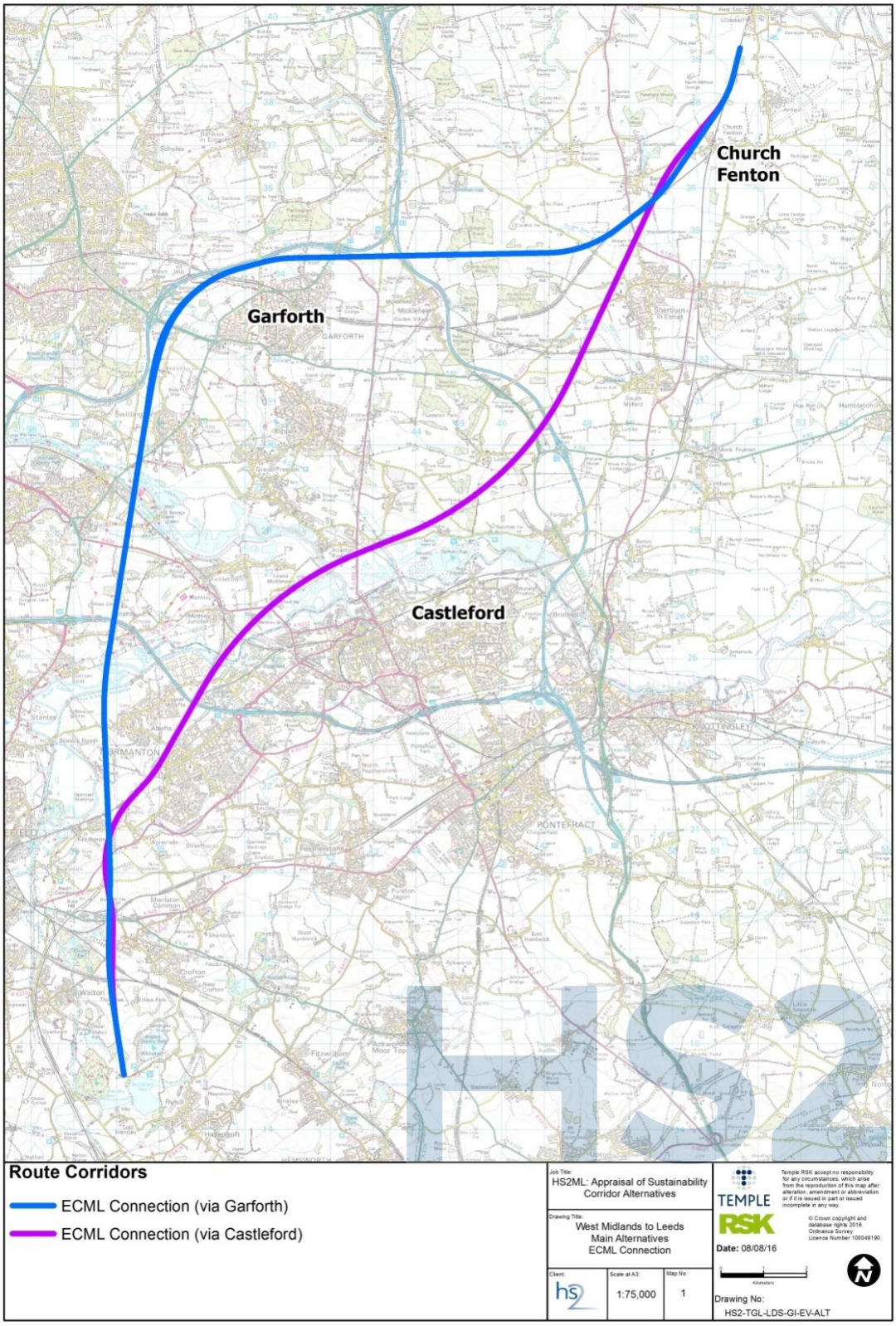
4.5.116 The route corridor via Garforth would travel north between Wakefield and Normanton and cross over the M62 and twice over the River Calder and the Aire and Calder Navigation Canal as they meander across the broad river valley to the south-east of Leeds. The route would then run in an eastern direction, parallel with the M1, to the north of Garforth. It would then cross beneath the A1 (M) and would turn northwards towards Sherburn in Elmet to connect with the ECML.

4.5.117 The route corridor via Castleford would follow the conventional railway corridor at Normanton in a north-east direction and would cross the M62 near junction 31. The route would cross the River Calder on a long viaduct north of Castleford and would cross under the A1 (M) near junction 42. The route would then pass to the west of Sherburn in Elmet and would connect to the existing conventional railway at Church Fenton.

Selection of the ECML connection

4.5.118 Both routes would have adverse impacts on landscape and visual receptors, on heritage receptors and ecological receptors at different points along the routes. Both would affect the development of a new commercial and industrial waste recycling facility at Welbeck. The route via Castleford would pass over several floodplains and Bishop Dyke. Furthermore, this route would have a moderate risk of hydrological impacts to Madbanks and Ledsham Banks SSSI. The route option via Garforth would be slower by around a minute but would cost substantially less than the route via Castleford, depending on which approach into Leeds was selected. For these reasons the route via Garforth was selected as the preferred route to connect to the ECML. Following consultation in 2013/2014, these two route corridors were refined and subject to further review.

Figure 26: ECML connection corridors



Summary of sustainability impacts

4.5.119 In 2015, a full sift comparison was undertaken between the route via Garforth and the route via Castleford.

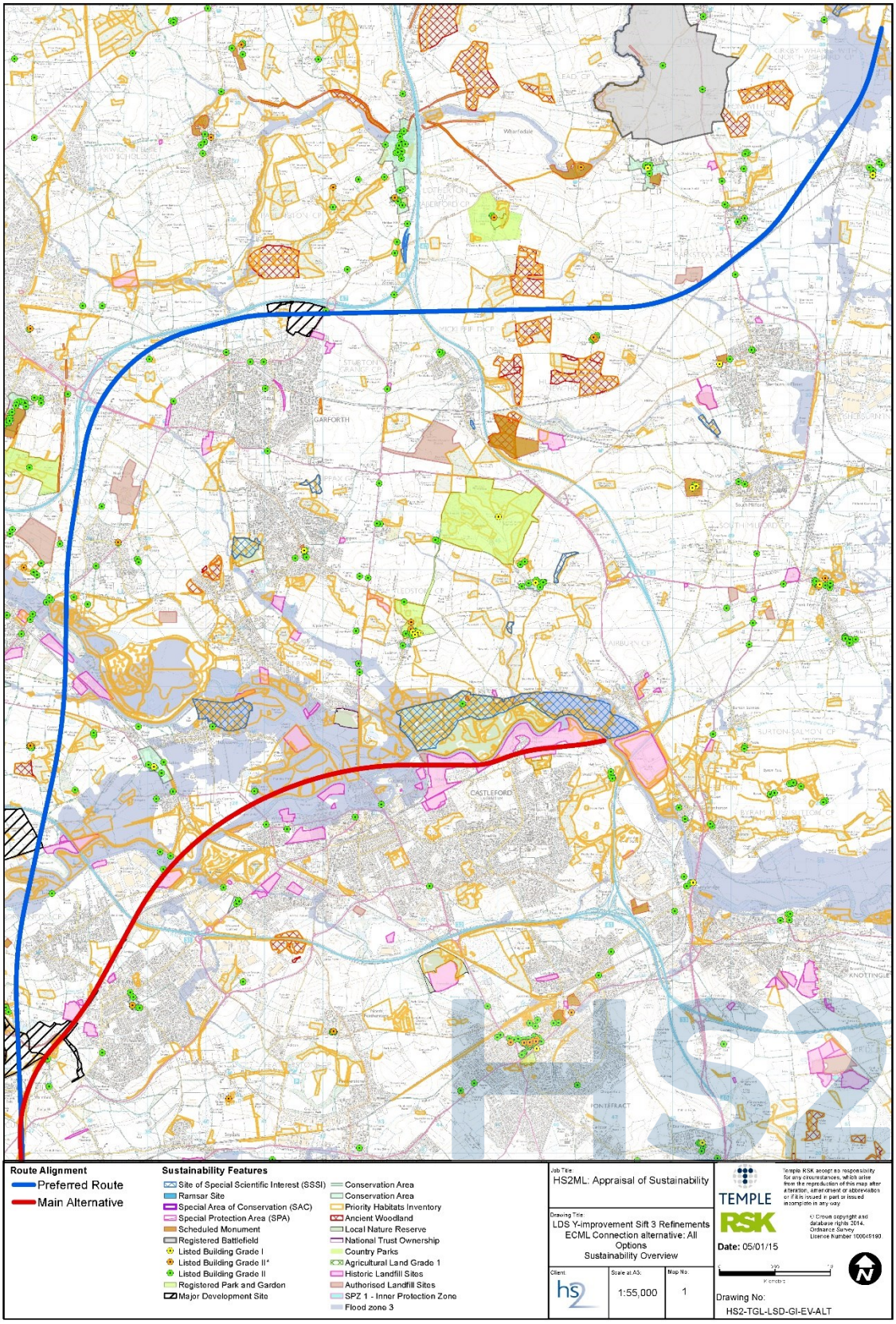
4.5.120 The route via Garforth would require approximately 11 residential demolitions, compared to approximately four residential demolitions on the route via Castleford. Both route sections would result in direct impacts to three Habitats of Principal Importance. However, in addition, the route via Castleford would also pose a moderate to high risk to three SSSI as the route would pass in very close to these sites.

4.5.121 On the basis of the cost and environmental considerations above, HS2 Ltd recommended that the route via Garforth be progressed, as shown in Figure 27. The sustainability impacts identified as part of that assessment are summarised in Table 4.

Table 4: ECML connection via Garforth and alternative connection via Castleford comparison table

	Route via Garforth (route refinement baseline)	**Route via Castleford**
Property and Community Integrity	Demolitions: Approximately 11 residential **Approximate Total: 11**	Demolitions: Approximately four residential Approximately two commercial **Approximate Total: 6**
Noise (numbers of properties potentially qualifying for noise insulation)	Approximately 22	Approximately 26
Landscape and Visual Impacts	Moderate landscape and visual impacts at two locations along the route	Major landscape and visual impacts at two locations along the route
Cultural Heritage	Direct impact on one Grade II listed milepost Moderate setting impact on six Grade II listed buildings Impact on the setting of one Grade II* listed building	Moderate impact on the setting of two Grade II listed buildings
Biodiversity and Wildlife	38 Habitats of Principal Importance intersected for approximately 3.1km	39 Habitats of Principal Importance intersected for approximately 5.3km Two SSSI potentially affected (hydrological impact) Two Local Nature Reserves directly affected
Water Resources and Flood Risk	Nine diversions of minor watercourses	One diversion of major watercourse Three diversions of minor watercourses
Land use resources	One active landfill site intersected One historical landfill site intersected	One active landfill site intersected Four historical landfill sites intersected

Figure 27: 2015 preferred route via Garforth and alternative via Castleford sustainability map



Approach to Leeds

4.5.122 The choice of station option to serve the Leeds city centre was strongly influenced by the route combinations on the approach to the city centre and the onwards connection to the ECML. HS2 Ltd remit was to define options to serve a city centre station in Leeds and route options to facilitate a connection to the ECML to serve York and the North East of England.

4.5.123 As shown on Figure 28, two main route options were considered for the approach to Leeds city centre; a route from the south-east via Woodlesford and an alternative route that would pass to the south of the city to ultimately approach the city centre from the west via Morley (Transpennine corridor). The two routes would provide different station locations. The route via Woodlesford would serve a high speed station located south of the existing Leeds Station and oriented perpendicular to the existing station alignment, for which two local options were considered. The route via Morley would serve a high speed station located adjacent to the north side of the existing Leeds Station and orientated parallel to the existing conventional rail line. As part of its 2013 initial preferred scheme, and set out in the Government's 2013 Command Paper, the Government selected a route via Woodlesford because of its desire to deliver the benefits of a new station at New Lane in Leeds city centre. A high speed station at Leeds New Lane would be located just to the south of the existing station in the city centre. Given the aspirations in the city for extending the city centre south of the river and to see major new development around this area, a high speed station located close by could support this refocusing on the city centre and support the regeneration in this area. In turn, this would make the station accessible to new centres of activity that would develop south of the river.

4.5.124 Following 2013/2014 consultation, the approaches were re-examined as set out below. The process for selecting the preferred station option at Leeds is described later in this section.

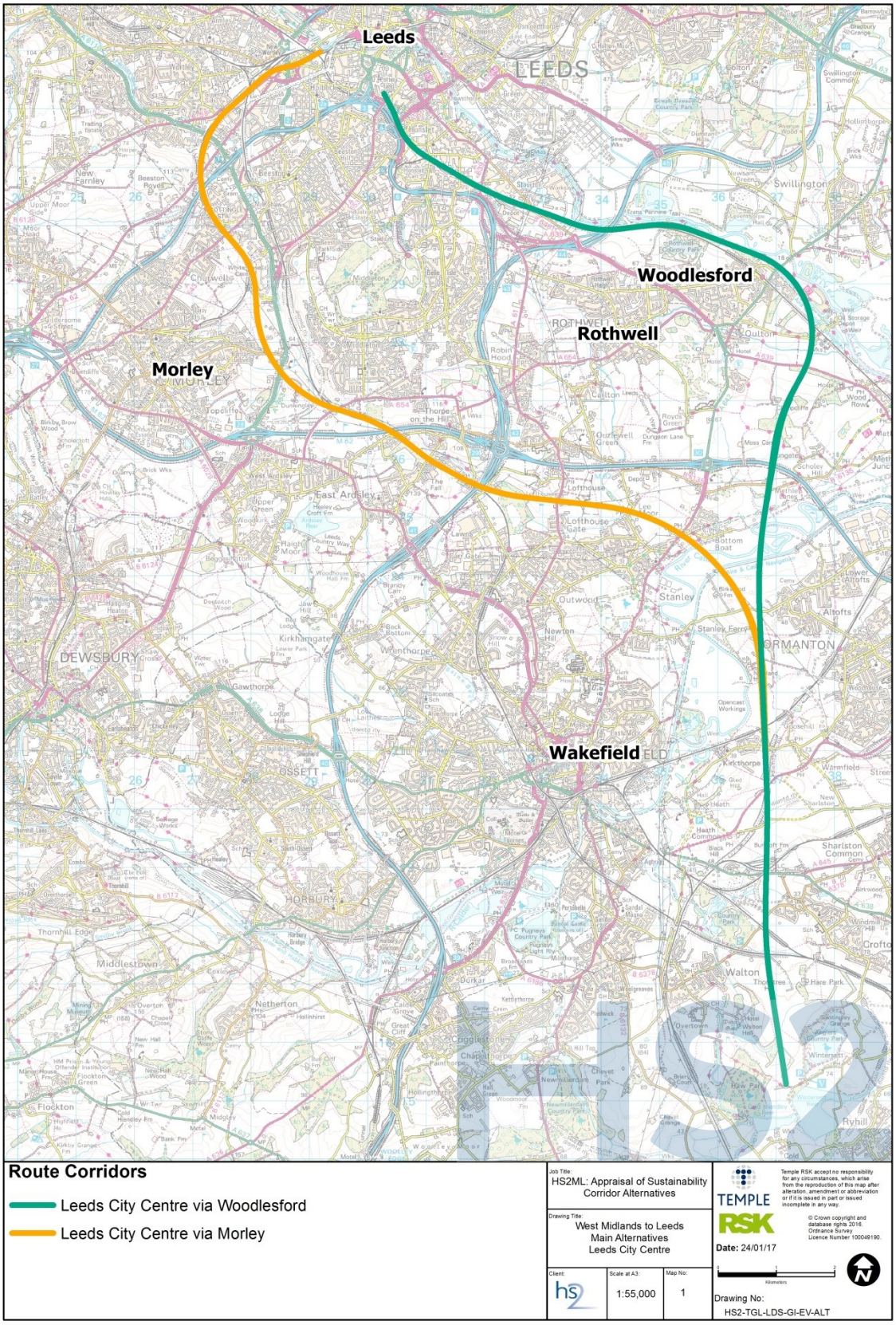
Approach to Leeds via Woodlesford

4.5.125 The route corridor proposed as part of the 2013 proposed scheme for consultation included an approach to Leeds city centre from the south-east via Woodlesford. The HS2 main line route would pass Swillington and would bear east to join the corridor of the M1 north of Garforth to facilitate onward connection to the ECML.

4.5.126 North-east of Kirkthorpe, the route would be on embankment over the existing Wakefield to Normanton railway. The route would be on viaduct over the Aire and Calder Navigation Canal and would require multiple crossings of the River Calder and its floodplain. After crossing over the M62, the route would cross the valley of the River Aire on embankment, before passing on viaduct over the existing Normanton to Leeds railway, the Aire and Calder Navigation Canal, River Aire floodplain and the A642 Aberford Road. The route would then cross a narrow area of land between the Aire and Calder Navigation Canal and the River Aire.

4.5.127 From Woodlesford towards Hunslet, the route would cross under the M1 on the existing conventional railway which would require the existing Normanton to Leeds railway to be diverted in this area. For the remainder of the route into Leeds, the high speed route would run parallel to the existing Normanton to Leeds railway on its northern side through the industrial areas of Stourton and Hunslet, just north of the M621. The spur would continue in cutting into Pottery Field and would terminate at an elevated high speed station on New Lane, Leeds city centre.

Figure 28: Approach to Leeds corridors



Reasonable alternative – approach to Leeds via Morley

4.5.128 The alternative spur towards Leeds via Morley would cross the Aire and Calder Navigation Canal, and the River Calder and its floodplain on viaduct. It would then continue to the west between Stanley and Bottom Boat. The route would be in deep cutting north of Lofthouse and would pass under a number of roads through this area.

4.5.129 The route would pass under both the M1 and M62, then over the existing conventional railway tunnel at Ardsley on viaduct and would then join the existing Dewsbury to Leeds railway. The route would pass over part of the surface car park at the White Rose Shopping Centre and then would cross the A643 on a viaduct parallel to the existing Dewsbury to Leeds Line viaduct in the area. The route would then continue adjacent to the existing conventional railway and would continue in cutting past Cottingley Station.

4.5.130 The route would then pass under the M621 making use of former railway land on the approach into the proposed high speed Leeds north station. Just short of the existing Leeds Station, the route would pass over a number of arterial roads, industrial premises and the western approach tracks to Leeds Station on a long viaduct.

Summary of sustainability impacts

4.5.131 In 2015, following the 2013/2014consultation, a full sift comparison was undertaken between the preferred approach to the high speed Leeds New Lane station via Woodlesford and the reasonable alternative approach via Morley, going to Leeds high speed station north.

4.5.132 The route via Woodlesford (Figure 29) would require significantly fewer property demolitions than the route via Morley. It would also have half the number of residential properties potentially qualifying for noise insulation. The route via Morley (Figure 29) would likely require a diversion of the River Calder and would affect areas of best and most versatile agricultural land.

4.5.133 Both route options into Leeds would have engineering challenges. The route via Morley would require an approximately 1.7km (1 mile) realignment of the Doncaster to Leeds Line and the Woodlesford corridor would require an approximately 2.1km (1.3 mile) realignment of the Leeds to Woodlesford Line. The route via Woodlesford would also require an approximately 4.8km (3 mile) section constructed adjacent to the River Aire and Aire and Calder Navigation Canal.

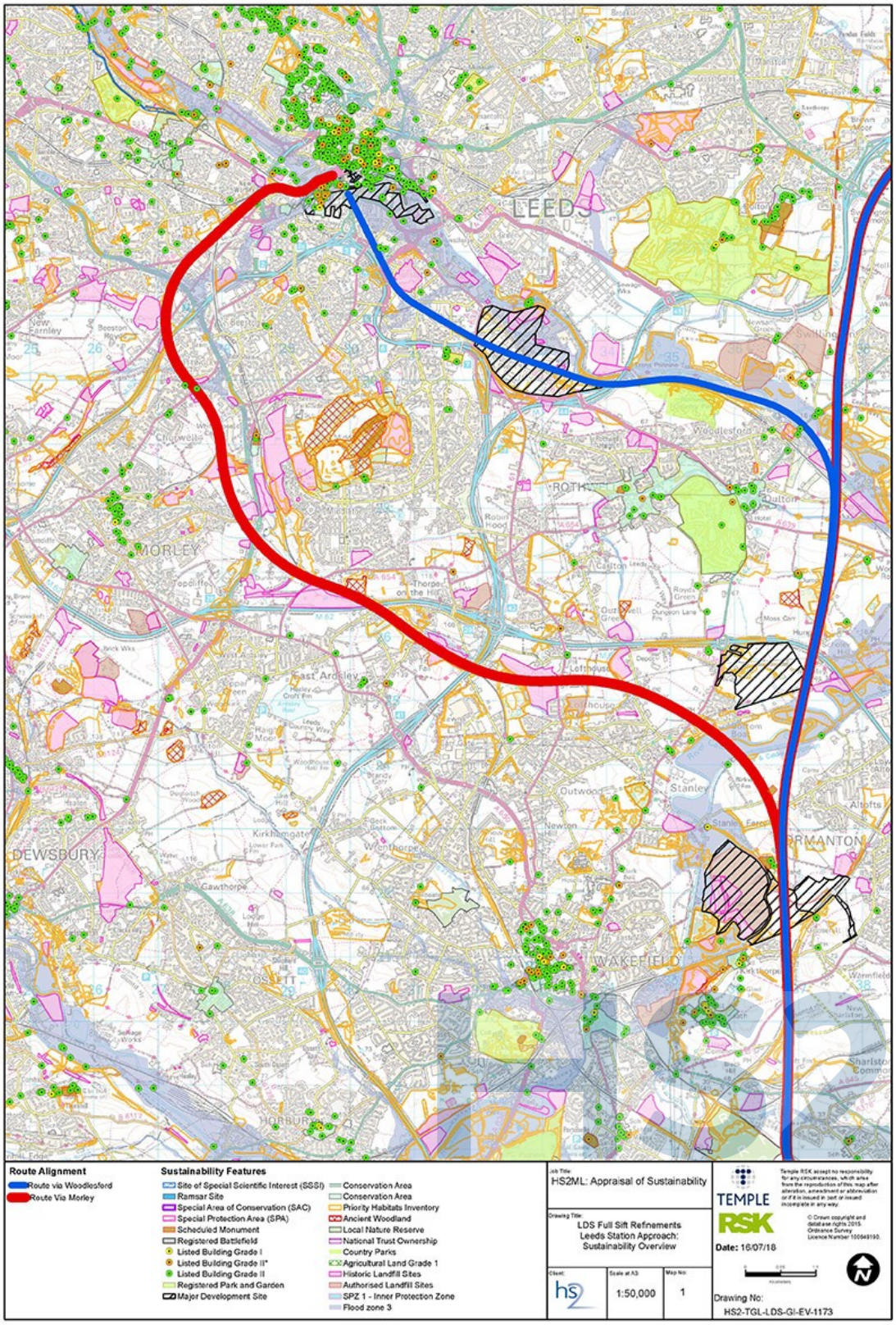
4.5.134 Although Leeds station north would benefit from being located near the established centres of commerce and business to the north of the existing Leeds Station, the development of the new high speed station would make Network Rail's planned expansion of the existing station very difficult and costly.

4.5.135 The sustainability impacts identified as part of the appraisal are summarised in Table 5. At this stage of the appraisal process, the selection of the preferred station option was a major factor in the decision making for the preferred station approach. The selection of the preferred Leeds terminus station is provided in the following sections.

Table 5: Approach to Leeds via Woodlesford and alternative via Morley summary table

	Route via Woodlesford	**Route via Morley (route refinement baseline)**
Property and Community Integrity	Demolitions: Approximately 11 residential Two commercial 0 community 0 industrial **Approximate Total: 13**	Demolitions: Approximately 31 residential Approximately 14 commercial One community One industrial **Approximate Total: 47**
Noise (numbers of properties potentially qualifying for noise insulation)	Approximately 39	Approximately 122
Landscape and Visual Impacts	Moderate to major landscape and visual impacts at seven locations along the route	Moderate to major landscape and visual impacts at eight locations along the route
Cultural Heritage	Direct impact on one Grade II listed building Moderate impact on the setting of six Grade II listed buildings Impact on the setting of one Grade II* listed building	Moderate impact on the setting of one scheduled monument Moderate impact on the setting of six Grade II listed buildings
Biodiversity and Wildlife	60 Habitats of Principal Importance intersected for approximately 8.1km One country park/local nature reserve	79 Habitats of Principal Importance intersected for approximately 7.1km One country park/local nature reserve
Water Resources and Flood Risk	Four diversions of major watercourses Nine diversions of minor watercourses	0 diversion of major watercourse Eight diversions of minor watercourses
Land use resources	One active landfill site intersected One historical landfill site intersected	One active landfill site intersected 10 historical landfill sites intersected

Figure 29: Approach to Leeds via Woodlesford and alternative via Morley sustainability map



Selection of the preferred Leeds terminus station option

Leeds Station - initial shortlisting 2012

4.5.136 As described in *High speed rail: investing in Britain's future – Phase Two report* (2013), the Government's initial preferred option was for a station located to the south of the existing Leeds Station at New Lane. New Lane was identified as the preferred terminus station on the basis of a combination of engineering, sustainability, cost and/or operational factors.

4.5.137 Initially three main options for a station in Leeds city centre were appraised (Figure 30). Two were located immediately south of the River Aire, at New Lane and at Sovereign Street south, and a third immediately to the north of, and parallel to, the existing Leeds Station (Leeds station north). These options, and those considered as part of the initial, long list and short list sifting processes are described in more detail within the *Options for Phase Two – appraisal of sustainability report* (2012).

Leeds station north (Option 1a)

4.5.138 Leeds station north would be located adjacent to, and directly north of, the existing Leeds Station. It would be orientated east-west, on the site of the current station car park bound on one side by the station and the other by the River Aire. This high speed station would be served by an approach via Lofthouse (Transpennine).

4.5.139 Leeds station north would comprise five platforms, elevated at a similar level to the existing station footbridge. They would be higher than existing platform level due to the approach to the new high speed station having to cross over the existing conventional railway junction to the west. The platform edges would be curved and tapered towards the west end to reduce the overhang of the station structure over the river. The site is highly constrained and a high speed station on the site would make any future Network Rail expansion of the existing Leeds Station very difficult and costly to achieve.

4.5.140 The station platforms would be constructed on structures partly over the River Aire. The highly constrained nature of the site would likely mean multiple phases during the construction.

4.5.141 This station option would result in no residential dwellings being demolished.

4.5.142 This station option would have some limited impacts on the existing townscape fabric with slight impacts on the waterfront areas and views. In particular, the southerly aspect of the buildings on the north side of the River Aire would be adversely affected by the new high speed station structure and proposed elevated road bridge and throat to the west. This would reinforce the existing visual severance.

4.5.143 At the time Leeds City Council had progressed their core strategy to the preferred approach stage. In this, the city centre is promoted as a primary focus for shopping, economic development and urban renewal. The station option would support these policies.

4.5.144 The works would potentially displace businesses providing an estimated 500 jobs. However, an estimated 14,500 jobs would be supported through development around the station generated as a result of HS2. There would be an estimated 1,900 housing units supported.

Sovereign Street south (Option 13e)

4.5.145 Leeds Sovereign Street south would be a new high speed station, located approximately 200m south of the existing Leeds Station, and would be aligned north-south. While the elevated tracks would terminate on the southern side of the River Aire, the concourse would cross the river and would front onto the new public plaza associated with the currently proposed Sovereign Street development.

4.5.146 This station option would comprise five platforms, elevated over the adjacent streets with access from a concourse at grade. Elevating the main structure over Meadow Lane and Great Wilson Street would help reduce potential east-west severance that the high speed station would cause. This station option would be served by the Woodlesford (variant) approach.

4.5.147 This station option would result in no dwellings being demolished.

4.5.148 This station option would be elevated and span the width of the River Aire. The roof line would be approximately 20m above the River Aire and would obstruct key views along the river from the open space and adjoining bridges and would affect the distinctive historic riverside setting. Overall, a major adverse impact would be expected on townscape, with some opportunities for townscape enhancement as part of the future redevelopment south of the river in the longer term.

4.5.149 This station option would conflict with the Sovereign Street[46] and South Bank[47] Planning Statements.

4.5.150 The works would potentially displace businesses providing an estimated 5,500 jobs. However, an estimated 12,100 jobs would be supported through development around the station generated as a result of HS2. There would be an estimated 1,100 housing units supported.

New Lane (Option 13f)

4.5.151 The high speed Leeds New Lane station would be located approximately 200m south of the existing Leeds Station, just south of Victoria Bridge. It would be bound by Asda House and Leeds Business Park to the east and Bridgewater Place to the west. The high speed station would be orientated approximately north-south and positioned so as to end directly on the south side of the River Aire. This station option would be served by the Woodlesford approach.

4.5.152 This station option would comprise five platforms. The platforms would be elevated over the adjacent Meadow Lane to avoid east-west severance. It would be necessary

[46] Leeds City Council (2011) Sovereign Street Planning Statement. Adopted July 2011. Available online at: https://www.leeds.gov.uk/docs/15.%20Sovereign%20Street%20planning%20statement%20ADOPTED%202011%20web%20version.pdf
[47] Leeds City Council (2011) South Bank Planning Statement. Adopted October 2011. Available online at: https://www.leeds.gov.uk/docs/South%20Bank%20planning%20statement%20ADOPTED%20web%20LR.pdf

to close the west end of Great Wilson Street to through traffic in order to accommodate the station.

4.5.153 This station option would result in no residential dwellings being demolished.

4.5.154 The station roof for this option would be approximately 20m above ground level, broadly in keeping with the taller existing buildings in the area. However, the station and high level passenger link would potentially cause an adverse impact on the local townscape.

4.5.155 There would be substantial impacts on the Canal Wharf Conservation Area. The proposed high level passenger link would restrict views from across the river and affect river users. It would also change the character of the conservation area. There would also be a moderate impact on the setting of the Grade II listed Victoria Bridge.

4.5.156 This station option would conflict with the South Bank Planning Statement. This station option would support the growth of the southern side of the city and the wider city region, as identified in the Council's draft core strategy[48].

4.5.157 The works would potentially displace businesses providing an estimated 1,500 jobs. However, an estimated 13,200 jobs would be supported by development around the station generated as a result of HS2. There would be an estimated 1,700 housing units supported.

Options appraisal

4.5.158 Appraisal of the three station options identified that Leeds station north would require the fewest demolitions (approximately 10) and Sovereign Street south would require the most (approximately 24). Leeds station north would also displace the fewest existing jobs (approximately 500) whilst also supporting the greatest job generation of the three options (approximately 14,500). New Lane station would displace approximately 1,500 jobs and generate an estimated 13,200 jobs following completion. Sovereign Street south would displace the greatest number of jobs and generate the fewest number of jobs (5,500 and 12,100 jobs respectively) of the three options. All options were considered to generate adverse visual impacts upon townscape and would necessitate significant works to the River Aire and its associated floodplain. New Lane and Sovereign Street south stations would both conflict with Leeds City Council's South Bank development proposals.

4.5.159 Of all the options, Leeds station north would provide the easiest possible interchange with services at the existing Leeds Station and would also be located the closest to the existing city centre. However, the site proposed for the high speed station was constrained, and building the high speed station here would effectively prevent future expansion of the existing Leeds Station and high speed station in the long-term. In addition, the route serving Leeds station north would involve a longer connection on to the HS2 main line that would generate higher impacts on local communities and the environment.

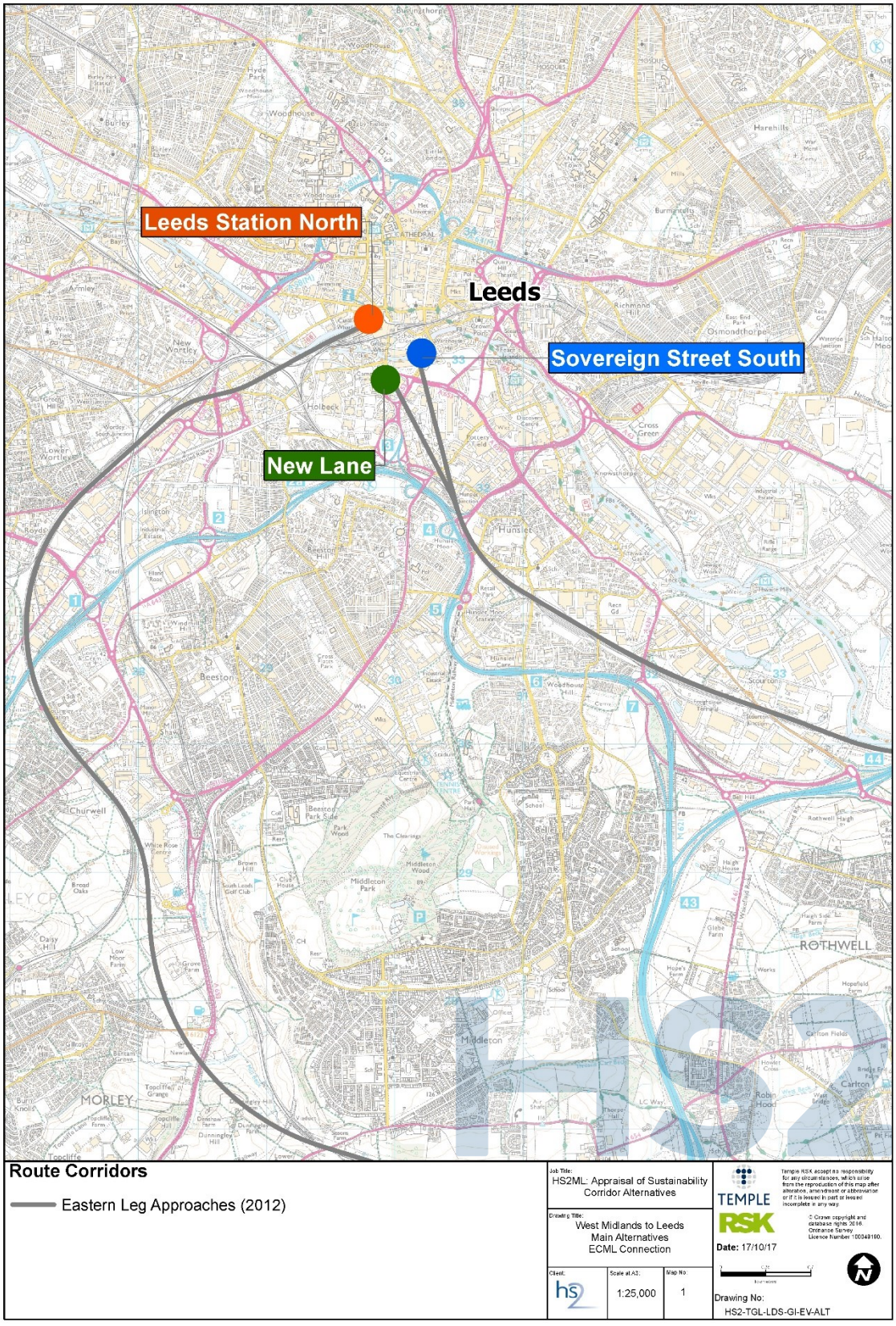
[48] Leeds City Council (2012) Core Strategy – Leeds Local Development Framework. Draft Leeds Infrastructure Delivery Plan. Publication Draft. Available online at: https://www.leeds.gov.uk/docs/FPI_CS_Pub%20008%20core%20strategy%20idp%201%20feb%20web(1).pdf

4.5.160 The Government's initial preferred station option at New Lane to the south of the River Aire could be served by a more direct and less impactful route. This route would expose fewer properties to increased levels of noise, necessitate fewer demolitions and save travel time.

4.5.161 The Sovereign Street south option was considered unlikely to generate any additional benefits over the New Lane option, and would not be any cheaper. It was also considered to present a significant challenge to the city's aspiration to regenerate the South Bank area of the city which would be partially occupied by the station option.

4.5.162 Overall, New Lane station was considered likely to be the best location for a city centre station. The selection of New Lane as the preferred location for a high speed station therefore dictated the preference for the approach options into Leeds.

Figure 30: Leeds station locations



Further development of Leeds Station options

4.5.163 In July 2013, the Government launched a consultation on the route for Phase Two, which included the preferred option for a high speed station in Leeds at New Lane as set out previously. During the consultation, Leeds City Council and representatives from across the region expressed concern about the linkage between high speed services and existing national and regional conventional rail services at Leeds Station. Leeds City Council emphasised the importance of creating a hub that was in line with their ambition for Leeds and the ambitions of the wider Leeds city region.

4.5.164 In November 2014, the *HS2 Rebalancing Britain report* was published, which recognised this issue and the importance of reaching a solution which satisfied broader connectivity across the Leeds city region and enhanced the economic and regeneration aspirations for the area.

4.5.165 In February 2015, the Chancellor of the Exchequer, launching the *Long term economic plan for Yorkshire*[49], asked David Higgins to prepare an interim report looking specifically at the future of the high speed station in Leeds.

4.5.166 After continued engagement with Leeds City Council, local authorities across West Yorkshire, the Leeds City Region Enterprise Partnership, the West and North Yorkshire Chamber of Commerce and Network Rail, a clear consensus around a single preferred option emerged.

4.5.167 The *Yorkshire hub report* (2015)[50] was an interim report submitted to Government to consider in November 2015, as a recommendation from HS2 Ltd. The report sets out five principles agreed with stakeholders by which to assess options for a station in Leeds. It presents each option and a consensus around Option 2 (approaching from the south, described below), reflecting the views of the Leeds City Council, the Chamber of Commerce and representatives from the wider city region.

4.5.168 The five principles laid down for a station within Leeds city centre within the *Yorkshire hub report* (2015) were the provision for: a common concourse with the existing conventional rail station; an integrated transport hub allowing improved car and bus access; sufficient capacity to support initiatives such as the Northern Powerhouse through trains to enhance both the Northern Powerhouse rail plans as well as local and regional services; and a major landmark station.

4.5.169 Three options were considered:

- Option 1 – approaches from the east providing a parallel high speed station to the existing Leeds Station;
- Option 2 – approaches from the south (as the 2013 consultation scheme), but goes over the river to form a T-shaped high speed station integrated with the Leeds Station;

[49] News story Long Term Economic Plan for Yorkshire and Northern Lincolnshire announced (2015): Available at: https://www.gov.uk/government/news/long-term-economic-plan-for-yorkshire-and-northern-lincolnshire-announced
[50] Department for Transport (2015) The Yorkshire Hub - An interim report on the redevelopment of Leeds Station. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/480396/Higgins_-_The_Yorkshire_Hub.pdf

- Option 3 – approaches from the south and does not go over the river (as per the 2013 consultation scheme).

4.5.170 As mentioned above, the stakeholder consensus was for Option 2 to be progressed. A detail comparative appraisal of these options is set out in Section 5.3 of this report.

Station option decision – November 2016

4.5.171 In November 2016, the DfT published *HS2 from Crewe to Manchester, the West Midlands to Leeds and beyond report* (2016) which confirmed the Government's decision to adopt Option 2.

5 Local alternatives considered before July 2017

5.1 Introduction

5.1.1 This section provides an overview of the alternatives studied and sifted within different geographic areas (refinement areas) following 2013/2014 consultation and prior to July 2017, the option chosen for progression and the reasons to support this decision.

5.1.2 For each refinement area, a decision tree diagram shows the options taken forward to full sift appraisal, with a short description of them in the summary box in the diagram. The preferred option in each case is highlighted in green. Further options in grey were proposed but were either not progressed or not considered the preferred option for that appraisal stage. Those shown in blue were progressed to the next sift stage.

5.1.3 For each package of alternatives studied, each option is appraised in terms of sustainability performance against the preferred option taken forward.

5.2 Crewe to Manchester

Local alternatives considered post 2013/2014 consultation

Introduction

Route refinements – post 2013/2014 consultation

5.2.1 Following the period of public consultation on the proposed Phase Two route between July 2013 and January 2014, route refinement work was undertaken. The western leg of the 2013 proposed scheme for consultation was divided into geographically based refinement areas, within which options were subject to further design and appraisal. The post 2013/2014 consultation refinement areas presented within this report were as follows and shown on Figure 31:

- Crewe surface;
- Middlewich to Pickmere (routes through salt mining areas);
- WCML connections north of Crewe;
- Delta junction zone 1;
- Delta junction zone 2;
- Manchester Ship Canal;
- East and west of Culcheth;
- Lowton gap;
- Alternative rolling stock depots locations;
- Golborne (without rolling stock depot);

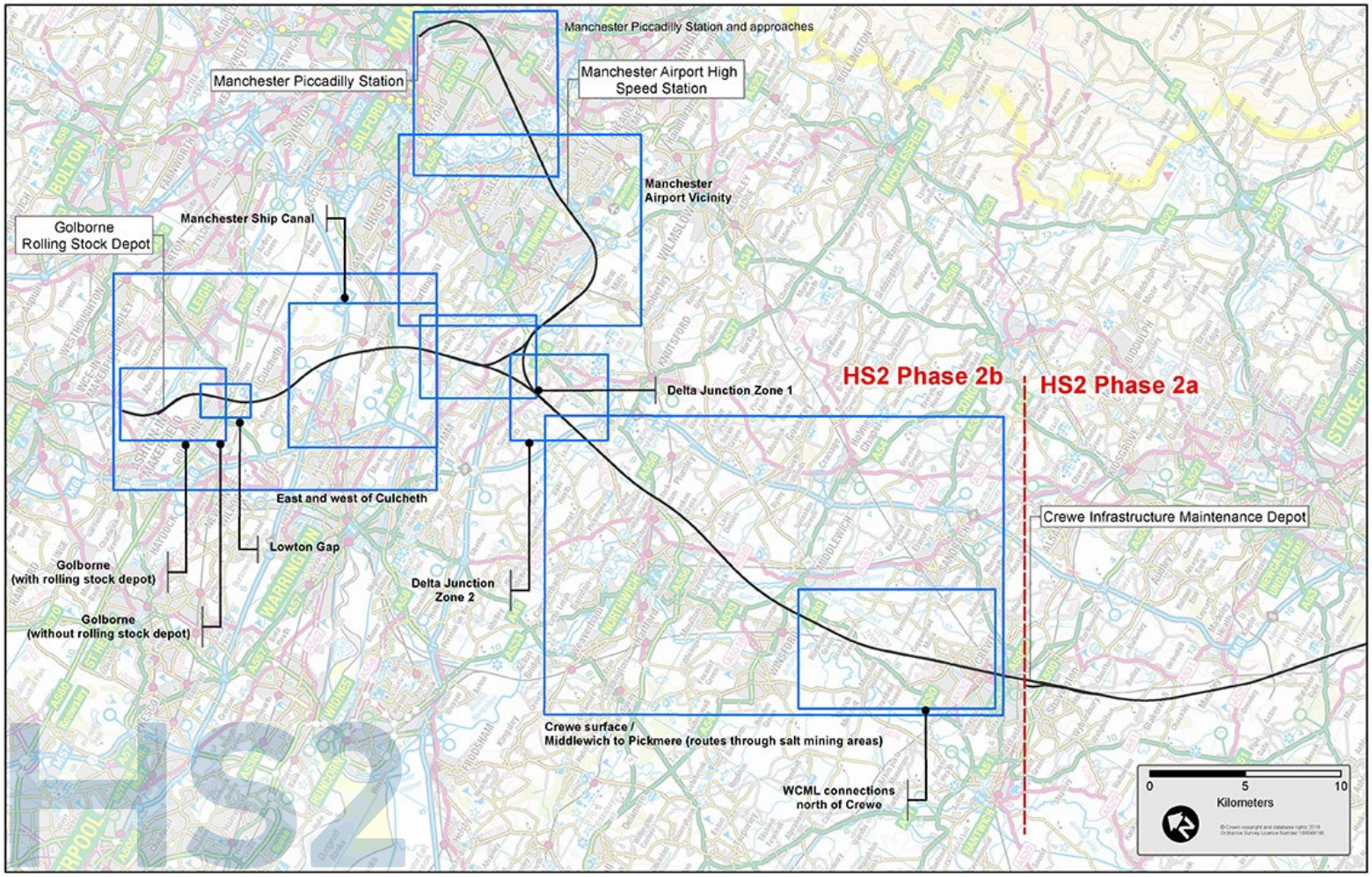
- Maintenance loops at Golborne;
- Manchester Airport vicinity; and
- Manchester Piccadilly Station and approaches.

5.2.2 Post-consultation refinements of the western leg focused on discrete sections of route. In some instances, on the route to Manchester, there is an overlap between the refinement areas meaning that certain parts of the route may have been refined multiple times. There are also sections of the route, which following the public consultation in 2013 and 2014, were not refined. These sections were subject to minor amendments to meet the developing standards and requirements, but not subject to formal refinement.

5.2.3 For the purposes of undertaking post 2013/2014 consultation refinements, the baseline proposition used for comparison was described as the route refinement baseline (RRB). This was similar to the 2013 proposed scheme for consultation but with updated design standards applied. This RRB option is shown in dark blue on the tree diagrams presented in this report. The other options considered as part of the initial sift are shown in light blue.

5.2.4 Each of the options was appraised against the RRB. However, the comparison of the impacts is presented below against the option that was chosen to be taken forward into the design (the preferred option). In some instances, whilst the preferred option was chosen as the most appropriate at that stage of development, subsequent work may have led to the option being revisited. Where this is the case it is noted in the relevant sections below.

Figure 31: Local alternatives considered post 2013/2014 consultation

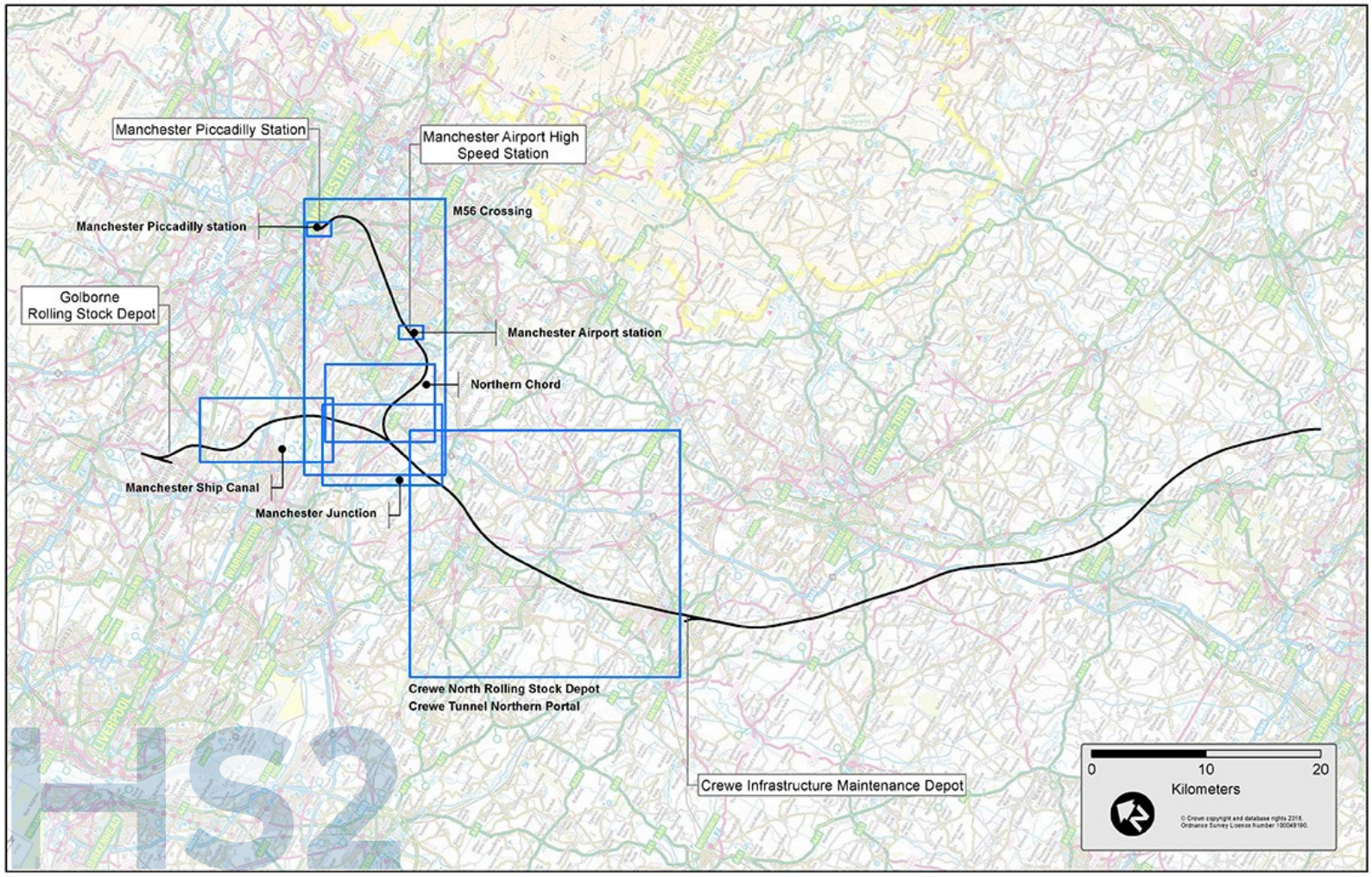


Further route refinements

5.2.5 A series of further refinements were undertaken in late 2015. These refinements addressed comments arising from consultation and ongoing engagement that required further consideration. For these refinements, all options were sifted against the draft refined route (DRR) as the baseline, as opposed to the RRB used during the refinements following the 2013/2014 consultation. The DRR incorporated the preferred route options adopted following the 2013/2014 consultation refinements (listed above). These further refinements considered more detailed changes in areas that had been considered in earlier stages of the sifting process. The further refinement areas were as follows, as shown on Figure 32:

- Crewe tunnel northern portal;
- Manchester junction;
- Northern chord;
- M56 crossing;
- Manchester Ship Canal;
- Crewe north rolling stock depot;
- Manchester Airport station; and
- Manchester Piccadilly Station.

Figure 32: Local alternatives considered in 2015 (further refinements)



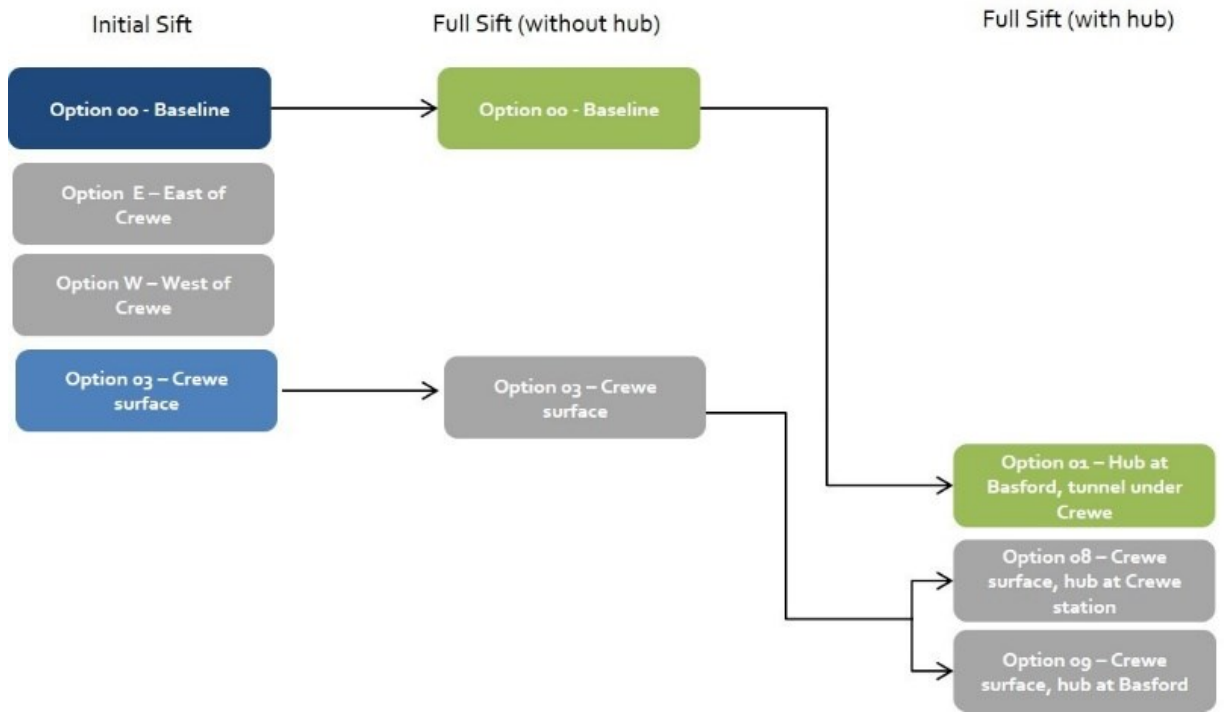
Crewe surface

5.2.6 This refinement covered approximately 32km of the route running from Chorlton to the M6 crossing north of Pickmere. The specific focus of the refinement was the area around Crewe, with the route north of Crewe after crossing the A530 the same across all options. The refinement sought initially to explore the possibility of reducing the costs associated with the approximately 3.8km tunnel under Crewe with options to run through or around Crewe on the surface. Further options also looked at potential integration with Network Rail proposals for a Crewe Hub station, providing platforms for connection with Phase 2b at Crewe.

5.2.7 Four options were considered initially for this section of the route. Options exploring routes east and west of Crewe were discounted early on due to the operational, logistical and environmental impacts. Two options were taken forward after an initial sift appraisal to a full sift (without the Crewe Hub station). Following this, a further three options were taken to a full sift following a recommendation for further refinement to take into consideration the likely interface with a Crewe Hub station. Further studies were also undertaken to consider alternate surface routes through Crewe and to review potential options for road diversions and the associated requirement for demolitions.

5.2.8 All options presented at the full sift had the same horizontal and vertical position to the north of Crewe. The areas to the south of, and through Crewe, varied between the options to allow for two possible locations of a Crewe Hub station. All options had a WCML connection and a dedicated HS2 main line platform at the hub station. The options taken forward in the sift stages are shown in Figure 33 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 34.

Figure 33: Local alternatives considered for surface routes through Crewe



5.2.9 For the sift without Crewe Hub scenario, HS2 Ltd determined that Option 00 should be progressed as the preferred option over Option 03. Option 00, would approach Crewe in cutting alongside the existing WCML and would then be in tunnel under the existing Crewe Station. Option 00 would have substantially fewer sustainability impacts in terms of noise and demolitions, as well as reduced engineering and interface complexity, would have less impacts on highway infrastructure and would cost less than Option 03. Following this sift, Option 00 became Option 01 in order to test a scenario serving a Crewe Hub station.

5.2.10 For the sift with a Crewe Hub station scenario, the following three options were taken forward to the full sift review:

- Option 01 would approach Crewe in a cutting alongside the existing WCML before entering an approximately 3.8km bored tunnel under the existing Crewe Station. The bored tunnel would surface towards the northern edge of Crewe, north of Bradfield Road, and would then continue north and north-east across the Cheshire Plain. This would include provision for an interface with a potential Crewe Hub station at Basford, south of the existing Crewe Station;
- Option 08 would similarly approach Crewe alongside the existing WCML, but would continue to run on the surface, in a cutting alongside the existing WCML through central Crewe. This would include provision for an interface with a potential Crewe Hub station at the existing Crewe Station location; and
- Option 09 would approach Crewe alongside the existing WCML, but would continue to run on the surface, in a cutting alongside the existing WCML through central Crewe. This would include provision for an interface with a potential Crewe Hub station near Basford Hall, south of the existing Crewe Station.

5.2.11 HS2 Ltd determined that Option 01 should be progressed as the preferred option. The bored tunnel option would have substantially fewer sustainability impacts, as well as reduced engineering and interface complexity relating to running alongside the existing WCML, whilst still providing provision for interfacing with a potential Crewe Hub station, if required. In addition, any surface option would have significant implications for the existing road network through Crewe.

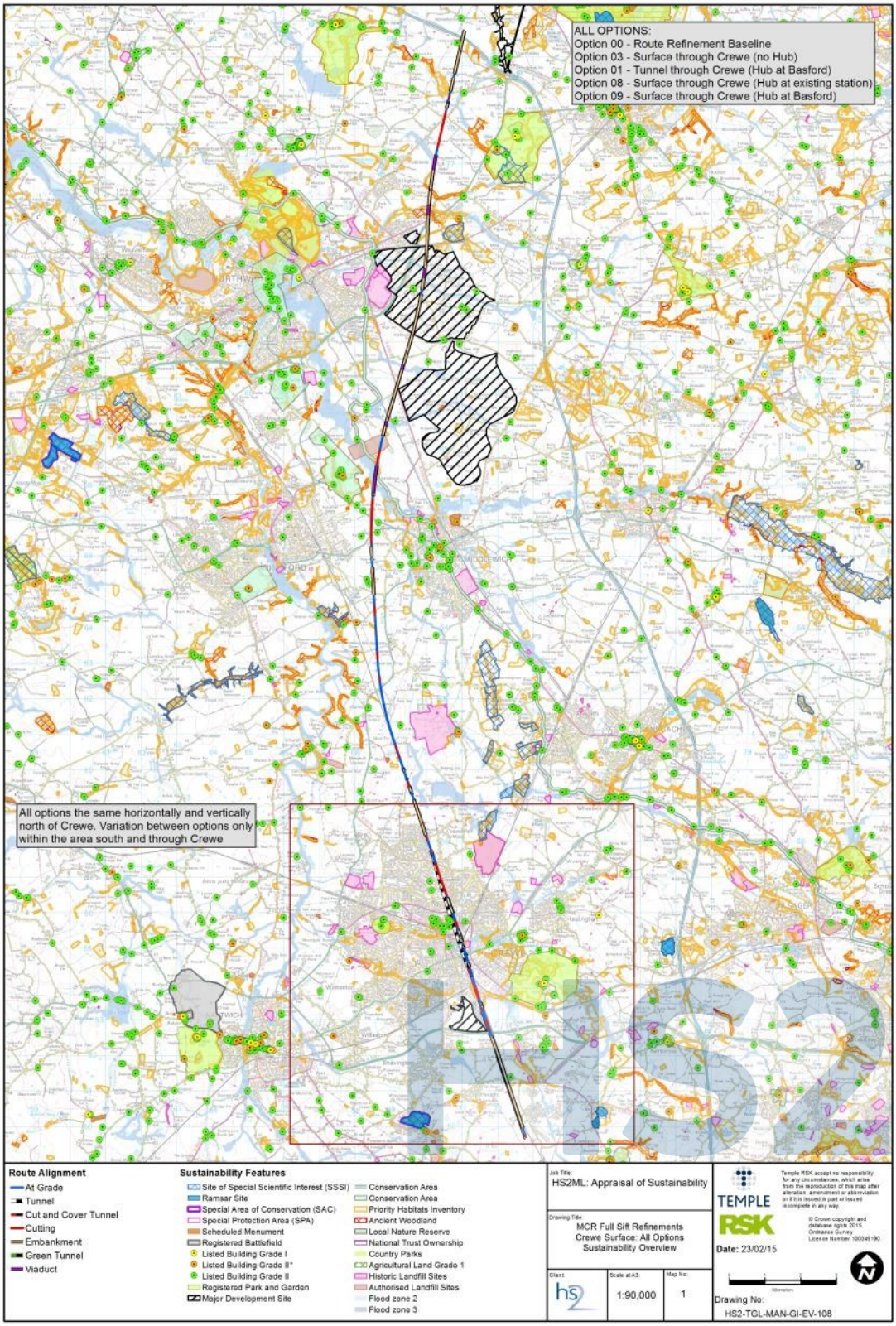
5.2.12 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.13 The preferred option, Option 01, would have moderate landscape and visual impacts, particularly at Chorlton to the south of Crewe where the route would be on a high viaduct before lowering on the approach into Crewe. Before entering the bored tunnel south of the existing Crewe Station, the route would pass in cutting through Gresty Brook, where there would be a risk of fluvial flooding. For the area of route around Crewe, there would be approximately two demolitions, both close to the northern tunnel portal. These impacts were similar to those of the alternative Option 00, which was the previously preferred option.

5.2.14 Option 08 would similarly have moderate landscape and visual impacts around the Chorlton area to the south of Crewe. Whilst this route option would avoid the flood risk associated with crossing Gresty Brook in cutting, the surface route through Crewe would have a substantial increase in community impacts, requiring over approximately 110 demolitions in and around Crewe. Noise impacts would also be significantly increased compared with the preferred option, with the surface route through central Crewe in proximity to a number of residential areas.

5.2.15 Option 09 would, similar to the preferred option, have moderate landscape and visual impacts around the Chorlton area to the south of Crewe. As with Option 08, this route would avoid the flood risk associated with crossing Gresty Brook in cutting. However, similar to Option 08, the surface route through Crewe would have a substantial increase in community impacts, requiring over approximately 90 demolitions in, and around, Crewe. Noise impacts would also be significantly increased compared with the preferred option, with the surface route through central Crewe in proximity to a number of residential areas.

Figure 34: Local alternatives considered for surface routes through Crewe



Middlewich to Pickmere (routes through salt mining areas)

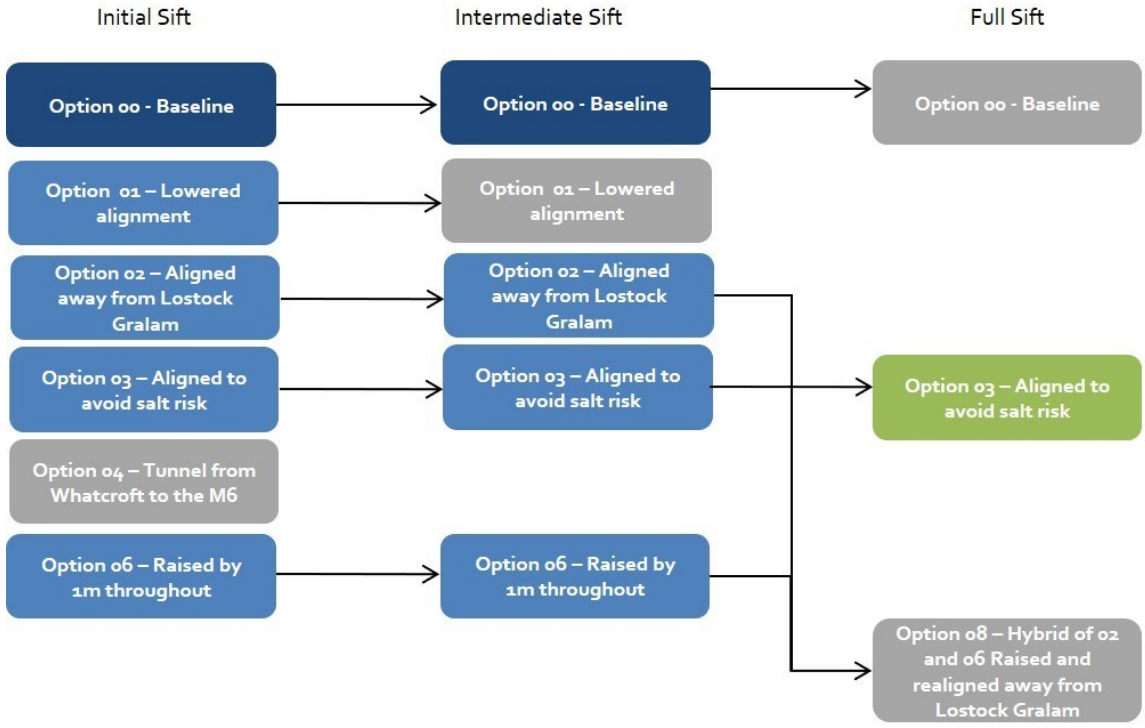
5.2.16 This refinement area covered approximately 26km of the route, from the tunnel portal south of Crewe to the M6 crossing north of Pickmere. The refinement considerations were to address the concerns over the proximity of the HS2 main line to the villages of Lostock Green and Lostock Gralam as well as Pickmere Telescope. The refinement also considered risks associated with the large expanse of salt fields and salt mining north of Crewe, and gas storage in the area. As part of the refinement, a further review of alternative route corridors from Crewe heading north-east towards Manchester Airport via Mobberley was also undertaken.

5.2.17 HS2 Ltd considered three options as part of alternative routes towards Manchester Airport via Mobberley. These were taken to an intermediate sift based on a review of previous evidence, which reaffirmed the original conclusions that these were less viable from a cost, engineering and/or sustainability perspective, when compared with the existing RRB. A further six options were considered as alternatives to the route across north Cheshire to join with the Manchester junction at Hoo Green. Five options were taken to an intermediate sift, of which two existing options plus a further option were progressed to full sift. These were Options 00, 03 and 08. Option 08 was developed following the intermediate sift, and was a hybrid of previously considered Options 02 and 06.

5.2.18 Following more detailed investigation into concerns raised regarding geological salt and gas storage risk, some further refinement work was undertaken. Options previously considered were revisited, with Option 03 brought back into consideration from the earlier intermediate sift.

5.2.19 Following this review, three options were considered as part of the July 2014 Middlewich to Pickmere refinements, which sought to address geological salt and gas storage risks. These included the RRB, together with the hybrid Option 08 and a redesigned Option 03. These three options were progressed to a full sift, as shown in Figure 35 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 36.

Figure 35: Local alternatives considered for Middlewich to Pickmere



5.2.20 The following options were studied during the full sift:

- Option 00: the RRB. The route would run in a bored tunnel under Crewe, surfacing to the north near Coppenhall alongside the existing WCML. It would continue northwards in a mix of shallow cutting and at grade, moving away from the WCML near Wimboldsley, and would continue north between Winsford and Middlewich. It would cross the River Dane and the Trent and Mersey Canal on an approximately 10m high viaduct, before rising onto embankment, and would veer north-east towards Lostock Gralam, passing to the east of Lostock Green. The route would continue to the west of Pickmere Telescope before entering cutting and then onto embankment approaching the M6;
- Option 03: would run in bored tunnel under Crewe before surfacing near Coppenhall and upon reaching the surface would continue throughout the remainder of the route section at a minimum elevation of 1m above ground level. This would reduce the risk associated with salt dissolution and gas storage compared to Option 00. North of Crewe, it would initially follow a similar horizontal profile to Option 00 (RRB) and would head north to the west of Wimboldsley on embankment between Middlewich and Winsford. The route would then continue north and would cross the River Dane on an approximately 26m high viaduct, with three crossings of the Trent and Mersey Canal. Approaching Rudheath, the route would start to head north-east, alongside the existing A556 to the west of Lostock Green, and would continue north to the east of Lostock Gralam and Pickmere Telescope. It would continue on embankment over the M6; and

- Option 08: would follow a similar horizontal alignment to that of Option 00 (RRB), but upon surfacing north of Crewe would be elevated throughout the length of this section to a minimum height of approximately 1m above ground level in order to reduce the risks associated with salt dissolution and gas storage compared to Option 00. The route would head north of Crewe on low embankment, before an approximately 26m high viaduct crossing of the River Dane, and would continue on a mix of embankment and viaduct towards Lostock Gralam. This route would include an approximately 60m shift eastwards (compared to the RRB) and would pass Lostock Green and continue north towards and across the M6 on embankment.

5.2.21 Options 03 and 08 were taken forward as viable alternatives, pending further investigation into the salt/brine and gas storage risks. Option 03 was confirmed as the preferred option.

5.2.22 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.23 Option 03 was considered preferable as it would avoid large swathes of land associated with salt mining and gas storage, which would reduce the engineering, constructability and maintenance risk associated with crossing this terrain. However, it was acknowledged that in avoiding these areas, there would be increased landscape, visual, noise and community (demolitions) impacts due to the need to elevate the route and the proximity of the alignment under this option to larger population areas.

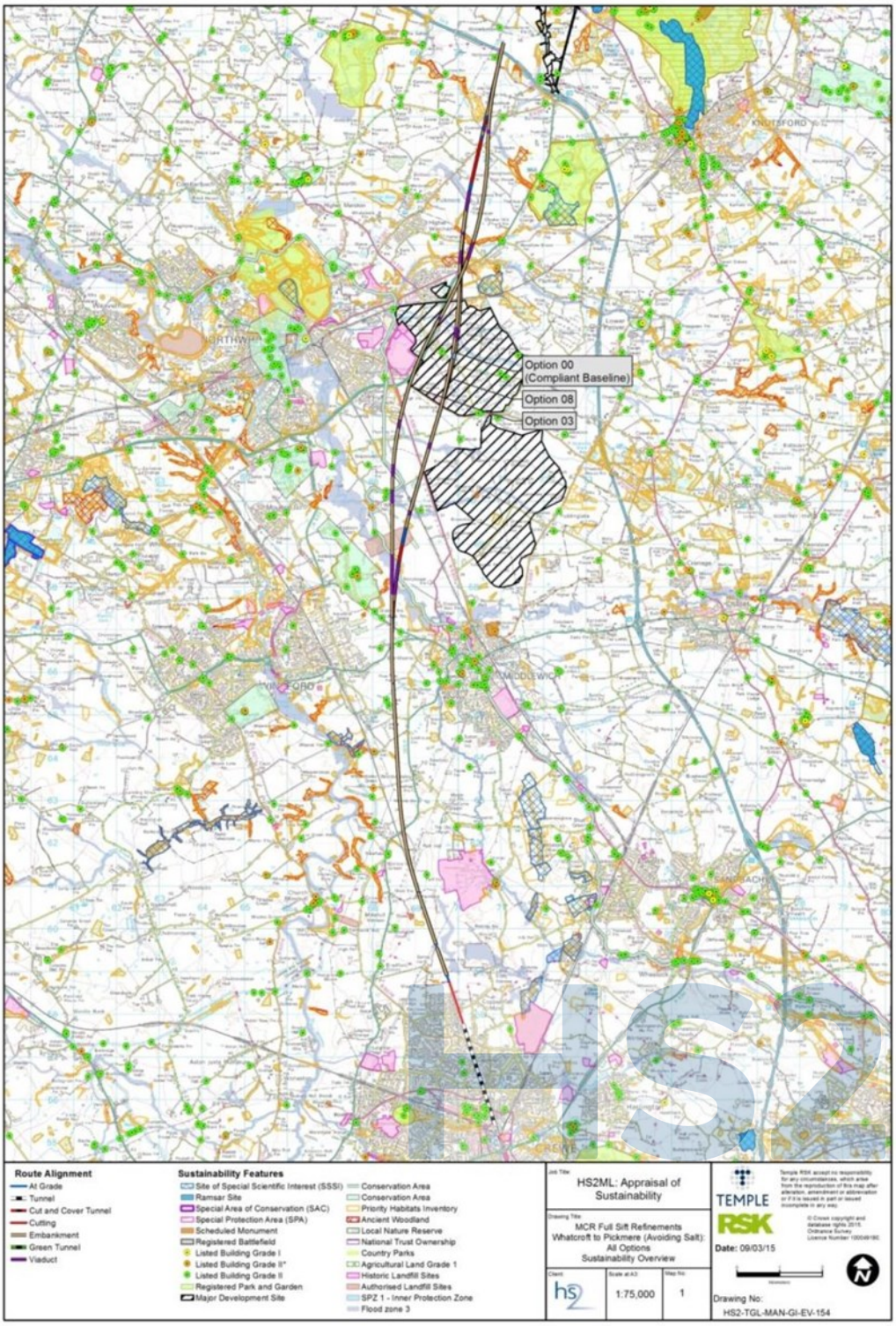
5.2.24 The preferred option, Option 03 would have moderate to localised major landscape and visual impacts as a result of the raised profile throughout much of the low-lying Cheshire Plains and proximity to communities. This would include an approximately 26m high crossing of the River Dane, which would affect the landscape character with additional visual impacts for the residents of Lostock Green and Lostock Gralam, with the route on embankment within approximately 200m of both settlements. The triple crossing of the Trent and Mersey Canal would have an impact on the setting of the associated conservation area and have a visual impact on recreational users. A diversion of the River Dane may also be required. The preferred option would also have a direct impact on two ancient woodlands (Leonards and Smokers Wood and Winnington Wood) north of Lostock Green, where the route would cross on high viaduct. Approximately 24 demolitions would be required, including two clusters of residential property demolitions near Lostock Green. Coppenhall Moss, Lostock Green, Lostock Gralam, Higher Wincham and Pickmere would all experience noise impacts as a result of the elevated route through this area. This option would also clip the western edge of the proposed Keuper Gas Storage development site.

5.2.25 Option 00 (RRB) would have minor to moderate landscape and visual impacts as a result of some intrusive structures within a relatively flat rural landscape, although less of an impact compared with the preferred option due to the greater distance from settlements along the route and lower alignment throughout. There would be only one crossing of the Trent and Mersey Canal, compared with the three crossings associated with the preferred option, although similar to the preferred route, there would be an impact on two ancient woodlands (Leonards and Smokers Wood and

Winnington Wood). Option 00 would cross through the middle of the proposed Keuper Gas Storage development site. Option 00 would require approximately 11 demolitions, fewer than the preferred option.

5.2.26 Option 08 would have moderate landscape and visual impacts as a result of being raised a minimum of approximately 1m above ground level along its length upon surfacing north of Crewe. Following a broadly similar route to Option 00, it would have a single crossing of the Trent and Mersey Canal, with approximately 11 demolitions, both fewer than the preferred option. There would be visual impacts at Lostock Green and Lostock Gralam with the route on high embankment near the settlements, similar to the preferred option, and greater than Option 00. Similar to both Option 00 and the preferred option, this route would have a direct impact on two ancient woodlands (Leonards and Smokers Wood and Winnington Wood). Similar to Option 00, this route would cross the centre of the proposed Keuper Gas Storage development site, unlike the preferred option, which would clip the western edge of the development site.

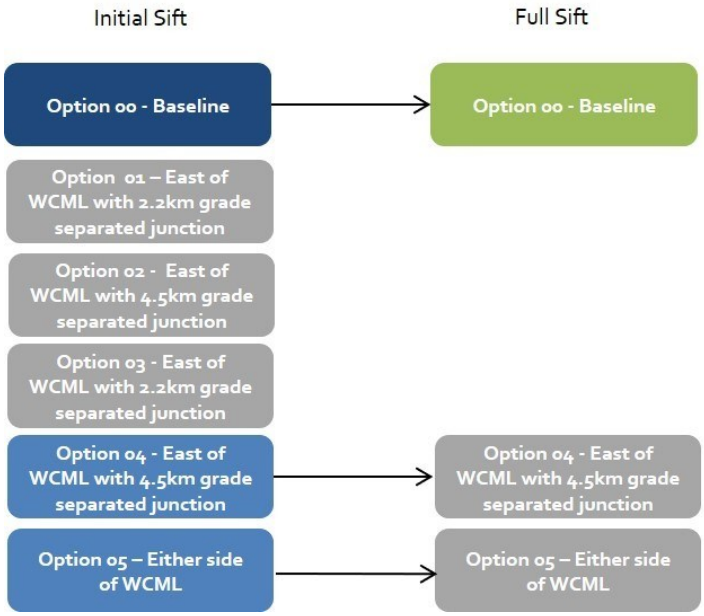
Figure 36: Local alternatives considered for Middlewich to Pickmere



WCML connections north of Crewe

5.2.27 This refinement area covered approximately 15km of the route from Crewe to Whatcroft. Reponses to the consultation requested the provision of high speed services from Crewe to Manchester and other destinations to the North. To facilitate this, the opportunity for a WCML connection to the north of Crewe, similar to the connection to the south of Crewe, was examined to enable the northbound conventional compatible services to stop at Crewe Station before returning to the HS2 main line for Manchester and the North. A total of six options were proposed, including four with grade separated junctions, with three not considered reasonable on the basis of cost, engineering and/or sustainability. The options taken forward in the sift stages are shown in Figure 37 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 38.

Figure 37: Local alternatives considered for WCML connections north of Crewe



5.2.28 The following options were studied during the full sift:

- Option 00: (the RRB) the route would include a bored tunnel under Crewe, which would surface to the north near Coppenhall alongside the existing WCML. It would continue northwards in a mix of shallow cutting and at grade to the west of Warmingham. No provision for a connection onto the WCML to the north of Crewe would be provided;
- Option 04: the route would follow a similar route to Option 00, and would include a bored tunnel under Crewe, surfacing to the north near Coppenhall alongside and to the east of the WCML. A connection to the WCML would be provided in the form of a grade separated junction, crossing over the existing WMCL; and
- Option 05: the route would include a tunnel under Crewe, surfacing to the north near Coppenhall. Upon surfacing, the route would run either side of the

existing WCML with connections on either side.

5.2.29 HS2 Ltd determined that Option 00 should be taken forward as the preferred option as there is currently no requirement to provide a connection to the WCML on the north side of Crewe. However, in the event that a WCML connection north of Crewe were to be introduced, there would be a preference for a configuration similar to Option 04 as this would provide a more viable engineering configuration for connecting with the WCML.

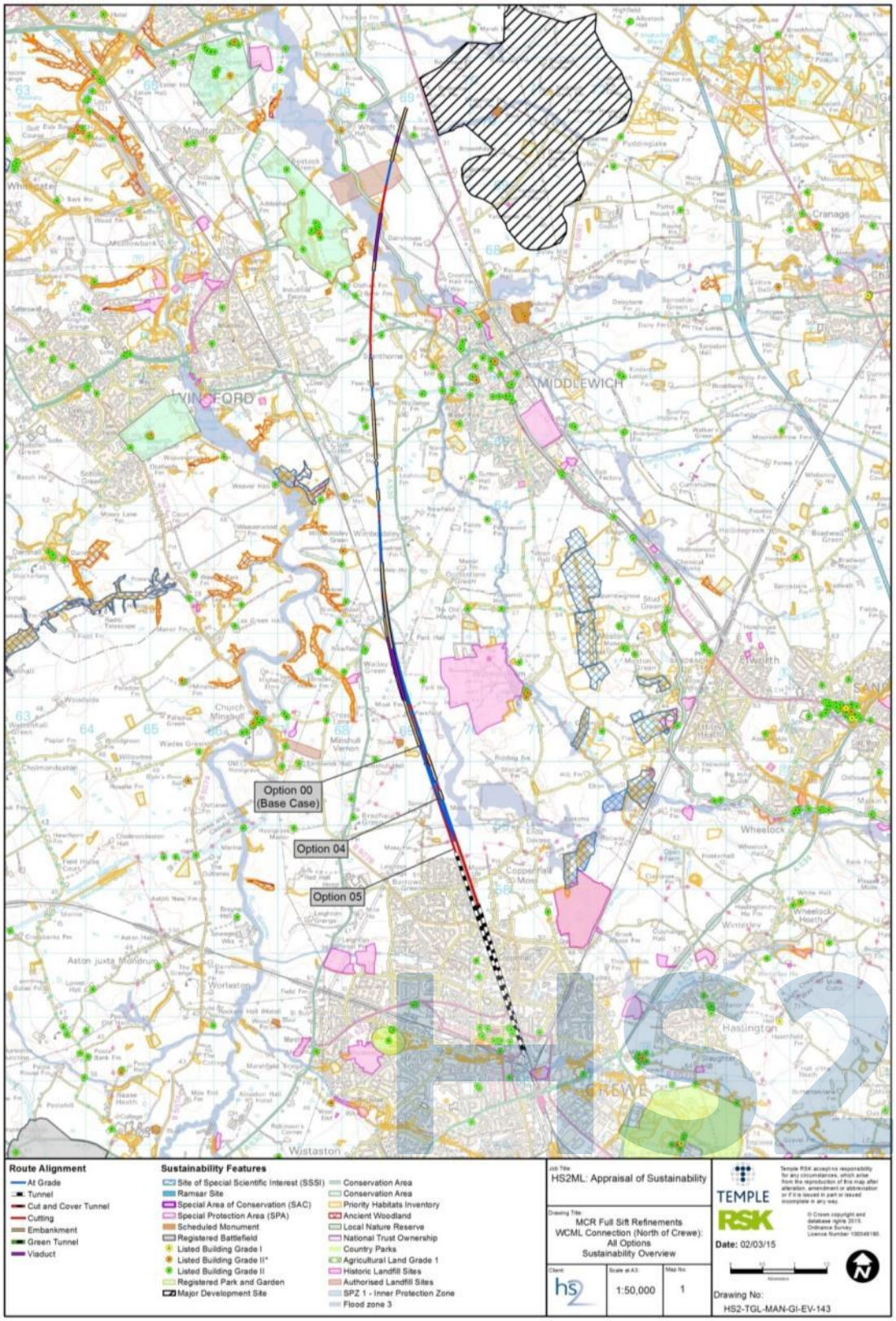
5.2.30 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.31 The preferred option, Option 00, would have minor to moderate visual impacts, predominantly in the area north of Crewe near Coppenhall, where the route would exit the bored tunnel and would run on low embankment past the residential area to the west of Crewe. There would also be some noise impacts in the same area.

5.2.32 Option 04, compared to the preferred option, would have some locally increased landscape and visual impacts as a result of the intrusive grade separated junctions to the north of Crewe, particularly for residents at Coppenhall. Noise impacts would be similar to the preferred option.

5.2.33 Option 05, similar to the preferred option, would have minor to moderate visual impacts north of Crewe where the route would begin to surface in proximity to the residential outskirts of Crewe. As a result of the connection configuration, there would be some additional land required either side of the route compared with both the preferred option and Option 04.

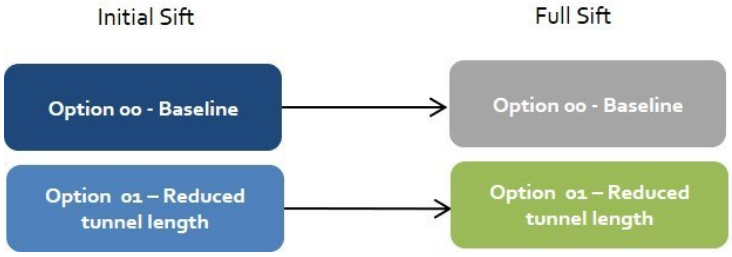
Figure 38: Local alternatives considered for WCML connections north of Crewe



Crewe tunnel northern portal (further refinement)

5.2.34 This refinement covered approximately 2km of the route and was focused around the northern portal location for the tunnel under Crewe. The refinements considered reducing the length of the tunnel under Crewe (following changes in design requirements) and improving the crossing of the Fowle Brook watercourse. Two options were proposed for this section of the route, both of which were taken to a full sift appraisal. The options taken forward in the sift stages are shown in Figure 39 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 40.

Figure 39: Local alternatives considered for Crewe tunnel northern portal



5.2.35 The following two options were taken forward to the final full sift review:

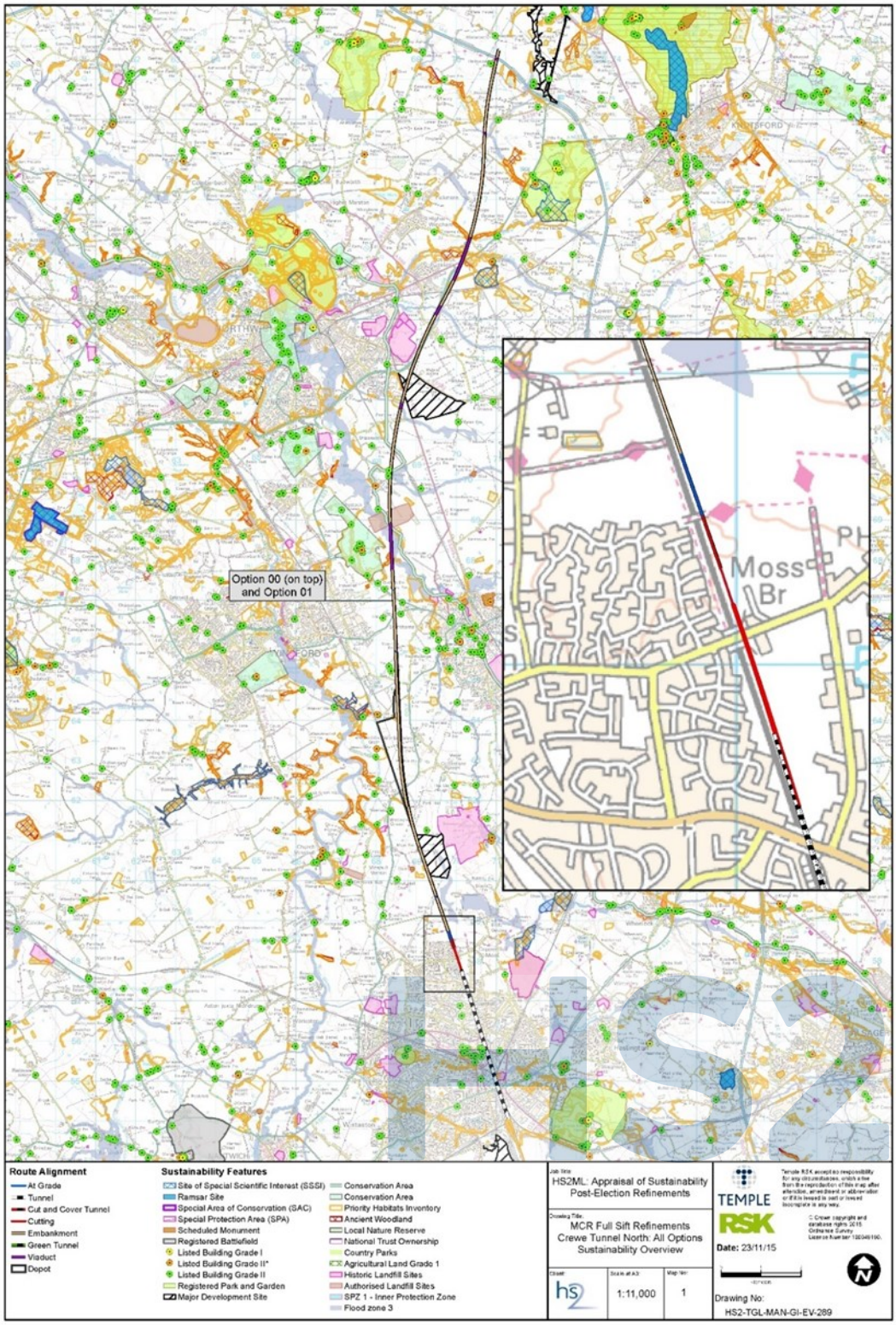
- Option 00: the DRR, would descend into a cutting south of Crewe and then into twin bored tunnel under Crewe, emerging on the northern outskirts of the town near Parkers Road; and
- Option 01: would follow a similar route to the DRR, but with a shorter tunnel under Crewe, moving the northern tunnel portal further south by approximately 265m.

5.2.36 HS2 Ltd determined that Option 01 should be progressed as the preferred option on the basis of the potential cost saving from the reduced tunnel length and the improved crossing of the Fowle Brook watercourse.

5.2.37 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.38 The preferred option, Option 01, would have a slight increase in noise and visual impacts for residents on the northern outskirts of Crewe when compared with Option 00, due to the shortening of the tunnel. It would, however, reduce the hydrological fluvial risk associated with the Fowle Brook crossing due to the tunnel surfacing sooner north of Crewe.

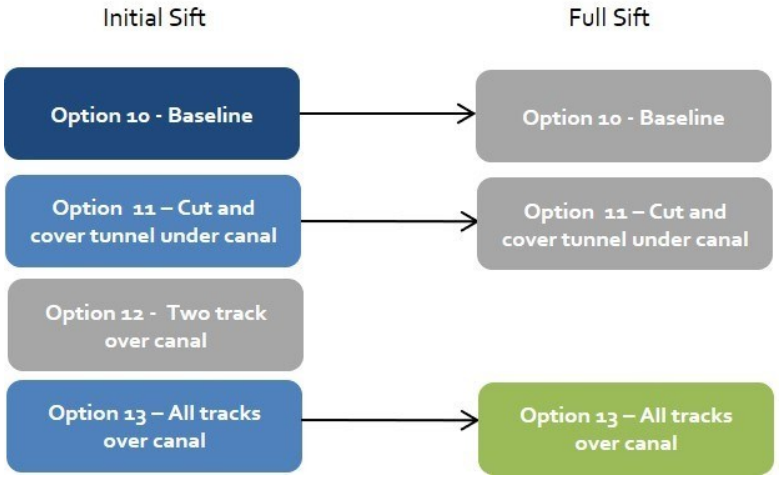
Figure 40: Local alternatives considered for Crewe tunnel northern portal (further refinement)



Delta junction zone 1

5.2.39 This refinement covered approximately 13km of the route from both Rostherne and Hoo Green to Heatley, the northern end of the delta junction. The refinement considerations were to address concerns raised during consultation regarding the crossing of the Bridgewater Canal and Agden Brook, particularly in relation to the provision of adequate clearance, navigational visibility and visual impacts. Four options were considered, with one not progressed to full sift on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 41 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 42.

Figure 41: Local alternatives considered for delta junction zone 1



5.2.40 The following options were studied during the full sift:

- Option 10: the RRB, would run in deep cutting under the M56 before rising onto viaduct over Agden Brook. This route would cross the Bridgwater Canal twice, once under the canal via a deep cut and cover tunnel and once over the canal on embankment before the north and southbound lines would converge to the north at Heatley having crossed the River Bollin;
- Option 11: would follow a similar route as Option 10 with a deep cutting under the M56. However, unlike Option 10, both the north and southbound lines would be in a cut and cover tunnel under the Bridgewater Canal; and
- Option 13: would follow a similar route as Option 10 under the M56, but at half the depth of the other options. Further north, the route would be on a raised viaduct over the Bridgewater Canal.

5.2.41 HS2 Ltd determined that Option 13 should be progressed as the preferred option. It was progressed on the basis that the alternatives would have similar impacts on the local environment but would incur additional cost or include engineering complexities associated with a section of cut and cover tunnel in a floodplain environment under the Bridgewater Canal.

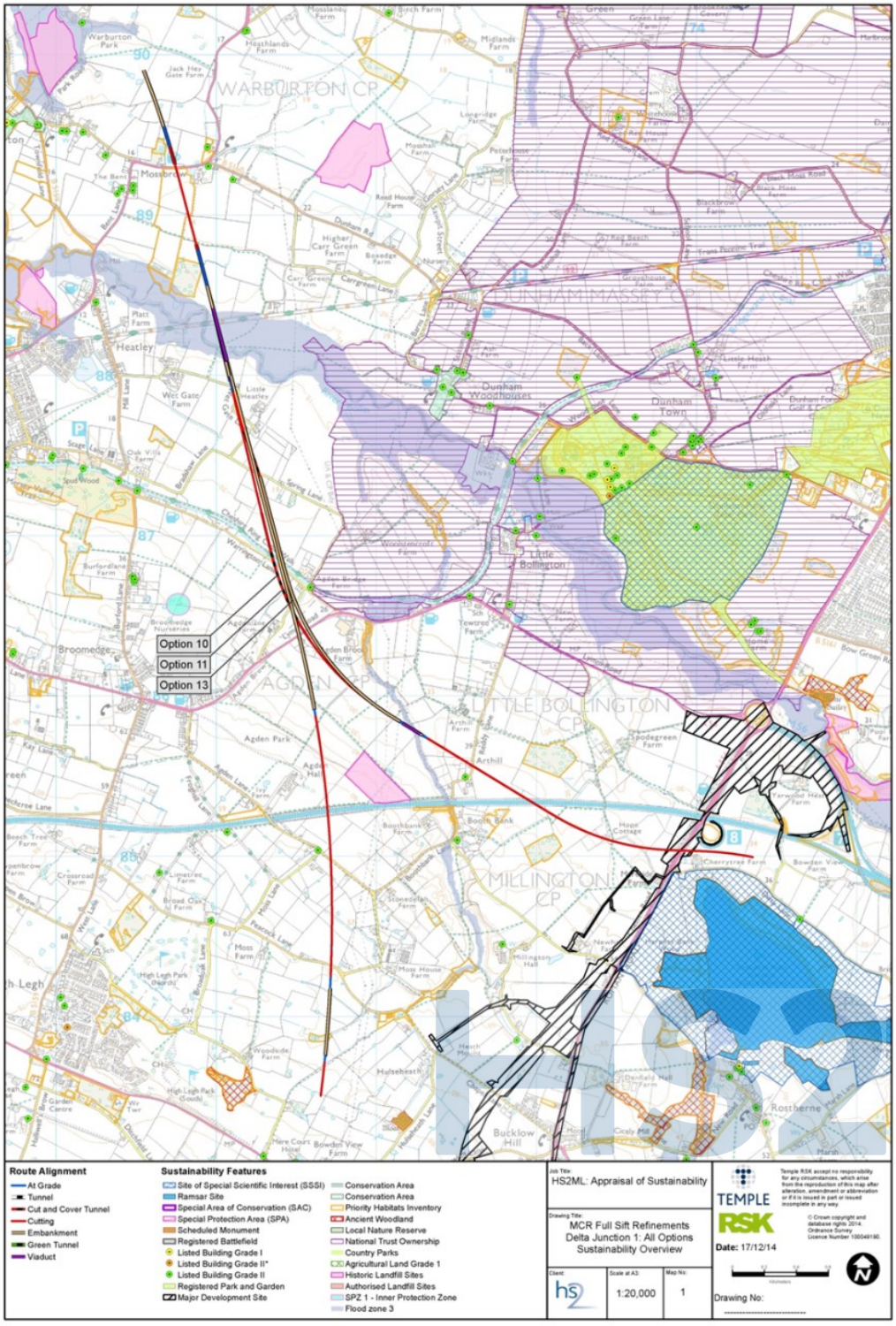
5.2.42 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.43 The preferred option, Option 13, would have moderate landscape and visual impacts as a result of the embankment structure over the Bridgewater Canal and viaduct over the River Bollin, would affect the recreational users of the canal and would intrude on the open floodplain character of the Bollin Valley. Whilst the route would cross under the M56 in cutting, it would not be as deep as either Option 10 or Option 11. There would be a moderate impact on the setting of two Grade II listed buildings (Oven Back Cottage and Chapel House), both within approximately 40m of the route. The route would also cross the development site for the realignment of the A556.

5.2.44 Option 10 would have moderate landscape and visual impacts as a result of the deep cutting under the M56 (approximately 20m below existing ground level) and the embankment and viaduct crossings of the Bridgewater Canal and River Bollin respectively. This option would also affect recreational users of the canal and would intrude on the open floodplain character of the Bollin Valley. Similar to the preferred option, there would be a moderate impact on the setting of two Grade II listed buildings (Oven Back Cottage and Chapel House), both within approximately 40m of the route. The route would also cross land required for the development site of the proposed realignment of the A556. Noise impacts would be slightly reduced when compared with both the preferred option and Option 11 due to the cut and cover tunnel under the canal.

5.2.45 Option 11 would have moderate landscape and visual impacts as a result of the deep cutting under the M56 (over 20m below existing ground level) and the viaduct crossing of the River Bollin further north, intruding on the open floodplain character of the Bollin Valley. Similar to the preferred option, there would be a moderate impact on the setting of two Grade II listed buildings (Oven Back Cottage and Chapel House), both within approximately 40m of the route. The route would also cross the land required for the proposed realignment of the A556.

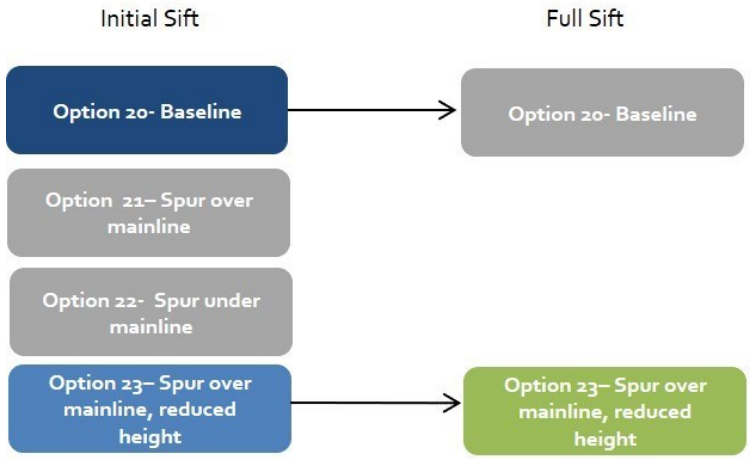
Figure 42: Local alternatives considered for delta junction zone 1



Delta junction zone 2

5.2.46 This refinement covered approximately 11km of the route. The route would run from Pickmere to Hulseheath and would also include the start of a spur from the HS2 main line towards the WCML connection at Golborne. The refinements considered reducing the impacts of the delta junction between the HS2 main line and the Manchester spur. Four options were considered for this section of the route, with two not progressed on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 43 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 44.

Figure 43: Local alternatives considered for delta junction zone 2



5.2.47 The following options were studied during the full sift:

- Option 20: the RRB. The southbound line of the spur to Manchester would pass over both the HS2 main line and the A50 at the junction of the spur and the HS2 main line at Hoo Green; and
- Option 23: would follow a similar route to Option 20, but the southbound line of the spur to Manchester would pass under the HS2 main line, reducing the overall height of the junction connections.

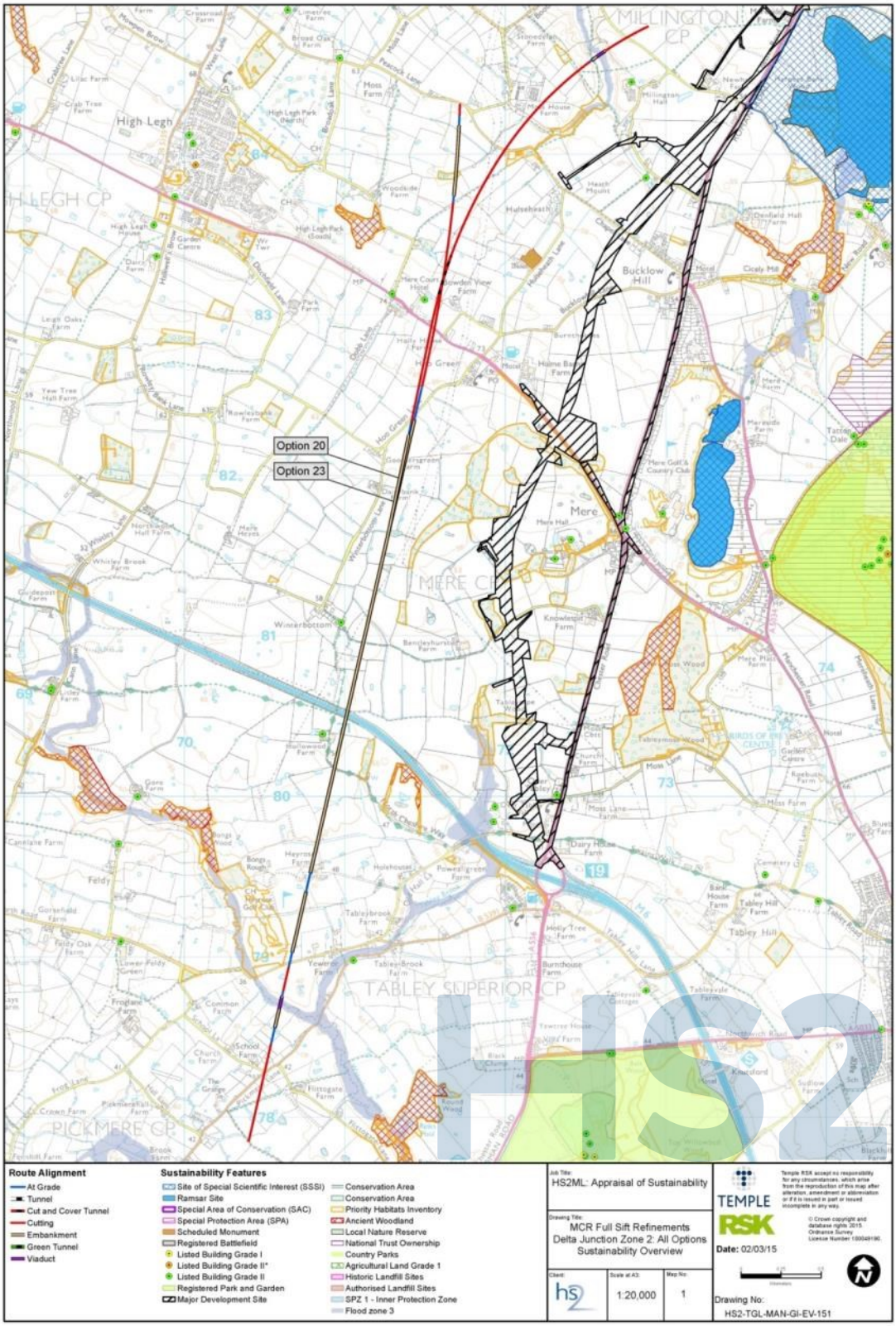
5.2.48 HS2 Ltd determined that Option 23 should be progressed as the preferred option on the basis of reduced visual impacts from lowering the junction configuration and the height needed to raise the existing A50 under Option 20.

5.2.49 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.50 The preferred option, Option 23, would have minor to moderate visual impacts as a result of sections of embankment within the flat open landscape, as well crossing the eastern edge of the golf course at Heyrose Golf Club, affecting its users. There would be a moderate to major impact on the setting of the Grade II listed Mere Court Hotel, adjacent to the Manchester junction, with land required from the hotel car park.

5.2.51 Option 20 would have moderate landscape and visual impacts as a result of sections of embankment within the flat open landscape and junction configuration, as well as the crossing the eastern edge of the golf course at Heyrose Golf Club. Similar to the preferred option, there would be a moderate to major impact on the setting of the Grade II listed Mere Court Hotel, adjacent to the Manchester junction, with land required from the car park.

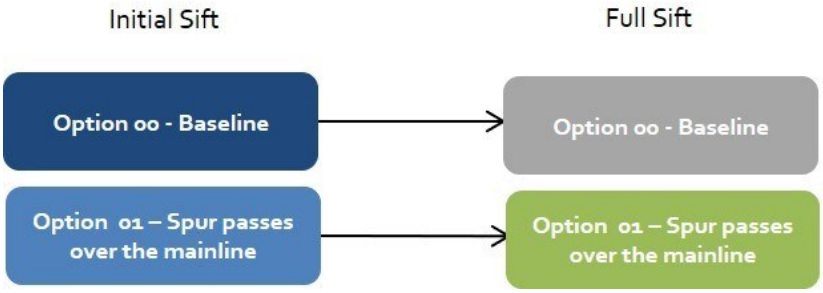
Figure 44: Local alternatives considered for delta junction zone 2



Manchester junction (further refinement)

5.2.52 This refinement comprised approximately 16km of the route and covered the Manchester junction between the HS2 main line and the WCML connection at Golborne and the spur to Manchester, close to Hoo Green. This refinement built upon the previously considered refinement of the delta junction, which reviewed the configuration of the junction between the HS2 main line and the spur to Manchester. The further refinements considered improved watercourse clearance at the grade separated junction between the HS2 main line and the spur to Manchester. Two options were progressed to full sift appraisal. The options taken forward in the sift stages are shown in Figure 45 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 46.

Figure 45: Local alternatives considered for Manchester junction



5.2.53 The following two options were taken forward to the full sift review:

- Option 00: the DRR. This option would cross the M6 and continue north, approaching Hoo Green and the Manchester junction, descending into deep cutting. The Manchester spur would pass under the HS2 main line and would head north-east towards Manchester in cutting, which would pass under Millington Clough, with limited clearance; and
- Option 01: this alternative option would similarly cross the M6 and would continue north and approach the junction at Hoo Green in a cutting. Under this option, the Manchester spur would pass over the HS2 main line and continue north-east towards Manchester and over Millington Clough, which could be culverted under the spur.

5.2.54 HS2 Ltd determined that Option 01 was the preferred option to be taken forward, on the basis of the improved crossing interface with the Millington Clough watercourse, which is what the refinement set out to achieve.

5.2.55 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.56 The preferred option, Option 01, would have moderate to localised major landscape character impacts as a result of the deep cutting close to Hoo Green where the Manchester junction would be located, alongside an impact on the setting of the Grade II listed Mere Court Hotel in the same location, to the east of the junction, with land required from the associated car park. Further north along the HS2 main line,

there would also be an impact on the setting of the Grade II listed Ovenback Cottage due to proximity to deep section of cutting where the route would approach the M56, as with the DRR. Visual impacts associated with the M6 and Bridgewater Canal crossings further north, near Winterbottom, would be the same with both the preferred option and Option 00. On the Manchester spur, the proposed crossing and culverting of Millington Clough watercourse would reduce flood risk.

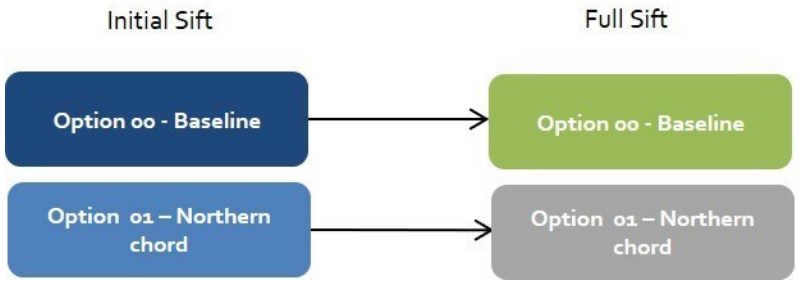
5.2.57 Option 00, the DRR, would have moderate to localised major landscape character impacts, similar to the preferred route. There would similarly be an impact on the setting of the Grade II listed Mere Court Hotel at Hoo Green, although the land required from the car park would be less than the preferred route. Further north along the HS2 main line, there would also be an impact on the setting of the Grade II listed Ovenback Cottage due to proximity to a deep section of cutting where the route would approach the M56, as with the preferred option. Visual impacts associated with the M6 and Bridgewater Canal crossings further north, near Winterbottom, would be the same with both the preferred route and alternative option. On the Manchester spur, the proposed crossing under Millington Clough watercourse would potentially require diversion of the watercourse, with increased risk of fluvial flooding.

Figure 46: Local alternatives considered for Manchester junction

Northern chord (further refinement)

5.2.58 This refinement covered approximately 8km of the route from south of Ashley to the crossing of the Bridgewater Canal near Mossbrow. The refinement considered the requirement for the northern chord of the Manchester delta junction, following the decision to relocate the RSD from Golborne to Crewe north (described in the description of the sift Crewe north RSD (further refinement) later in this section), and the associated costs. Two options were taken to a full sift appraisal. The options taken forward in the sift stages are shown in Figure 47 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 48.

Figure 47: Local alternatives considered for the northern chord



5.2.59 The following two options were taken forward to the full sift review:

- Option 00: the DRR. This option would have no northern chord and would remove the requirement for grade separated connections with the Manchester spur and the HS2 main line at either end; and
- Option 01: this option would include a northern chord, which would run from a connection with the Manchester spur, north of Rostherne, to a connection with the HS2 main line towards Golborne, near Little Heatley. Junctions at either end would be grade separated, each requiring a different configuration for the spur and HS2 main line connections.

5.2.60 HS2 Ltd determined that the northern chord was not required to support the operation of the RSD, which had been relocated to Crewe north. The chord previously facilitated the movement of rolling stock from Manchester to the RSD at Golborne.

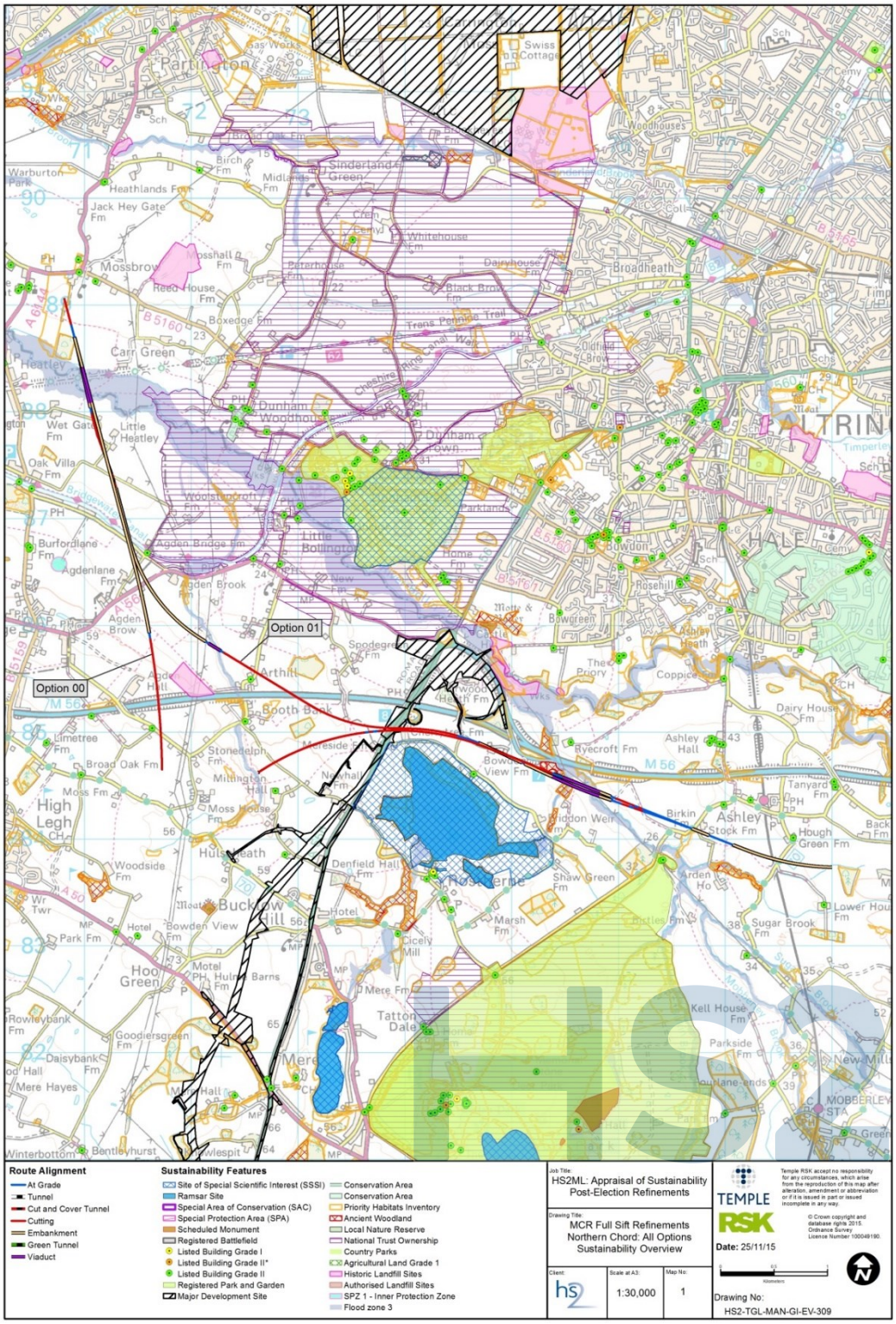
5.2.61 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.62 The preferred option, Option 00, would have moderate to localised major landscape and visual impacts south of Little Bollington and north of Rostherne Mere, as well as a direct impact on Hancock's Bank Ancient Woodland. The crossing of the Bridgewater Canal would impact recreational users of the canal near Little Heatley.

5.2.63 Option 01 would have increased major landscape and visual impacts, particularly associated with the grade separated junctions near Rostherne Mere and Little Heatley. There would also be an increased impact on recreational users of the Bridgewater Canal as a result of the additional high crossing near Little Heatley.

There would be a moderate impact on the setting of the Grade II listed Chapel House near Booth Bank due to the proximity of the northern chord in deep cutting. Option 01 would also increase the area of land required through Hancock's Bank Ancient Woodland. Approximately five additional demolitions would be required as a result of the additional infrastructure associated with the chord, when compared Option 00, which would have approximately six demolitions. Option 01 would also have a small increase in noise impacts.

Figure 48: Local alternatives considered for the northern chord

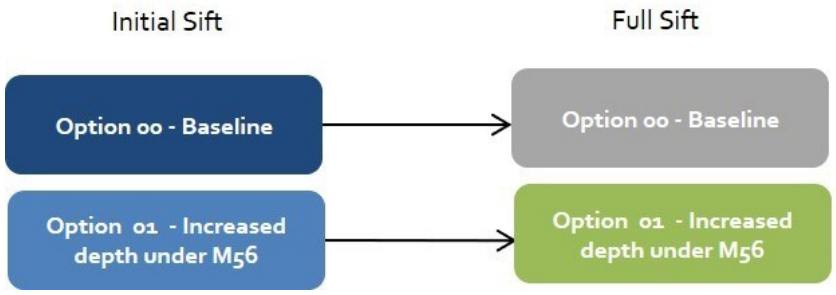


M56 crossing (further refinement)

5.2.64 This refinement covered a route section approximately 25km long. However, the focus of the refinement was on an approximately 4km section from Thorns Green to the proposed high speed station at Manchester Airport, and in particular, on the crossing under the M56 approaching the station. Two options were taken to a full sift level of appraisal. The options taken forward in the sift stages are shown in Figure 50.

5.2.65 Figure 49 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 50.

Figure 49: Local alternatives considered for the M56 crossing



5.2.66 The following two options were taken forward to the full sift appraisal:

- Option 00: The DRR. For this option, the route would be in cutting through Thorns Green and Halebank up to 9m below the existing ground level, heading east and north-east. Continuing north under the M56 and approaching the high speed station at Manchester Airport, the route would be in cutting at depths of approximately 14 to 20m below existing ground level. The crossing under the M56 may require a motorway diversion or realignment; and
- Option 01: would follow a similar route to Option 00, but at an increased depth of cutting by up to 4m. The improved clearance under the M56 would allow for a potentially favourable engineering solution for the crossing of the motorway (jacked-box construction) and reduced risk of the need for a motorway diversion.

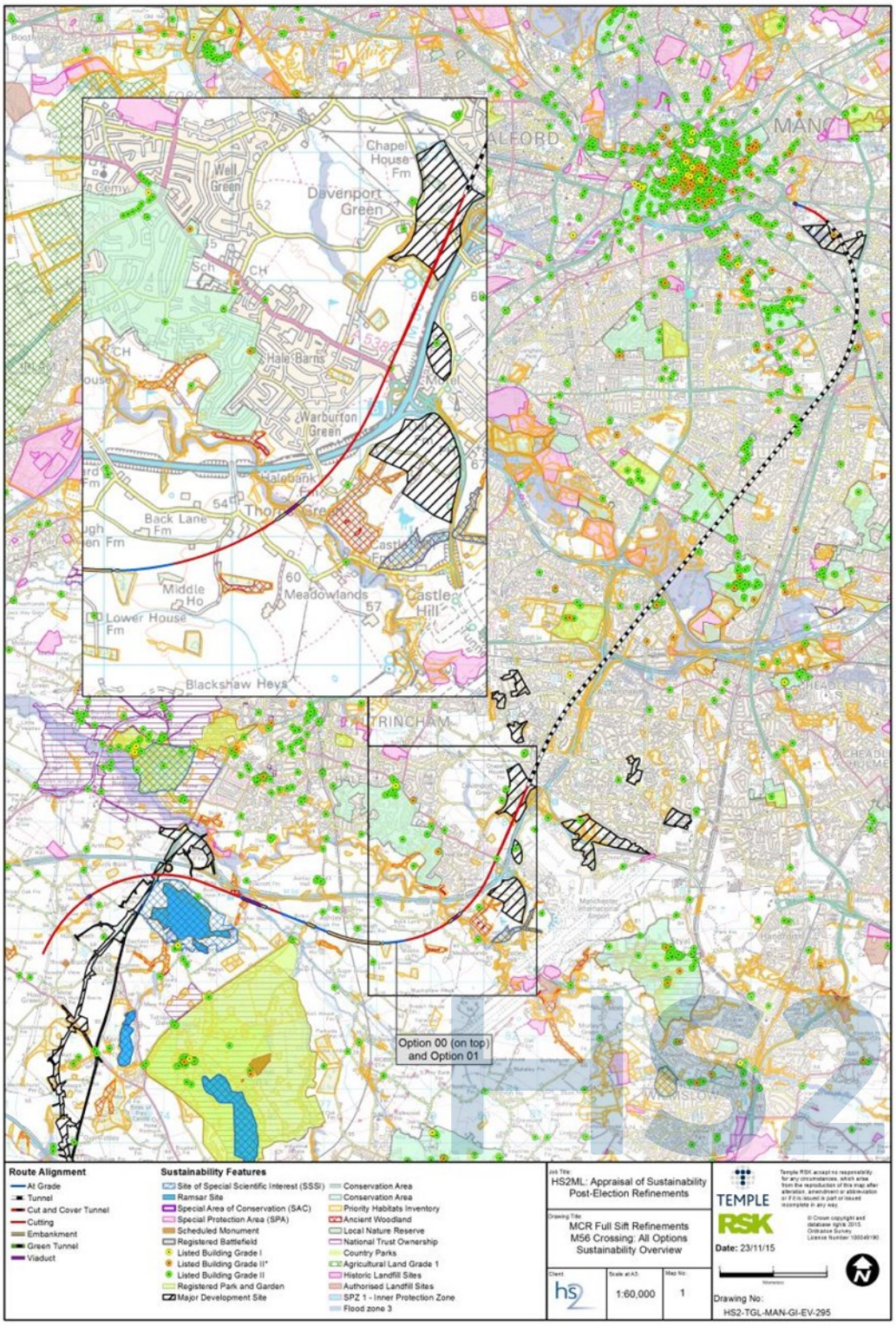
5.2.67 HS2 Ltd determined that Option 00 was the preferred option to be taken forward at this stage of the design phase. At the time of the appraisal, it was identified that construction options, and the potential for lowering the route where feasible, would be considered during the design development. Ongoing engagement with Highways England to understand their future aspirations for this section of the M56 was noted.

5.2.68 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.69 The preferred option, Option 00, would result in moderate landscape impacts due to the introduction of deep cuttings and intrusive features within a rural landscape. These would include the deep cutting through Thorns Green and Halebank and the viaduct crossing of the River Bollin. The approach to the high speed station at Manchester Airport would require the demolition of the Grade II listed Buckhall.

5.2.70 Similar to the preferred option, Option 01 would result in moderate landscape impacts, although these would be greater than those of Option 00 due to the increased depth of cuttings and associated increase in land required. As with the preferred option, this route would require the demolition of the Grade II listed Buckhall. Noise and property impacts across both options would be largely similar.

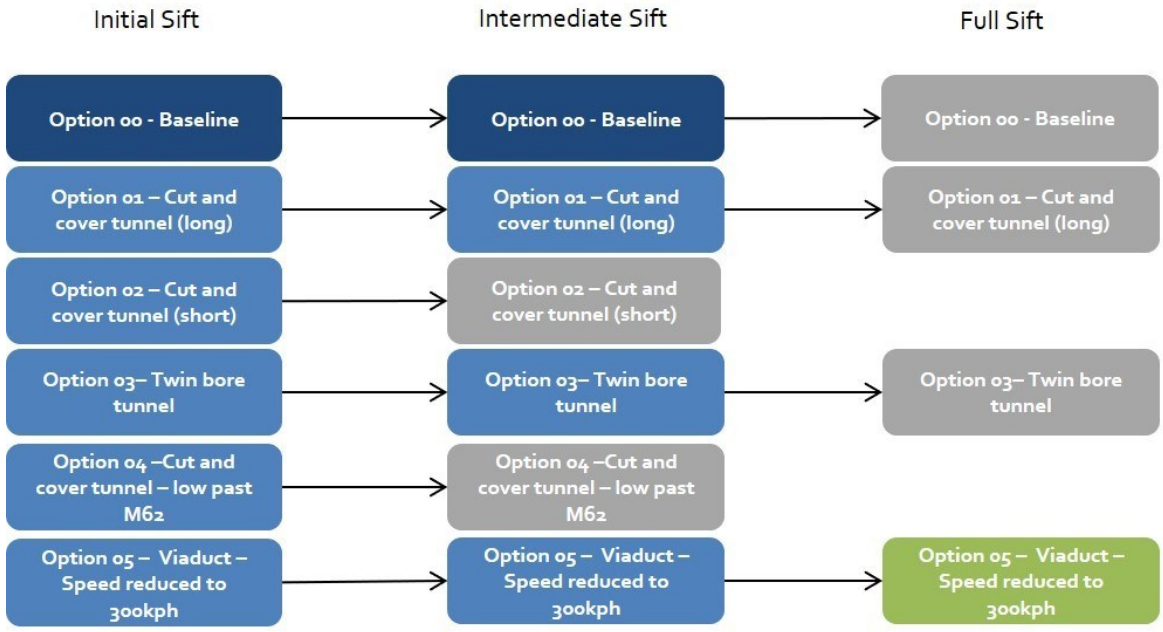
Figure 50: Local alternatives considered for the M56 crossing



Manchester Ship Canal

5.2.71 This refinement area covered approximately 12km of the route towards the WCML connection at Golborne. This route section would run from Mossbrow, across the Manchester Ship Canal and west of Culcheth to Lowton. This refinement sought to reduce landscape, visual and noise impacts of the route where it would cross the Manchester Ship Canal. Whilst the route section would cover approximately 12km, much of the focus for this refinement was around the southern section over the Manchester Ship Canal. Six options were considered for this section of the route, with two not progressed on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 51 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 52.

Figure 51: Local alternatives considered for Manchester Ship Canal



5.2.72 The following options were studied during the full sift:

- Option 00: the RRB would approach the Manchester Ship Canal on embankment and would cross the canal on a viaduct (approximately 28m high). The route would then be on embankment north of the canal and would pass to the west of Holcroft Moss on a combination of embankment and low viaduct before crossing the M62. The route would continue on low embankment past Risley landfill before continuing north-west of Culcheth. The line speed over the canal would be 345kph;
- Option 01: would follow a similar route to Option 00, but would cross under the Manchester Ship Canal in an approximately 2km long cut and cover box structure and would surface south of the M62 before rising onto embankment past Holcroft Moss and crossing over the M62. Further to the north, west of Culcheth, the route would follow a similar vertical and horizontal alignment to Option 00. The line speed under the canal would be 345kph;

- Option 03: would follow a similar route to Option 00, but would cross under the Manchester Ship Canal in an approximately 3.2km bored tunnel and would surface south of the M62 before rising onto embankment past Holcroft Moss and would cross over the M62. Further to the north, west of Culcheth, the route would follow a similar vertical and horizontal alignment to Option 00. The line speed under the canal would be 345kph; and
- Option 05: would follow a similar route to Option 00, but by reducing the line speed to 300kph on the crossing over the canal, the height of the embankments either side of the canal could be reduced. Similar to Option 00, north of the Manchester Ship Canal, the route would continue on embankment and low viaduct past Holcroft Moss and over the M62 before following a similar vertical and horizontal alignment to Option 00.

5.2.73 HS2 Ltd determined that Option 05 be taken forward as the preferred option. Whilst this would still incorporate a high viaduct crossing of the Manchester Ship Canal, the reduction in line speed on the canal crossing would allow for lower embankments either side of the canal with an associated reduction in noise impacts. Options to cross under the canal would potentially require a diversion of the canal, introducing additional engineering complexities and increased cost. The height of the canal crossing was based on clearance requirements at the time of design.

5.2.74 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

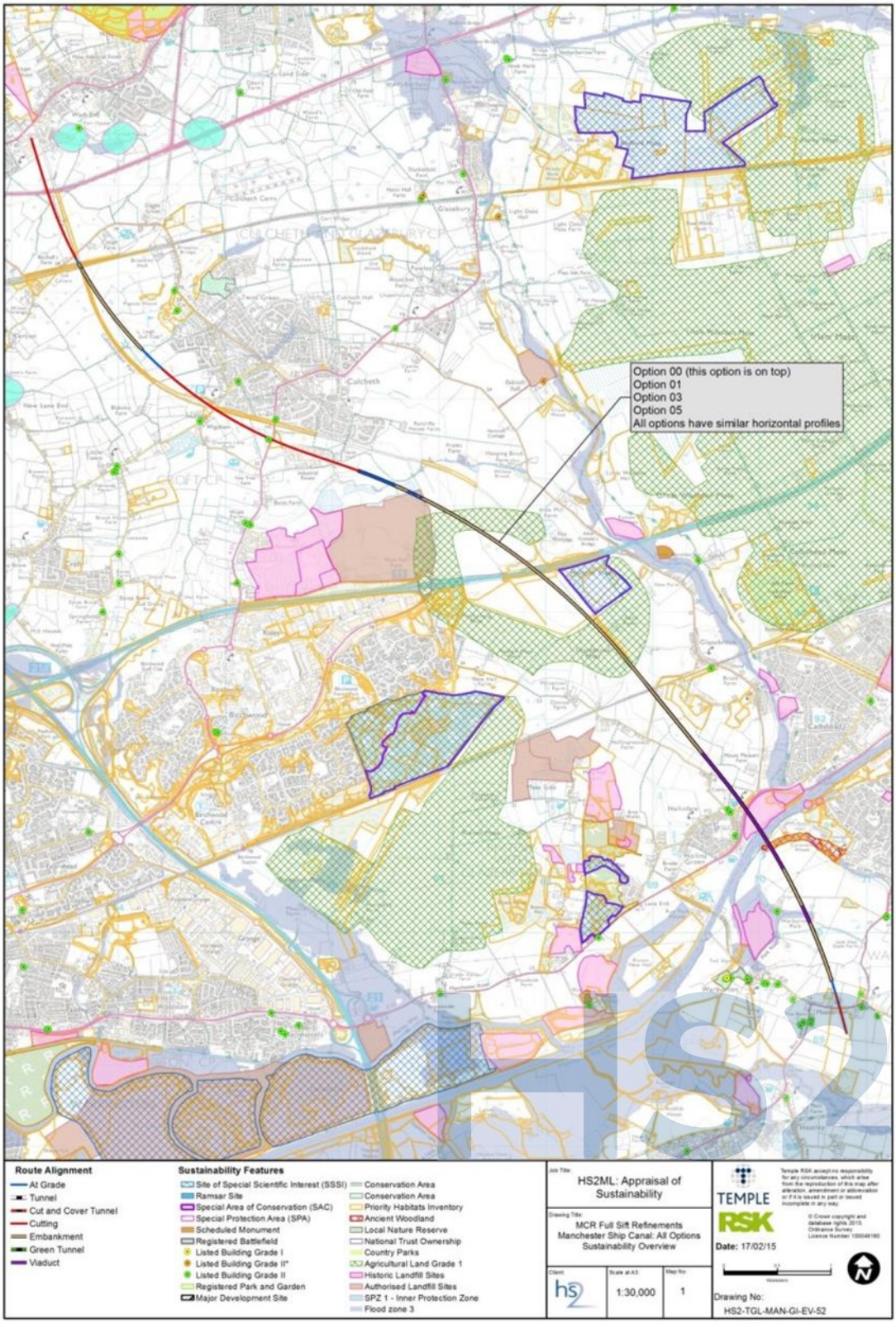
5.2.75 The preferred option, Option 05, would have major landscape and visual impacts as a result of the high viaduct crossing of the Manchester Ship Canal. The embankments either side of the canal crossing would have moderate landscape, visual, townscape and noise impacts, particularly for the residents of Hollins Green, Partington and Glazebrook. Approaching the canal, the route would cross Coroners Wood Ancient Woodland on viaduct, and to the north of the crossing, would pass to the west of Holcroft Moss SSSI within approximately 100m. North of the M62 crossing, the route would clip the edge of Risley landfill on low embankment, but would avoid impacts on the active deposition areas. West of Culcheth, the route would have a direct impact on the Grade II listed Newchurch Old Refectory, cross Culcheth Linear Park and clip the edge of Leigh Golf Club.

5.2.76 Similar to the preferred option, Option 00, would have major landscape and visual impacts as a result of the high viaduct crossing of the Manchester Ship Canal. The high embankments either side of the canal crossing would have moderate landscape, visual and townscape impacts, particularly for the residents of Hollins Green, Partington and Glazebrook, although noise impacts would be increased compared to the preferred option. Similar to the preferred option, approaching the canal, the route would cross Coroners Wood Ancient Woodland on viaduct, and to the north of the canal crossing would pass to the west of Holcroft Moss SSSI within approximately 100m. Similar to the preferred route, north of the M62 crossing, the route would clip the edge of Risley landfill on low embankment, but avoid any impacts on the active deposition areas. West of Culcheth, the route would similarly have a direct impact on the Grade II listed Newchurch Old Refectory, would cross Culcheth Linear Park and clip the edge of Leigh Golf Club.

5.2.77 Option 01 would have minor to moderate landscape and townscape impacts associated predominantly with the section of route to the north of the M62, approaching Culcheth. The cut and cover crossing under the Manchester Ship Canal would require land from Coroners Wood Ancient Woodland to the south and also introduce a major hydrological risk associated with construction of the box structure under the canal in potentially difficult ground conditions. This may require a diversion of the canal as well as box structure under the existing Warrington Railway north of the canal. Similar to the preferred option, north of the M62, the route would clip the edge of Risley landfill on low embankment, but avoid impacts on the active deposition areas. West of Culcheth, the route would have a direct impact on the Grade II listed Newchurch Old Refectory, cross Culcheth Linear Park and clip the edge of Leigh Golf Club, similar to the preferred option. Noise impacts would be substantially reduced compared with the preferred option as a result of much of the route being at, or below ground level.

5.2.78 Option 03 would have minor to moderate landscape and townscape impacts associated predominantly with the section of route to the north of the M62, approaching Culcheth. The bored tunnel crossing under the Manchester Ship Canal would require land from Coroners Wood Ancient Woodland to the south and also introduce a major hydrological risk associated with construction within a floodplain. This may require a diversion of the canal, with the tunnel also requiring a vent shaft due to its length. Similar to the preferred option, north of the M62, the route would clip the edge of Risley landfill on low embankment, but avoid impacts on the active deposition areas. West of Culcheth, the route would have a direct impact on the Grade II listed Newchurch Old Refectory, would cross Culcheth Linear Park and clip the edge of Leigh Golf Club. Noise impacts would be substantially reduced compared with the preferred option as a result of much of the route being at or below ground level.

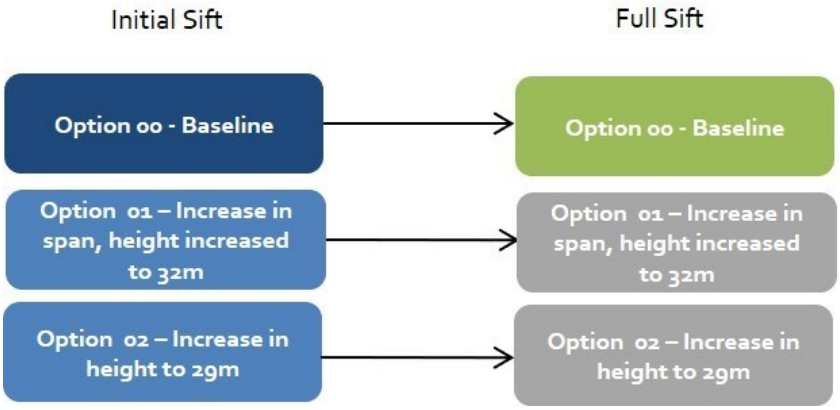
Figure 52: Local alternatives considered for Manchester Ship Canal following the 2013/2014 consultation



Manchester Ship Canal (further refinement)

5.2.79 This refinement covered approximately 12km of the route from Mossbrow to Lowton, crossing the Manchester Ship Canal, and followed a previous options review for crossing the ship canal (see previous section). The refinements specifically considered the engineering technicalities relating to the viaduct span and clearance over the canal, following further engagement with Peel Ports Ltd, who operate the ship canal. Three options were taken to a full sift appraisal. The options taken forward in the sift stages are shown in Figure 53 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 54.

Figure 53: Local alternatives considered for the Manchester Ship Canal (further refinement)



5.2.80 The following three options were taken forward to the full sift appraisal:

- Option 00: the DRR option would include a viaduct span over the canal of approximately 60m and with a maximum rail height of approximately 28m above the canal;
- Option 01: would follow the same horizontal alignment as Option 00, but would include an increased viaduct span to approximately 120m, with a maximum rail height of approximately 32m above the canal; and
- Option 02: would follow the same horizontal alignment as Option 00, and a similar viaduct span of approximately 60m, but with a maximum rail height of approximately 29m above the canal.

5.2.81 HS2 Ltd determined that Option 00 was the preferred option to be taken forward at this stage of the design phase because there was no significant improvement compared to the other options and Option 00 met the HS2 design requirements. At the time of the appraisal, it was identified that construction options and the potential for lowering the route where feasible will be considered during the design development.

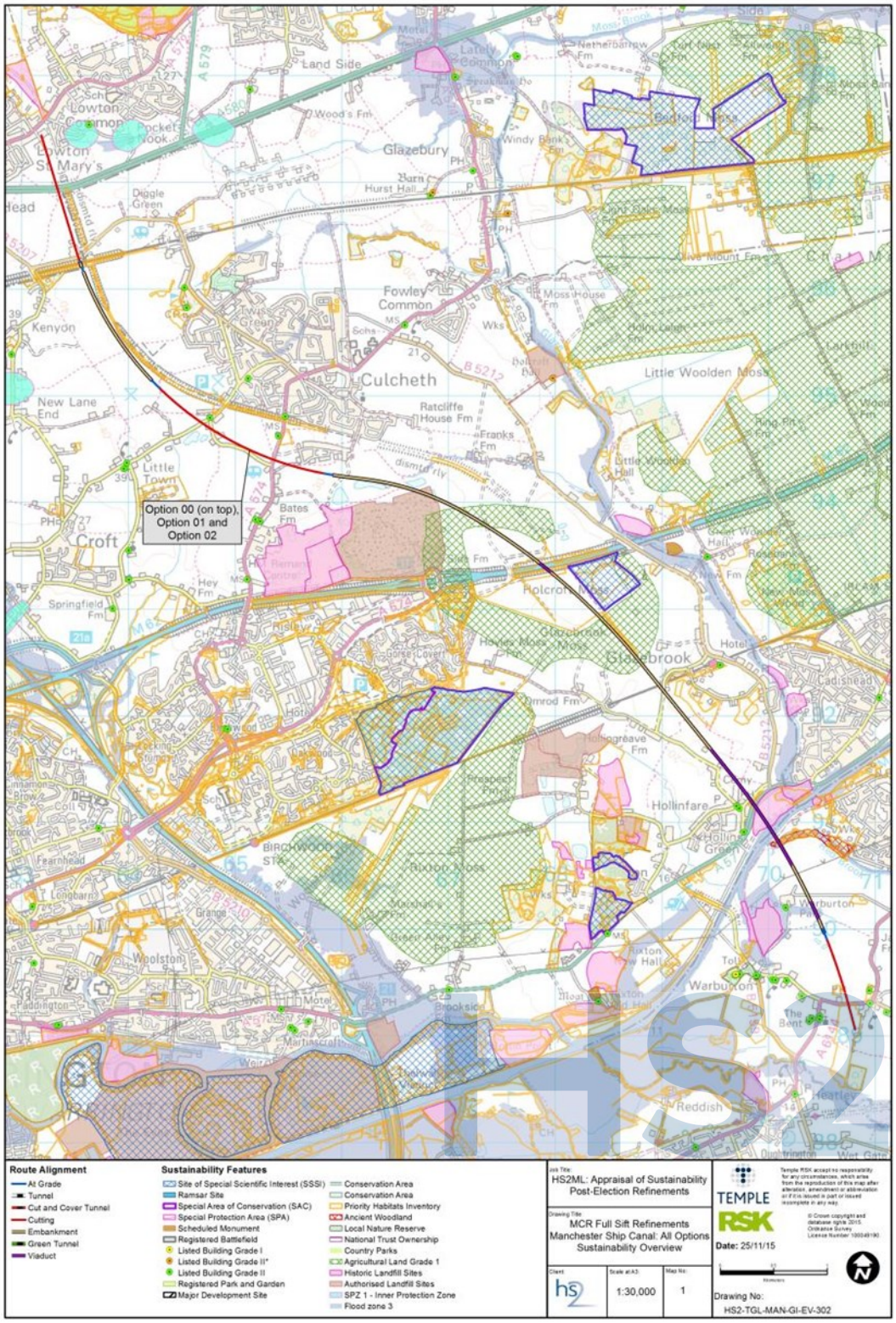
5.2.82 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.83 The preferred option, Option 00, would have major landscape and visual impacts associated with the high crossing of the Manchester Ship Canal, particularly for residents of Hollins Green, Partington and Glazebrook, where residents would also experience noise impacts.

5.2.84 Similar to the preferred option, Option 01 would have major landscape and visual impacts associated with high crossing of the Manchester Ship Canal, particularly for residents of Hollins Green, Partington and Glazebrook, where residents would also experience noise impacts. These would be slightly increased when compared with the preferred option due to the increased height of the structure over the canal.

5.2.85 Option 02, similar to the preferred option, would have major landscape and visual impacts associated with the high crossing of the Manchester Ship Canal, particularly for residents of Hollins Green, Partington and Glazebrook, where residents would also experience noise impacts. These impacts would be similar to the preferred option.

Figure 54: Local alternatives considered for the Manchester Ship Canal (further refinement)

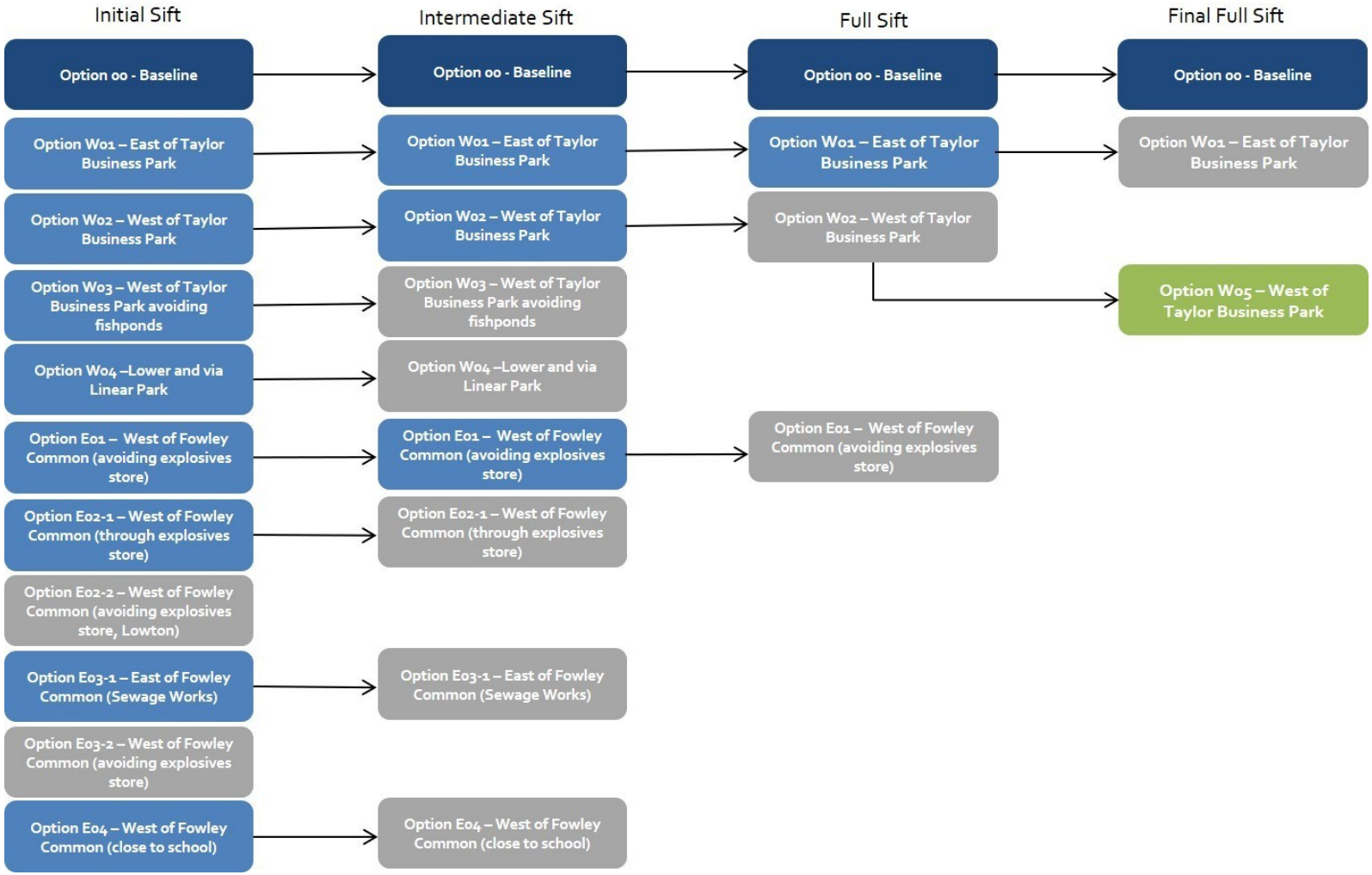


East and west of Culcheth

5.2.86 This refinement area covered approximately 17km of the route on the spur towards the WCML connection at Golborne. This route section would run from Mossbrow, across the Manchester Ship Canal, before the route options would diverge to the east and west of Culcheth and then connected with the WCML at Golborne. The aim of the refinement was to look at opportunities to reduce the impact of the route where it would pass Culcheth, particularly on Taylor Business Park and Culcheth Linear Park. A total of 11 options were considered for this section of the route, of which nine were progressed to an intermediate level, with four not considered for further progression on the basis of cost, engineering and/or sustainability grounds.

5.2.87 Following the intermediate sift, four options were progressed to full sift, comprising three options to the west of Culcheth and one further option to the east. Whilst HS2 Ltd identified a preferred option to the west of Culcheth as the refinement to progress in principle, further work was requested to be undertaken on the initial preferred option. The option to the east of Culcheth was not progressed due to a combination of sustainability impacts (including demolitions and noise), engineering challenges and associated costs. The final full sift considered the three options west of Culcheth. The options taken forward in the sift stages are shown in Figure 55 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 56.

Figure 55: Local alternatives considered for Culcheth



5.2.88 The following options were studied during the final full sift:

- Option 00: the RRB would cross the Manchester Ship Canal on high viaduct and would continue to the west of Holcroft Moss and over the M62 before passing to the south and west of Culcheth. The route would continue through the centre of Taylor Business Park in deep cutting before crossing Culcheth Linear Park and clipping the western edge of the golf course at Leigh Golf Club on embankment. The route would then head directly north, approaching Lowton in cutting before rising onto low embankment heading north-west of Golborne and joining the WCML south of Bamfurlong;
- Option W-01: would follow a broadly similar route to Option 00 over the Manchester Ship Canal and past Holcroft Moss. Approaching Culcheth, whilst remaining on the western side, the route would take a more easterly approach compared with the RRB, which would bring it approximately 90m closer to Culcheth, skirting to the east of the Taylor Business Park before continuing parallel to, and then across, Culcheth Linear Park. The route would continue north on embankment, clipping the golf course at Leigh Golf Club and would approach Lowton in cutting. It would then rise onto low embankment heading north-west of Golborne to join the WCML south of Bamfurlong; and
- Option W-05: would follow a broadly similar route to Option 00 over the Manchester Ship Canal and past Holcroft Moss. However, approaching Culcheth, the route would take a more westerly route (by up to approximately 250m) compared with the RRB, skirting to the west of the Taylor Business Park in a shallow cutting and continuing alongside and over Glaziers Lane, west of Wigshaw. The route would continue directly north, to the west of Culcheth Linear Park on embankment, and would approach Lowton in cutting before rising onto low embankment heading north-west of Golborne to join the WCML south of Bamfurlong.

5.2.89 HS2 Ltd determined that Option W-05 should be taken forward as the preferred option. This decision was on the basis of it achieving the refinement considerations of moving the route away from Culcheth, avoiding direct impacts on the Taylor Business Park, Culcheth Linear Park and the golf course at Leigh Golf Club, as well as avoiding the demolition of the Grade II listed Newchurch Old Refectory.

5.2.90 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

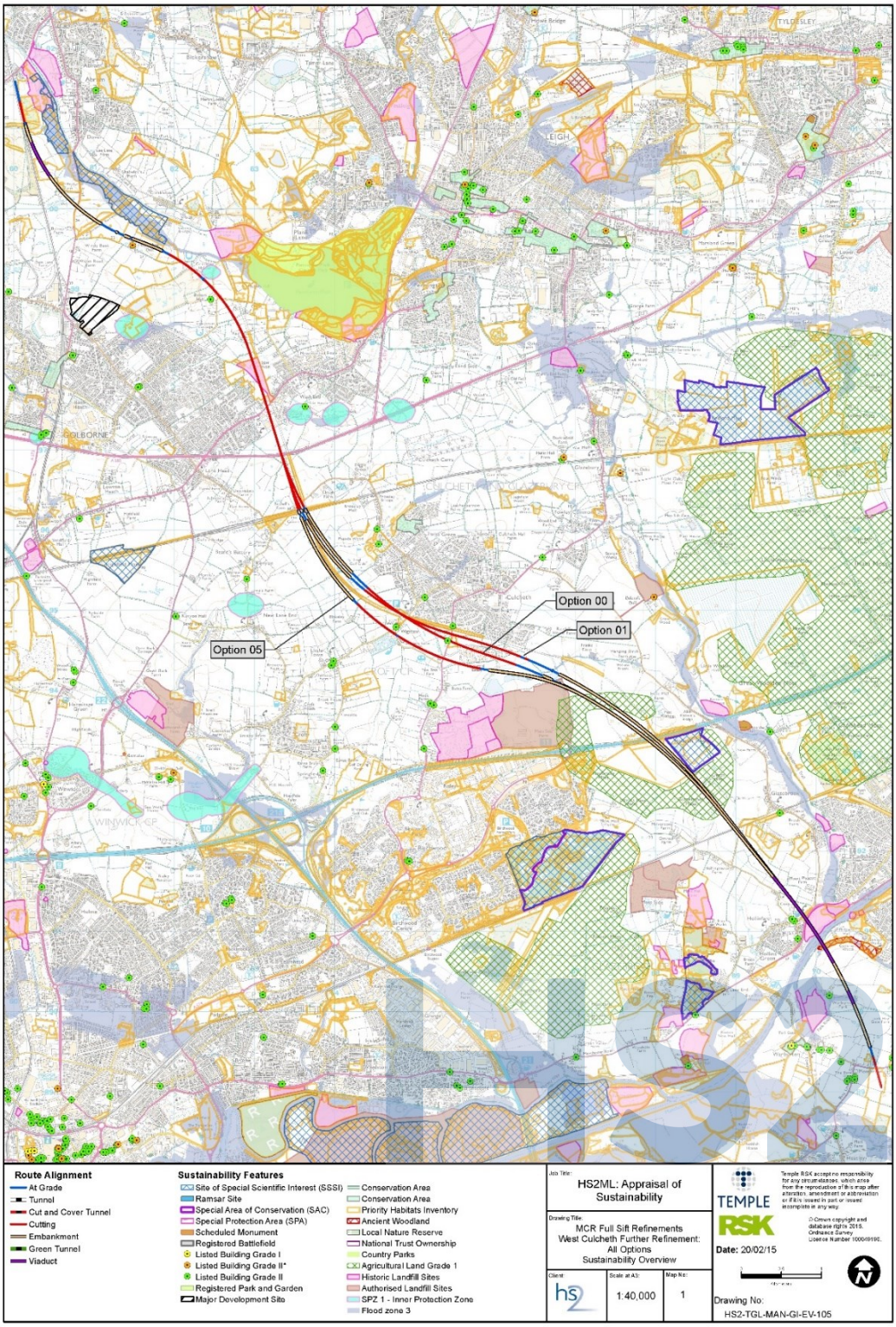
5.2.91 The preferred option, Option W-05, would have minor to moderate visual impacts on residents along the western edge of Culcheth and users of Culcheth Linear Park. South of Culcheth, and applicable to all route options, there would be major landscape and visual impacts associated with the high viaduct crossing of the Manchester Ship Canal. To the north, as with all options, the route would clip the eastern extent of Risley landfill, but avoid any impacts on the active deposition areas. There would be some noise impacts south of Culcheth and at Wigshaw, with the route also within approximately 100m of a fishery and associated commercial units where it would cross Glaziers Lane, but impacts on Taylor Business Park, the golf course at Leigh Golf Club

and the Grade II listed Newchurch Old Refectory would be avoided. North of Culcheth, and as with all options, there would be a cluster of demolitions comprising over approximately 20 commercial units as the route would run through Lowton.

5.2.92 Option 00 (RRB), would have moderate visual impacts on residents along the western edge of Culcheth and users of the Linear Park. South of Culcheth, and as with all route options, there would be major landscape and visual impacts associated with the high viaduct crossing of the Manchester Ship Canal. The route would clip the eastern extent of Risley landfill, but would avoid any impacts on the active deposition areas. There would be increased noise impacts for residents of Culcheth, compared with the preferred option, and the route would cross the Taylor Business Park in deep cutting, requiring over 20 commercial demolitions. The Grade II listed Newchurch Old Refectory would be demolished and the route would cross Culcheth Linear Park in cutting, with land also required from the golf course at Leigh Golf Club to the north. As with all options, there would be a cluster of demolitions of over approximately 20 commercial units as the route would run through Lowton.

5.2.93 Option W-01, would have moderate visual intrusion for residents on the western edge of Culcheth and users of the Linear Park. South of Culcheth, and applicable to all route options, there would be major landscape and visual impacts associated with the high viaduct crossing of the Manchester Ship Canal. The route would similarly cross the eastern edge of Risley landfill, but would avoid any impacts on the active deposition areas. There would be increased noise impacts for residents of Culcheth, compared with the preferred option, but impacts on Taylor Business Park and the Grade II listed Newchurch Old Refectory would be avoided. The route would cross Culcheth Linear Park in cutting with land also required from the golf course at Leigh Golf Club to the north. As with all options, there would be a cluster of demolitions of over approximately 20 commercial units as the route would run through Lowton.

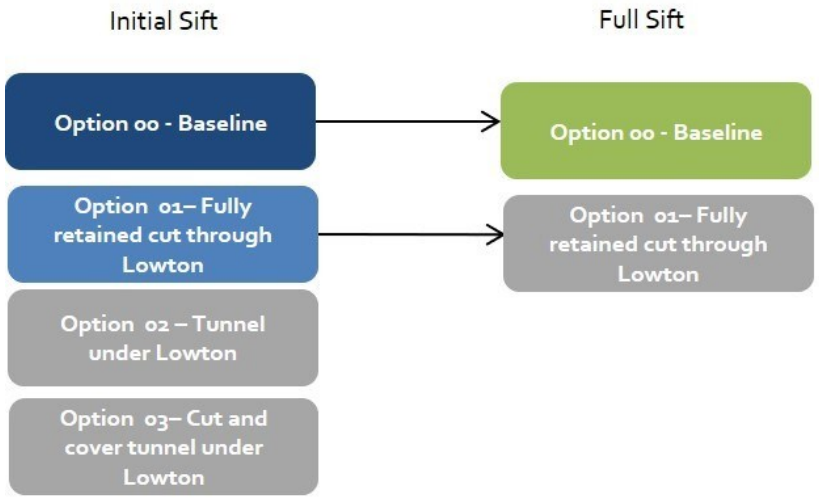
Figure 56: Local alternatives considered for Culcheth



Lowton gap

5.2.94 This refinement area covered approximately 17km of the route from Warburton to Abram, although the focus of the refinement was the short section between Lowton and Lowton Common, termed the Lowton gap. This route refinement sought to define the most appropriate route close to the community of Lowton. Four options were considered for this section of the route, with two not considered for further progression on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 57 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 58.

Figure 57: Local alternatives considered for Lowton



5.2.95 The following options were studied during the full sift:

- Option 00: the RRB would approach Lowton in cutting between approximately 4 and 8m below existing ground level and up to approximately 70m wide. The route would cross under Newton Road and would continue north through Lowton Common before rising north-east of Golborne; and
- Option 01: would follow the same horizontal and vertical alignment as Option 00, however, the cutting would be retained through Lowton and under Newton Road, reducing the maximum width by up to approximately 40m. Further to the north, the route would be identical to Option 00.

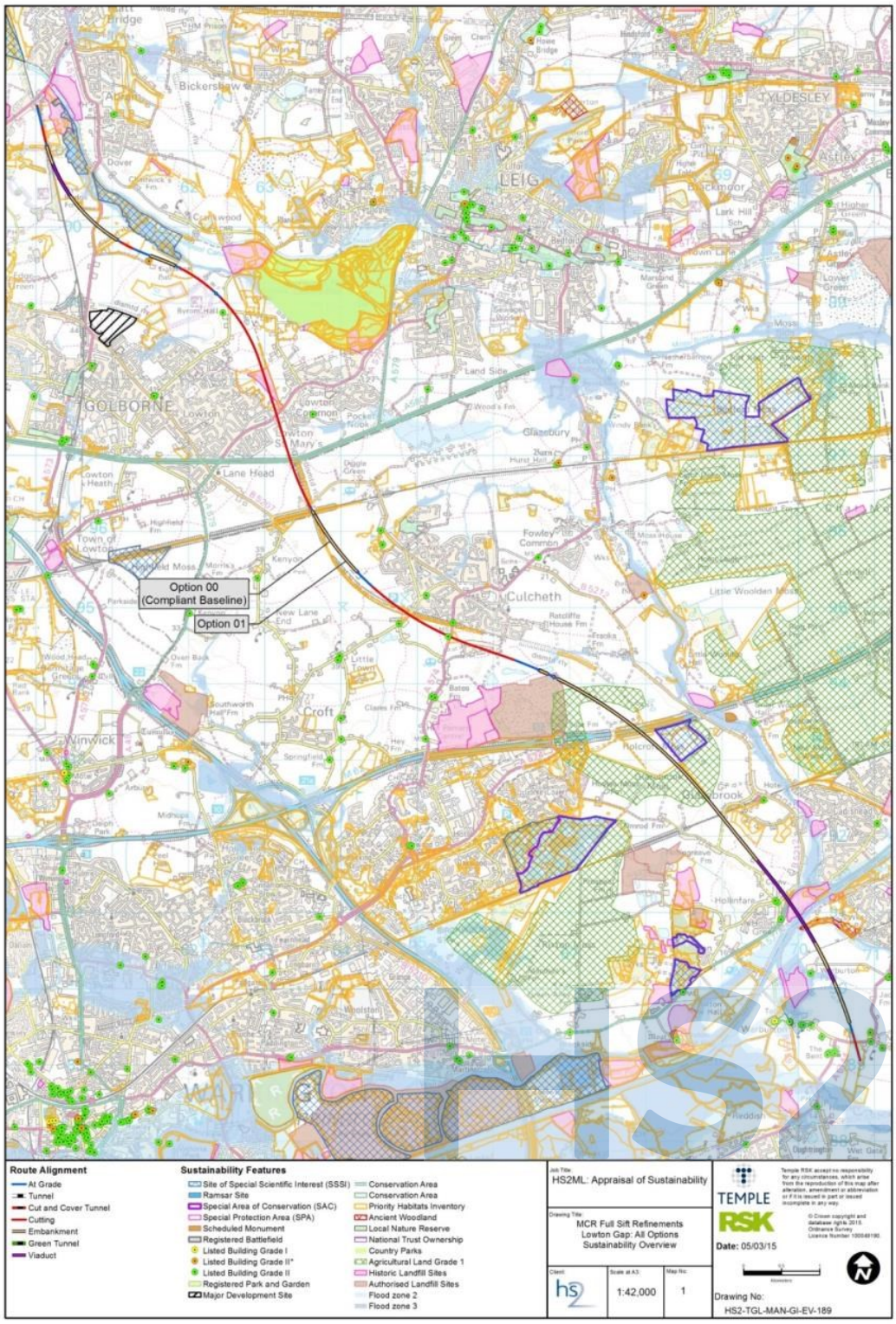
5.2.96 HS2 Ltd determined that Option 00 should be retained as the preferred option. The alternative option did not significantly reduce sustainability impacts to justify the additional cost and engineering complexities associated with the retained cut.

5.2.97 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.98 Option 00 (RRB), the preferred option, would have some noise impacts for residents at Lowton as the route would pass under Newton Road, although the depth of cutting would help to limit these impacts. There would also be a cluster of over approximately 20 commercial demolitions immediately south of Newton Road, with a cluster of approximately five residential property demolitions to the north.

5.2.99 Option 01, due to engineering complexity and greater costs, was not taken forward. Option 01 would have similar noise impacts for residents at Lowton as the route would also pass under Newton Road, although the depth of cutting would help to limit these impacts. There would also be a cluster of over approximately 20 commercial demolitions immediately south of Newton Road, although to the north, there would be two fewer residential demolitions as a result of the reduced width of cutting, when compared with the preferred option.

Figure 58: Local alternatives considered for Lowton



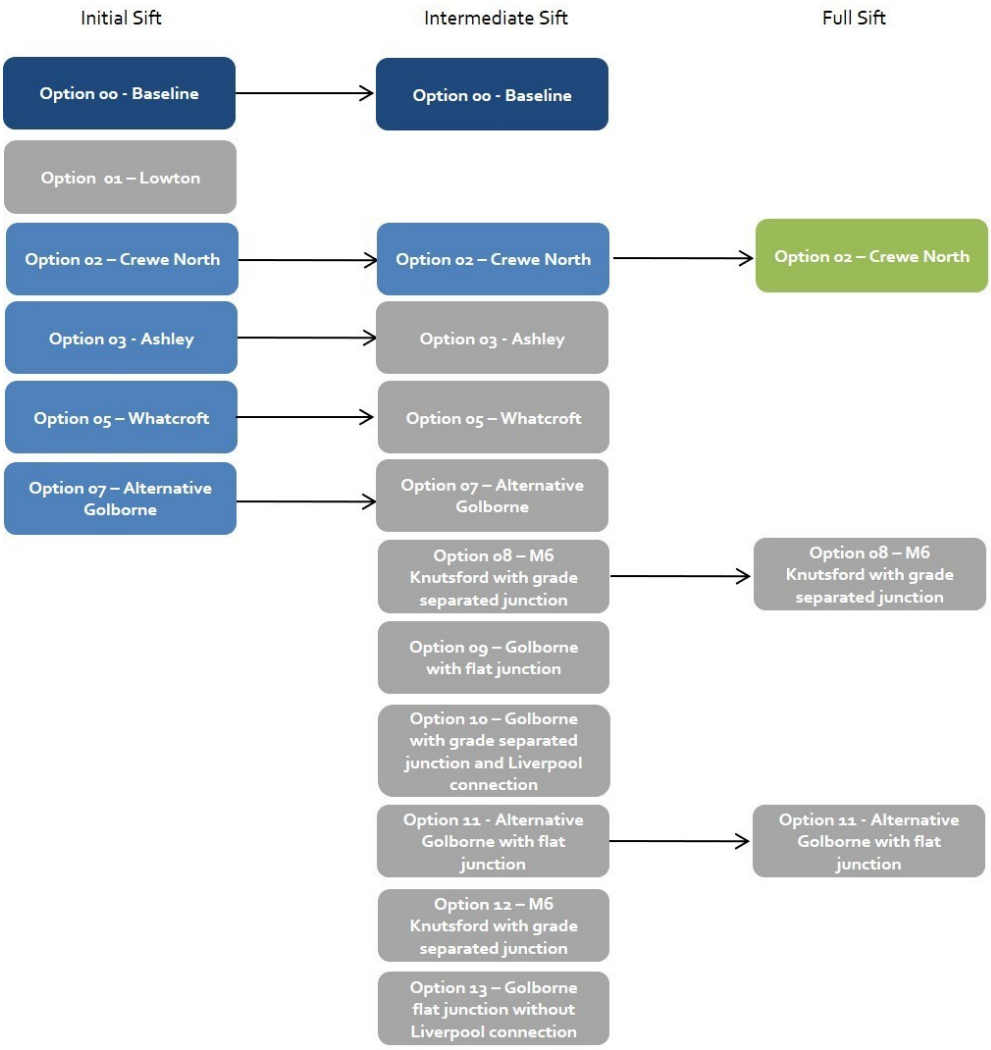
Alternative rolling stock depot locations

5.2.100 This refinement area covered options and alternative sites for the location of the RSD between Crewe, Manchester and the WCML connection at Golborne. The refinement considerations were to improve the RSD location and layout, address environmental and stakeholder concerns with the existing configuration and site at Golborne as well as ensuring compatibility with the wider network operational requirements.

5.2.101 A total of six options were considered initially. A further set of refinements then looked more specifically at the potential layout of a RSD at Golborne as well as the other preferred locations at Knutsford and Crewe north. HS2 Ltd considered a further option developed at Knutsford M6, four alternative layouts of the RSD at Golborne and the option previously progressed at Crewe north.

5.2.102 Of the options proposed for Golborne, Option 11 was chosen as the preferred option to be taken forward to the full sift and became the baseline option. This option had an alternative layout and moved the route away from the Grade II* listed Lightshaw Hall and Abram Flashes SSSI, with the associated at grade junction reducing some of the landscape and visual impacts. Options at both Knutsford and Crewe north were also progressed to the full sift. The options taken forward in the sift stages are shown in Figure 59 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 60 and Figure 61.

Figure 59: Local alternative locations considered for the depot



5.2.103 The following options were studied during the full sift:

- Option 02 would be located north of Crewe, east of Wimboldsley between the HS2 main line and the WCML. A connection with the HS2 main line would be provided via a grade separated junction at the northern end of the RSD site, close to Stanthorne;
- Option 08 would be located west of Knutsford, immediately north of where the HS2 main line would cross the M6. A connection with the HS2 main line would be provided via a grade separated junction over the HS2 main line; and
- Option 11 would be located to the north of Golborne, south of the HS2 main line and the connection with the WCML at Bamfurlong. However, this RSD would have an alternative internal layout compared with 2013 proposed scheme for consultation option bringing the RSD site closer to Golborne (and further from Lightshaw Hall), with an at grade junction to the north of the RSD with connections to both the WCML and Liverpool.

5.2.104 HS2 Ltd determined that Option 02 should be taken forward as the preferred option, with further work to be undertaken to find the optimal engineering configuration within the Crewe north site and re-evaluate the associated costs. Relocating the RSD would reduce sustainability impacts in the Golborne area, most notably through avoiding a direct impact on the Grade II* listed Lightshaw Hall, which was previously within the RSD site.

5.2.105 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.106 The preferred option, Option 02, would introduce landscape and visual impacts associated with the RSD and connections on residents of Wimboldsley, in addition to the impacts from the HS2 main line through the area. There would be impacts on the setting of the Grade II* listed Lea Hall and associated Grade II listed Gate Piers, along with minor impacts on the setting of the Grade II* listed Barn, part of Twelve Acres Farmhouse.

5.2.107 Option 11 would have moderate to major cumulative landscape and visual impacts for residents of Golborne as a result of the RSD, depot connections and the HS2 main line. There would also be visual impacts for recreational users of the Leeds and Liverpool Canal and Abram Flashes SSSI to the north of the RSD site. There would be moderate impacts on the setting of both the Grade II* listed Lightshaw Hall and Grade II listed Byrom Hall.

5.2.108 Option 08 would have moderate to major landscape and visual impacts as a result of intrusive structures within a predominantly flat open landscape west of Knutsford and Mere Hall. The depot and high grade separated connections would have a moderate impact on the setting of two Grade II listed buildings: Winterbottom Farmhouse and Hollow Wood Farm.

Figure 60: Local alternatives considered for the depot (part 1 of 2)

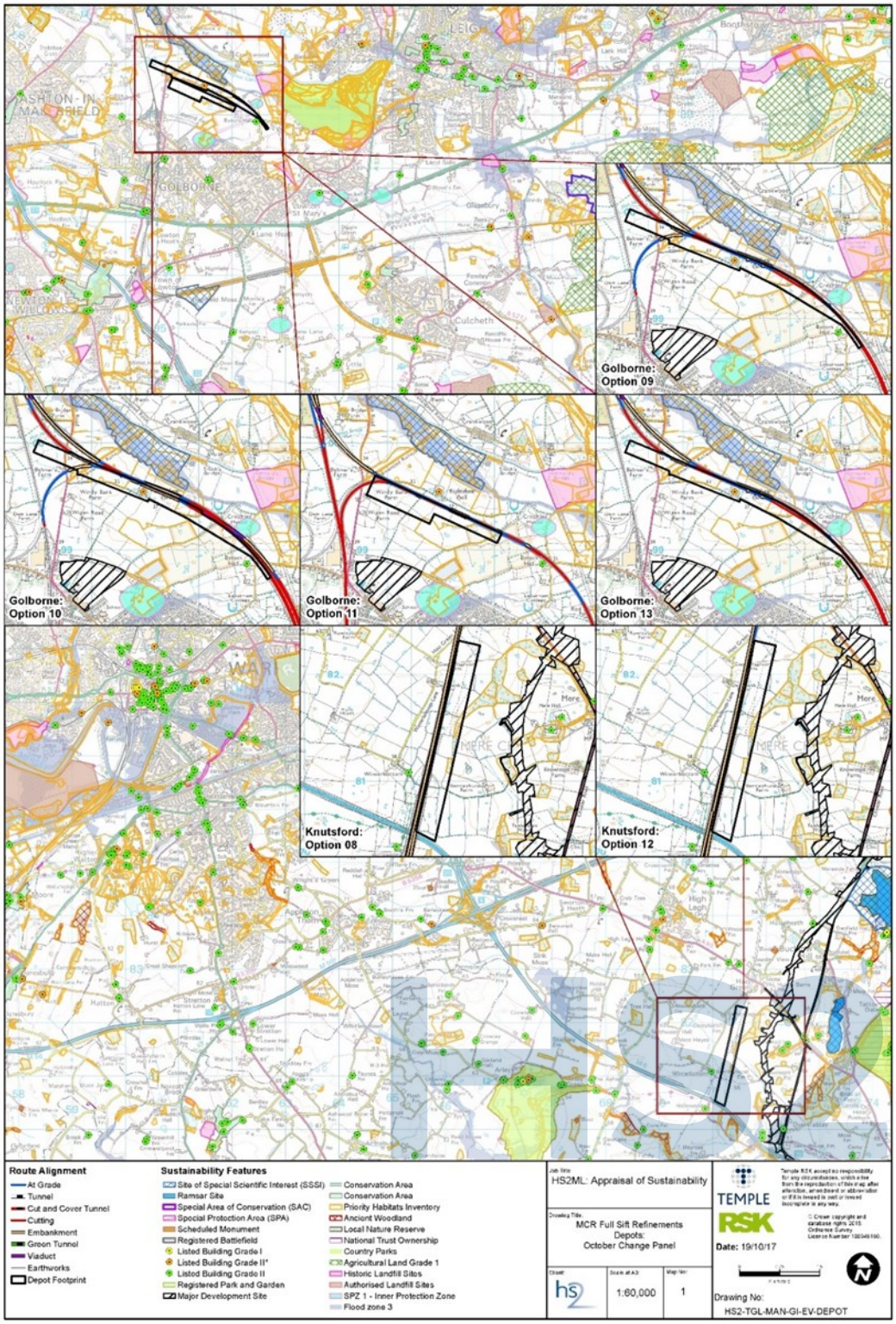
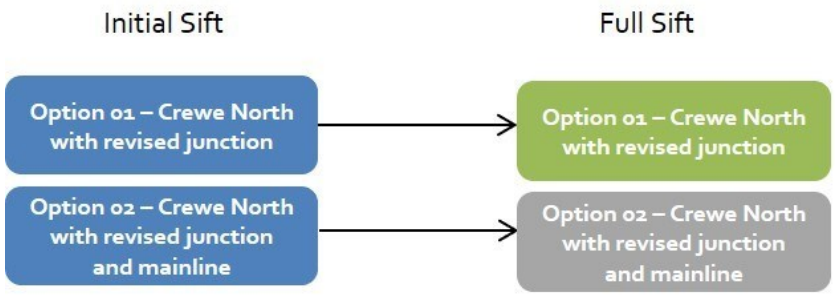


Figure 61: Local alternatives considered for the depot (part 2 of 2)

Crewe north rolling stock depot (further refinement)

5.2.109 This refinement covered an area of up to approximately 75 hectares north of Crewe near Wimboldsley where the HS2 main line would diverge from running parallel to the WCML. This follows on from the HS2 Ltd recommendation to Government that the RSD be relocated from Golborne to Crewe north. The refinement considerations were to ensure that the RSD footprint at Crewe north would be sufficient to meet the updated 2015 depot specification, including the latest stabling requirements. Two options were considered for this section of the route, both of which were taken to a full sift appraisal. The options taken forward in the sift stages are shown in Figure 62 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 63.

Figure 62: Local alternatives considered for Crewe north rolling stock depot



5.2.110 The following two options were taken forward to the full sift review:

- Option 01 would include a Crewe north RSD with a revised junction layout and operational footprint. No further horizontal amendments would be required to the HS2 main line past Wimboldsley and further north; and
- Option 02 would include a Crewe north RSD with revised junction layout and operational footprint, as well as revised horizontal alignment that would require the relocation of the HS2 main line by up to approximately 200m to the east, north of Crewe.

5.2.111 HS2 Ltd determined that Option 01 should be progressed as the preferred option, as this option would meet the increased stabling requirement for more trains in line with latest design specification. This option would move the junction for the RSD connections further north to address operational issues without moving the HS2 main line and RSD closer to Wimboldsley.

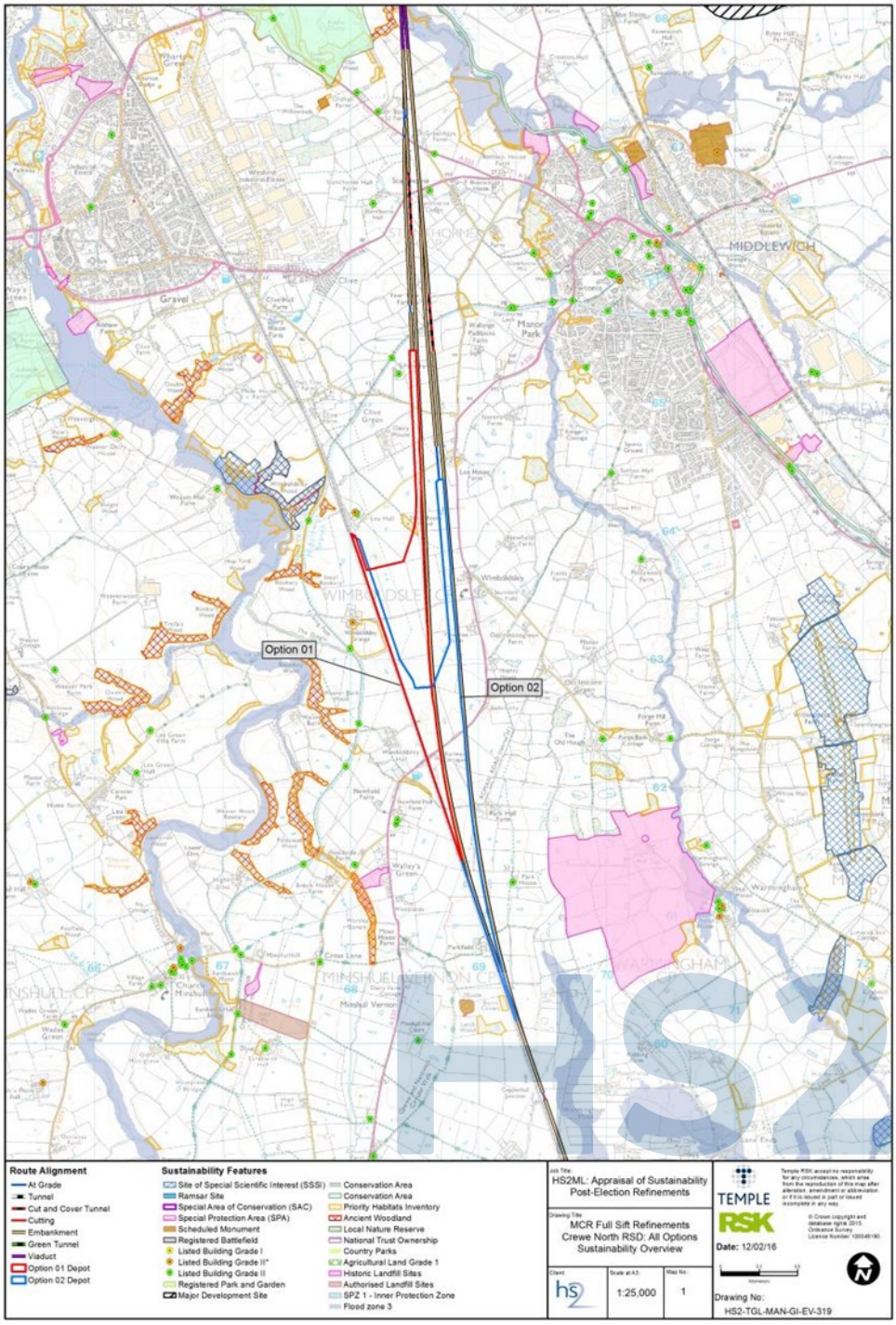
5.2.112 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.113 The preferred option, Option 01, would have major cumulative landscape and visual impacts as a result of the intrusive raised embankment structures associated with the HS2 main line and RSD connections, in a largely flat open rural landscape. There would be visual intrusion for residents of Wimboldsley and Stanthorne further north, where there would also be an impact on recreational users of the Shropshire Union Canaland major impact on the setting of the Grade II listed Bridge Canal and Cottage

(one listing). Further north, the triple crossing of the Trent and Mersey Canal within an approximately 2km stretch would adversely affect the setting of the associated conservation area, as well as recreational users of the canal, with an impact on landscape character associated with the high viaduct crossing of the River Dane (approximately 25m).

5.2.114 Option 02 would similarly have major cumulative landscape and visual impacts as a result of the intrusive raised embankment structures associated with the HS2 main line and RSD connections, in a largely flat open rural landscape. There would be increased visual intrusion for residents of Wimboldsley as result of the RSD and HS2 main line being approximately 200m closer, when compared with the preferred option. Further north towards Stanthorne, there would similarly be an impact on recreational users of the Shropshire Union Canal and major impact on the setting of the Grade II listed Bridge Canal and Cottage (one listing). Further north, the triple crossing of the Trent and Mersey Canal within an approximately 2km stretch would adversely affect the setting of the conservation area, as well as recreational users of the canal, with an impact on landscape character associated with the high (approximately 27m) viaduct crossing of the River Dane.

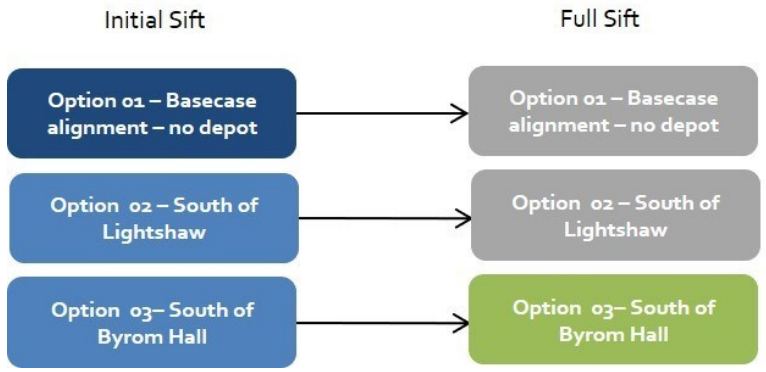
Figure 63: Local alternatives considered for Crewe north rolling stock depot



Golborne (without rolling stock depot)

5.2.115 This refinement area covered approximately 8km of the route from Lowton gap to the WCML connection at Bamfurlong. The area of refinement initially covered Golborne RSD alongside the connection of the HS2 main line to the WCML at Bamfurlong. However, as the refinement evolved and alternative RSD locations were considered, this refinement focused on optimising this section of the HS2 main line and the connection to the WCML without provision for a RSD at Golborne. Three options were considered for this section of the route, all of which were progressed to a full sift appraisal. The options taken forward in the sift stages are shown in Figure 64 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 65.

Figure 64: Local alternatives considered for Golborne (without depot)



5.2.116 The following options were studied during the full sift:

- Option 01: this option would run through Lowton in cutting and would head north-west, to the north of Byrom Hall and Lightshaw Hall, on low embankments and at grade. The route would continue west before heading north to connect with the WCML at Bamfurlong;
- Option 02 would be similar to Option 01, and would begin in cutting through Lowton and would head north-west to the north of Byrom Hall and south of Lightshaw Hall on low embankments and at grade. The route would continue north-west, south of Lightshaw Hall, and would head north and connect with the WCML at Bamfurlong; and
- Option 03 would be similar to Option 01, and would begin in cutting through Lowton, before heading north-west to the south of Byrom Hall on low embankments and at grade, approximately 500m closer to Golborne than Option 01. The route would continue north-west, to south of Lightshaw Hall, and would head north to connect with the WCML at Bamfurlong. This option would allow for the inclusion of maintenance loops should they be required at a later date.

5.2.117 HS2 Ltd determined that Option 03 should be taken forward as the preferred option on the basis of the provision for potential maintenance loops, as well as reduced sustainability impacts and in response to consultation feedback for this area.

This included moving the route away from the Grade II* listed Lightshaw Hall, as well as further south from the sensitive receptors of Abram Flashes SSSI and the Leeds and Liverpool Canal, both well used local recreational areas. It also increased the distance to Slag Lane abstraction borehole.

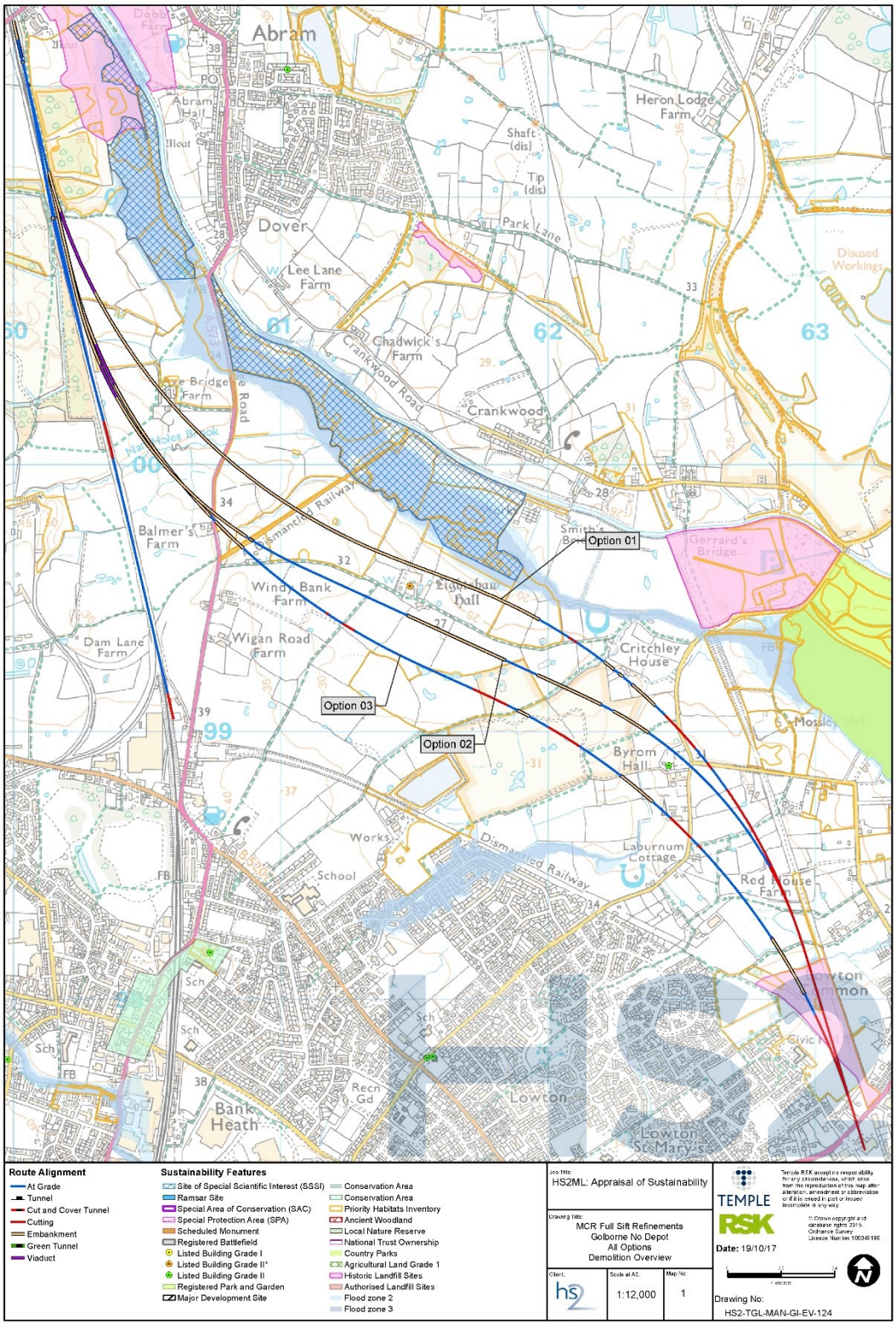
5.2.118 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.119 The preferred option, Option 03, would have minor to moderate landscape and visual impacts for residents of Golborne and recreational users of the Leeds and Liverpool Canal. There would be some visual intrusion within this open rural landscape as a result of the high viaduct connection with the WCML south of Bamfurlong. There would be minor impacts on the setting of the Grade II* listed Lightshaw Hall and Grade II listed Byrom Hall.

5.2.120 Option 01 would similarly have minor to moderate landscape and visual impacts. Whilst impacts for residents of Golborne would be less than with the preferred option, moving the route further north would increase visual impacts on recreational users of the Leeds and Liverpool Canal and on the Abram Flashes SSSI. South of Bamfurlong, this option, similar to the preferred route, would create some visual intrusion as a result of the high viaduct connection with the WCML in an open rural landscape. This option would have a greater impact on the setting of the Grade II* listed Lightshaw Hall and Grade II listed Byrom Hall as result of the reduced distance from both buildings.

5.2.121 Option 02 would similarly have minor to moderate landscape and visual impacts. Whilst impacts for residents of Golborne would be slightly less than with the preferred option, moving the route to the north would increase visual impacts on recreational users of the Leeds and Liverpool Canal and Abram Flashes SSSI. This option would have a greater impact on the setting of the Grade II* listed Lightshaw Hall and Grade II listed Byrom Hall as result of the reduced distance from both buildings, when compared to the preferred option. South of Bamfurlong, this option, similar to the preferred route, would cause some visual intrusion as a result of the high viaduct connection with the WCML in an open rural landscape.

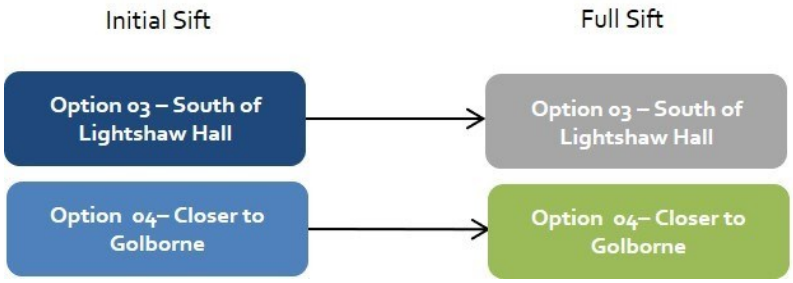
Figure 65: Local alternatives considered for Golborne (without depot)



Maintenance loops at Golborne

5.2.122 This refinement area covered approximately 8km of the route from Lowton gap to the WCML connection at Bamfurlong. The refinements were a further review of previous consideration of options near Golborne without a RSD (see previous section), but with a focus on the provision of maintenance loops, which would give greater operational resilience to the network. Two options were taken to full sift to explore the Golborne connection without an associated RSD. The options taken forward in the sift stages are shown in Figure 66 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 67.

Figure 66: Local alternatives considered for maintenance loops at Golborne (no depot)



5.2.123 The following options were studied during the full sift:

- Option 03 would run through Lowton in cutting and would then head north-west, to the south of both Byrom Hall and Lightshaw Hall, on low embankments and at grade. This option would then continue west before heading north to a connection with the WCML at Bamfurlong. There would be no provision for maintenance loops with this option; and
- Option 04 would be similar to Option 03, and would begin in cutting through Lowton and would then head north-west to the south of both Byrom Hall and Lightshaw Hall on low embankments and at grade, closer to Golborne than Option 03. The route would then head north to connect with the WCML at Bamfurlong. This option would include provision for maintenance loops should they be required in the future.

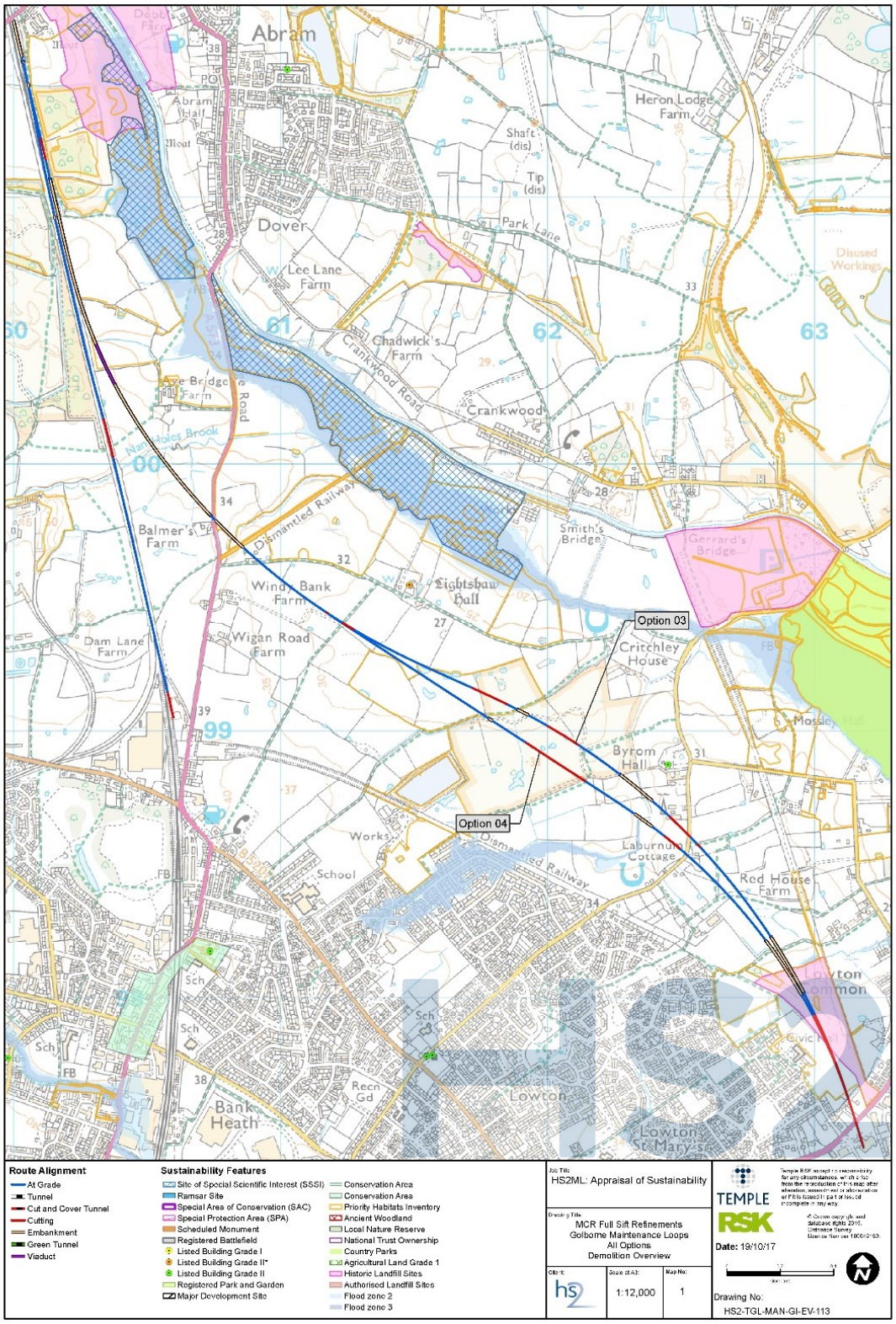
5.2.124 HS2 Ltd determined that Option 04 would be taken forward as the preferred option on the basis that it allowed for the inclusion of maintenance loops if these were determined to be needed in the future, as well as reduced sustainability impacts, and in response to consultation feedback for this area. This included moving the route away from the Grade II* listed Lightshaw Hall, as well as further south from the sensitive receptors of Abram Flashes SSSI and the Leeds and Liverpool Canal, both well used local recreational areas. It also increased the distance to Slag Lane water abstraction borehole.

5.2.125 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.126 The preferred option, Option 04, would have minor to moderate landscape and visual impacts for residents of Golborne and recreational users of the Leeds and Liverpool Canal. There would be some visual intrusion within this open rural landscape as a result of the high viaduct connection with the WCML south of Bamfurlong. There would be minor impacts on the setting of the Grade II* listed Lightshaw Hall and Grade II listed Byrom Hall.

5.2.127 Option 03 would similarly have minor to moderate landscape and visual impacts. Whilst impacts for residents of Golborne would be marginally less than with the preferred option, it would move the route closer to both the Grade II listed Byrom Hall and Grade II* listed Lightshaw Hall, with an increased impact on the setting of the former. Approaching Bamfurlong, this option would be similar to the preferred route, with some visual intrusion as a result of the high viaduct connection with the WCML in an open rural landscape.

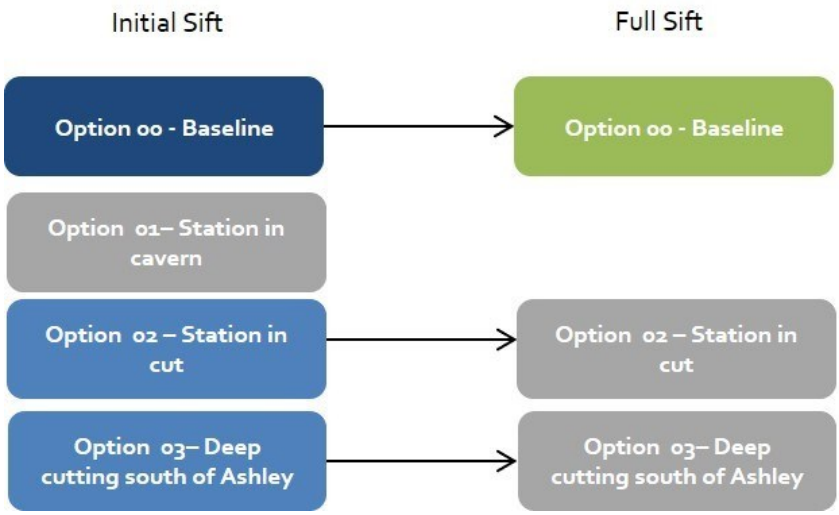
Figure 67: Local alternatives considered for maintenance loops at Golborne (no depot)



Manchester Airport vicinity

5.2.128 This refinement area covered approximately 19km of the route from Ashley, through the proposed high speed station at Manchester Airport, and would then enter an approximately 12.8km tunnel surfacing at West Gorton, east Manchester. The aim of this refinement was to mitigate the impacts on the areas in proximity to Tatton Park, Ashley, Rostherne Mere and Manchester Airport. Four options were proposed for this section of the route, one of which was not progressed past the initial sift as it was not considered reasonable on the basis of engineering, cost and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 68 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 69.

Figure 68: Local alternatives considered for Manchester Airport vicinity



5.2.129 The following options were studied during the full sift:

- Option 00: the RRB would run in a south-east direction on embankment north of Tatton Park and south of Ashley. The route would then curve north-east past Thorns Green in cutting before crossing the River Bollin and approaching the high speed station at Manchester Airport in deep cutting under the M56. The station would be in a cutting, west of the M56 in green belt, close to the community of Hale Barns. North of the HS2 station and to the east of Davenport Green, the route would be in an approximately 12.8km bored tunnel under the outskirts of south Manchester; and
- Option 02 would initially follow a similar route to Option 00, passing to the south of Ashley on embankment. However, this route would take a more easterly approach to the high speed station at Manchester Airport and would pass further to the east of Thorns Green and the M56, with the high speed station in cutting between Manchester Airport and the M56. North of the high speed station and to the east of Davenport Green, the route would be in an approximately 12.8km bored tunnel under the outskirts of south Manchester; and Option 03 would follow the same route as Option 00 and would run in a

south-east direction north of Tatton Park and south of Ashley. However, this route would be lower, passing south of Ashley, which would allow the HS2 main line to pass under the Mid-Cheshire Line (as opposed to over with Options 00 and 02). Heading north towards Thorns Green and the high speed station at Manchester Airport, the route would be in a deep cutting, lower than Option 00. The station would be in a cutting, west of the M56 in a green belt area, close to the community of Hale Barns. North of the high speed station and to the east of Davenport Green, the route would run under the outskirts of south Manchester into an approximately 12.8km bored tunnel.

5.2.130 HS2 Ltd determined that Option 00 should be progressed as the preferred option on the basis that the alternatives would have similar or increased impacts on the local environment, would incur substantial cost increase, and increase the engineering complexities.

5.2.131 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

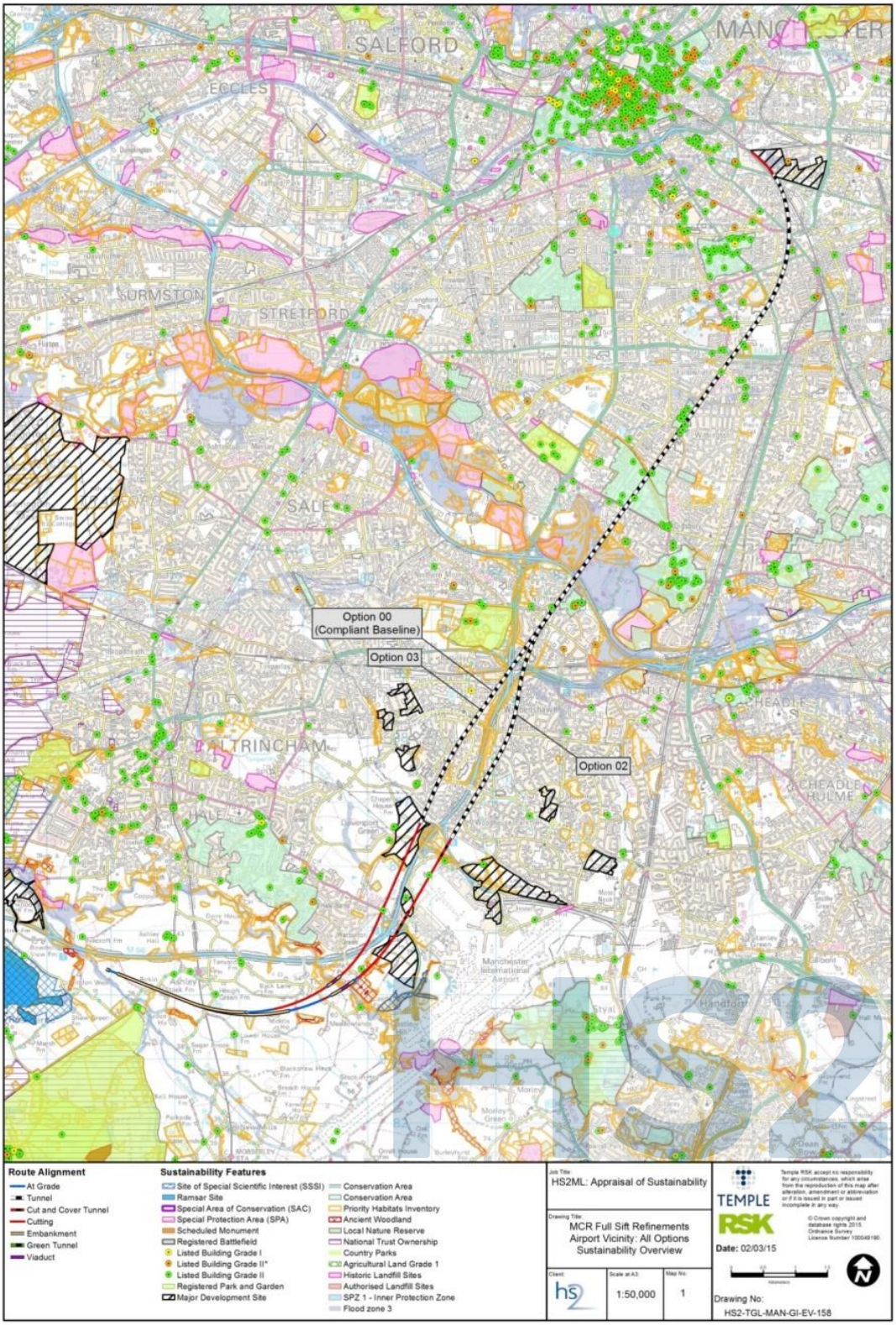
5.2.132 The preferred option, Option 00, would have moderate landscape and visual impacts, particularly for residents of Ashley where the route would pass to the south on embankment, as well as at Hale Barns and Davenport Green associated with the high speed station at Manchester Airport and approach, which would be in deep cutting. The route would require the demolition of the Grade II listed Buckhall on the station approach, and north of the high speed station at Manchester Airport, the route would cross Davenport Green development site. Further work would be required to understand how the route would impact the Timperley Brook watercourse and to ensure any flood risk is mitigated. There would be three clusters of residential demolitions approaching the station, each affecting approximately five properties, including at Hale Barns, Halebank and Thorns Green.

5.2.133 Option 02 would have similar moderate landscape and visual impacts to Option 00, with impacts at Ashley as a result of the embankment to the south, and woodland loss as part of a deep cutting through Sunbank Ancient Woodland. Approaching the high speed station at Manchester Airport, there would be an impact on the setting of the Grade II listed Yew Tree House, avoided by Options 00 and 03, alongside the demolition of the Grade II listed Buckhall, as with all other alternatives. The approach to the high speed station would, however, avoid the three clusters of residential demolitions at Hale Barns, Halebank and Thorns Green. Similar to the preferred option, the route would cross Davenport Green development site, with an additional impact on the Airport Enterprise Zone development site. Further work would be required to understand how this route would impact on the Timperley Brook watercourse and to ensure flood risk is mitigated.

5.2.134 Option 03 would have reduced visual impacts at Ashley, when compared with the preferred option, as a result of the lowered route south of the village, passing in cutting. However, further east and north, the deeper cutting would have an increased impact on the landscape character of the surrounding area. Similar to the preferred route, this option would also require the demolition of the Grade II listed Buckhall on the high speed station approach. To the north of the high speed station at Manchester Airport, the route would cross Davenport Green development site. Further work

would similarly be required to understand how this route would impact on the Timperley Brook watercourse and to ensure any flood risk is mitigated. As with the preferred option, this route would require three clusters of residential demolitions approaching the station, each with approximately five properties, including at Hale Barns, Halebank and Thorns Green.

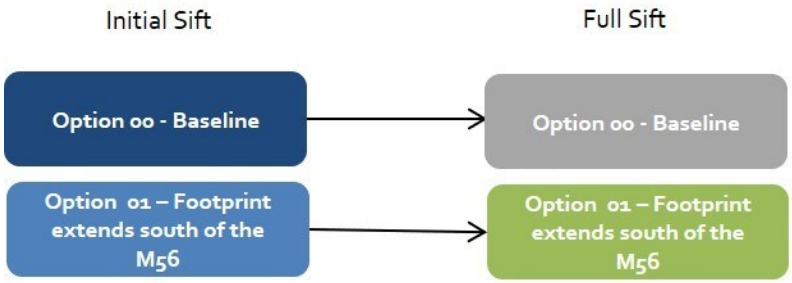
Figure 69: Local alternatives considered for Manchester Airport vicinity



Manchester Airport station (further refinements)

5.2.135 This refinement considered a review of the operational requirements and layout of the high speed station at Manchester Airport near Warburton Green. Two options were proposed for this section of the route, both of which were taken to a full sift with a focus on understanding the potential effects of changes to the station footprint on property impacts. The options taken forward in the sift stages are shown in Figure 70 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 71.

Figure 70: Local alternatives considered for Manchester Airport station



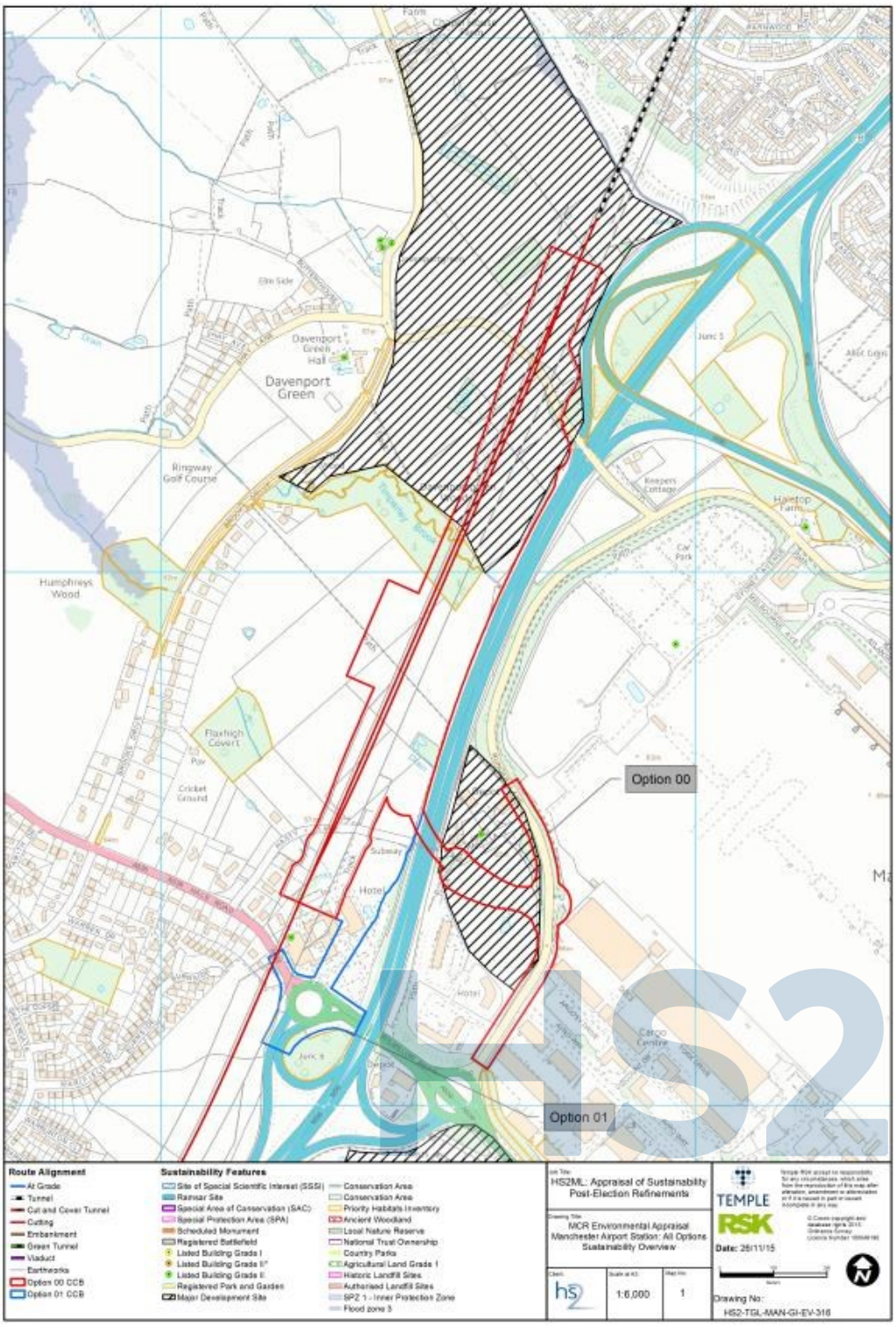
5.2.136 The following two options were taken forward for full sift review:

- Option 00: the DRR would have the high speed station at Manchester Airport in cutting to the west of the M56 and to the east of Hale Barns, but with no provision within the station footprint for connection to the existing highways network; and
- Option 01: would have the high speed station at Manchester Airport in cutting to the west of the M56 and to the east of Hale Barns, including provision within the station footprint for highway connections with the M56 junction 6 and A538 Hales Road to the south.

5.2.137 HS2 Ltd determined that Option 01 was the preferred option to be taken forward, ensuring consistency in the design with other proposed stations, which also included connections to the existing highway network.

5.2.138 The sustainability impacts of each of the options are set out below with those of the preferred option presented first. The sustainability impacts for both options were similar. Both options would have broadly similar impacts and the same number of demolitions. The preferred option, Option 01, would have a direct impact on the Grade II listed Buckhall. The high speed station layout, car parks and platforms would be the same for both options. The high speed station car park would be located between the HS2 main line and the M56, with the high speed station in deep cutting with limited visual and landscape character impacts. To the north of the high speed station and approaching the tunnel portal land would be required from the Davenport Green development site.

Figure 71: Local alternatives considered for Manchester Airport station



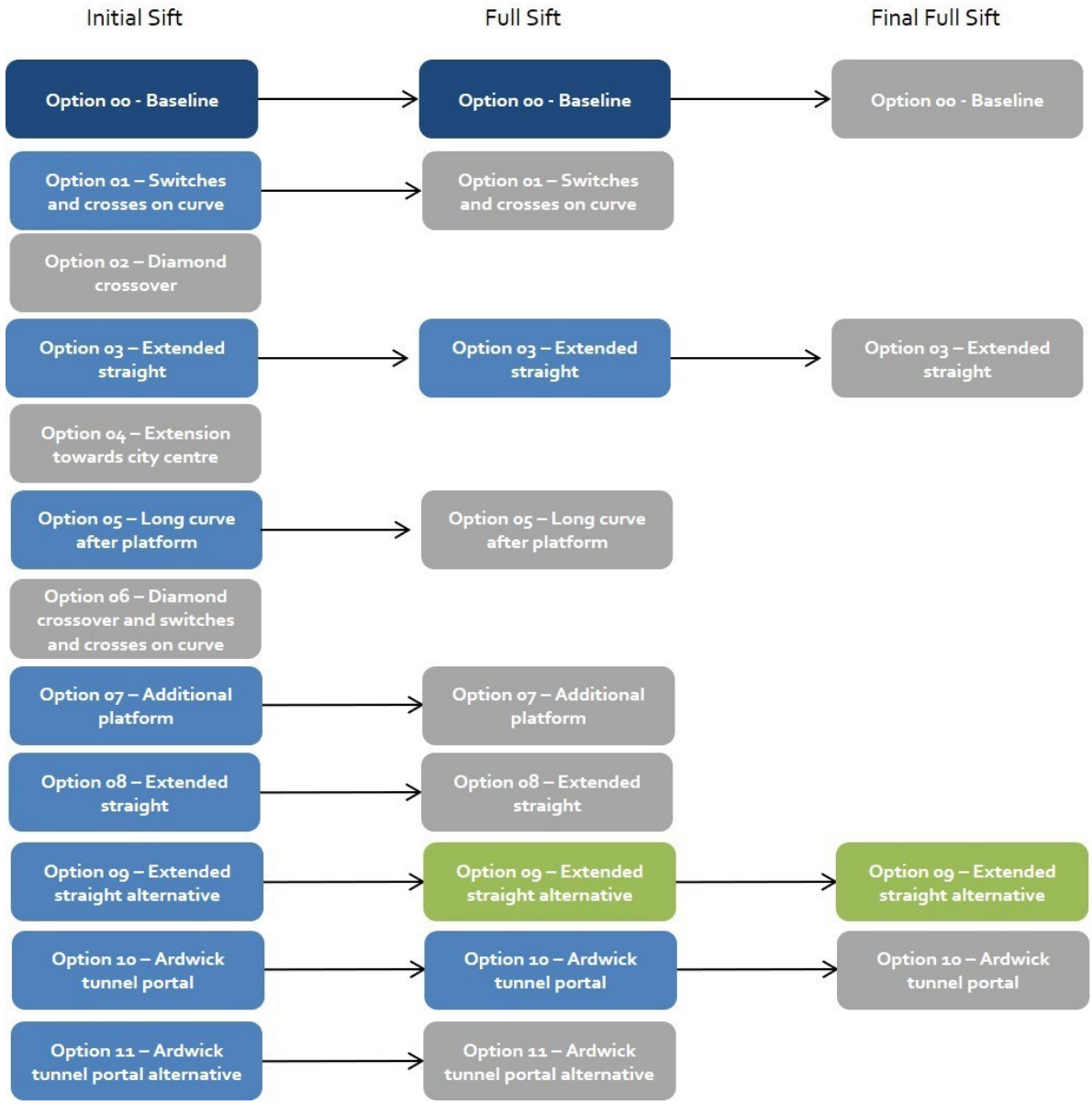
Manchester Piccadilly station and approaches

5.2.139 This set of refinements covered approximately 14km of the route including the approach to Manchester Piccadilly Station and the proposed high speed station site adjacent to the existing Manchester Piccadilly Station.

5.2.140 The refinement of both the proposed high speed station and the approach focused on optimising the orientation of the platforms and station throat with the aim of reducing the construction impact on Network Rail assets and reducing the re-occupation time (the minimum time between different trains using platforms) for trains in the station. This refinement also sought to review the demolition of a block of approximately 47 residential properties on Chapeltown Street.

5.2.141 A total of 12 options were considered as part of this refinement area, with new options introduced or revisited at various stages of the optioneering process. A final full sift considered a total of four options. The options taken forward in the sift stages are shown in Figure 72 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 73 and Figure 74.

Figure 72: Local alternatives considered for Manchester Piccadilly



5.2.142 The following four options were taken forward to the final full sift review:

- Option 00: the RRB. This option would run north-east in an approximately 11.9km bored tunnel from just north of the high speed station at Manchester Airport, under much of south Manchester and would surface approximately 500m south of Ardwick Depot. Here, the route would head north-west in a cutting through the western edge of West Gorton and would then continue on viaduct through Ardwick towards Manchester Piccadilly station alongside the existing WCML;
- Option 03 would have an extended bored tunnel approximately 12.8km in length approaching Manchester Piccadilly station, with the tunnel portal approximately 500m further to the north near Ardwick, compared with the RRB. It would similarly approach Manchester Piccadilly on viaduct, although

slightly further to the north of the RRB and thus would require an extended construction footprint, although the platform configuration would be similar to the RRB;

- Option 09 would follow a broadly similar route to Option 03, including an extended bored tunnel approximately 12.8km in length approaching Manchester Piccadilly, with the tunnel portal approximately 500m further to the north within the Ardwick Depot site. However, the gradient of the tunnel would be reduced to meet engineering requirements and to help provide simplified vent shaft solutions. It would similarly approach Manchester Piccadilly on viaduct, although slightly further to the north of the RRB, which would require an extended construction footprint. This option also has a revised platform configuration to improve the operational performance of trains entering and leaving the high speed station at Manchester Piccadilly; and
- Option 10 would follow a broadly similar route to Option 09, including an extended bored tunnel approximately 12.8km in length approaching Manchester Piccadilly, with the tunnel portal approximately 500m further to the north within the Ardwick Depot site. However, the gradient of the tunnel would be reduced to meet engineering requirements and to help provide simplified vent shaft solutions. As with Option 09, this option would have a revised platform configuration to improve the operational performance of trains entering and leaving the high speed station at Manchester Piccadilly.

5.2.143 HS2 Ltd determined that Option 09 should be progressed as the preferred option. This option would have less of a sustainability impact on West Gorton and the associated Corn Brook floodplain, on the development site at West Gorton and on a cluster of residential demolitions. This option would also provide an improved engineering and operational arrangement at Manchester Piccadilly station associated with the reduced tunnel gradient, simpler vent shaft solution, and revised platform configuration, which would improve operational performance of trains at the high speed station.

5.2.144 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.2.145 The preferred option, Option 09, would have minor to moderate landscape character and visual impacts, specifically relating to the large viaduct structures approaching Manchester Piccadilly close to the Medlock Valley, an area of public open space. The Grade II listed Train Shed at Manchester Piccadilly would fall within the high speed station boundary, although the listed structure would be retained. A cluster of demolitions would be required as part of the high speed station at Manchester Piccadilly, including a block of approximately 47 residential properties on Chapeltown Street. A diversion of the River Medlock would be required, as would be the case with all station options at Manchester Piccadilly.

5.2.146 Option 00 would have minor landscape and visual impacts as a result of running alongside the existing WCML approaching Manchester Piccadilly station. However, unlike the preferred option, this route would require additional demolitions on the

station approach as a result of cutting through West Gorton, with a cluster of approximately 22 residential demolitions. Unlike the preferred option, the tunnel portal and sections of cutting would be located within the Corn Brook floodplain, posing a flood risk, with land also required from the West Gorton development site. A diversion of the River Medlock would be required, as would be the case with all station options at Manchester Piccadilly.

5.2.147 Similar to the preferred route, Option 03 would have minor to moderate landscape character and visual impacts specifically relating to the large viaduct structures approaching Manchester Piccadilly close to the Medlock Valley, an area of public open space. Similarly, the Grade II listed Train Shed at Manchester Piccadilly would fall within the high speed station boundary, although the structure would be retained. A cluster of demolitions would be required as part of the high speed station, including a block of approximately 47 residential properties on Chapeltown Street. A diversion of the River Medlock would be required, as would be the case with all station options at Manchester Piccadilly.

5.2.148 Similar to the preferred route, Option 10 would have minor to moderate landscape character and visual impacts specifically relating to the large viaduct structures approaching Manchester Piccadilly close to the Medlock Valley public open space. Similarly, the Grade II listed Train Shed at Manchester Piccadilly would fall within the high speed station boundary, although the structure would be retained. A cluster of demolitions would be required as part of the high speed station, including a block of approximately 47 residential properties on Chapeltown Street. A diversion of the River Medlock would be required, as would be the case with all station options at Manchester Piccadilly.

Figure 73: Local alternative station footprints considered for Manchester Piccadilly station (part 1 of 2)

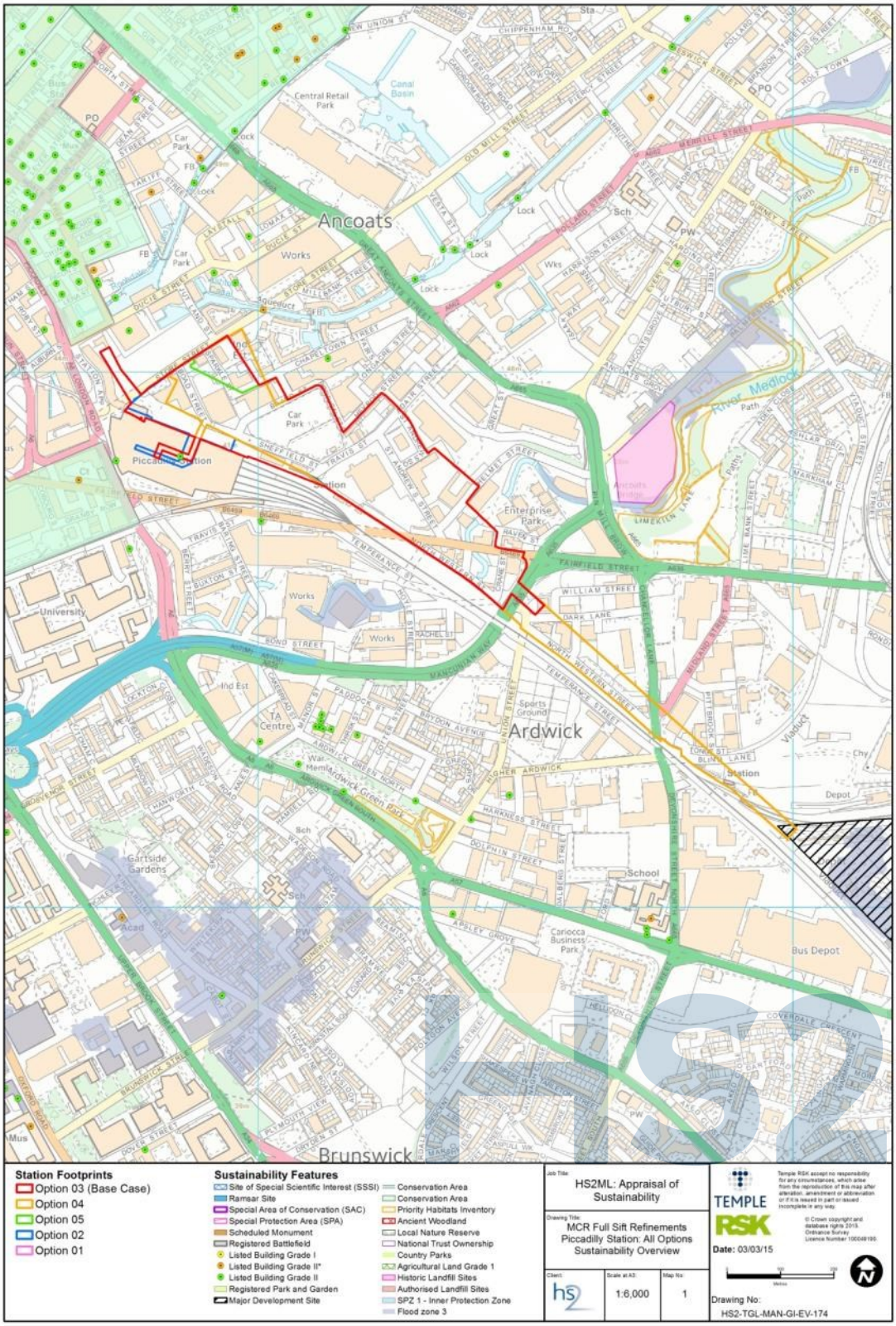
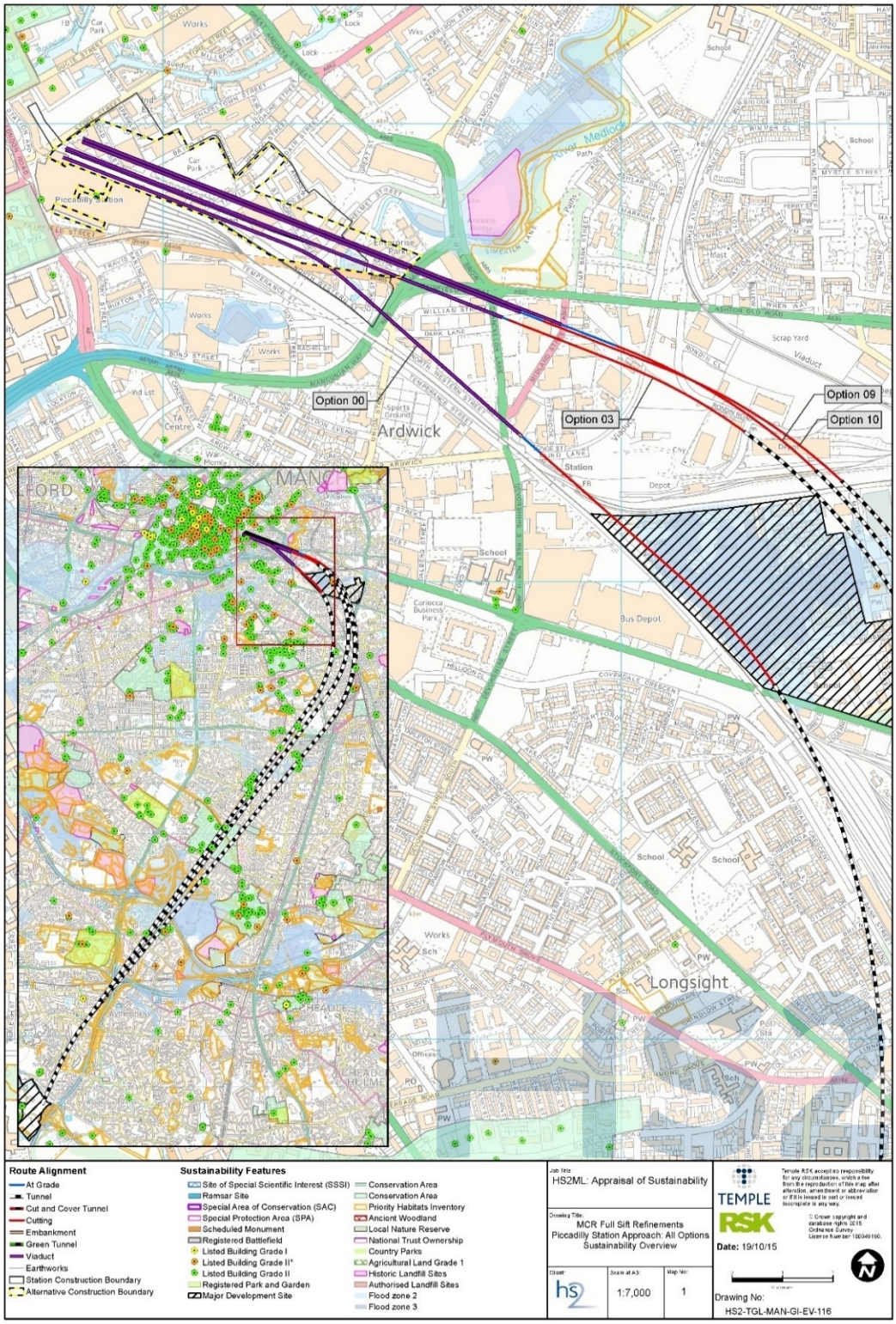


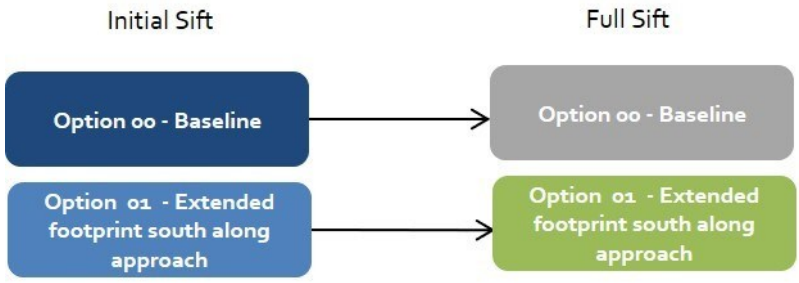
Figure 74: Local alternatives station approaches considered for Manchester Piccadilly station (part 2 of 2)



Manchester Piccadilly station (further refinement)

5.2.149 This refinement considered the high speed station footprint at Manchester Piccadilly Station and a review of the operational requirements and layout, including provision for possible highway reconfiguration, was undertaken. Two options were proposed for this section of the route, both of which were taken to a full sift with a focus on understanding the potential effects of changes to the station footprint on property impacts. The options taken forward in the sift stages are shown in Figure 75 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 76.

Figure 75: Local alternatives considered for Manchester Piccadilly Station



5.2.150 The following two options were taken forward for review:

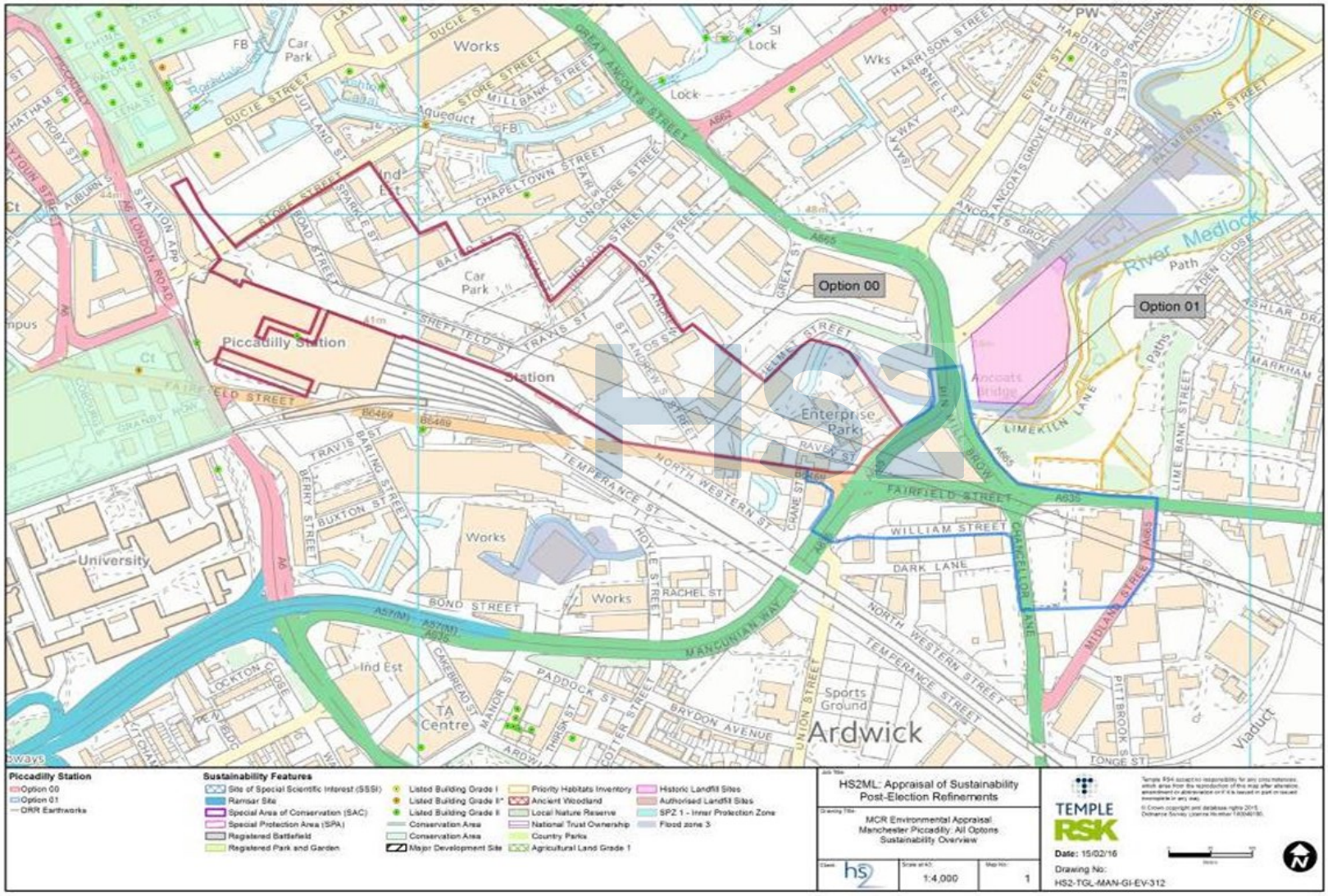
- Option 00: the proposed high speed station footprint at Manchester Piccadilly would extend out towards Mancunian Way, but would have no provision for highway works associated with the crossing of Mancunian Way and Fairfield Street junction within the construction boundary; and
- Option 01 would have a similar operational layout to Option 00, but with the footprint extending out to the east across Mancunian Way and Fairfield Street to take into consideration works required for the reconfiguration of highways within this location.

5.2.151 HS2 Ltd determined that Option 01 was the preferred option to be taken forward as it made provision for potential highway reconfiguration within the design.

5.2.152 The sustainability impacts of each option were similar, except in terms of property impacts as a result of the change in the station footprint.

5.2.153 The preferred option, Option 01, would require a total of approximately 109 demolitions within the high speed station construction boundary, and an increase of three commercial demolitions, when compared with Option 00. These are the only variations between the two options.

Figure 76: Local alternatives considered for Manchester Piccadilly station (further refinements)



Post 2016/2017 consultation route refinements

Introduction

5.2.154 Between November 2016 and March 2017, public consultation was held for areas of the Phase 2b route where substantial changes had been made to the route as a result of the route refinement work following the 2013/2014 consultation. On the western leg, the consultation route refinement areas were as follows:

- relocating the RSD from a site near Golborne to a site north of Crewe;
- changing the route between Middlewich and Pickmere; and
- changing the approach to the high speed station at Manchester Piccadilly Station.

5.2.155 Following the period of public consultation, there was a phase of additional route refinements, which sought to address specific consultee concerns raised during the consultation period. For the post-consultation (2016/2017) refinements, a baseline option was presented as part of each package of refinement options. This was the 2016 preferred route to Manchester and Leeds. A summary is provided below for each of the areas, together with the recommendations adopted. Further detail can be found in the *Phase 2b route refinements report* (2017).

Crewe north rolling stock depot

5.2.156 In light of consultation feedback, HS2 Ltd reviewed the decisions that had been made previously regarding the location of the western leg RSD to ensure that the location to the north of Crewe remained the optimal solution. This included revisiting the previously discounted options at Golborne and Knutsford, and confirming that there were no brownfield sites available that met the requirements for the RSD on the current route.

5.2.157 As a result of this work, HS2 recommended that the location of the western leg RSD should remain at the proposed site to the north of Crewe, near Wimboldsley. This site would deliver a good fit with the requirements for a RSD. It would allow connection to the WCML, would be centrally located on the western leg and would have fewer sustainability impacts elsewhere on the route, including at Golborne and other alternative sites. Moving the site away from Golborne would remove direct impacts on the Grade II* listed Lightshaw Hall and Grade II listed Byrom Hall as well as at Abram Flashes SSSI near Golborne.

5.2.158 Relocating the RSD from Golborne would also mean that substantially less infrastructure would be required at the junction between the HS2 main line and the spur into Manchester, including the approximately 7km (4.5 mile) long northern chord that would link the Manchester spur and the HS2 main line, and associated grade separated junctions. The purpose of the chord was to enable empty trains to move between the RSD, which was previously proposed to be located at Golborne, and the high speed station at Manchester Piccadilly. The relocation of the RSD would mean that this section of the track would no longer be required, resulting in reduced land requirements and less noise and visual impacts in this area. It would also substantially reduce the estimated cost of the route.

Middlewich to Pickmere (routes through salt mining areas)

5.2.159 In responding to feedback from the 2016/2017 consultation, HS2 Ltd undertook a strategic review of all previous route options in this area, including the previous route refinement options considered following the 2013/2014 consultation. In addition, consideration was given to alternatives suggested as part of consultation feedback, including a route closer to the M6 corridor, a tunnelled route under Sandbach, a route east of Middlewich and a route that followed the A556.

5.2.160 Previous work undertaken by HS2 Ltd indicated that routes following the M6 corridor would have similar issues associated with passing over an area of salt and would require a less favourable location for the junction of the Manchester spur and HS2 main line connection to the WCML. These options would also have adverse community and environmental impacts, including property demolitions, and adverse impacts on SSSI and heritage assets.

5.2.161 HS2 Ltd also assessed an alternative proposed during the 2016/2017 consultation of extending the proposed tunnel beneath Crewe, taking it deeper into the bedrock below the salt strata, and returning to surface near the M6 crossing. Although this option would have environmental advantages over the 2016 preferred route to Manchester and Leeds (reduced noise, visual intrusion and reduced surface disruption to the general public during construction), the relatively long and potentially deep tunnelling option would be considerably more costly to construct than the preferred route. Due to the depth and length of tunnel required, this option could also increase construction and safety risks. Extending the tunnel would also require identification of an alternative suitable site for the relocation of the western leg RSD.

5.2.162 HS2 Ltd previous work indicated that a route passing via Knutsford would present a range of issues, including a less favourable location for the Manchester junction. Therefore, options looking at this were discounted in previous sifting work. Other options that would pass via Sandbach or to the east of Middlewich were discounted due to increased sustainability impacts on the local communities of Sandbach and Elsworth, poor ground conditions from known brine runs and similar impacts to the 2013 proposed scheme for consultation route with regards to passing through controlled brine and gas storage sites.

5.2.163 HS2 Ltd also considered the scope for reducing the speed of the HS2 main line in this area to facilitate tighter curves, and allow for a more flexible alignment that could reduce the height of the railway and also reduce some of the local environmental impacts. This part of the HS2 main line would be used by direct HS2 services not only to Manchester, but also to the North West of England and Scotland. Accordingly, the work suggested that relatively small reductions in speed could have substantial impacts on the overall benefits of HS2.

5.2.164 A review of previous route options (including the alternatives proposed during the 2016/2017 consultation) indicated that the 2016 preferred route to Manchester and Leeds would carry the least risk regarding the construction, operation and long-term maintenance of HS2. HS2 Ltd recommended that if the route was to successfully avoid existing brine and gas storage caverns in the area, this route would remain the preferred route based on the information currently available.

5.2.165 It was, therefore, decided that the route between Middlewich and Pickmere would remain as designed for the 2016 preferred route to Manchester and Leeds. This route would avoid directly affecting the existing brining and gas storage infrastructure, such as caverns, wellheads and surface infrastructure, and would reduce the risk of subsidence from ground movement at the brine field site, thereby reducing construction and operational risk. The route would be raised in this area to allow for the management of drainage and geological risk and to provide more flexibility with regard to ground stability mitigation options.

Manchester Piccadilly Station approach

5.2.166 As a result of the feedback received from the 2016/2017 consultation, HS2 Ltd reviewed the previous route refinement decision-making regarding the route of the Manchester tunnel on the approach into Manchester Piccadilly station. Specific options that were suggested via the consultation included an alternative tunnel alignment to change the location of vent shafts, an underground station at Manchester Piccadilly for high speed services and options that were similar to the 2013 proposed scheme for consultation route that avoided Ardwick Depot. HS2 Ltd reviewed the consultation response suggesting an alternative tunnel alignment to change the location of the vent shafts, but did not progress the option as it would require an increase in the curvature in the tunnel resulting in reduced line speed and an increased journey time.

5.2.167 HS2 Ltd did not consider, beyond an initial options review, an entirely underground high speed station at Manchester Piccadilly to enable through services north as the proposed HS2 timetable requires Manchester Piccadilly to be a terminus station. An underground box and longer tunnel alignment would be more costly and would present considerable engineering challenges.

5.2.168 Options that were similar to the 2013 proposed scheme for consultation route avoiding Ardwick Depot were previously considered. These options were not taken forward as they would have similar impacts to the 2013 proposed scheme for consultation route, particularly in terms of locating the tunnel portal in a floodplain and the impacts at West Gorton. Another option that avoided the depot was previously considered and discounted, as it would require a longer tunnel, longer journey time and increased costs.

5.2.169 As a result of this work, HS2 Ltd recommended that the tunnel alignment for the 2016 preferred route to Manchester and Leeds remained the optimal approach into Manchester Piccadilly. This alignment would reduce the flood risk by moving the tunnel portal out of the Corn Brook floodplain and would reduce engineering complexity by moving away from existing conventional railway viaducts. The changes would also allow the approach to Manchester Piccadilly to be straightened, maximising operational capacity and reducing the impact on the existing structures at Manchester Piccadilly Station. The relocated tunnel portal to the north of the TransPennine Express rail line would reduce impacts on the existing conventional railway during construction. Previous community impacts at West Gorton would also be avoided, including a cluster of residential demolitions, a development site and a local primary school.

5.3 West Midlands to Leeds

Local alternatives considered post 2013/2014 consultation

Introduction

Local alternatives considered post 2013/2014 consultation

5.3.1 Following the period of public consultation on the proposed Phase Two route between July 2013 and January 2014, route refinement work was undertaken. On the eastern leg, the 2013 proposed scheme for consultation was divided into geographically based refinement areas, within which options were subject to further design and appraisal. The post-consultation 2013/2014 refinement areas presented within this report are as follows, as shown in Figure 77.

- Whateley;
- Measham;
- Tonge;
- East Midlands Airport tunnel;
- East Midlands Hub, Toton;
- Strelley;
- Bogs Farm Quarry SSSI;
- Tibshelf;
- Hardwick Hall;
- Church Fenton;
- Woodlesford;
- Leeds Station; and
- Staveley Depot.

5.3.2 Post-consultation refinements of the eastern leg focused on discrete sections of route and included the section of the route via Meadowhall, which is now superseded by the M18/Eastern route. Refinements made to the Meadowhall route are therefore described within the Sheffield and South Yorkshire route corridors section (within Section 4.4) and not in this section.

5.3.3 In some instances, on the route to Leeds there is an overlap between the refinement areas meaning that certain parts of the route may have been refined multiple times. There are also sections of the route, which following the public consultation in 2013 and 2014, were not refined. These sections were subject to minor amendments to adjust to developing standards and requirements, but not subject to formal refinement.

5.3.4 For the purposes of undertaking post 2013/2014 consultation refinements, the baseline proposition used for comparison was described as the RRB. This was similar to the 2013 proposed scheme for consultation route but with updated design standards applied. This RRB option is shown in dark blue on the maps presented in this report. The other options considered as part of the initial sift are shown in light blue.

5.3.5 Each of the options was appraised against the RRB. However, the comparison of the impacts is presented below against the option that was chosen to be taken forward into the design (the preferred option). In some instances, whilst the preferred option was chosen as the most appropriate at this stage of development, subsequent work may have led to the option being revisited. Where this is the case it is noted in the relevant sections below.

Further route refinements

5.3.6 A series of further refinements were undertaken in late 2015. These refinements addressed comments from consultation and ongoing engagement that required further consideration.

5.3.7 For these refinements, all options were sifted against the DRR as opposed to the RRB used during the refinements following the 2013/2014 consultation. The DRR incorporated the preferred route options adopted following the 2013/2014 consultation refinements.

5.3.8 These further refinements considered more detailed changes in areas (see Figure 78) that had been considered in earlier stages of the sifting process.

5.3.9 Further refinement areas considered were as follows:

- East Midlands Hub, Toton; and
- Church Fenton.

Figure 77: Local alternatives considered 2013-2016

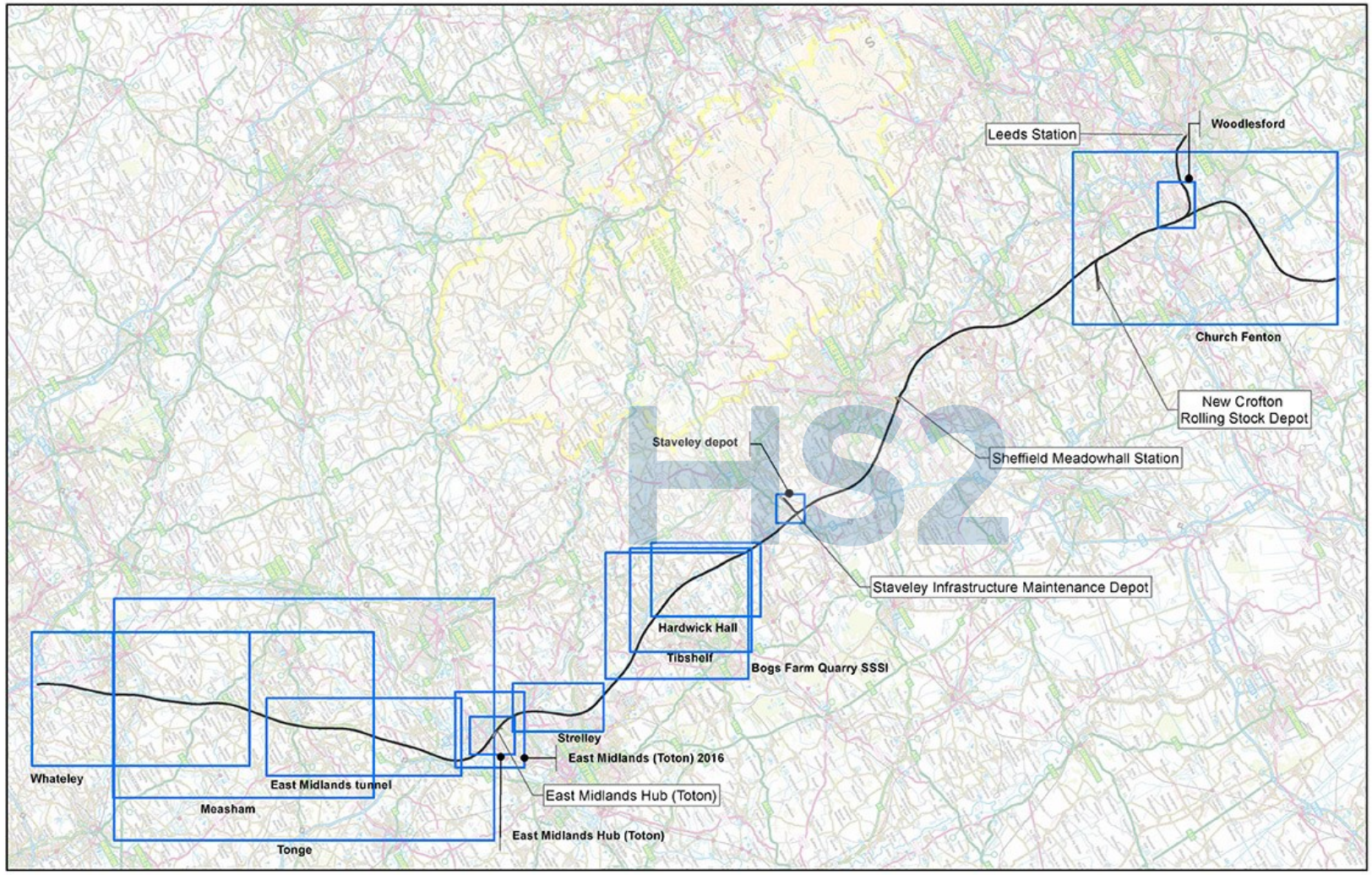
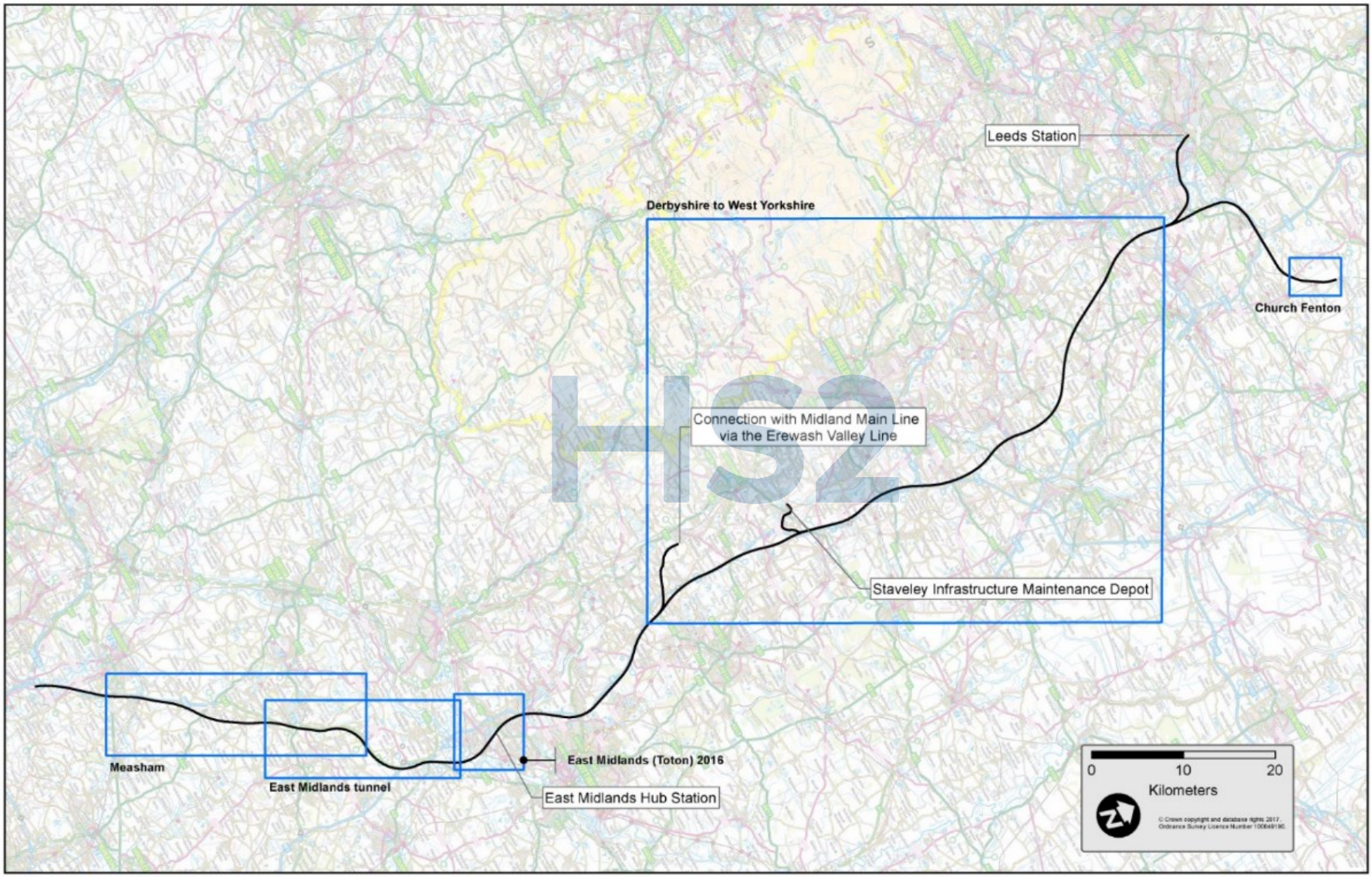


Figure 78: Local alternatives further refinements considered

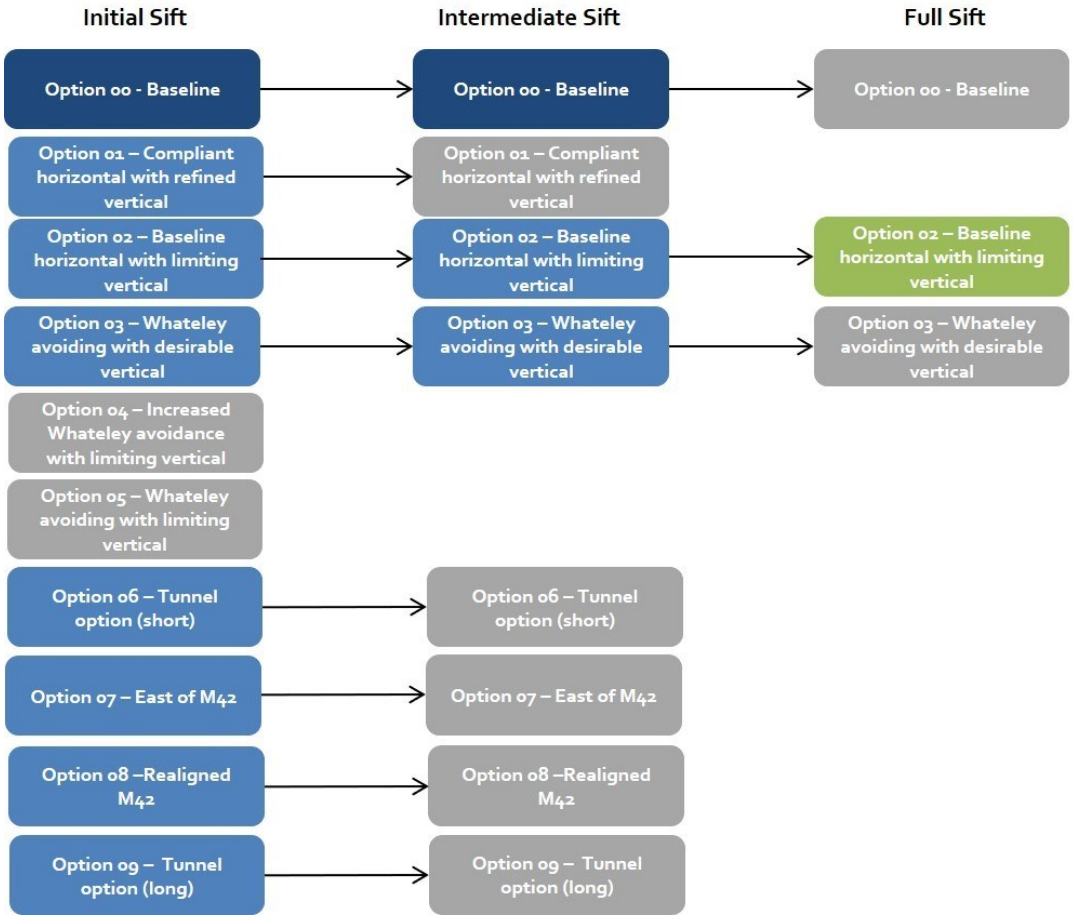


Whateley

5.3.10 This refinement area covered approximately 23km of the route from Marston to Measham. Options developed sought to review the increase in the vertical profile following updates to design standards in order to provide compliant clearances in respect of existing infrastructure through Kingsbury Water Park and past Kingsbury and Polesworth, avoid demolitions in Whateley, avoid Pooley Country Park, and reduce impacts on Tamworth, Hockley and Birchmoor.

5.3.11 Ten options were considered for this section of the route, eight of which were progressed to intermediate sift. Of those, five were not considered for further progression to full sift on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 79 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 80.

Figure 79: Local alternatives considered for Whateley



5.3.12 The following options were studied during the full sift:

- Option 00: the RRB. This route would run in a north-east direction from Marston alongside the M42. The route would pass to the north of Kingsbury at an increased height compared to the 2013 proposed scheme for consultation. The route would then continue to follow the M42 and would pass through Whateley, before crossing back over the M42 and would then run almost

adjacent to its eastern edge, past Austrey, Appleby Parva and Appleby Magna, to Oakthorpe;

- Option 02 would follow a similar route to Option 00 past Kingsbury and through Whateley, although the height would be comparatively lower as it passes Kingsbury. The height through the Kingsbury area would be the same height as that of the 2013 proposed scheme for consultation; and
- Option 03 would follow a lower vertical alignment in the Kingsbury area and a shift in the route eastwards around Whateley.

5.3.13 HS2 Ltd determined that Option 02 should be taken forward as the preferred route. Option 02 would lower the route past Kingsbury and Kingsbury Water Park, returning it to the same level as the 2013 proposed scheme for consultation. The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.14 The preferred option, Option 02, would have moderate landscape impacts resulting from a high embankment (approximately 20m) north of Kingsbury and a high viaduct over the M42, although these would be reduced when compared with Options 00 and 03. Similar to Options 00 and 03, Option 02 would also have a moderate impact on the setting of the Grade II listed Holt Hall Farm.

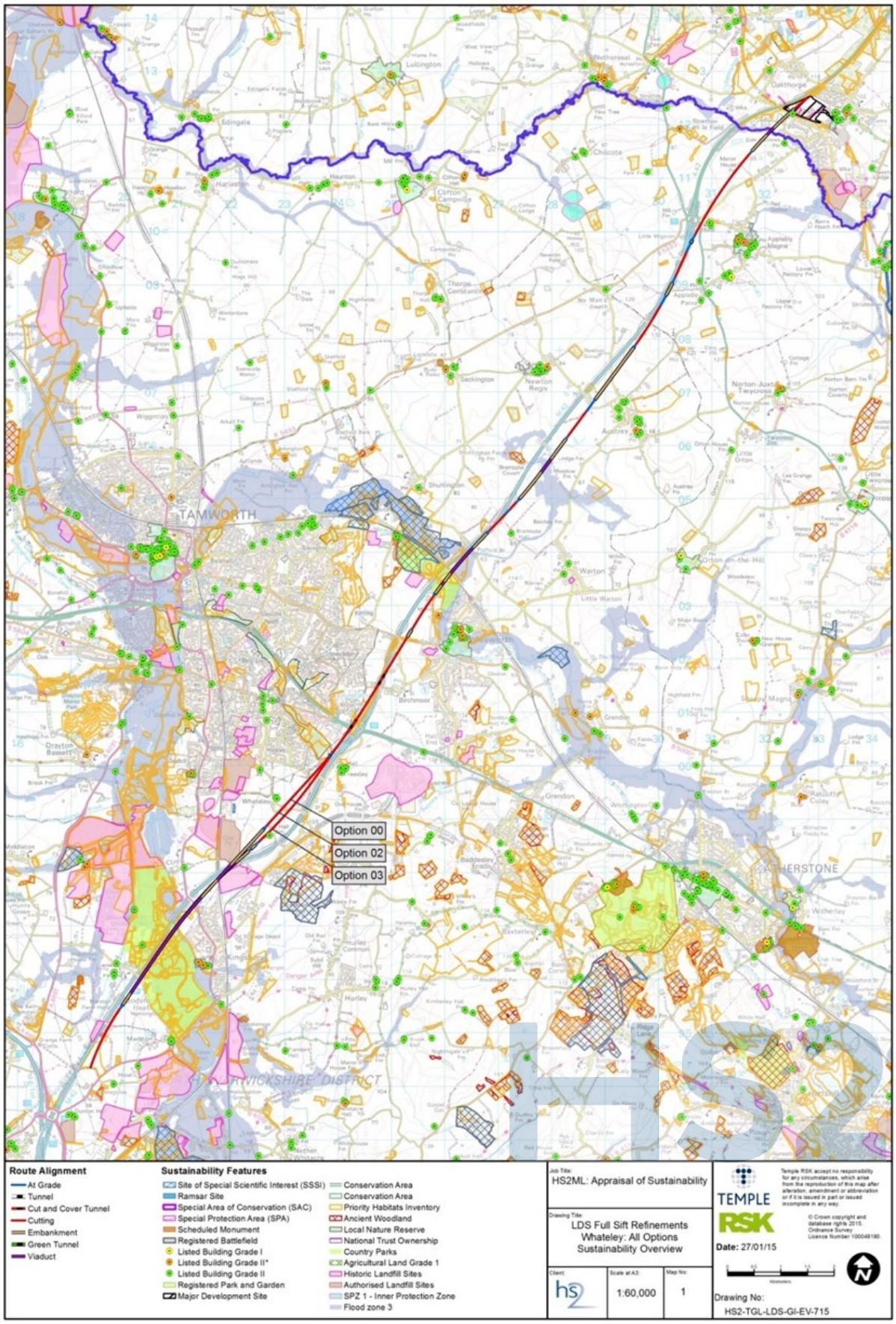
5.3.15 All options would cross the River Mease SAC/SSSI. A study to inform the Habitats Regulations Assessment (HRA) was undertaken for the River Mease SAC in consultation with Natural England and the Environment Agency. The HRA screening report concluded that there was a potential significant effect on the SAC due to shading of the river caused by crossing the SAC on viaduct. A draft Appropriate Assessment was then undertaken, which included a detailed study of shading impacts on the river habitats. This concluded there would be no adverse effects on the River Mease SAC arising from the construction or operation of the Proposed Scheme. HS2 Ltd will continue to consult with these bodies (and other relevant key stakeholders) as the design develops to ensure that the submitted design in the hybrid Bill and its construction comply with the Habitats Regulations 2017. Where required, further assessment will be undertaken and an appropriate design will be developed through an iterative process. Any studies to inform the required assessments will be completed and the outcomes agreed with Natural England prior to submission of the hybrid Bill.

5.3.16 All options could also potentially affect the Alvecote Pools SSSI during the construction phase.

5.3.17 Option 00 would follow the same route as Option 02 crossing over the M42 on a high viaduct with a slightly higher embankment north of Kingsbury, which would result in moderate visual intrusion to residents. Beyond this, Option 00 would follow the same route as the preferred option, and therefore, all other impacts would be the same.

5.3.18 Similar to the preferred option, Option 03 would pass to the north of Kingsbury on high embankment and would continue on an approximately 17m high viaduct over the M42, resulting in moderate visual intrusion to residents. Option 03 would avoid impacts to the Grade II listed Holt Hall Farm, which would be affected by Options 00 and 02. Option 03 would avoid a cluster of residential demolitions at Whateley, which would be affected by Options 00 and 02.

Figure 8o: Local alternatives considered for Whateley

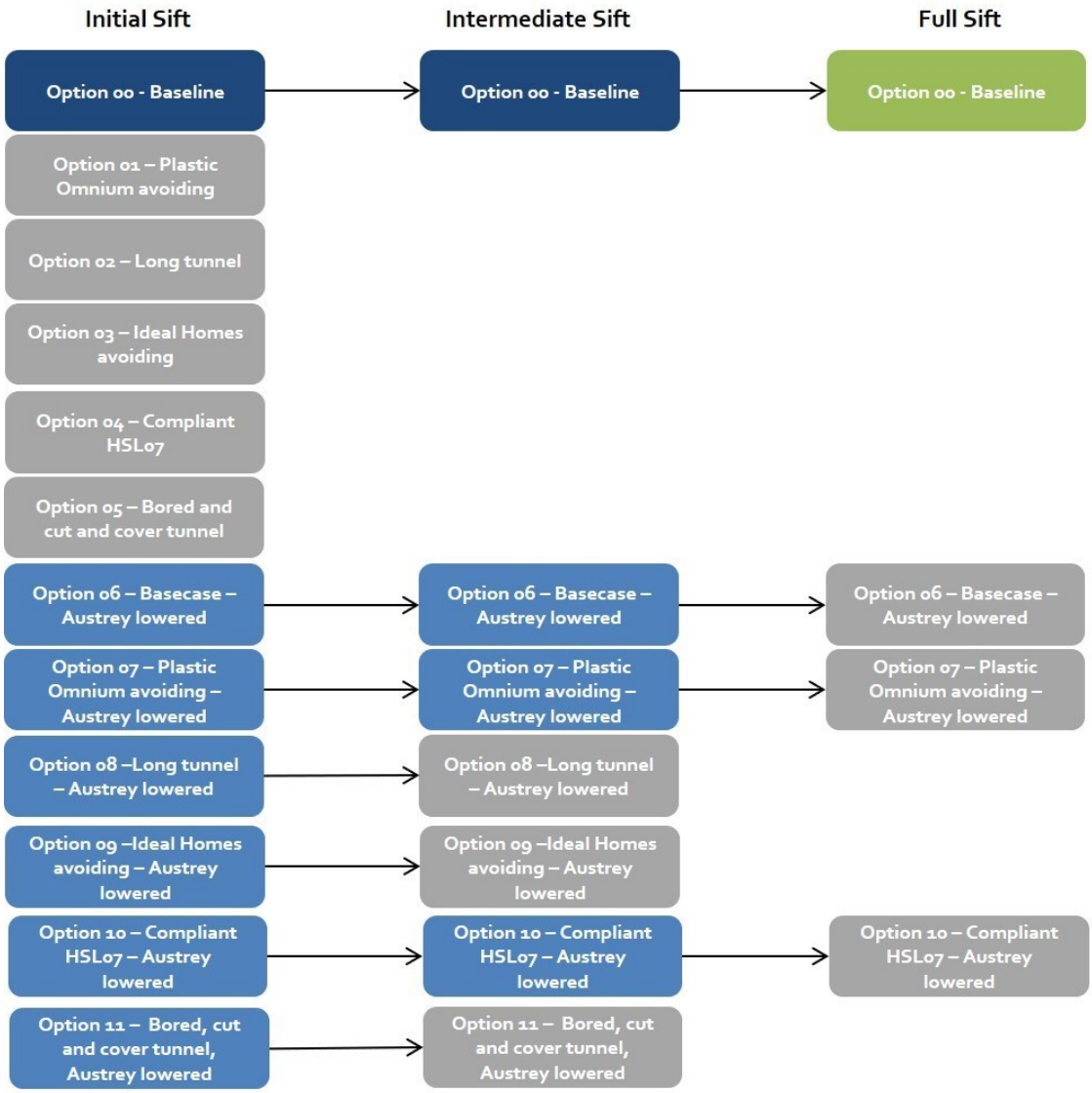


Measham

5.3.19 This refinement covered approximately 28km of the route between Birchmoor and Tonge. The refinement sought to reduce the route height past Austrey, and determine the preferred route past Measham, whilst identifying if it would be feasible to avoid the Plastic Omnium business property and/or the Measham Wharf development site. A total of 12 options were proposed, eight of which were not progressed to full sift on the basis of cost, engineering and/or sustainability grounds.

5.3.20 The options taken forward in the sift stages are shown in Figure 81 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 82.

Figure 81: Local alternatives considered for Measham



5.3.21 The following options were studied during the full sift:

- Option 00: the RRB, which would run north-east from Birchmoor along the eastern side of the M42/A42 passing to the west of Measham;
- Option 06 would follow the same route as Option 00, but would be lower past Austrey for a length of approximately 2km to a maximum of approximately 7m in height;
- Option 07 would be initially similar to Option 06, with the route lower past Austrey for a length of approximately 2km to a maximum of approximately 7m in height. However, the route would move east of Option 00 at Appleby Parva and would avoid the Plastic Omnium building (although would still cross the car park) and would re-join the route of Option 00 just after crossing the Measham Wharf development site; and
- Option 10 would be realigned away from the A42 corridor to the east of Measham, avoiding the Plastic Omnium site and Measham Wharf development site.

5.3.22 HS2 Ltd determined that Option 00 should be retained as the preferred option on the basis that Options 06 and 07 substantially increased costs. Additionally, Option 07 would result in increased impacts to three Grade II listed buildings. Option 10 would include a less favourable crossing of the River Mease (because of the meanders in that location), whilst Options 06 and 07 did not improve the River Mease crossing when compared to Option 00.

5.3.23 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.24 The preferred option, Option 00, would have moderate landscape and visual impacts where the route would be on high embankment past Austrey and on viaduct past Packington. Similar to Options 06 and 07, the preferred option would have major impacts on the Grade II listed 4 and 5 Park Farm and Meer Bridge. Overall, Option 00 would have fewer impacts on listed building than Option 07. However, the preferred option would impact Plastic Omnium (a locally important employer) and the development site at Measham Wharf.

5.3.25 The preferred option (Option 00), like all options considered in this refinement, would include a crossing of the River Mease. Option 00, similar to Options 06 and 07, would involve a more preferable crossing of the River Mease when compared to Option 10, which could have required a more complex crossing of the River Mease.

5.3.26 A study to inform the Habitats Regulations Assessment (HRA) was undertaken for the River Mease SAC in consultation with Natural England and the Environment Agency. The HRA screening report concluded that there was a potential significant effect on the SAC due to shading of the river caused by crossing the SAC on viaduct. A draft Appropriate Assessment was then undertaken, which included a detailed study of shading impacts on the river habitats. This concluded there would be no adverse effects on the River Mease SAC arising from the construction or operation of the Proposed Scheme. HS2 Ltd will continue to consult with these bodies (and other relevant key stakeholders) as the design develops to ensure that the submitted design

in the hybrid Bill and its construction comply with the Habitats Regulations 2017. Where required, further assessment will be undertaken and an appropriate design will be developed through an iterative process. Any studies to inform the required assessments will be completed and the outcomes agreed with Natural England prior to submission of the hybrid Bill.

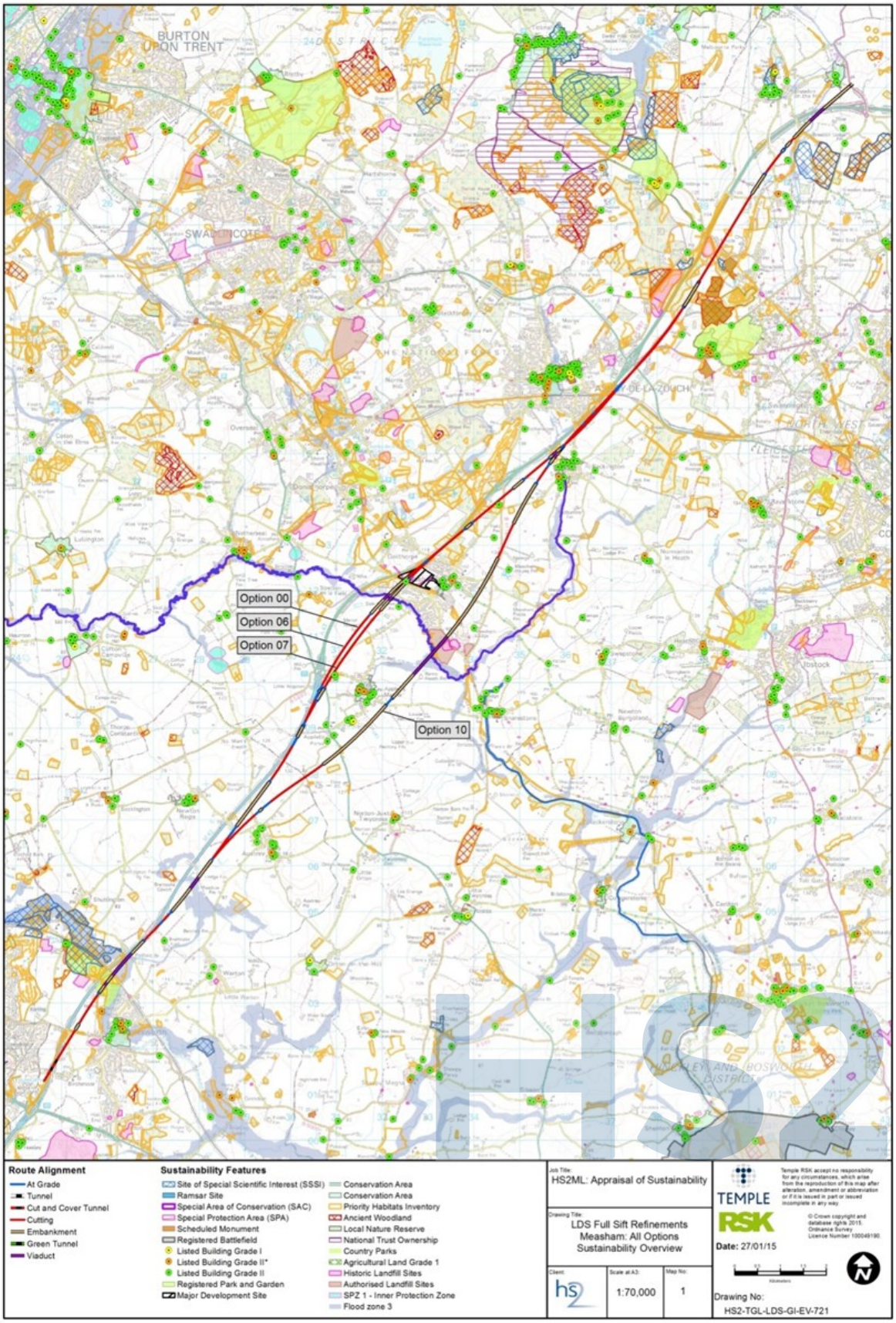
5.3.27 Option 06 would also have moderate landscape and visual impacts, although impacts at Austrey would be slightly reduced where the route would be lower than the preferred option. This option would have the same impacts on listed buildings as the preferred option. Option 06 would follow a similar route to the preferred option in Measham and therefore would also directly impact on Plastic Omnium and the development site at Measham Wharf.

5.3.28 The height past Austrey would be lower for Option 07, which would result in slightly reduced landscape and visual impacts when compared to the preferred option. This option would follow the same route near Packington, and therefore, would have a major impact on the Grade II listed 4 and 5 Park Farm. The revised route around Measham in Option 07 would result in major impacts on two additional Grade II listed buildings (the Old Rectory and the coach house and stables at the Old Rectory) when compared to the preferred option. Option 07 would avoid a direct impact on Plastic Omnium, however, it would continue to directly impact the development site at Measham Wharf.

5.3.29 Option 10 would follow a route to the east of Measham, diverging from the A42/M42. It would result in major landscape and visual impacts at Austrey, Appleby Magna, east of Measham and Packington. This option would also isolate Austrey, Appleby Magna, Appleby Parva and Measham between the A42/M42 and the Option 10 route. Following the route east of Measham, this option would avoid direct impacts to the Grade II listed Meer Bridge and 4 and 5 Park Farm. Additionally, this option would also avoid a direct impact on Plastic Omnium and the development site at Measham Wharf, but the Measham active landfill site would fall within land required.

5.3.30 All options would perform similarly from a sound, noise and vibration perspective. However, Option 10 would have greater noise impacts and would move the route further from the existing transport corridor (A42), which would increase the impacts on communities at Measham, Appleby Parva and Appleby Magna.

Figure 82: Local alternatives considered for Measham



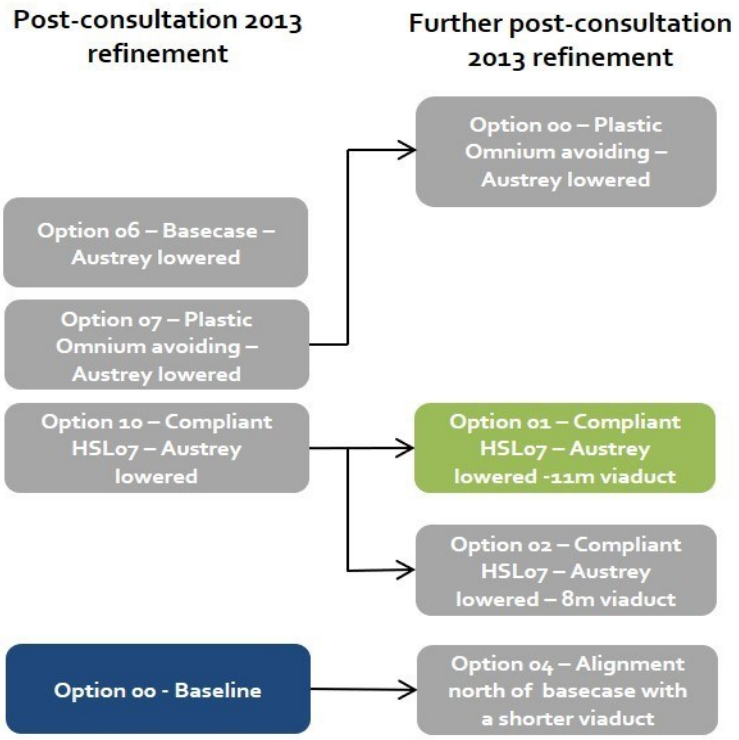
Measham (2016)

5.3.31 In early 2016, the Government requested further work be undertaken on all the options at Measham in order to seek to identify the possibility of avoiding direct impacts on a major employer in the area (Plastic Omnium).

5.3.32 Three options were considered further (as described below and illustrated on Figure 84) and compared against the new base case (a revised version of Option 07, amended to include a longer viaduct over the River Mease, which would avoid a direct impact on Plastic Omnium). Options 01 and 02 below were revised versions of the previously considered Option 10, with alternative height options for the viaduct crossing of the River Mease (Option 01 would be approximately 11m high and Option 02 would be approximately 8m high) to the south of Measham. Option 04 was the previous base case, which would broadly follow the route of the 2013 proposed scheme for consultation and would have a direct impact on Plastic Omnium. All options would cross the River Mease SAC/SSSI.

5.3.33 The options taken forward in the sift stages are shown in Figure 83 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 84.

Figure 83: Local alternatives considered for Measham



5.3.34 The following options were studied during the full sift:

- Option 00: the new baseline, a revised version of Option 07 considered in 2015, was amended to include a longer viaduct crossing of the River Mease. The route would avoid Plastic Omnium and would rejoin the previous alignment

where it would cross the development site at Measham Wharf;

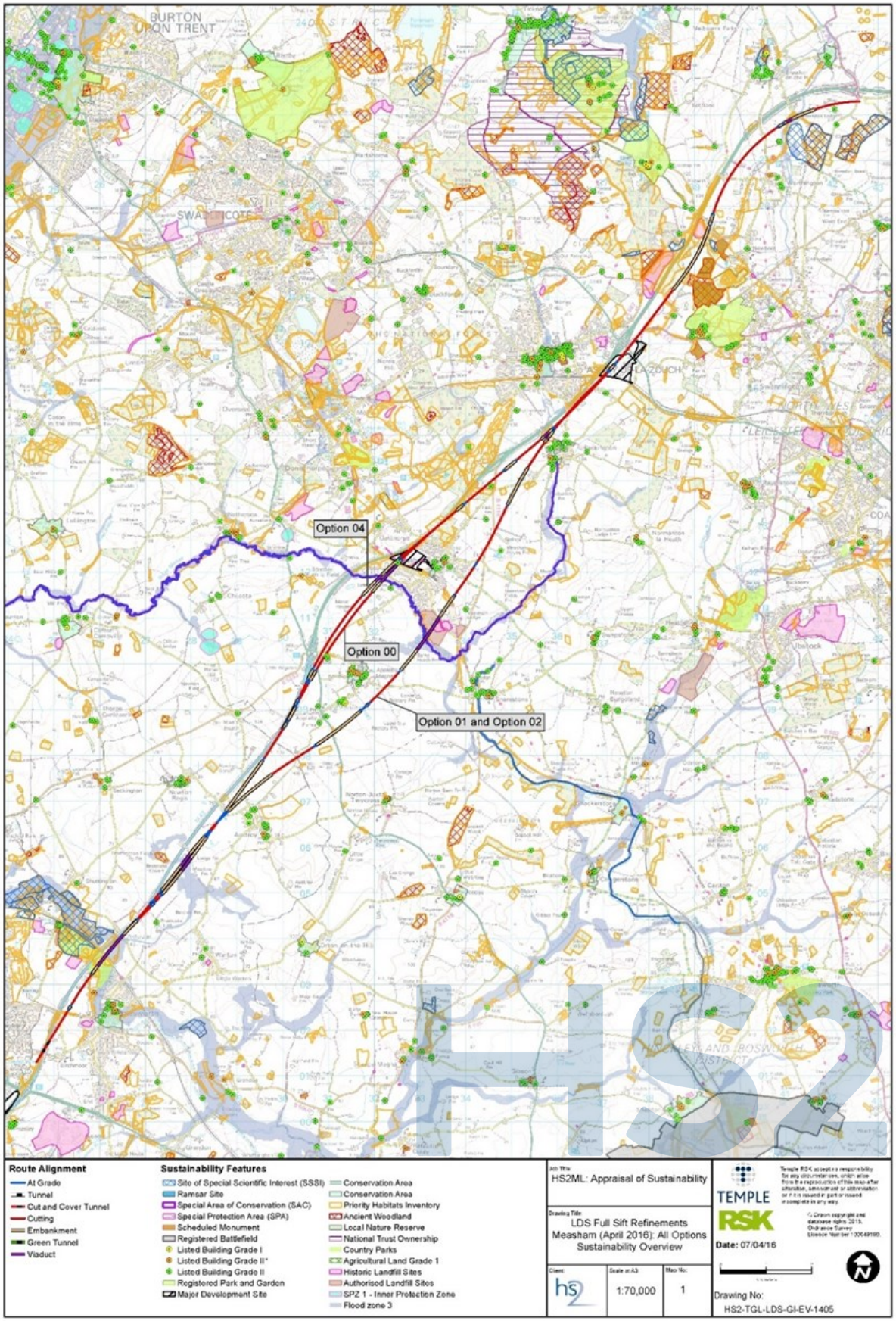
- Option 01 would run east at Austrey, away from the A42 corridor before crossing the River Mease to the east of Measham, and would avoid Plastic Omnium and the development site at Measham Wharf. The option would include an improved alignment (when compared to the previous Option 10), which would reduce the skew, and associated length and complexity, of the crossing of the River Mease, avoiding the meander in the river. This route would rejoin the route of Option 00 at Ashby-de-la-Zouch. It would require an approximately 11m high viaduct to cross the River Mease floodplain and an active landfill site;
- Option 02 would be similar to Option 01 and would include the same alignment across the River Mease. However, this option would provide an approximately 8m high viaduct to cross the River Mease floodplain and an active landfill site; and
- Option 04 would run north-west of Polesworth, along the east side of the M42/A42. It would pass on the west side of Measham, crossing Plastic Omnium and the Measham Wharf development site.

5.3.35 In April 2016, HS2 Ltd determined that Option 01 should be taken forward as it would avoid any direct impacts to the Plastic Omnium and Measham Wharf sites (which Option 00 and 04 would fail to achieve).

5.3.36 A study to inform the Habitats Regulations Assessment (HRA) was undertaken for the River Mease SAC in consultation with Natural England and the Environment Agency. The HRA screening report concluded that there was a potential significant effect on the SAC due to shading of the river caused by crossing the SAC on viaduct. A draft Appropriate Assessment was then undertaken, which included a detailed study of shading impacts on the river habitats. This concluded there would be no adverse effects on the River Mease SAC arising from the construction or operation of the Proposed Scheme. HS2 Ltd will continue to consult with these bodies (and other relevant key stakeholders) as the design develops to ensure that the submitted design in the hybrid Bill and its construction comply with the Habitats Regulations 2017. Where required, further assessment will be undertaken and an appropriate design will be developed through an iterative process. Any studies to inform the required assessments will be completed and the outcomes agreed with Natural England prior to submission of the hybrid Bill.

5.3.37 This decision was reconsidered following feedback from further consultation. This is set out in the Post 2016/2017 consultation refinements section below.

Figure 84: Local alternatives considered for Measham (April 2016)

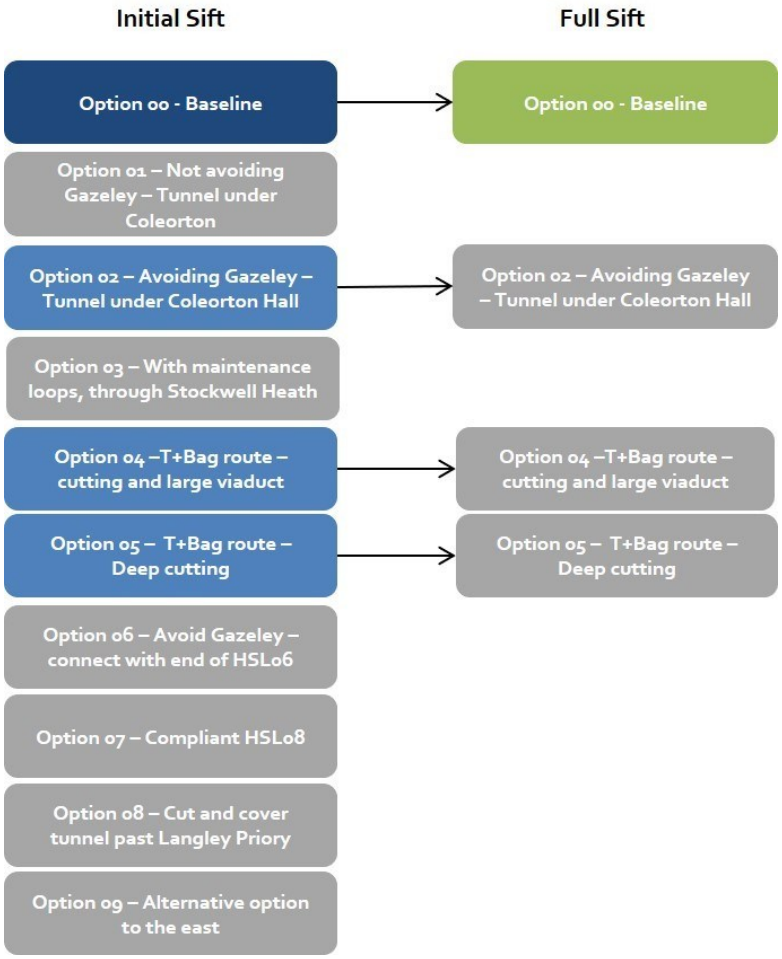


Tonge

5.3.38 This refinement covered approximately 43km of the route between Birchmoor and Long Eaton. This refinement sought to determine the preferred route past Tonge and Breedon on the Hill (seeking to reduce impacts upon these settlements and conservation areas), whilst addressing consultation concerns in reducing the visual impact to the Grade II* listed Langley Priory. Other concerns arising from consultation were associated with impacts on an industrial and distribution centre (also referred to as the G.Park near Ashby-de-la-Zouch) and the East Midlands Gateway strategic rail freight interchange (SRFI).

5.3.39 A total of 10 options were proposed, with six not progressed to full sift on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 85 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 86.

Figure 85: Local alternatives considered for Tonge



5.3.40 The following options were studied during the full sift:

- Option 00: the RRB would run to the east of the A42 and then to the east of Tonge and Breedon on the Hill. The route would be in tunnel under East Midlands Airport and partly under the East Midlands Gateway SRFI;

- Option 02: this option would run further to the east of the A42 corridor, Tonge and Breedon on the Hill compared to Option 00. The route would be in tunnel under the East Midlands Gateway SRFI and Coleorton Hall with the northern tunnel portal located in Coleorton Hall Registered Park and Garden;
- Option 04: this option would run further east of the A42 corridor, Tonge and Breedon on the Hill compared to Option 00 and would be in cutting to the south of Coleorton Hall and through Coleorton Hall Registered Park and Garden; and
- Option 05: this option would run further east of the A42 corridor, Tonge and Breedon on the Hill compared to Option 00, through deeper cutting compared to Option 04. The route would be to the south of Coleorton Hall and through Coleorton Hall Registered Park and Garden.

5.3.41 HS2 Ltd determined that Option 00 should be retained as the preferred option as, although Options 02, 04 and 05 would avoid Tonge and Breedon on the Hill, they would result in additional demolitions and severance of scattered communities in the area to the south and east of Coleorton Hall Registered Park and Garden.

5.3.42 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.43 The preferred option, Option 00, would have moderate landscape and visual impacts, particularly at Breedon on the Hill, Tonge and Langley Priory. However, impacts would largely be contained due to sensitive design, which would reduce impacts when compared against all other options. The preferred option would have a major impact on Thrumpton Conservation Area, where the route would be in cut and cover tunnel, and on Long Eaton Conservation Area, where the route would largely be contained within the existing rail corridor. This option would also have a direct impact on the Grade II listed 4 and 5 Park Farm, which would be intersected by the route earthworks.

5.3.44 All options considered would require a short viaduct crossing of the River Mease SAC/SSSI. A study to inform the Habitats Regulations Assessment (HRA) was undertaken for the River Mease SAC in consultation with Natural England and the Environment Agency. The HRA screening report concluded that there was a potential significant effect on the SAC due to shading of the river caused by crossing the SAC on viaduct. A draft Appropriate Assessment was then undertaken, which included a detailed study of shading impacts on the river habitats. This concluded there would be no adverse effects on the River Mease SAC arising from the construction or operation of the Proposed Scheme. HS2 Ltd will continue to consult with these bodies (and other relevant key stakeholders) as the design develops to ensure that the submitted design in the hybrid Bill and its construction comply with the Habitats Regulations 2017. Where required, further assessment will be undertaken and an appropriate design will be developed through an iterative process. Any studies to inform the required assessments will be completed and the outcomes agreed with Natural England prior to submission of the hybrid Bill.

5.3.45 Option 00 would also have an impact on the Alvecote Pools SSSI as a result of noise disturbance and waterborne pollution during construction, and Lount Meadows SSSI, as a result of potential airborne and waterborne pollution during construction.

The Measham Wharf development site and East Midlands Gateway SRFI would be directly affected by the preferred option.

5.3.46 Option 04 would follow a similar route to the preferred option and would diverge at Breedon on the Hill and Tonge further east of the A42. This would result in moderate to localised major landscape and visual impacts. Similar to Options 00 and 02, Option 04 would also have major impacts on Thrumpton and Long Eaton conservation areas and an additional major impact on Coleorton Conservation Area. As well as impacting the Grade II listed 4 and 5 Park Farm and Hillpark Farmhouse, this option would also have a direct impact on the Grade II* listed Coleorton Hall and registered park and garden.

5.3.47 Option 04 would have the same impact upon the Alvecote Pools SSSI as the preferred option, however, it would avoid impacts to Lount Meadows SSSI. This option would also introduce a direct impact on the Rough Park Ancient Woodland where the route would result in habitat loss and shading. Similar to the preferred option, this option would also have an impact on the development sites at Measham Wharf and East Midlands Gateway SRFI.

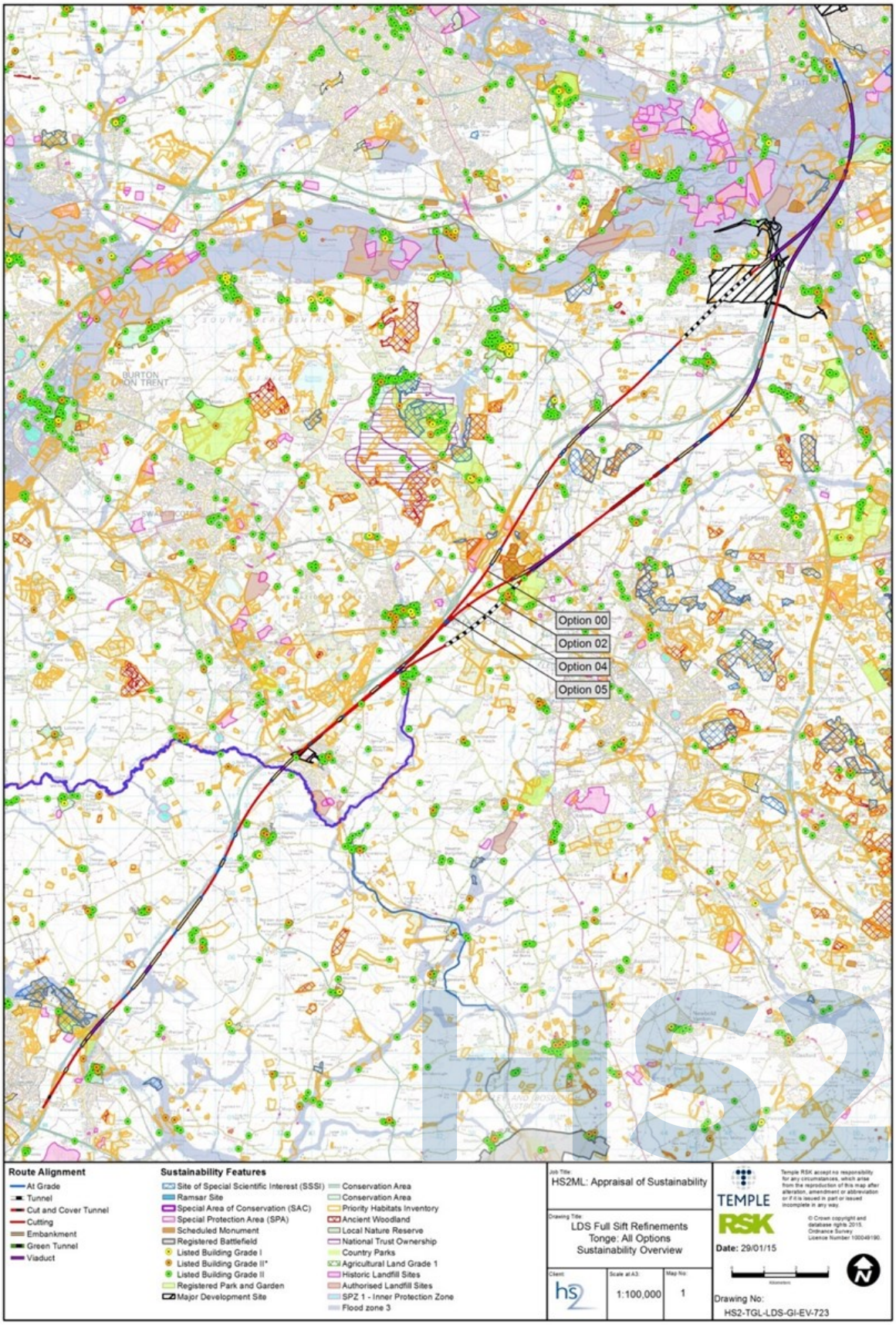
5.3.48 Option 05 would follow a similar route to Options 02 and 04 and would also result in moderate to localised major landscape and visual impacts, largely because the route would pass through attractive and largely unspoilt open countryside away from the A42. This option would also have major impacts on Thrumpton and Long Eaton conservation areas, and similar to Option 04, would introduce a major impact on Coleorton Conservation Area. Option 05 would also impact on the Grade II listed 4 and 5 Park Farm, Hillpark Farmhouse and the Grade II* listed Coleorton Hall and registered park and garden.

5.3.49 Option 05 would have the same impact upon the Alvecote Pools SSSI as the preferred option, but would avoid Lount Meadows SSSI. As with Option 04, this option would also directly impact on the Rough Park Ancient Woodland. Similar to the preferred option, this option would also impact on the development sites at Measham Wharf and East Midlands Gateway SRFI.

5.3.50 Option 02 would follow a broadly similar route to the preferred option and would also result in moderate to localised major landscape and visual impacts, largely because the route would pass through attractive and largely unspoilt open countryside away from the A42. Similar to Option 00, this option would also have major impacts on Thrumpton and Long Eaton conservation areas, and the Grade II listed 4 and 5 Park Farm. Option 02 would also have a major impact on the Grade II listed Canterbury Lodge in the Coleorton Estate and the Hillpark Farmhouse.

5.3.51 Option 02 would have the same impact on Alvecote Pools SSSI as the preferred option, however, it would avoid impacts to Lount Meadows SSSI. This option would also impact on the development sites at Measham Wharf and East Midlands Gateway SRFI.

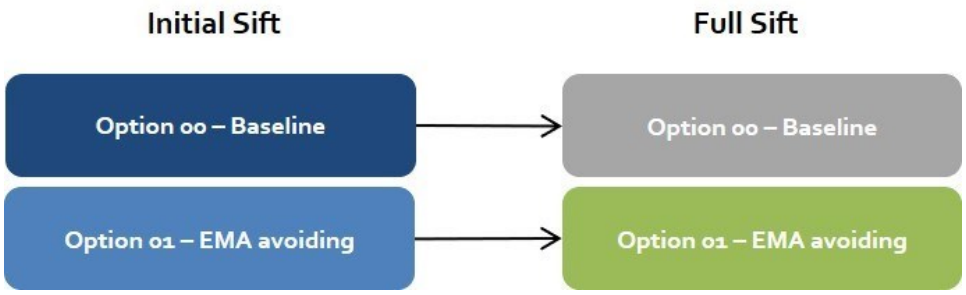
Figure 86: Local alternatives considered for Tonge



East Midlands Airport tunnel

5.3.52 This refinement covered approximately 18km of the route from Ashby-de-la-Zouch up to the Trent Valley, near Kegworth. The refinement objectives were focused on concerns raised during consultation relating to noise and visual impacts affecting the communities at Tonge and Breedon on the Hill, as well as stakeholder concerns regarding impacts on the East Midlands Gateway SRFI and concerns about tunnelling underneath an operational airport. This refinement also sought to review previous options to identify any opportunities to address engineering complexities and to identify cost efficiencies associated with tunnelling under an operational airport. Two options were considered for this section of route, both of which were taken to a full sift appraisal. The options taken forward in the sift stages are shown in Figure 87 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 88.

Figure 87: Local alternatives considered for East Midlands tunnel



5.3.53 The following two options were taken forward to the full sift review:

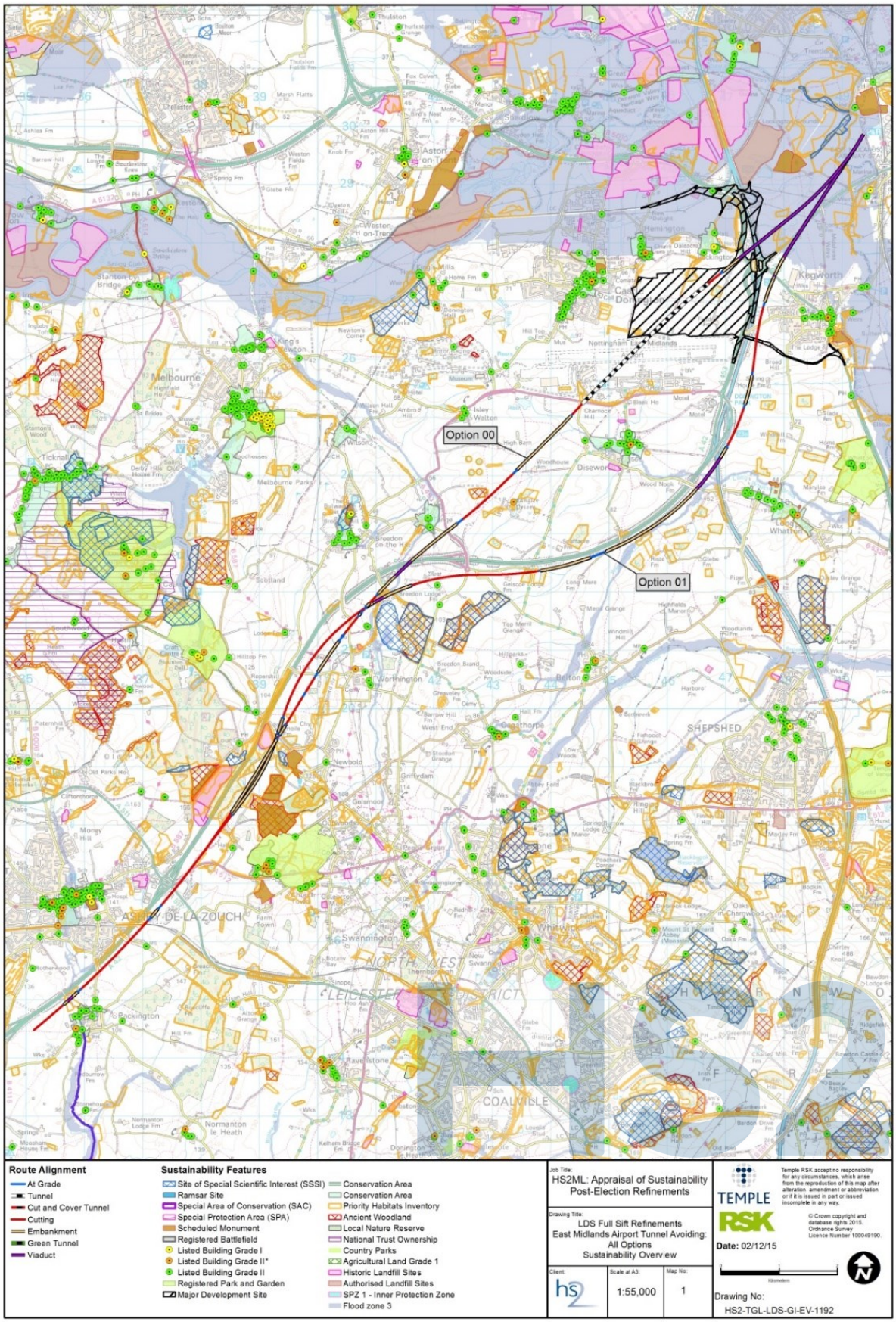
- Option 00: the DRR would follow the A42 initially and would cross to the east of Breedon on the Hill before diverging from the A42 and would then continue north-east, passing under the East Midlands Airport in a bored tunnel. The route would surface east of Castle Donnington, would rise onto viaduct to cross the M1, before continuing on viaduct across the floodplains of the River Soar and River Trent; and
- Option 01 would remain on the east side of the A42 and would closely follow alongside in a mix of cutting, embankment and viaduct approaching the M1. The route would cross the M1 south of junction 23a on viaduct, and would continue between the M1 to the east and Kegworth to the west, heading north-east and thus avoiding East Midlands Airport. A viaduct would take the route across the floodplains of the River Soar and River Trent. Speed would be restricted to 270kph for this option.

5.3.54 HS2 Ltd determined that Option 01 was the preferred option to be taken forward. This was on the basis of combined, cost, engineering and sustainability considerations, including the avoidance of potentially costly tunnelling underneath the East Midlands Airport, and the associated engineering challenges. It was noted that the route may cross the airports' Public Safety Zone and that there would be risks undertaking construction in proximity to the airport runway. It was determined that this would

need to be discussed with the airport owner/operator during further design development.

5.3.55 The preferred option, Option 01, would have moderate landscape and visual impacts, including at Coleorton Hall where the route would be in deep cutting in proximity to the conservation area and on viaduct crossing the M1. There would also be a visual impact on recreational users of the River Soar and Midshires Way long distance path as a result of the viaduct over the River Soar. However, the route would be further from both Tonge Conservation Area and Worthington, when compared with Option 00, resulting in reduced noise and visual impacts. Option 01 would have a moderate impact on the setting of the Grade II listed Breedon Lodge (a new impact when compared with Option 00) but Option 01 would avoid impacts on the setting of the Grade II* listed Langley Priory. Option 01 would also cross part of the East Midlands Gateway SRFI, but impacts would be limited to the crossing of a proposed access road, which would have a much reduced impact when compared with Option 01.

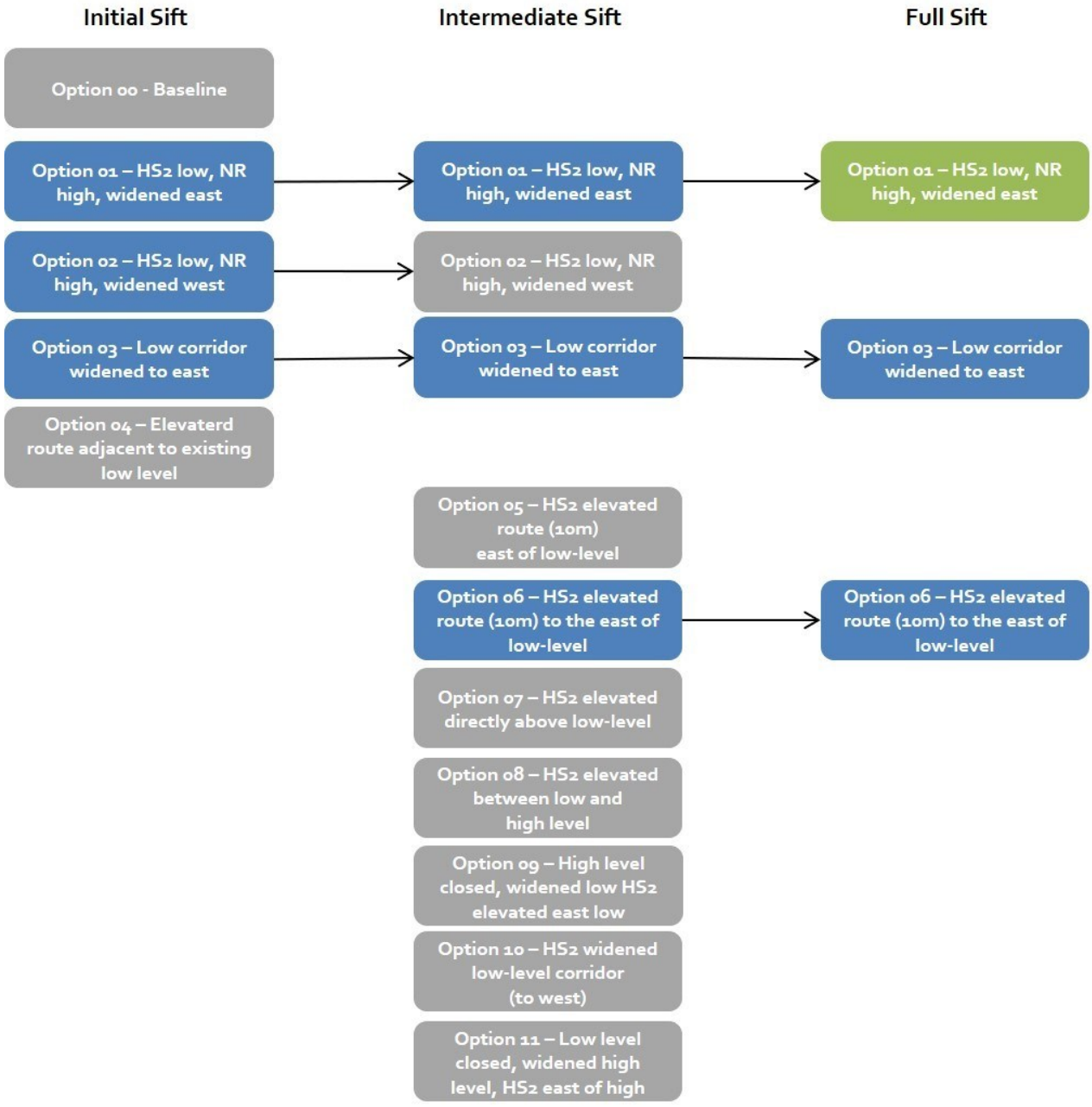
Figure 88: Local alternatives considered for East Midlands Airport tunnel



East Midlands Hub (Toton)

5.3.56 This refinement area covered approximately 16.5km of the route from Long Eaton to Trowell. The key aim of the refinement was to find a station solution that was compliant with HS2 Ltd standards and would reduce potential impacts to the River Erewash, whilst also reducing impacts to highways and the communities of Long Eaton, Toton and Stapleford. An important aim of this work was to find a solution that allowed adequate capacity for conventional trains to access the new Network Rail station in Toton, and to maintain existing links into the existing freight yard. A total of 12 options were proposed, with nine not considered reasonable on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 89 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 90.

Figure 89: Local alternatives considered for the East Midland Hub



5.3.57 The following options were studied during the full sift:

- Option 01 would be very similar to the 2013 proposed scheme for consultation and would require the existing conventional Network Rail low-level corridor within Long Eaton, with the conventional train services from that corridor, moved to the high level corridor. The high level corridor would need to be widened to the east to accommodate this change. This option would cross Main Street on embankment and Station Road level at grade, with both roads requiring to be realigned. The route would then pass under the A6005, which would be realigned to the north of the East Midlands Hub station. To the north, the route would pass in cutting under the A52 and a realigned Derby Road before traversing the River Erewash and Erewash Canal. Option 01 was used as the baseline comparator during sifting, in the absence of an existing compliant option (the 2013 proposed scheme for consultation had non-compliant clearances over the floodplain, the A6005 and the proposed 'freight' bridge);
- Option 03 would provide a widened low level corridor to the east of the existing low level conventional railway and the high level corridor would not be widened. The alignment would be raised to the south approaching Long Eaton; and
- Option 06: this option would see the HS2 main line on an elevated route to the east of the low level corridor.

5.3.58 HS2 Ltd determined that Option 01 should be taken forward as the preferred option, subject to further work being undertaken to understand the flooding implications. All options follow the same route with some vertical differences, and impacts would, therefore, be largely the same.

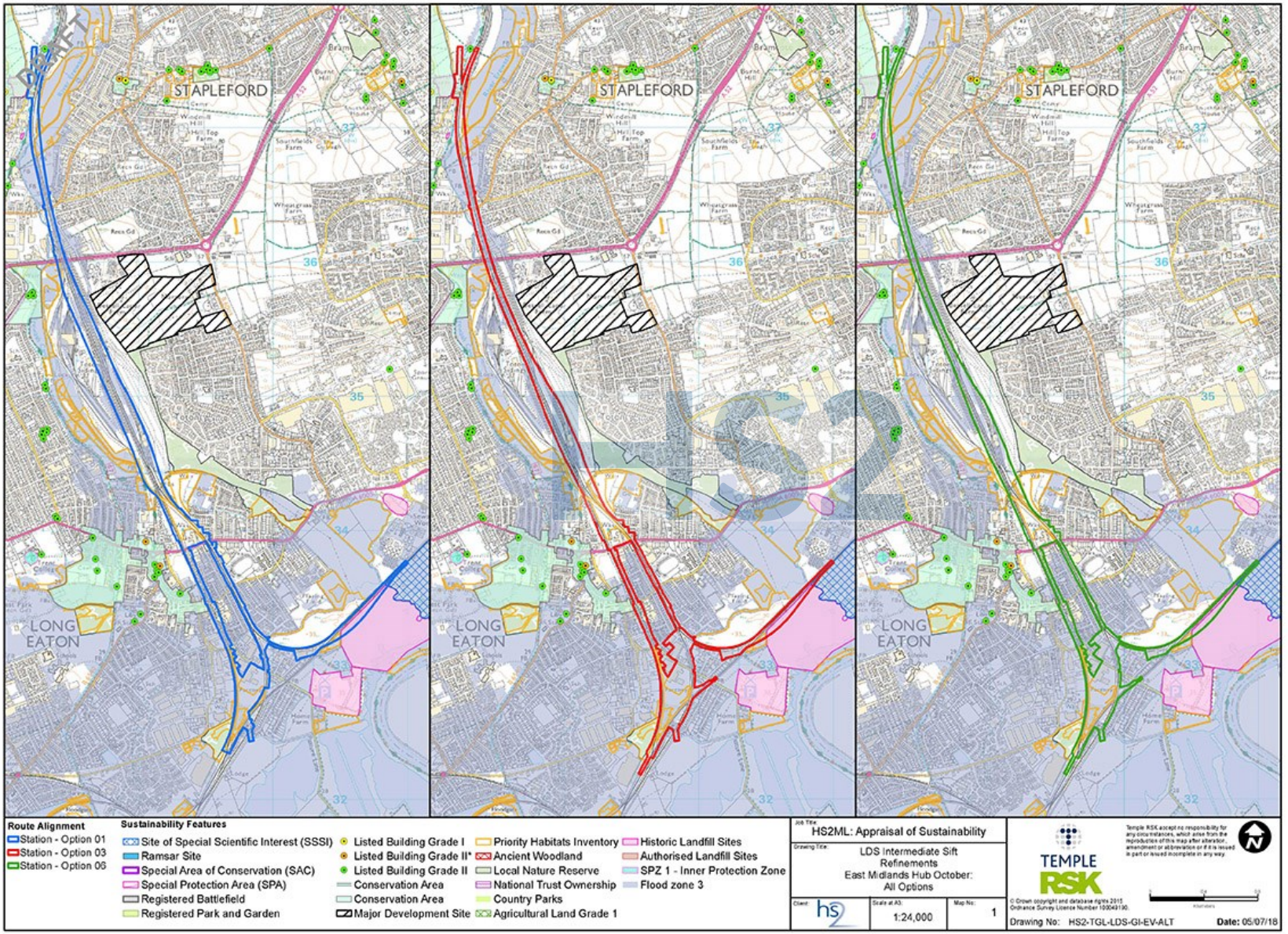
5.3.59 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.60 The preferred option, Option 01, would have moderate landscape and visual impacts due to long viaducts over the River Trent and River Erewash at Sandiacre. This option would result in localised moderate visual impacts on residents of Toton. Option 01 would also have a major impact on the Roman site on Red Hill Scheduled Monument and minor impacts on Attenborough Gravel Pits SSSI. Two major diversions of the River Erewash would also be required for this option.

5.3.61 Option 03 would have major landscape impacts, largely due to an approximately 2.5km long and approximately 21m high viaduct over the River Trent, which would increase townscape impacts in Long Eaton compared to the preferred option. Similar to the preferred option, this option would have a major impact on the Roman site on Red Hill Scheduled Monument and would also require two major diversions of the River Erewash.

5.3.62 Similar to Option 03, Option 06 would have a major landscape impact due to the long viaduct over the Trent Valley, which would require an elevated HS2 main line through Long Eaton, resulting in visual intrusion on the townscape. Common to all options, Option 03 would have a major impact on a Roman site on Red Hill Scheduled Monument and would also require two major diversions of the River Erewash.

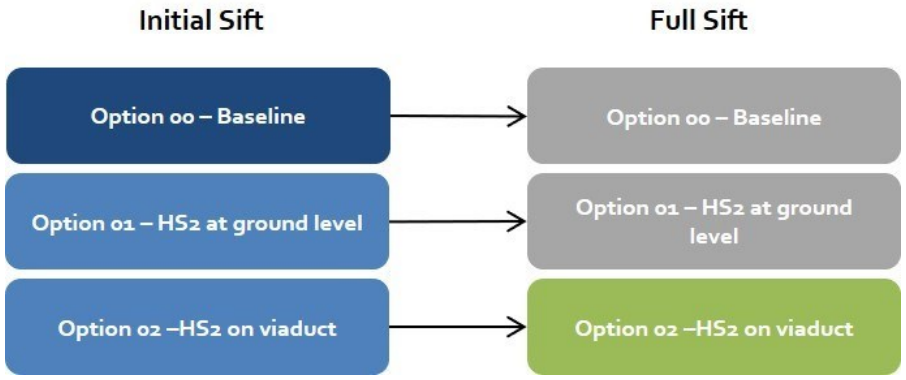
Figure 90: Local alternatives considered for the East Midland Hub



East Midlands Hub, Toton (further refinement)

5.3.63 This refinement undertaken in 2016 built on previous work undertaken in 2014 and encompassed approximately 7km of the route, covering an area from Thrumpton Park through to north of Sandiacre. This refinement sought to determine the preferred route through Toton with regard to flood risk, highway impacts and severance. It was also to recognise the Erewash Borough Council consultation response, which requested the route to be raised on viaduct through Long Eaton. It also follows on from a review of the route, following the application of Phase One design standards, flood modelling work and a review of construction impacts through the area. Three options were proposed for this section of the route, all of which were progressed to full sift. The options taken forward in the sift stages are shown in Figure 91 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 92.

Figure 91: Local alternatives considered for East Midlands avoiding



5.3.64 The following three options were taken forward to the full sift review:

- Option 00: the DRR would be at ground level in a widened low level corridor through Toton. Network Rail passenger and freight services would be provided on a high level corridor, widened to the east as the existing freight line would be moved from the low level corridor, resulting in two additional tracks at the higher level. There would be an approximately 1.5km long viaduct across the River Trent approaching Long Eaton;
- Option 01 would be at ground level in a widened low level corridor to the east of the existing conventional railway. The viaduct approach to Long Eaton would be extended to the north, approximately 2km long in total, with embankments between Long Eaton and Toton, which would be longer than Option 00. The high level corridor for conventional rail services would not be widened; and
- Option 02 would be on a viaduct stretching from the River Trent through to Toton sidings, which would be approximately 5km long. Under this option the route would be in a widened low level corridor to the east of the existing conventional railway. The high level corridor for conventional rail services would not be widened. At the East Midlands Hub station, an additional level change would be required to access platforms.

5.3.65 HS2 Ltd proposed Option 02 as the preferred route as it would have a reduced flood risk when compared to both Options 00 and 01, whilst also improving accessibility east to west through Long Eaton as a result of the raised HS2 main line and the roads remaining open beneath the viaduct. This was also deemed the more cost-effective solution.

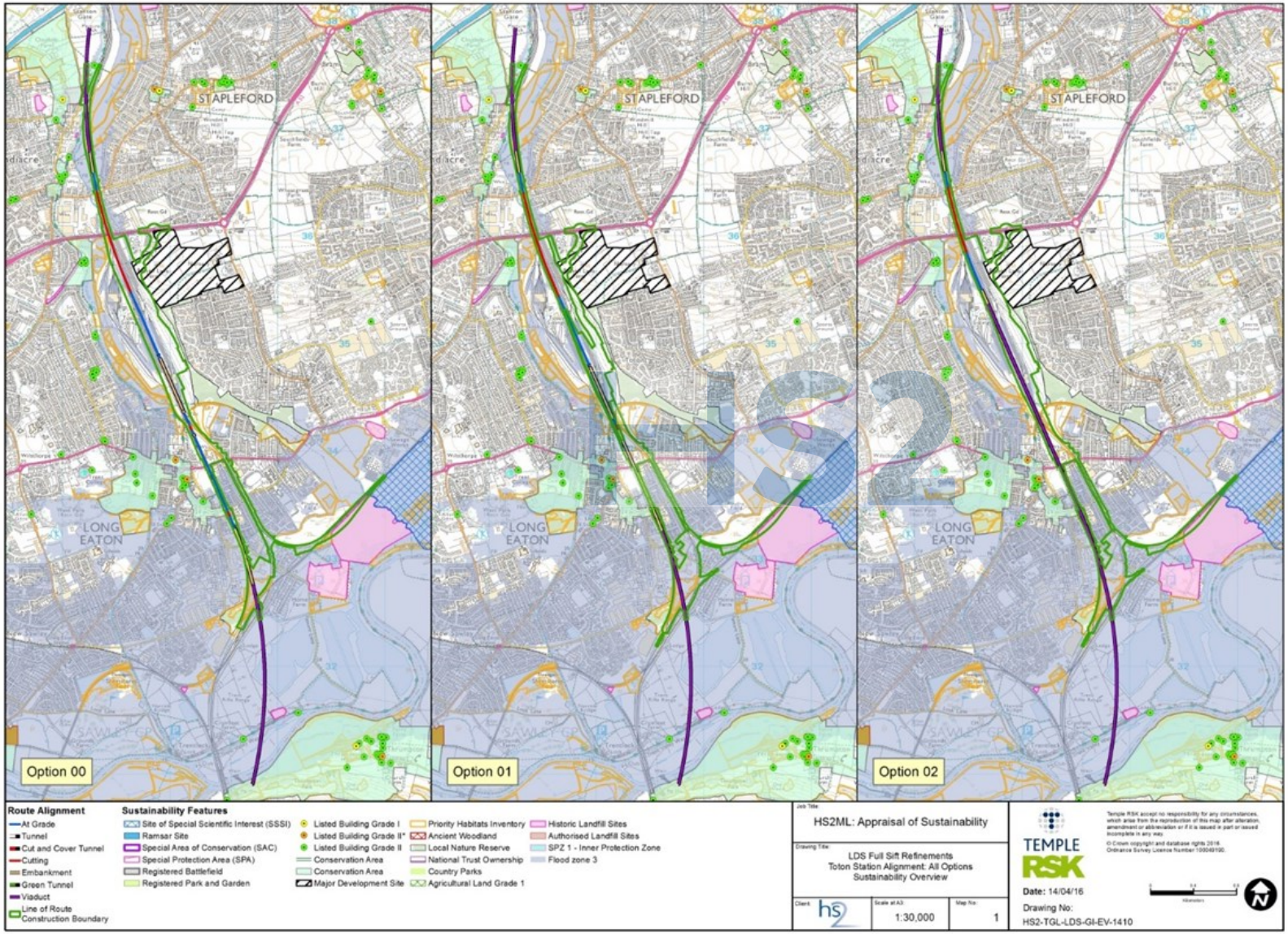
5.3.66 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.67 The preferred option, Option 02, would have increased landscape and visual impacts resulting from the higher HS2 main line, particularly through the Trent Valley and Long Eaton. There would also be an increase in noise impacts through Long Eaton, when compared with both Options 00 and 01. Residents in the area may also have a perceived sense of severance as a result of the raised approach to the East Midlands Hub. However, by raising the HS2 main line through Long Eaton there would be a considerably reduced risk of fluvial flooding from the River Erewash compared to the other options. Similar to all other options, there would be an impact on the setting of the Grade II listed Redhill Tunnel North Portal as well as on Thrumpton Conservation Area, through which the route would pass in a combination of cut and cover tunnel and on viaduct. The total number of demolitions would be lower than for Option 00, as Option 02 would have a lower impact on existing Network Rail infrastructure.

5.3.68 Option 00 would have landscape and visual impacts as a result of the viaduct crossing of the River Trent, although these would be comparatively lower than Option 02 and Option 01 due to shorter section of viaduct. However, Option 00 would have a greater risk of fluvial flooding from the River Erewash than Option 02 as the route would run at ground level through Long Eaton. Whilst there would still be noise impacts through Long Eaton, these would be reduced when compared with Option 02 and Option 01, although there would be an increase in total demolitions due to the widened Network Rail corridor. Similar to all other options, there would be an impact on the setting of the Grade II listed Redhill Tunnel North Portal as well as Thrumpton Conservation Area, through which the route would pass in a mix of cut and cover tunnel and on viaduct.

5.3.69 Option 01 would also have landscape and visual impacts as a result of the viaduct crossing of the River Trent, although these would be comparatively lower than Option 02, but greater than Option 00, due to the length of the viaduct. Option 01 would have a similar risk of fluvial flooding from the River Erewash as Option 00 as the route would run on embankment through Long Eaton. Whilst there would still be noise impacts through Long Eaton, these would be reduced when compared with Option 02 but greater than Option 01. The total number of demolitions for Option 01 would be similar as for Option 02 and slightly less than for Option 00. Similar to all other options, there would be an impact on the setting of the Grade II listed Redhill Tunnel North Portal as well as Thrumpton Conservation Area, through which the route would pass in a mix of cut and cover tunnel and on viaduct.

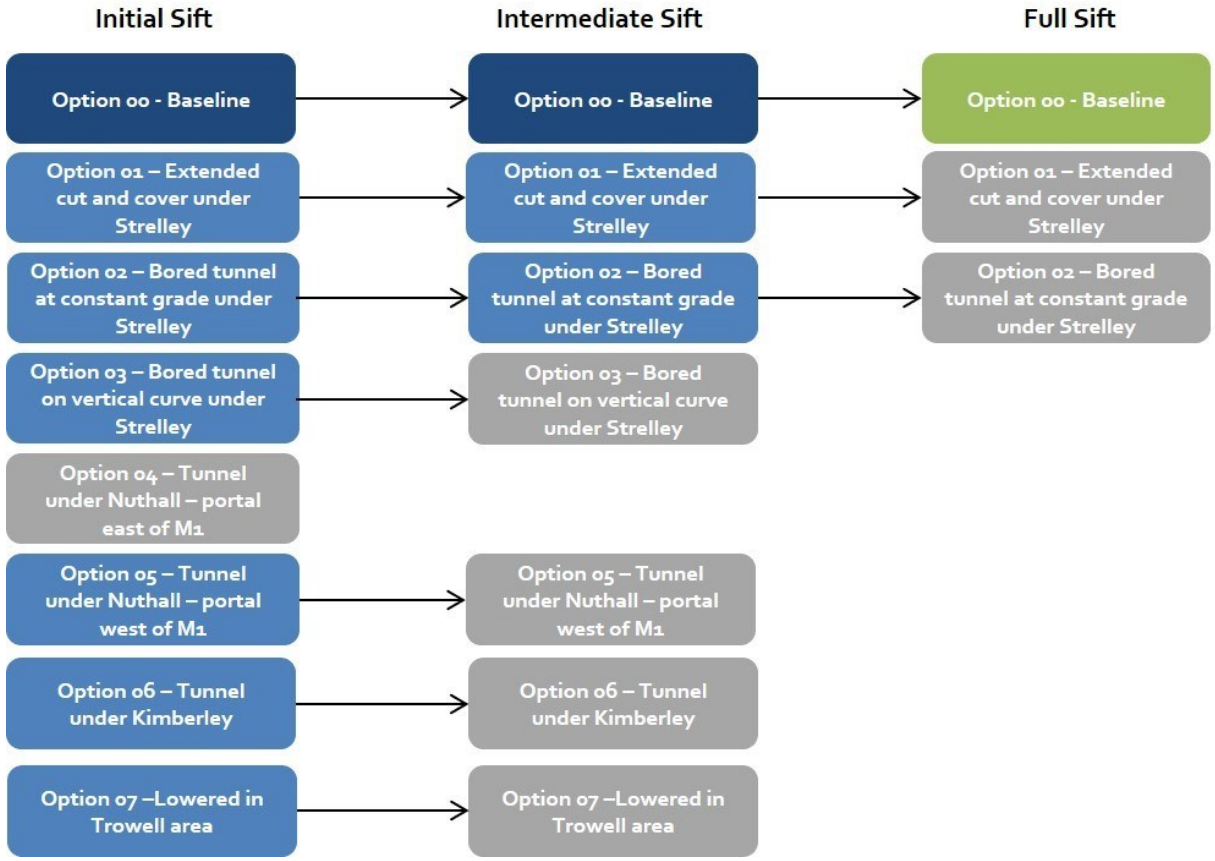
Figure 92: Local alternatives considered for East Midlands Hub - Toton



Strelley

5.3.70 This refinement covered approximately 10km of the route from Sandiacre to Westville. This refinement sought to reduce impacts on the Nottingham Business Park and Strelley Conservation Area and the listed buildings within it. This includes one Grade I listed building (Church of All Saints) and six Grade II listed buildings. A total of eight options were proposed, with five not progressed to full sift on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 93 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 94.

Figure 93: Local alternatives considered for Strelley



5.3.71 The following options were studied during the full sift:

- Option 00: the RRB, would travel north-east from Stanton Gate on viaduct. The route would then pass to the east of Trowell before passing under and west of Strelley village in cut and cover tunnel. The route would remain in a cut and cover tunnel until Nottingham Business Park, where the majority of the route would then run in deep cutting, before passing to the east of Nuthall;
- Option 01: similar to Option 00, but with an extended cut and cover tunnel, approximately 310m longer than Option 00, which resulted in generally lower route heights; and
- Option 02 would include a twin bored tunnel under the Strelley Conservation Area and would continue further north of the Nottingham Business Park. Due

to the lowering of the route height, Option 02 would pass under the A610 in a cut and cover tunnel, whereas Options 00 and 01 would pass over on viaduct.

5.3.72 HS2 Ltd determined that Option 00 should be retained as the preferred option. All options would follow the same route with some variation in tunnel construction and depth. In comparison to Option 00, Option 01 would involve additional cost and potentially cause greater temporary impacts to Strelley during construction. Option 01 would not substantially reduce impacts on Strelley Conservation Area or associated listed buildings when compared to Option 00. Option 02 would have substantial cost implications due to the addition of a bored tunnel. Overall, it was considered that the reduction in impacts associated with Option 01 and 02 did not justify the additional cost. HS2 Ltd considered that further design development may provide opportunities to mitigate impacts associated with this option.

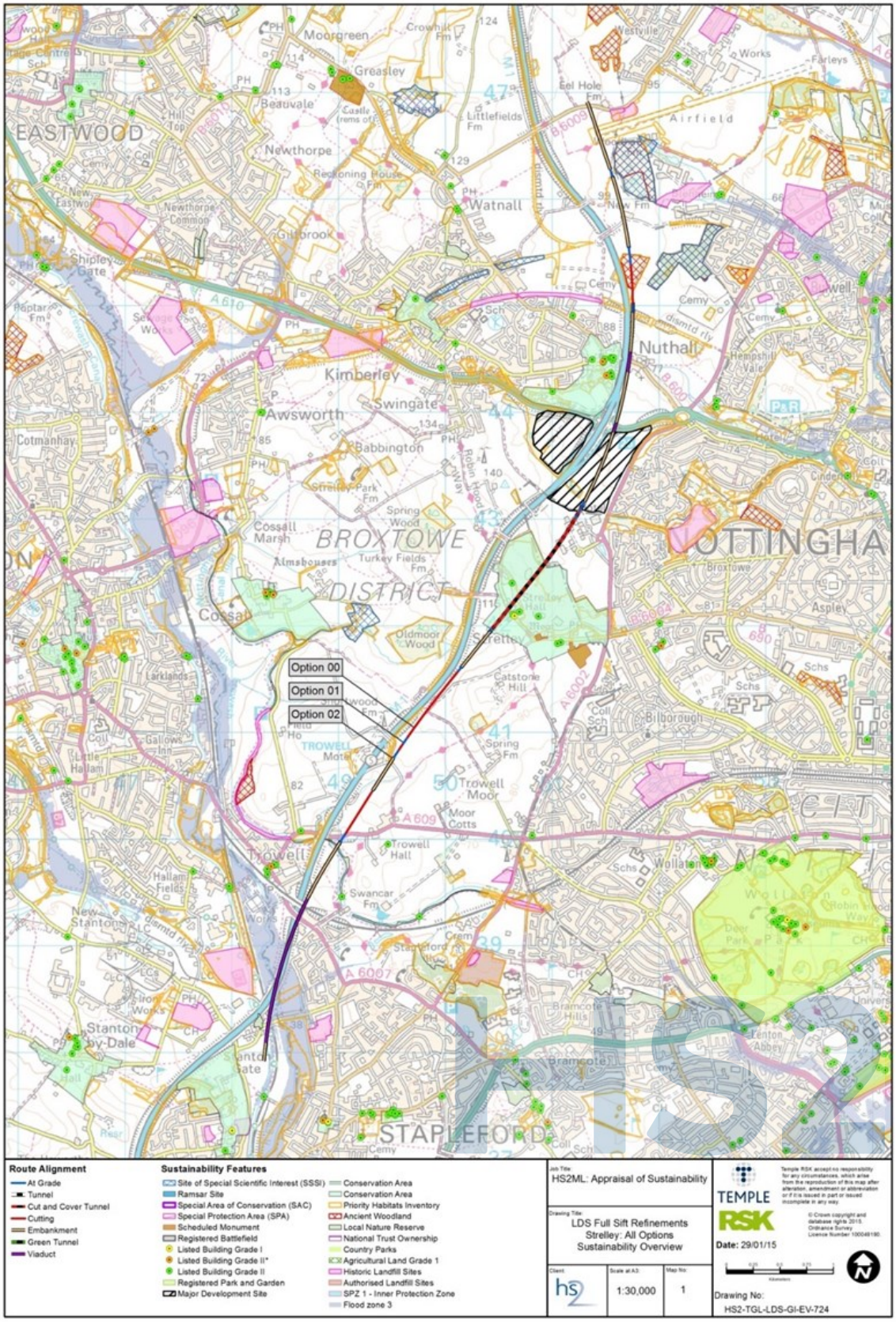
5.3.73 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.74 The preferred option, Option 00, would have landscape and visual impacts due to high embankments at Stanton Gate, the M1 crossing and Broxtowe, and a high viaduct at Stapleford in the Erewash Valley. There would be a direct impact to Strelley Conservation Area as well as impacts upon the setting of several listed buildings within it. These would include the Grade I listed Church of All Saints and six Grade II listed buildings (Golder Close and adjoining boundary wall; Ice House approximately 200m south-east of Strelley Hall; Kitchen Garden walls approximately 250m north-west of Strelley Hall; Stables at Golder Close; Stables at Strelley Hall and adjoining dairy cottage and gate; and Strelley Hall). This option would include a cluster of approximately 12 commercial demolitions at Nottingham Business Park and approximately five residential demolitions at Nuthall.

5.3.75 Option 01 would reduce visual impacts at Stanton Gate when compared to the preferred option as the embankment and viaduct structures would be lower and shorter. Similar to the preferred option, this option would have a direct impact on Strelley Conservation Area, which would be significantly altered by the construction of the cut and cover tunnel and the location of the portal site. The impact on listed buildings resulting from this option would be the same as the preferred option as the route broadly follows the same alignment. Likewise, demolitions resulting from this option would be the same as those estimated for the preferred route due to the common alignment.

5.3.76 Option 02, like Option 01, would reduce visual impacts at Stanton Gate as the alignment is lower and structures shortened when compared to the preferred option. Option 02 would have a minor impact on the setting of the Strelley Conservation Area, reduced from major compared to the preferred option, as the HS2 main line would be in bored tunnel. Impacts on listed buildings from Option 02 would be the same as the preferred option as the route is broadly similar. Due to the lowered vertical alignment, this option would result in fewer demolitions than the preferred option.

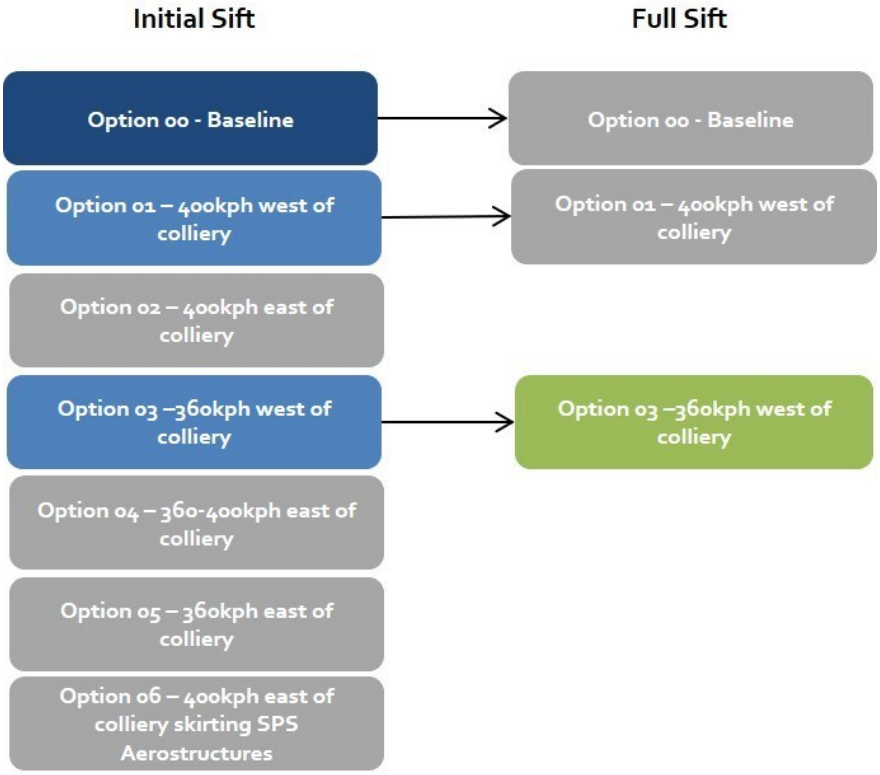
Figure 94: Local alternatives considered for Strelley



Bogs Farm Quarry SSSI

5.3.77 This refinement covered approximately 20km of the route from Westville to Heath. This refinement sought to look at opportunities to avoid Bogs Farm Quarry SSSI, the site of the former Bentinck Colliery (specifically a high risk spoil heap) and avoid a cluster of demolitions at Langton Hall. A total of seven options were proposed, with four not considered reasonable on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 95 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 96.

Figure 95: Local alternatives considered for Bogs Farm Quarry SSSI



5.3.78 The following options were studied during the full sift:

- Option 00: the RRB would be a 400kph route running in a north-west direction from Hucknall, which would cross the narrowest section of Bogs Farm Quarry SSSI on viaduct, before passing through Langton Hall on embankment. The route would then travel to the west of Huthwaite on embankment and to the east of Tibshelf in cutting. This option would then continue north under the M1 in cut and cover tunnel and to the west of Hardwick Hall towards Sutton Scarsdale;
- Option 01 would travel at the same speed as Option 00, taking a more western route further away from Annesley Woodhouse and would cross the western edge of Bogs Farm Quarry SSSI on viaduct and through the western boundary of the former Bentinck Colliery. The route would then take a more eastern route past Sutton in Ashfield, Sawpit Lane Industrial Estate and Tibshelf and would rejoin the route of Option 00 to the south-west of Hardwick Hall.

Compared to Option 00, Option 01 would require a longer viaduct crossing of the Erewash Valley due to the ground reducing in height from east to west; and

- Option 03 would be a 360kph route that would run further west and closer to the M1 at Annesley Woodhouse compared to the other options. This option would then cross the western tip of Bogs Farm Quarry SSSI and would continue north with a longer and more easterly cut and cover tunnel under junction 27 of the M1 to avoid the former Bentinck Colliery. This option would then rejoin the route of Option 00 to the south-west of Hardwick Hall.

5.3.79 HS2 Ltd determined that Option 03 should be taken forward as the preferred option. Option 03 would remove the need for the cluster of demolitions at Langton Hall and would have less impact on the former Bentinck Colliery. Option 03 would be the only option to completely avoid the colliery lagoons and spoil heap. Option 03 would bring the route closer to the existing M1 corridor, which would reduce impacts on Bogs Farm Quarry SSSI and avoid a cluster of demolitions at Langton Hall. Additionally, this option was considered to be the most cost-effective option.

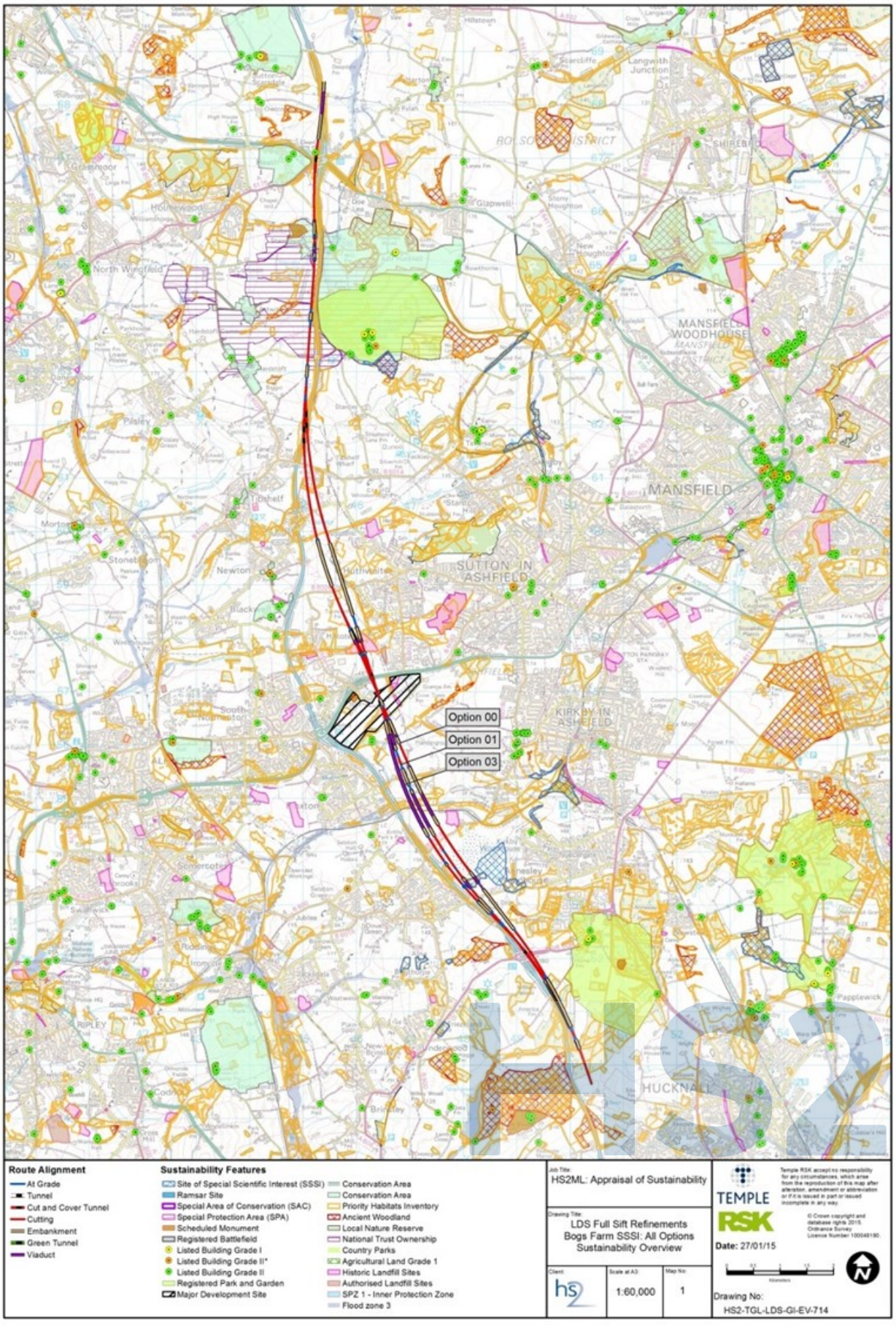
5.3.80 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.81 The preferred option, Option 03, would have major landscape and visual impacts due to a general mismatch of the alignment of the HS2 main line with the landform of the area, specifically near Annesley, Pinxton and Sutton Scarsdale. Park Forest (a potential SPA site for nightjar and woodlark) would be directly affected by Option 03. Option 03 would have a reduced impact at Bogs Farm Quarry SSSI, compared to the base case (Option 00) due to the smaller area of the site that would be crossed and the reduced shading impacts. Option 03 would avoid the cluster of residential demolitions at Langton Hall that would be required by Option 00.

5.3.82 Option 00 would have a moderate landscape and visual impact overall due to a general mismatch with landform. This option would directly impact the Park Forest potential SPA site affected by the preferred option. Option 00 would impact the Bogs Farm Quarry SSSI, which would be reduced by the preferred option. This option would include the demolition of a cluster of approximately seven residential properties at Langton Hall.

5.3.83 Similar to Option 00, Option 01, would have a moderate landscape and visual impact overall with large visually intrusive structures required near Annesley and Stainsby. This option would impact the Park Forest potential SPA site, similar to the preferred option and Option 00. This option would also have a direct impact on the Bogs Farm Quarry SSSI site. This option would include the demolition of a cluster of approximately seven residential properties at Langton Hall.

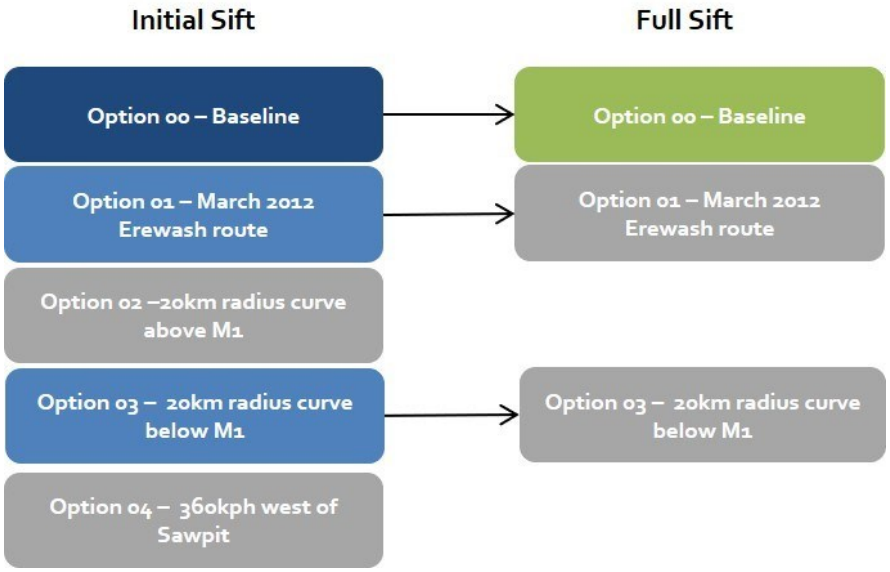
Figure 96: Local alternatives considered for Bogs Farm Quarry SSSI



Tibshelf

5.3.84 This refinement covered approximately 16km of the route from Bogs Farm Quarry SSSI to Heath. This refinement sought to avoid impacts at Sawpit Lane Industrial Estate and reduce the potential visual impacts of the deep cutting at Tibshelf on views from Hardwick Hall. A total of five options were proposed, with two not considered reasonable on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 97 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 98.

Figure 97: Local alternatives considered for Tibshelf



5.3.85 The following options were studied during the full sift:

- Option 00: the RRB would run in a north-west direction from Annesley Woodhouse. This route would pass to the west of Sutton in Ashfield and would cross under the M1 between Tibshelf and Hardwick Hall and through Sawpit Lane Industrial Estate in cutting. The route would then continue north towards Sutton Scarsdale;
- Option 01 would travel further east of Pinxton compared to Option 00 and would pass to the east of Sawpit Lane Industrial Estate, closer to Huthwaite compared to Option 00. This route would also cross over the M1 on viaduct and would re-join the route of Option 00 at Astwith; and
- Option 03 would branch to the east of Option 00 at the development site at Castle Grange and would curve to the east of Sawpit Lane Industrial Estate and pass closer to Huthwaite compared to Option 00. Similar to Option 00, this option would cross under the M1 between Tibshelf and Hardwick Hall but would additionally include a retaining wall in order to avoid Sawpit Lane Industrial Estate.

5.3.86 HS2 Ltd determined that Option 00 should be taken forward as the preferred option. Options 01 and 03 would have fewer demolitions (the latter would avoid all demolitions at Sawpit Lane Industrial Estate), but Option 03 would cost substantially more. Option 01 would potentially have a greater impact on views from Hardwick Hall due to the viaduct crossing of the M1.

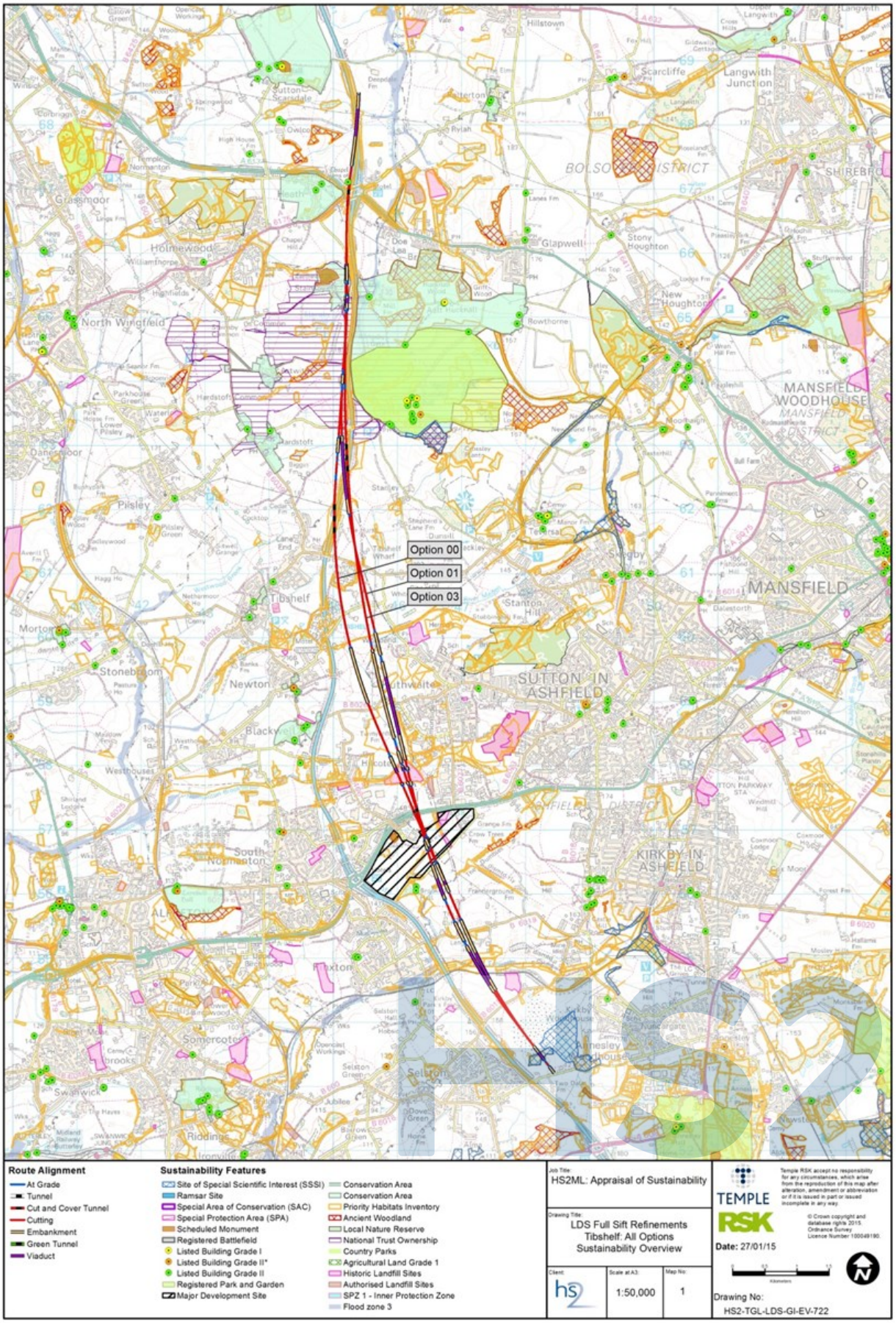
5.3.87 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.88 The preferred option, Option 00, would have moderate landscape and visual impacts associated with the crossing of the River Erewash and long sections of cutting and embankment. The preferred option would avoid major landscape and visual impacts associated with the visually intrusive structures of Options 01 and 03. However, this option would be visually intrusive when viewed from the Grade I listed Hardwick Hall Registered Park and Garden and the Hardwick Hall National Trust site. This option would have a direct impact on Bogs Farm Quarry SSSI as well as minor indirect impacts on Annersley Woodhouse Quarries SSSI. The preferred option would include a cluster of approximately seven residential demolitions at Langton Hall, Pinxton and a cluster of approximately seven commercial demolitions at Sawpit Lane Industrial Estate.

5.3.89 Option 01 would have increased landscape and visual impacts when compared to the preferred option, largely due to the major visual intrusion at Pinxton and north of the A38 resulting from high viaducts over the River Erewash. This option would also require a deep cutting resulting in major landscape impacts on sensitive historic field patterns. Similar to the preferred option, this option would have a direct impact on Bogs Farm Quarry SSSI and minor impacts on the Annersley Woodhouse Quarries SSSI. Option 01 would result in fewer demolitions than the preferred option, avoiding the clusters at Sawpit Lane and Langton Hall.

5.3.90 Similar to Option 01, Option 03 would increase landscape and visual impacts resulting from a direct impact on the historic landscape field patterns at Huthwaite and also visual impacts at the River Erewash crossing. Major visual intrusion at Pinxton would result from the high viaducts over the River Erewash, similar to Option 01. Option 03 would also directly impact Bogs Farm Quarry SSSI, and similar to the preferred option, indirectly impact on the Annesley Woodhouse Quarries SSSI. This option would require the demolition of a cluster of approximately seven residential properties at Langton Hall.

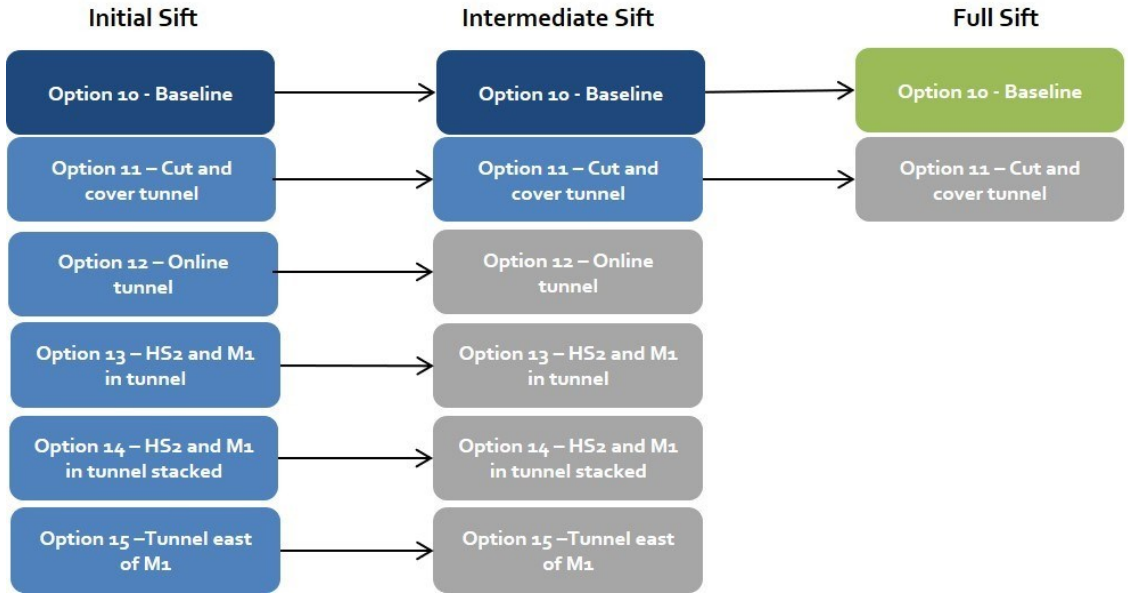
Figure 98: Local alternatives considered for Tibshelf



Hardwick Hall

5.3.91 This refinement covered approximately 14km of the route from Tibshelf to Long Duckmanton. The aim of this refinement was to look at opportunities to reduce the visual impacts on Hardwick Hall (a National Trust site, Grade I listed building and registered park and garden) and Hardwick Old Hall Schedule Monument. A total of six options were proposed, with four not progressed to full sift on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 99 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 100.

Figure 99: Local alternatives considered for Hardwick Hall



5.3.92 The following options were studied during the full sift:

- Option 10: the RRB would run from the south-west of Sutton in Ashfield in a north-west direction towards Huthwaite in cutting and along embankment past Huthwaite. The route would then be predominantly in cutting to the east of Tibshelf and in cutting under the M1 and would then follow the M1 north. It would pass to the west of Hardwick Hall and the M1 in this area; and
- Option 11 would follow the same route as Option 10 but with a reduced height, and would include an additional cut and cover tunnel to the west of Hardwick Hall. This would commence just south of Deep Lane and would continue for approximately 1.2km. The cut and cover tunnel would be designed to reduce the deep cutting near Deep Lane.

5.3.93 HS2 Ltd determined that Option 10 should be retained as the preferred option, subject to further work during further design development to review costs and investigate whether a retained wall past Hardwick Hall at Deep Lane could be included to reduce visual impacts. Both options follow the same route with some vertical differences and impacts would therefore be largely similar.

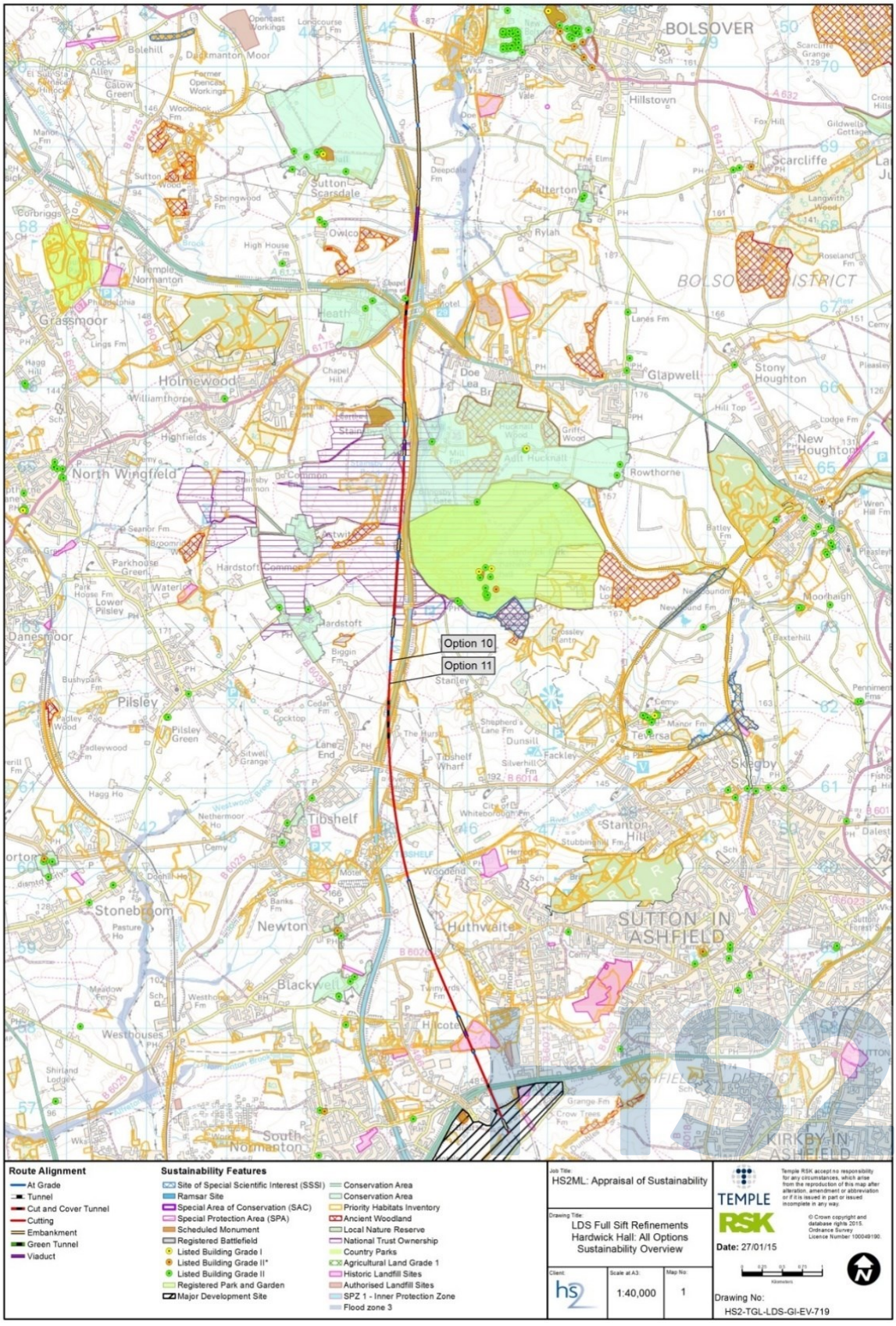
5.3.94 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.95 The preferred option, Option 10, would have moderate landscape and visual impacts due to long, deep cuttings and embankments. However, these impacts would be reduced due to proximity to the existing transport corridor. Specifically, a deep cutting at Tibshelf would result in landscape character impacts at Hardwick Hall and Sutton Scarsdale. There would be direct impacts on Stainsby Conservation Area and on the Grade II listed ruins of the Old Heath Church.

5.3.96 To reduce visual impacts on views from Hardwick Hall, Option 11 would incorporate a cut and cover tunnel, increasing cost and engineering complexity. However, this option would result in notable landscape scarring to the north of the cut and cover tunnel and increased impacts on views from Stainsby due to a long, deep and wide cutting. A longer, higher viaduct over the M1 would also increase the impact on views from Sutton Scarsdale village. Option 10 would result in slightly fewer earthworks in these sensitive areas.

5.3.97 Option 11 would have moderate landscape and visual impacts, although these would be increased due to generally larger structures when compared to the preferred option. Views from Sutton Scarsdale village would be obstructed by a longer and higher crossing of the M1 compared to Option 10. Option 11 would have a major impact on the Grade II listed ruins of the Old Heath Church and a moderate impact on the Grade I listed Hardwick Hall Registered Park and Garden, intersecting National Trust land at Hardwick Hall. The Sutton Scarsdale and Heath village conservation areas would be affected by this option.

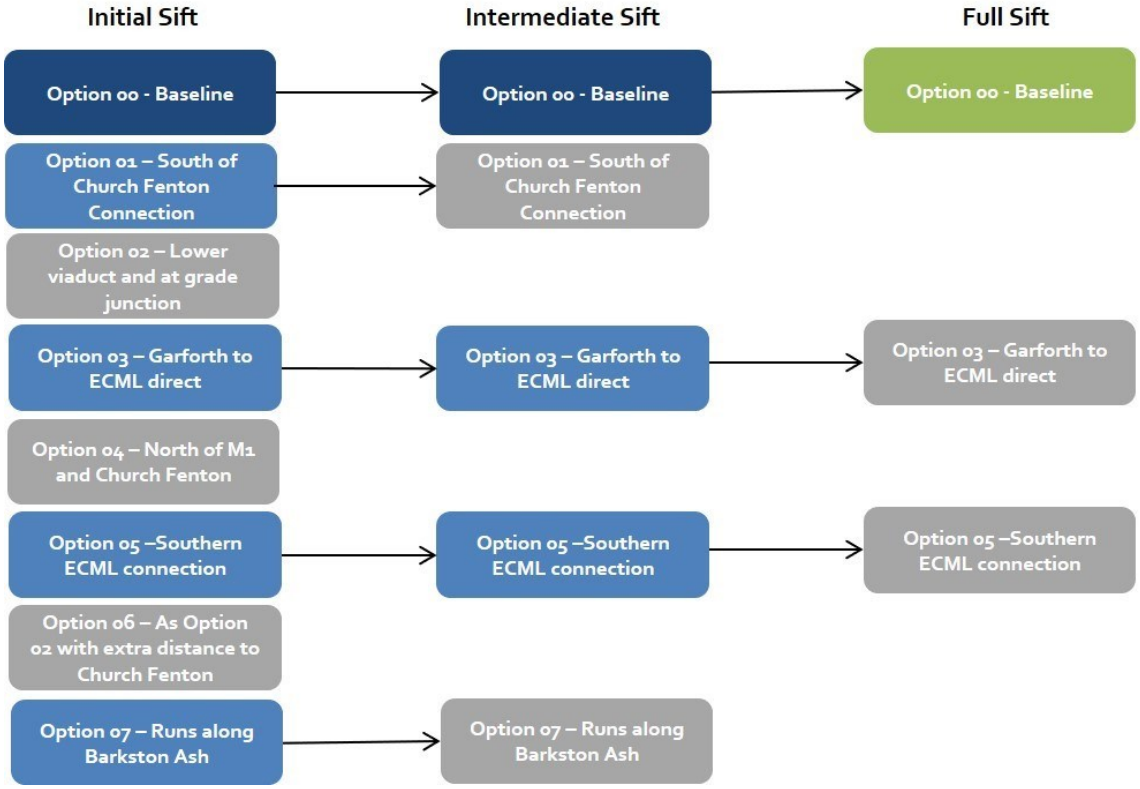
Figure 100: Local alternatives considered for Hardwick Hall



Church Fenton

5.3.98 This refinement covered approximately 45km of the route between Cold Hiendley, Colton Junction and the M1 at Rothwell. The aim of the refinement was to determine the preferred route past Church Fenton and review whether the route could be moved away from Church Fenton or extended to connect with the ECML further south. A total of eight options were proposed at initial sift, with five not considered reasonable for full sift on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 101 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 102.

Figure 101: Local alternatives considered for Church Fenton



5.3.99 The following options were studied during the full sift:

- Option 00: the RRB would travel north on viaduct past Crofton and in cutting past Kirkthorpe. The route would continue north past Normanton and Swillington before curving east to the north of Garforth to follow the existing M1 corridor. The route would continue east before turning north-east to the north of Sherborn in Elmet and would pass to the west of Church Fenton on viaduct;
- Option 03 would initially follow the same route as Option 00 but would continue east on viaduct to the north of Sherborn in Elmet and would then cross over the floodplain before curving north-west of Biggin. This option would avoid Church Fenton and would connect further south to the ECML than Option 00 (south of Colton Junction); and

- Option 05 would branch initially west from the route of Option 00 at Crofton, would cross back over to the east of Option 00 at Kirkthorpe, before heading north-east past Castleford and would then cross the River Aire and River Calder on viaduct. The route would then continue past Fairburn and Monk Fryston, south of South Milford, Sherburn in Elmet and Gascoigne Wood.

5.3.100 HS2 Ltd determined that Option 00 should be retained as the preferred option. Option 03 resulted in similar noise impacts as Option 00 and would move impacts from one community to another. However, Option 03 would result in additional visual impacts on residents and landscape impacts on a wide area of open countryside. Option 03 would also result in additional costs, due to engineering requirements.

5.3.101 Although Option 5 would result in reduced noise impacts compared to Option 00 and Option 03, it was noted that it would likely transfer many impacts to a different set of communities. HS2 Ltd considered that adopting this route would involve significant new impacts, including the crossing of five additional historic landfills and one additional authorised landfill, being in close proximity to Newton and Fairburn Ings SSSI and hydrological risk associated with the floodplain crossing. The new engineering and cost risks associated with this option were considered unacceptable as they did not offer a significant overall improvement in sustainability performance.

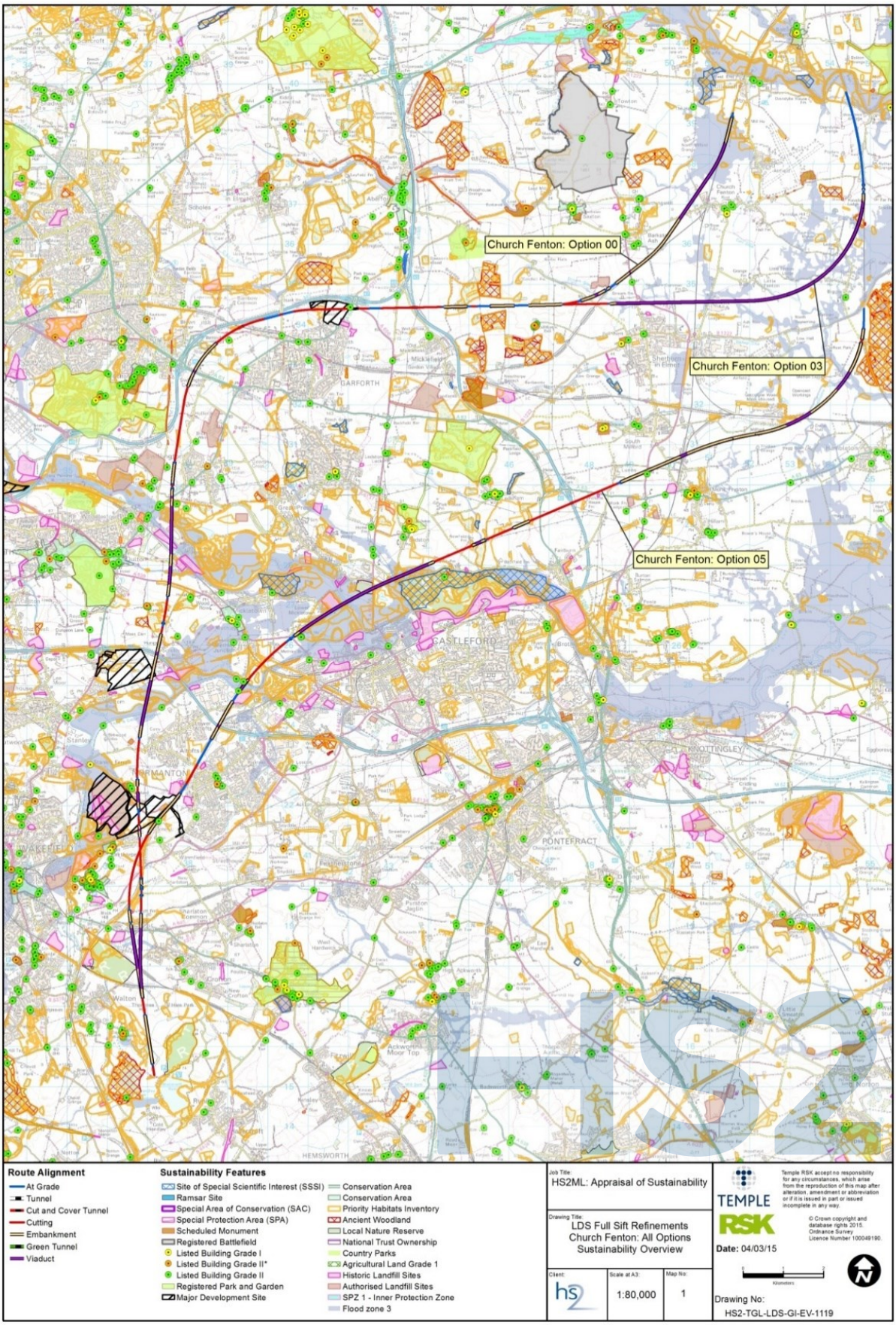
5.3.102 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.103 The preferred option, Option 00, would have moderate landscape impacts and major visual intrusion impacts, particularly on recreational users of the Aire and Calder valleys due to high embankments and long viaducts over the floodplain. This option would result in a direct impact on Rothwell Country Park. Option 00 would have impacts on the setting of five Grade II listed buildings (including South Lodge and Swillington Park) which would also have been affected by Option 03. There would also be an impact on the setting of the Grade II* listed gazebo north of Clumpcliffe Farmhouse.

5.3.104 Option 03 would result in similar landscape and visual impacts to the preferred option, with moderate impacts overall and major visual intrusion at the Aire and Calder valleys due to long viaducts. Similar to the preferred option, this option would have a direct impact on Rothwell Country Park and the Grade II* listed gazebo north of Clumpcliffe Farmhouse. Option 03 would introduce a direct impact on Great Lawn Wood Ancient Woodland with potential impacts at the Sherburn Willows SSSI.

5.3.105 Option 05 would have moderate landscape and visual impacts, similar to the preferred route, with major visual impacts at the Aire and Calder valleys. This option would introduce indirect impacts to Fairburn and Newton Ings SSSI and Mickleton Ings SSSI. Impacts to the Grade II* listed gazebo north of Clumpcliffe Farmhouse associated with the preferred option would be avoided on Option 05. This option would result in impacts to the setting of four Grade II listed buildings at New Hall Lodge and Dunford House.

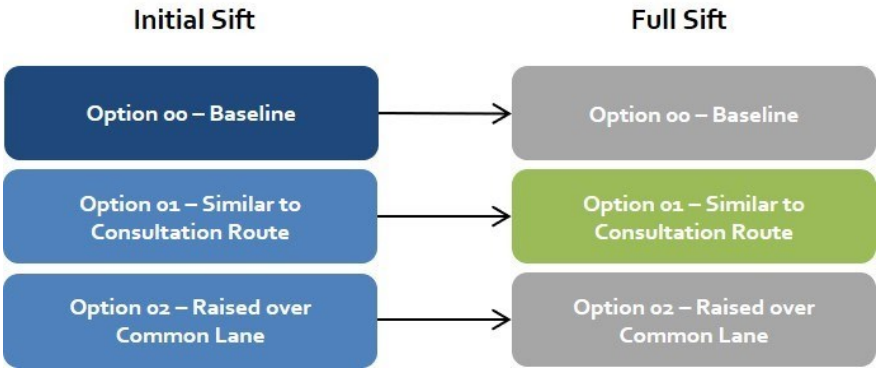
Figure 102: Local alternatives considered for Church Fenton



Church Fenton (further refinement)

5.3.106 This refinement undertaken in 2015 covered approximately 5km of the route near Church Fenton and sought to consider vertical alignment alternatives in this area. This route refinement was driven by technical concerns regarding road clearance at Common Lane, between Barkston Ash and Church Fenton, the associated impacts on drainage and also the visual impact of the viaduct that would pass to the west of the community of Church Fenton. Three options were proposed for this section of route, all of which were progressed to a full sift appraisal. The options taken forward in the sift stages are shown in Figure 103 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 104.

Figure 103: Local alternatives considered for Church Fenton



5.3.107 The following three options were taken forward to the full sift review:

- Option 00: the DRR would be on low level embankment south of Barkston Ash (approximately 5m high) and would then be on viaduct where the route would pass Church Fenton to cross over the Leeds to York railway, before joining it further north on the eastern side. Common Lane would need to be lowered or routed over the top of the HS2 main line;
- Option 01 would follow a similar route to Option 00, but would pass south of Barkston Ash on a high embankment (up to approximately 11m high) before continuing on viaduct past Church Fenton. The route would then similarly cross over the Leeds to York railway, before joining it further north on the eastern side. Common Lane would need to be lowered under HS2 main line; and
- Option 02 would follow a similar route to Option 00, but would be raised throughout. It would pass south of Barkston Ash on a high embankment (up to approximately 11m high) before continuing on a high viaduct past Church Fenton. The route would then similarly cross over the Leeds to York railway, before joining it further north on the eastern side. No change would be required to Common Lane.

5.3.108 HS2 Ltd determined that Option 01 was the preferred option to be taken forward at this stage. The decision was made on a balance of cost, engineering and sustainability considerations. An additional recommendation was made to review the interface with Common Lane and undertake further work to understand any flood risk and drainage implications during design development.

5.3.109 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.110 The preferred option, Option 01, would have moderate landscape and visual impacts as a result of sections of embankment and viaduct, particularly for residents near Barkston Ash and Church Fenton.

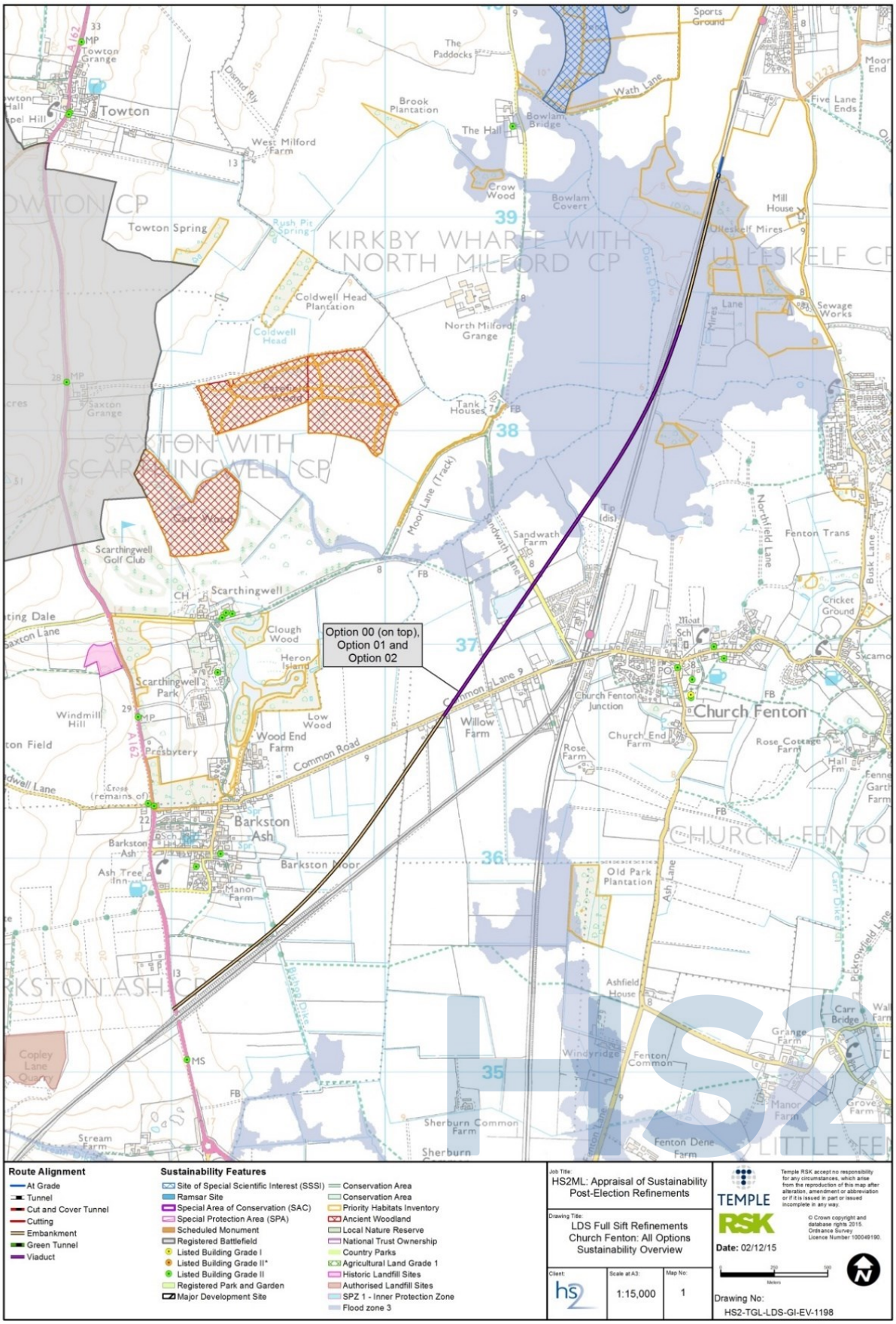
5.3.111 Option 00 would have minor to moderate landscape and visual impacts, slightly lower than the preferred option due to the lowered embankment south of Barkston Ash.

5.3.112 Option 02 would have moderate to localised major landscape and visual impacts due to the sections of high embankment and high viaduct past both Barkston Ash and Church Fenton, greater than both other options.

5.3.113 Demolitions and noise impacts would be similar across all options.

5.3.114 Option 01 would present fewer engineering challenges than Option 00, but would be more complex to construct than Option 02.

Figure 104: Local alternatives considered for Church Fenton (further refinement)

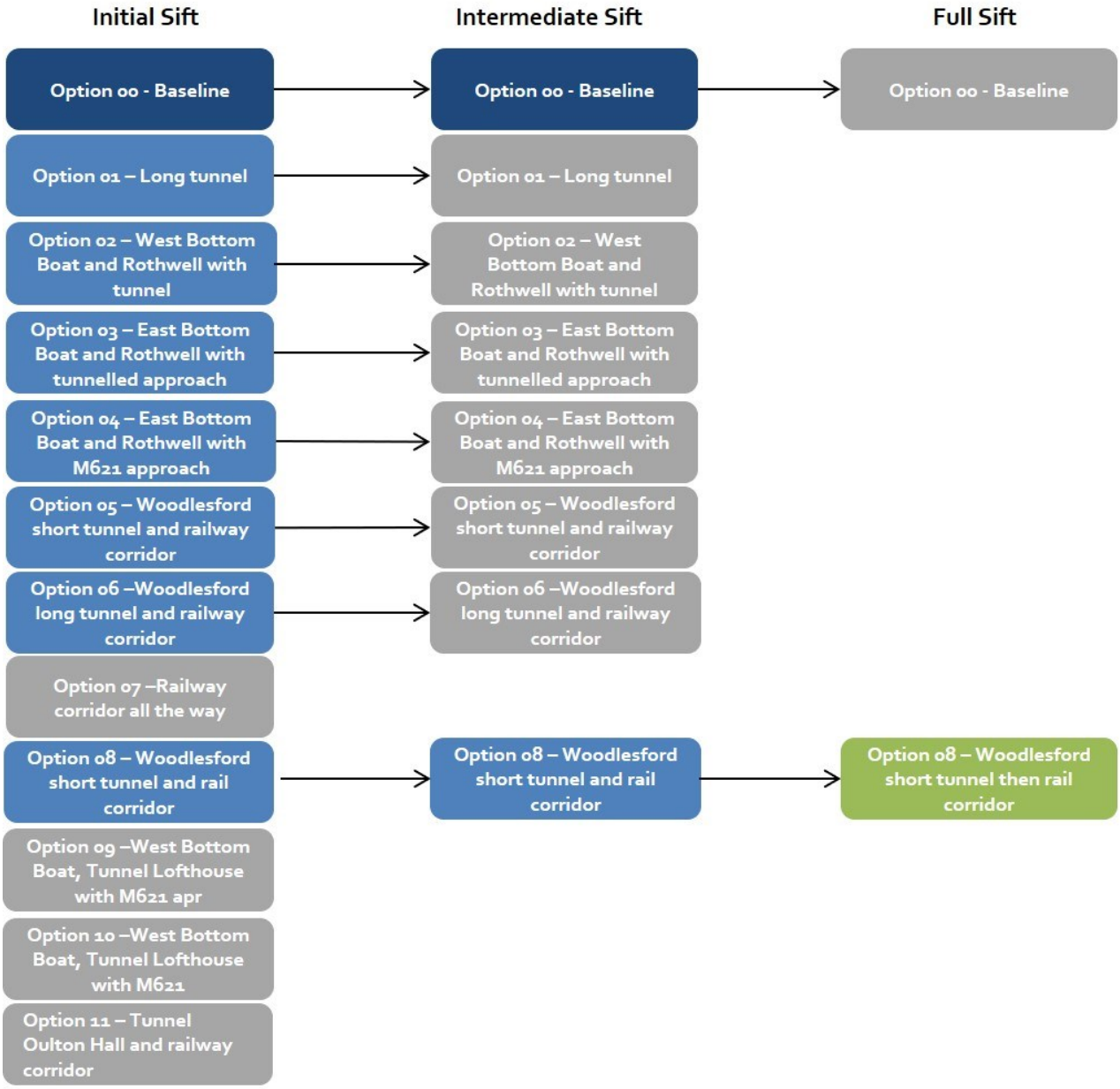


Woodlesford

5.3.115 This refinement area covered approximately 41km of the route (approximately 29km spur and 12km HS2 main line) between Cold Hiendley and the M1 at Rothwell. The aim of this refinement was to address concerns relating to the proximity of the route to Woodlesford and the height of the viaducts around Woodlesford. This refinement also looked to reduce the risk associated with the route requiring three major river diversions of the River Aire and being constructed between the River Aire and the Aire and Calder Navigation Canal.

5.3.116 As well as addressing these consultation concerns, options under consideration focused on the engineering solution for a grade separated junction for the Leeds spur over the River Aire and Aire and Calder Navigation Canal. A total of 12 options were proposed, eight of which progressed to an intermediate sift. Of the eight options presented at the intermediate sift, six were not considered reasonable on the basis of cost, engineering and/or sustainability grounds, leaving two to progress to the full sift. The options taken forward in the sift stages are shown in Figure 105 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 106.

Figure 105: Local alternatives considered for Woodlesford



5.3.117 The following options were studied during the full sift:

- Option 00: the RRB would travel in a north-east direction from Methley Lanes, over the M62 on viaduct before entering the grade separated junction where the route would travel west of Methley Park. The route would continue north and would travel on viaduct over the existing conventional railway, over the River Aire, its associated floodplain and the Aire and Calder Navigation Canal before continuing on viaduct around the north-eastern edge of Woodlesford and over the A642. The route would then continue west and pass along the northern edge of Rothwell Country Park towards the M1; and
- Option 08 would run to the west of the RRB route at Methley Park and would pass beneath Woodlesford in bored tunnel, with the tunnel portal sited just to the south of Woodlesford. The bored tunnel would then extend into cut and cover tunnel to the north-west of Woodlesford and would pass underneath

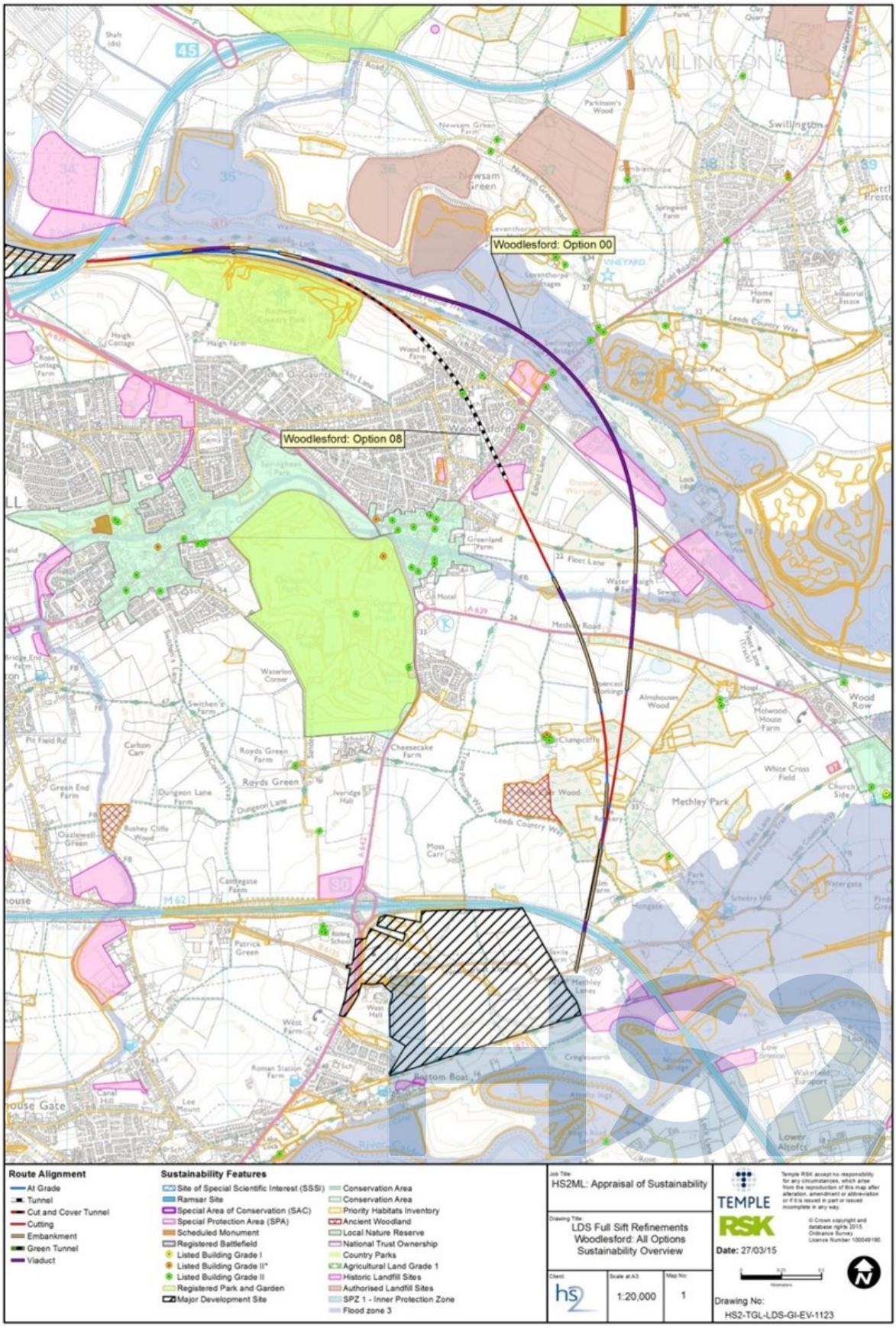
the existing conventional railway, before crossing the northern edge of Rothwell Country Park and rejoining the RRB route. The junction for the Leeds spur associated with Option 08 would be located further south than that for Option 00.

5.3.118 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.119 HS2 Ltd determined that Option 08 should be taken forward as the preferred option. This approach would avoid the need for potential major river diversions of the River Aire and would deliver a reduction in landscape and visual impacts at Woodlesford, as well as upon recreational users of the Aire and Calder Navigation Canal. It was noted that although noise impacts from the spur in to Leeds past Woodlesford would be slightly reduced, noise impacts from the HS2 main line going towards Church Fenton/ECML would remain.

5.3.120 The preferred option, Option 08, would have moderate landscape and visual impacts, though significantly reduced when compared with Option 00 due to the section of bored tunnel beneath Woodlesford. Option 08 would result in a greater direct impact associated with the crossing of Rothwell Country Park and would result in additional visual intrusion when compared to Option 00. Noise impacts from Option 08 would remain at Woodlesford as a result of the spur to Church Fenton. The preferred option would result in a cluster of approximately six demolitions at Methley Lanes, similar to Option 00.

Figure 106: Local alternatives considered for Woodlesford



Leeds Station

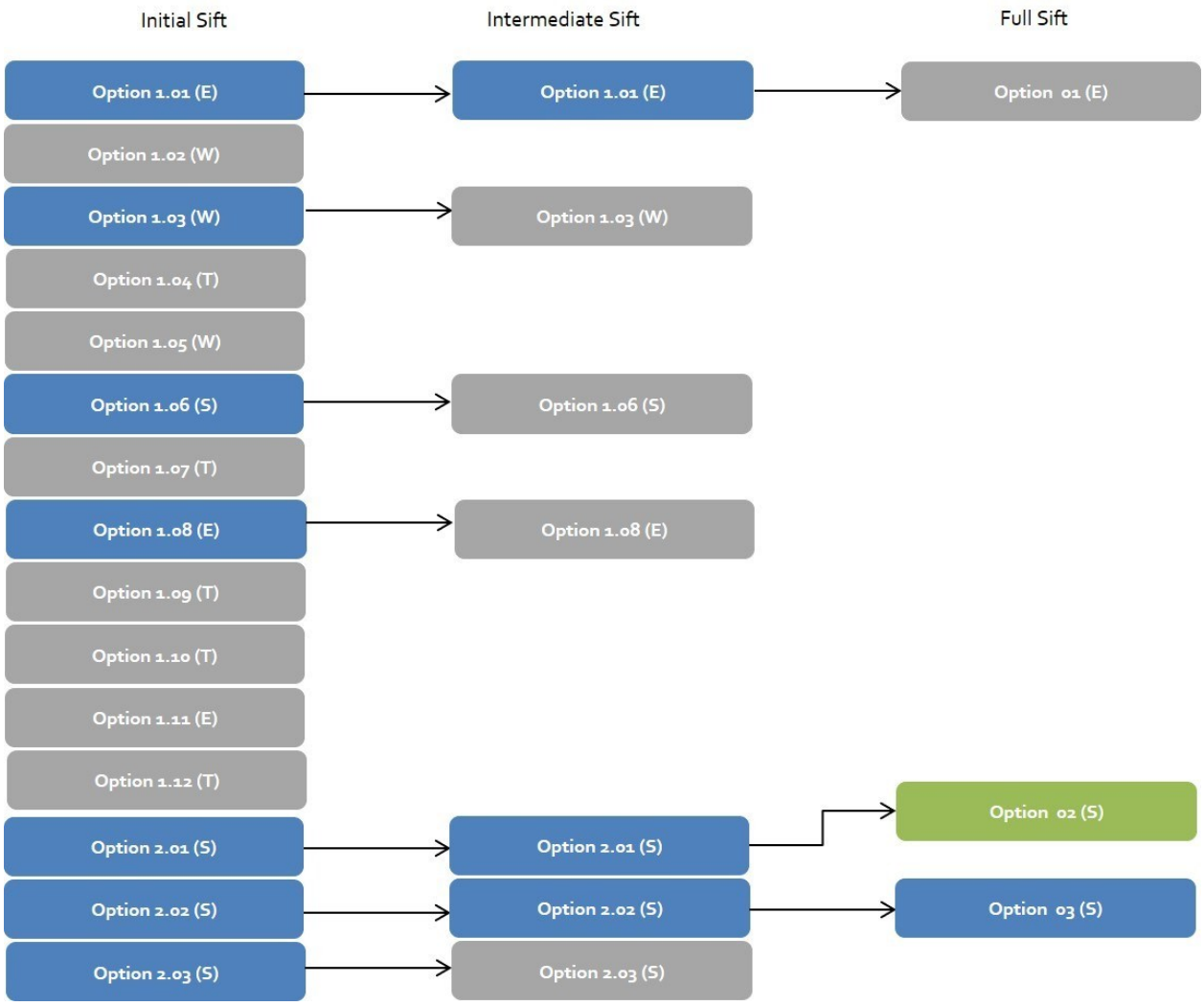
5.3.121 This refinement area covered the terminus station options for Leeds and sought to respond to the recommendations set in the HS2 *rebalancing Britain report (2014)* and the *Yorkshire hub report* (2015)[51] to deliver a high speed station in Leeds that would complement stakeholders' aspirations, long term plans for regeneration and Network Rail's plans for the future of the existing Leeds Station.

5.3.122 Three approach options were developed for station locations. These included: a southern approach, as presented in the 2013 proposed scheme for consultation, which took a route via Woodlesford; an eastern approach that would be further north of the 2013 proposed scheme for consultation to the east of Swillington; and a western approach which would leave the HS2 main line at Altofts and would head north of Wakefield and west of Middleton. A series of station options were developed to work with each of the approach routes.

5.3.123 A total of 15 options were proposed initially. Of these, seven were progressed to an intermediate sift and three were taken forward to full sift. Options consisted of either high speed station development at the existing Leeds Station, or alternative stations at new sites. Options that were not progressed past either the initial or intermediate sift on the basis that they were not considered reasonable on cost, engineering and/or sustainability grounds, or did not meet with the aspirations of the stakeholders. The options taken forward in the sift stages are shown in Figure 107 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 108.

[51] Department for Transport (2015) The Yorkshire Hub - An interim report on the redevelopment of Leeds Station. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/480396/Higgins_-_The_Yorkshire_Hub.pdf

Figure 107: Local alternatives considered for Leeds station



5.3.124 The following options were studied during the full sift:

- Option 01 would be a single station with a common concourse accommodating high speed and conventional trains, with five terminal platforms for high speed trains located within the footprint of this existing Leeds Station. For Option 01, the route would approach Leeds Station from the east and sit parallel to the existing Leeds Station. This would involve widening the current railway corridor to accommodate HS2 main line;
- Option 02 would be a high speed station with five terminal platforms immediately adjacent to the existing Leeds Station in a north-south orientation. The proposed route would approach Leeds city centre from the south, on broadly the same route as the 2013 proposed scheme for consultation but would go over the river to form a T-shaped high speed station integrated with the Leeds Station; and
- Option 03 would be a high speed station with five terminal platforms to the south of the River Aire. The proposed route would approach Leeds city centre from the south, on broadly the route as the 2013 proposed scheme for

consultation and would not go over the river (as per the 2013 consultation scheme).

5.3.125 HS2 Ltd, together with input from key stakeholders, determined that Option 02 should be taken forward as the preferred option due to the greater benefit to the wider region as a consequence of the enhanced rail to rail connectivity and the opportunity to create a common concourse with the existing Leeds Station.

5.3.126 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

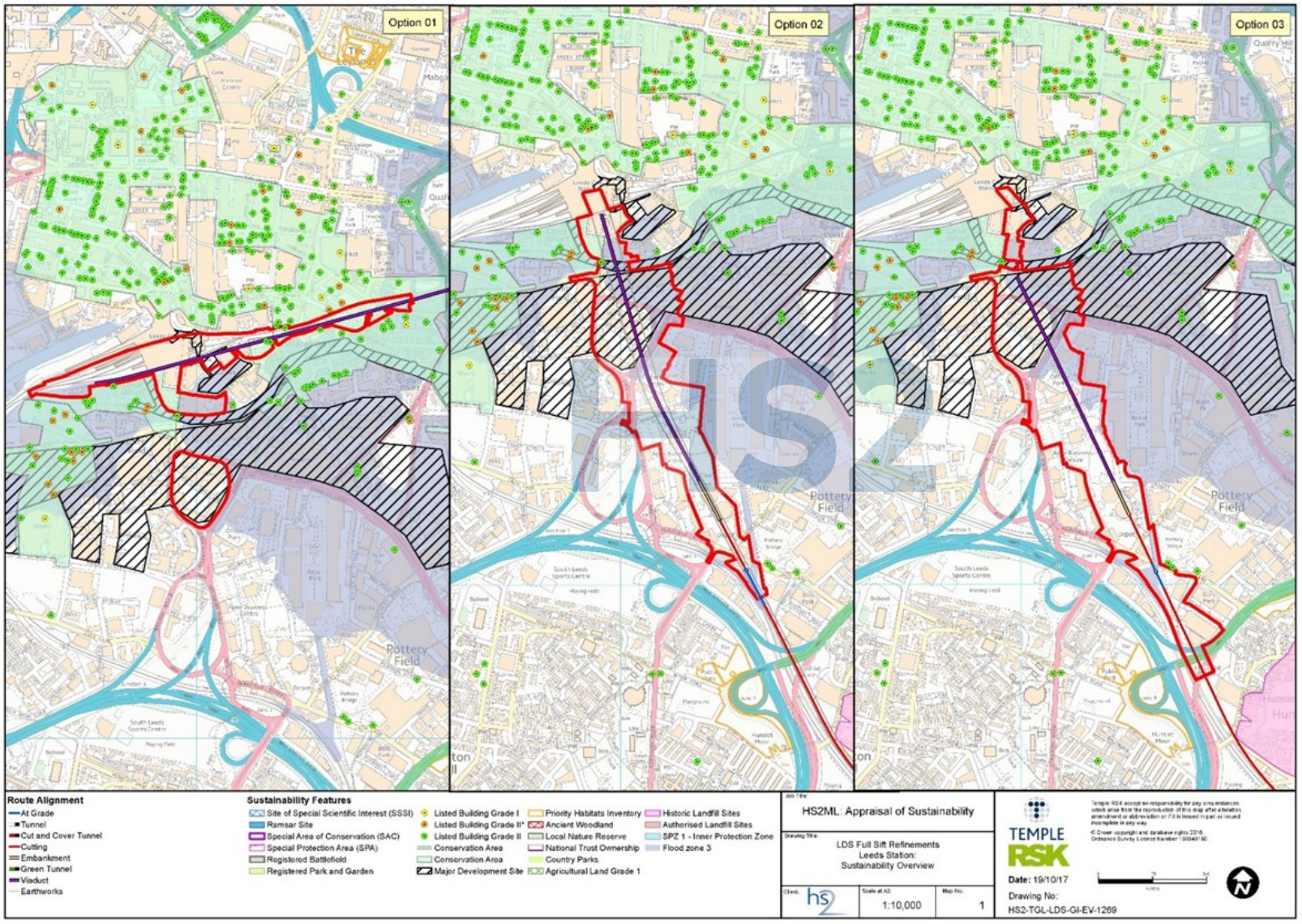
5.3.127 Option 02 does present risks regarding impacts to the River Aire and in relation to the Water Framework Directive (WFD), as well as how well it would sit within the city centre. Work has already taken place to understand the likelihood of the WFD risk and further engagement with the Environment Agency on this issue would need to be undertaken. HS2 Ltd will continue to review this and understand how further mitigation can be provided during design development.

5.3.128 Option 02 would give rise to approximately 156 demolitions, as well as impact the setting of one conservation area. There would also be challenges due to visual intrusion, severance and overshadowing associated with the new station structure. Option 02 also carries risks with major construction within the floodplain, with further engagement with the Environment Agency required during the next phase of design.

5.3.129 Option 01 would have a footprint limited to the existing Leeds Station and would therefore be a good fit with local development aspirations. However, Option 01 would require approximately 234 demolitions, including three Grade II listed buildings. This option would also introduce visual impacts due to its approach viaduct, however, not to the extent associated with Option 02. There would also be the land required from Penny Pocket Park as well as the potential loss of floodplain capacity.

5.3.130 Option 03 would have the fewest demolitions of all the options (approximately 63) with no listed buildings demolitions required. The setting of one conservation area would however be affected, although it was considered there was an opportunity to design the urban realm to complement the character of the Canal Wharf Conservation Area. There would be the loss of floodplain storage due to the station footprint (although marginally less when compared with Option 02). This approach would also avoid the need for major diversions of the River Aire.

Figure 108: Local alternatives considered for Woodlesford

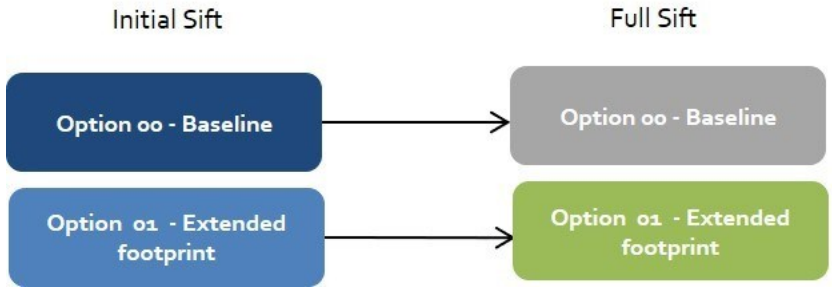


Staveley depot

5.3.131 This refinement was based on the site of the proposed IMD at Staveley and sought to ensure that there would be sufficient footprint for the IMD based on the updated sizing requirements and specification.

5.3.132 Based on Phase One development for Calvert IMD, HS2 Ltd had greater detail for the sizing requirements for the IMD and therefore updated its specification. A further option (Option 01) was therefore developed to take into account the updated specification, which increased the requirement for storage and stabling areas. The layout of Option 01 also sought to provide an improved connection to the Barrow Hill freight lines and allowed for a headshunt, both of which delivered greater operational flexibility. Two options were proposed for this refinement, both of which were progressed to a full sift appraisal. The options taken forward in the sift stages are shown in Figure 109 and described in the subsequent paragraphs of this section of the report.

Figure 109: Local alternatives considered for Staveley depot



5.3.133 The following options were studied during the full sift:

- Option 00: the base case option reflecting the 2011 specification; and
- Option 01 would require a larger footprint based on the updated 2014 specification.

5.3.134 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.135 HS2 Ltd determined that Option 01 should be taken forward as the preferred option due to meeting the updated sizing requirements, with the larger footprint providing greater operational flexibility.

5.3.136 Option 01 would have increased landscape, visual and heritage impacts compared with Option 00. Option 01 would require the demolition of the Grade II listed Cavendish Place (which may be avoidable through subsequent more detailed design development, however, an adverse impact on setting would remain). There would also be a major impact on the setting of the Barrow Hill Conservation Area and visual impacts upon residents of Barrow Hill.

Post 2016/2017 consultation route refinements

Introduction

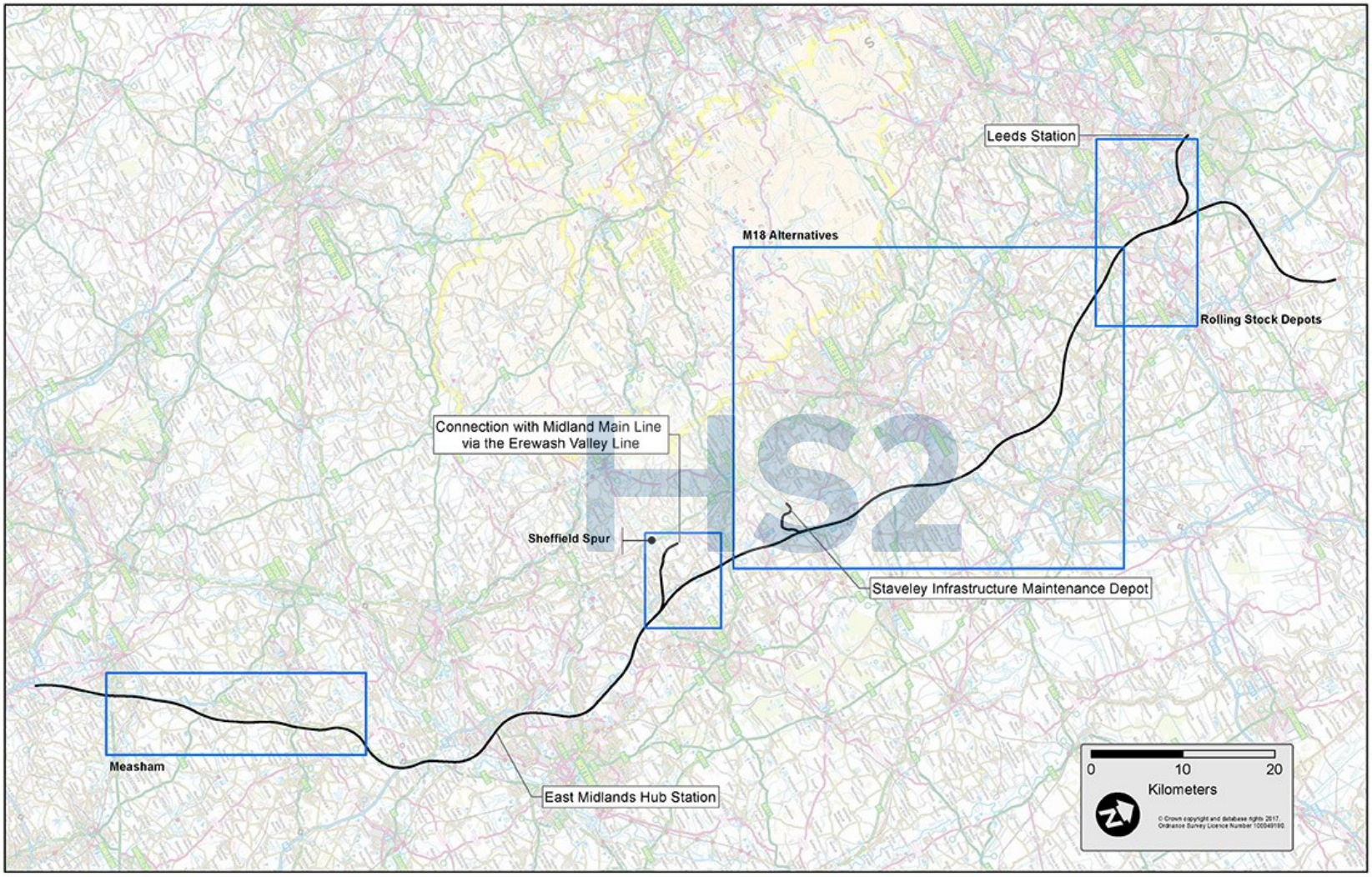
5.3.137 Between November 2016 and March 2017, public consultation was held for areas of the Phase 2b route where substantial changes had been made to the route as a result of the route refinement work following the 2013/2014 consultation. On the eastern leg to Leeds, the consultation route refinement areas were as follows, as shown in Figure 110:

- Measham;
- East Midlands tunnel;
- East Midlands Hub approach; and
- Derbyshire to West Yorkshire (M18/Eastern route).

5.3.138 Following the period of public consultation between November 2016 and March 2017, there was a phase of additional route refinements, which sought to address specific consultee concerns raised during the consultation period. For the post-consultation (2016/2017) refinements, a baseline option was presented as part of each package of refinement options. This was the 2016 preferred route to Manchester and Leeds. A summary is provided below for each of the areas, together with the recommendations adopted. Further detail can be found in the *Phase 2b route refinements report* (2017).

5.3.139 On the preferred Phase 2b route that the Government consulted on between November 2016 and March 2017, the proposed location of the eastern leg RSD was at New Crofton. However, Government recognised that the adoption of the M18 / Eastern route from Derbyshire to West Yorkshire, and the resulting approach into the RSD, would result in greater impact on the local community than when HS2 Ltd previously consulted on this in 2013. As a result, it was requested that HS2 Ltd undertake a study to consider alternative sites for the RSD on the eastern leg. The consideration of alternatives sites involved a public consultation between July 2017 and October 2017. A summary of this work is provided below.

Figure 110: Local alternatives considered post 2016/2017 consultation



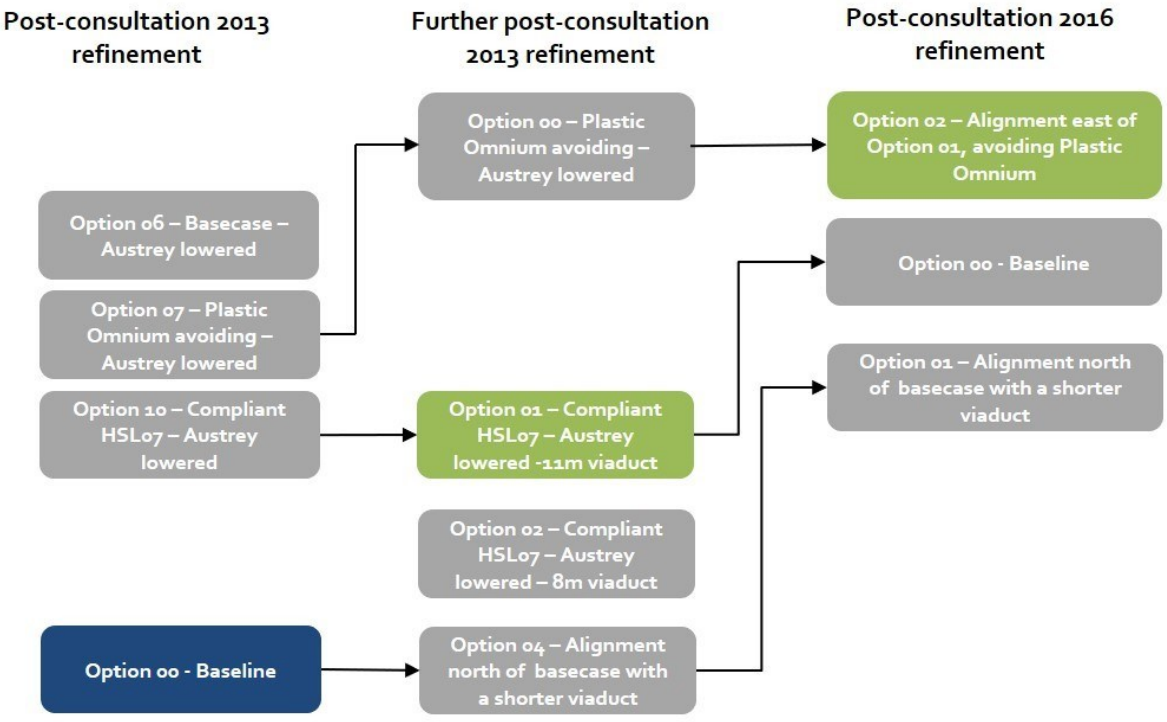
Measham

5.3.140 The approximately 28km route from Polesworth through to Worthington was reviewed to reconsider both the horizontal and vertical alignment of the HS2 main line past Measham. This was in response to concerns raised during the 2016/2017 public consultation. The route at Measham presented during the public consultation had been moved approximately 1.6km to the east following previous post-2013 consultation refinement work in 2015 and 2016. In the context of 2016/2017 consultation responses, options at Measham were revisited with a more developed understanding of the local area.

5.3.141 The refinement sought to address the concerns raised following the consultation on the 2016 preferred route to Manchester and Leeds. During the consultation, new information came to light regarding local employers and farmers potentially affected by the route. Additionally, North West Leicestershire District Council stated within their response to the consultation that they were confident that alternative housing sites would be available to meet their strategic housing allocation targets should the development at Measham Wharf be affected, as was the case with the 2013 proposed scheme for consultation around Measham.

5.3.142 No new environmental appraisal work was undertaken as part of this exercise as the design of the options through the area had not changed, but previous options considered during the post-consultation refinement work were reviewed. Three options were considered; the base case was the 2016 preferred route to Manchester and Leeds, Option 01 was the Measham 2015 DRR and Option 02 was a revised option that was east of the 2013 proposed scheme for consultation considered during the post-consultation refinement work in 2015. The options taken forward in the sift stages are shown in Figure 111 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 112.

Figure 111: Local alternatives considered for Measham



5.3.143 The following three options were taken forward to the full sift review following the 2016/2017 public consultation:

- Option 00 would branch east at Austrey, away from the A42 corridor and would cross the River Mease to the east of Measham. The option would include a revised alignment that would reduce the skew of the crossing of the River Mease, moving away from a meander in the river. An approximately 11m high viaduct would be required over the River Mease floodplain and landfill site;
- Option 01 would run north-west of Polesworth, along the east side of the M42/A42. It would pass on the west side of Measham and would intersect the Plastic Omnium site and a development site at Measham Wharf; and
- Option 02 would follow a similar route to Option 01 but slightly to the south-east and would extend the viaduct over the River Mease to avoid the majority of the Plastic Omnium site.

5.3.144 Following a recommendation from HS2 Ltd, the Government confirmed Option 02 should be taken forward. This was on the basis of avoiding the Plastic Omnium site whilst still addressing many of the concerns raised during consultation. Specifically, Option 02 removes the issue of 'islanding' the communities of Appleby Parva, Appleby Magna and Measham between the route and the A42, which was a key concern raised during the 2016/2017 consultation, and would reduce the impact on local employers identified by respondents to the consultation.

5.3.145 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

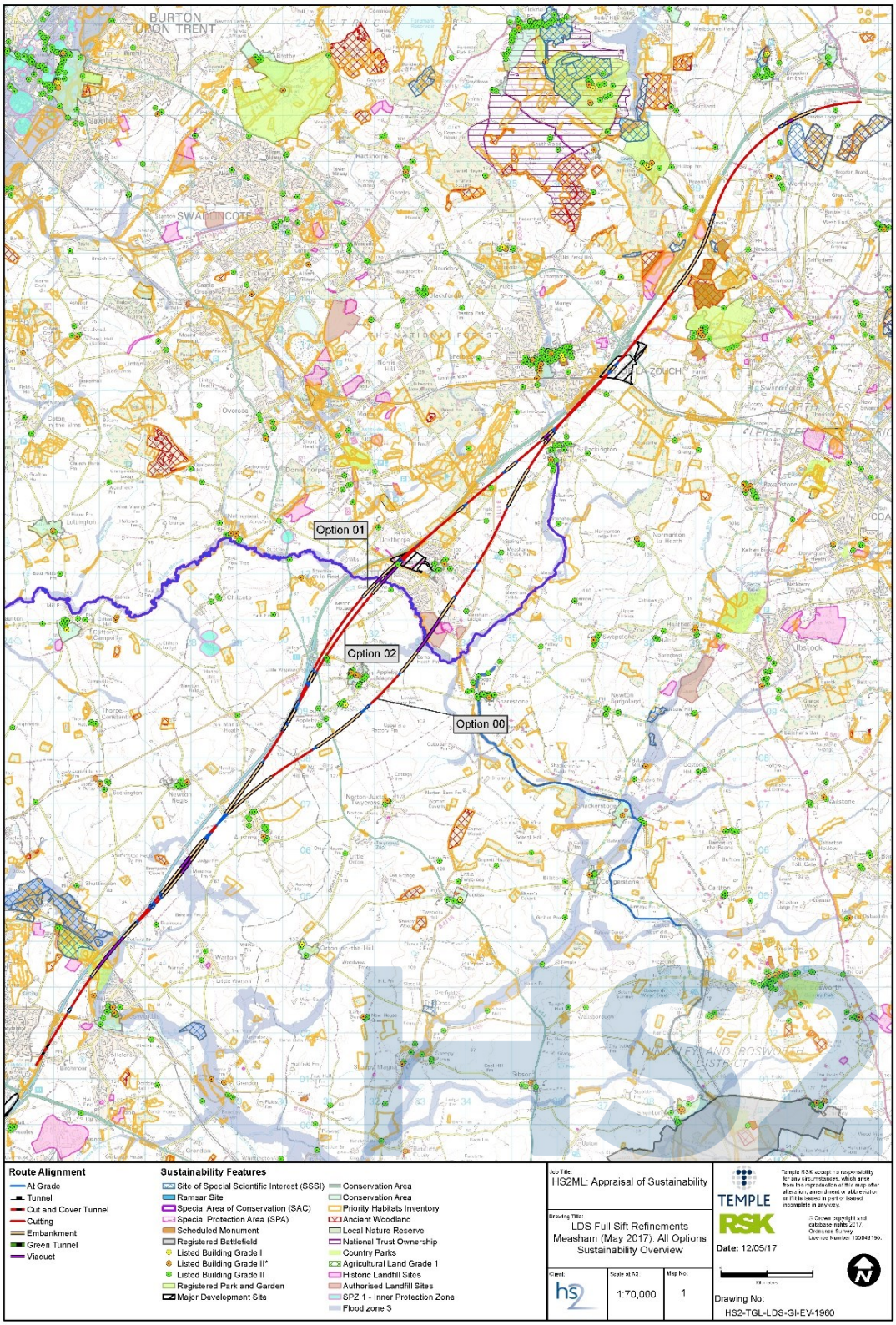
5.3.146 The preferred option, Option 02, would have landscape impacts at both Appleby Magna and Measham as a result of land isolated between the HS2 main line and the M42. There would also be direct impacts on the Grade II listed Meer Bridge, 4 and 5 Park Farm, and Breedon Lodge Farmhouse and Cottage. There would also be a direct impact on the Measham Wharf development site.

5.3.147 A study to inform the Habitats Regulations Assessment (HRA) was undertaken for the River Mease SAC in consultation with Natural England and the Environment Agency. The HRA screening report concluded that there was a potential significant effect on the SAC due to shading of the river caused by crossing the SAC on viaduct. A draft Appropriate Assessment was then undertaken, which included a detailed study of shading impacts on the river habitats. This concluded there would be no adverse effects on the River Mease SAC arising from the construction or operation of the Proposed Scheme. HS2 Ltd will continue to consult with these bodies (and other relevant key stakeholders) as the design develops to ensure that the submitted design in the hybrid Bill and its construction comply with the Habitats Regulations 2017. Where required, further assessment will be undertaken and an appropriate design will be developed through an iterative process. Any studies to inform the required assessments will be completed and the outcomes agreed with Natural England prior to submission of the hybrid Bill.

5.3.148 Option 00 would similarly have landscape and visual impacts at both Appleby Magna and Measham, but would be to the east of both villages, causing the villages to be enclosed by transport corridors to the east and west. Unlike the preferred option, Option 00 would avoid an impact on the development site at Measham Wharf, as well as avoiding direct impacts on the three Grade II listed buildings, although there would be an impact on the setting of the Grade II listed Breedon Lodge and Cottage. Option 00 would have a direct conflict with the Ashby Canal restoration scheme, which was subject to an approved Transport and Works Act Order.

5.3.149 Option 02 would have broadly similar impacts to that of the preferred option (Option 01) including landscape impacts at both Appleby Magna and Measham as a result of land isolated between the HS2 main line and the M1. There would be impacts on the setting of the Grade II listed Meer Bridge, 4 and 5 Park Farm and Breedon Lodge Farmhouse and Cottage, although this route would avoid direct impacts to all three listed buildings, unlike the preferred option. Similar to the preferred option, there would also be a direct impact on the development site at Measham Wharf.

Figure 112: Local alternatives considered for Measham (April 2017)



East Midlands Airport tunnel

5.3.150 As a result of the feedback received in response to the 2016/2017 consultation, the alternative suggestions made and previous decisions taken on the route in this area were reviewed.

5.3.151 Given a number of consultation responses stating a preference for the 2013 proposed route for consultation, HS2 Ltd reassessed this route against the 2016 preferred route to Manchester and Leeds. This work concluded that the 2016 preferred route remained the optimal solution for the route in this area, based on substantial cost saving and reduced engineering challenges.

5.3.152 Although the 2016 preferred route would be 1.3km longer and the route speed would be slower (275kph (170.8mph)), which would result in an increased journey time of 55 seconds, this route would avoid a 3km (two-mile) long tunnel under the East Midlands Airport, and an associated vent shaft. It would also avoid engineering complexities of the impact associated with the 2013 proposed scheme for consultation on the East Midlands Gateway SRFI and the M1/A50 crossing. The viaduct over the River Soar floodplain would also be reduced in length by 460m.

5.3.153 In terms of sustainability impacts, the two options broadly perform equally, although some impacts are either removed or transferred to new receptors. In addition, impacts on the East Midlands Gateway SRFI would be reduced with the 2016 preferred route. The 2016 preferred route would also avoid heritage impacts on the Grade II* listed Langley Priory and would reduce impacts on the communities at Tonge and Breedon on the Hill, as well as on the Tonge Conservation Area. The 2016 preferred route would also reduce noise impacts compared to the 2013 proposed scheme for consultation. However, the 2016 preferred route would introduce heritage impacts to the Grade II listed Breedon Lodge, severing the lodge from an associated moat.

East Midlands Hub approach

5.3.154 The 2016/2017 consultation presented two options for consideration in this area. The first option would lengthen the viaduct over the River Trent floodplain to approximately 4,700m, so that the route would pass through Long Eaton on a viaduct, with the HS2 main line directly to the east of the existing low level conventional rail corridor (Option 01). The viaduct would cross Main Street at a height of approximately 17m, Station Road at a height of approximately 16m, and the A6005 Nottingham Road at approximately 8m.

5.3.155 The second option would lengthen the viaduct over the River Trent floodplain to approximately 2,470m, with the route then on a retained embankment through Long Eaton (Option 02). This would have a lower height than Option 01 with HS2 main line crossing Station Road at a height of 4m, after which the route would follow the same horizontal alignment as Option 01.

5.3.156 As a result of responses received following the 2016/17 consultation, HS2 Ltd reviewed the alternative suggestions made and the previous decisions taken on the route in this area. Alternative suggestions included placing the route in tunnel under Long Eaton. However, tunnelling under Long Eaton was not progressed due to the substantial length and cost of tunnel that would be required as a result of the River Trent and River Soar floodplains.

5.3.157 As a result of this work, HS2 Ltd concluded that the horizontal alignment of the route through Long Eaton is the most appropriate, given the challenges and constraints as the route would approach the East Midlands Hub station at Toton.

5.3.158 Based on the feedback received to the consultation, HS2 Ltd recommended that the route should use the high level option (Option 01), lengthening the viaduct over the River Trent floodplain to pass through Long Eaton, with HS2 main line directly to the east of the existing low level corridor. Placing the route on a viaduct would reduce interactions between the HS2 main line and the existing conventional rail network, requiring less disruptive work on existing railway infrastructure. It would also help address concerns over the interaction between HS2 main line and the floodplain in the area (requiring fewer flood defences). Option 01 would also maintain an east–west permeability through Long Eaton. Lengthening the viaduct would, however, potentially increase noise and visual impacts.

5.3.159 The lower level option (Option 02) would introduce a physical barrier through Long Eaton, potentially increasing severance of the community. This would also introduce a number of conflicts with the existing highways network that would need to be resolved, including Station Road and the A6005 Nottingham Road.

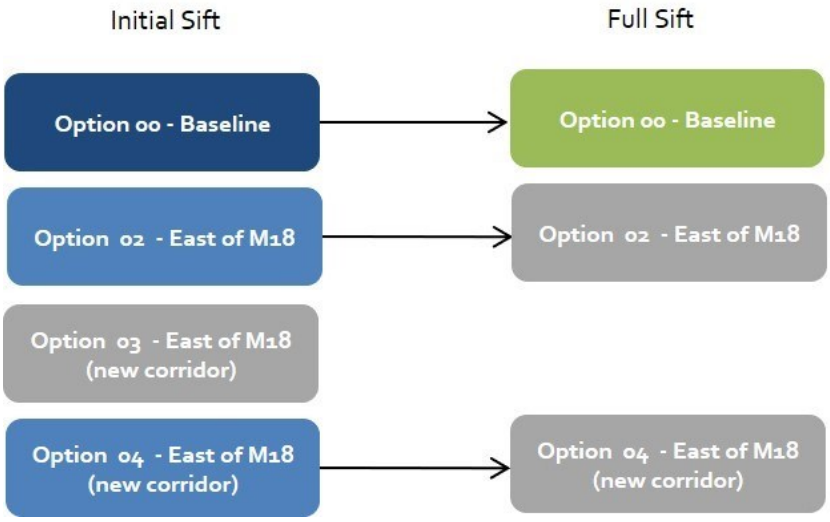
Derbyshire to West Yorkshire (M18 / Eastern route)

5.3.160 In responding to the 2016/2017 consultation, and the concerns and suggestions that were raised, HS2 Ltd considered a range of potential route refinements to the M18/Eastern route. These included new routes and alignments to the east of the M18 and separate and more local refinements at Aston and Mexborough. Alternative Sheffield spur connections were also assessed.

M18 – Routes to the east of the preferred route

5.3.161 This refinement focused on approximately 45km of the M18/Eastern route in South Yorkshire. It sought to address key concerns raised during consultation and to avoid impacts at Wales, Aston and Bramley by moving the route further east. As a result, this refinement focused on the section of route between Barlborough and South Kirby. A total of four options were considered for this refinement, three of which were considered at full sift, as illustrated below. The options taken forward in the sift stages are shown in Figure 113 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 114.

Figure 113: Local alternatives considered for the M18/ Eastern route east of Conisbrough and Mexborough



5.3.162 The following three options were taken forward to the full sift review following the 2016/2017 public consultation:

- Option 00: the 2016 preferred route through Wales, Aston and Bramley, between Conisbrough and Mexborough;
- Option 02 would reduce the impacts of the route at Wales, Aston and Bramley by moving the route to the eastern side of the M1/M18. The route would travel west at the start of its divergence from the 2016 preferred route due to the constraints to cross the M1 at Wales. The route would continue along the eastern side of the M1/M18 and would cross back to the western side at Bramley; and

- Option 04 would reduce impacts of the route at Wales, Aston and Bramley by moving the route into a new transport corridor to the east of the M1/M18 corridor. The route would cross the M1 north of Barlborough and would travel between Harthill and Kiveton Park and then would continue past Loughton Common, the eastern side of Thurcroft, Maltby and Hellaby. The route would then continue past the east of Conisbrough, avoiding direct impacts at Mexborough and would move the route away from Barnburgh and Hickleton. However, the route would be closer to Sprotbrough.

5.3.163 HS2 Ltd determined that Option 00 should be retained as the preferred option as, although Options 02 and 04 would generally reduce impacts at Wales, Aston and Bramley, they would both introduce or transfer adverse impacts onto new communities and the environment, and involved additional engineering complexity.

5.3.164 Option 04 would involve a new transport corridor on a mix of cutting, embankment and viaducts. This option would be longer in length, adding journey time to the eastern leg of Phase 2b. It would also introduce new community impacts, 'islanding' a number of communities between the M1 and the HS2 corridor.

5.3.165 Option 02 would involve a new alignment directly to the east of the M1 and would introduce complex skewed crossings of the M1 at Wales and the M18 at Bramley. Both of these crossings would involve complex constructability issues and would transfer impacts from one side of the community to the other in these locations.

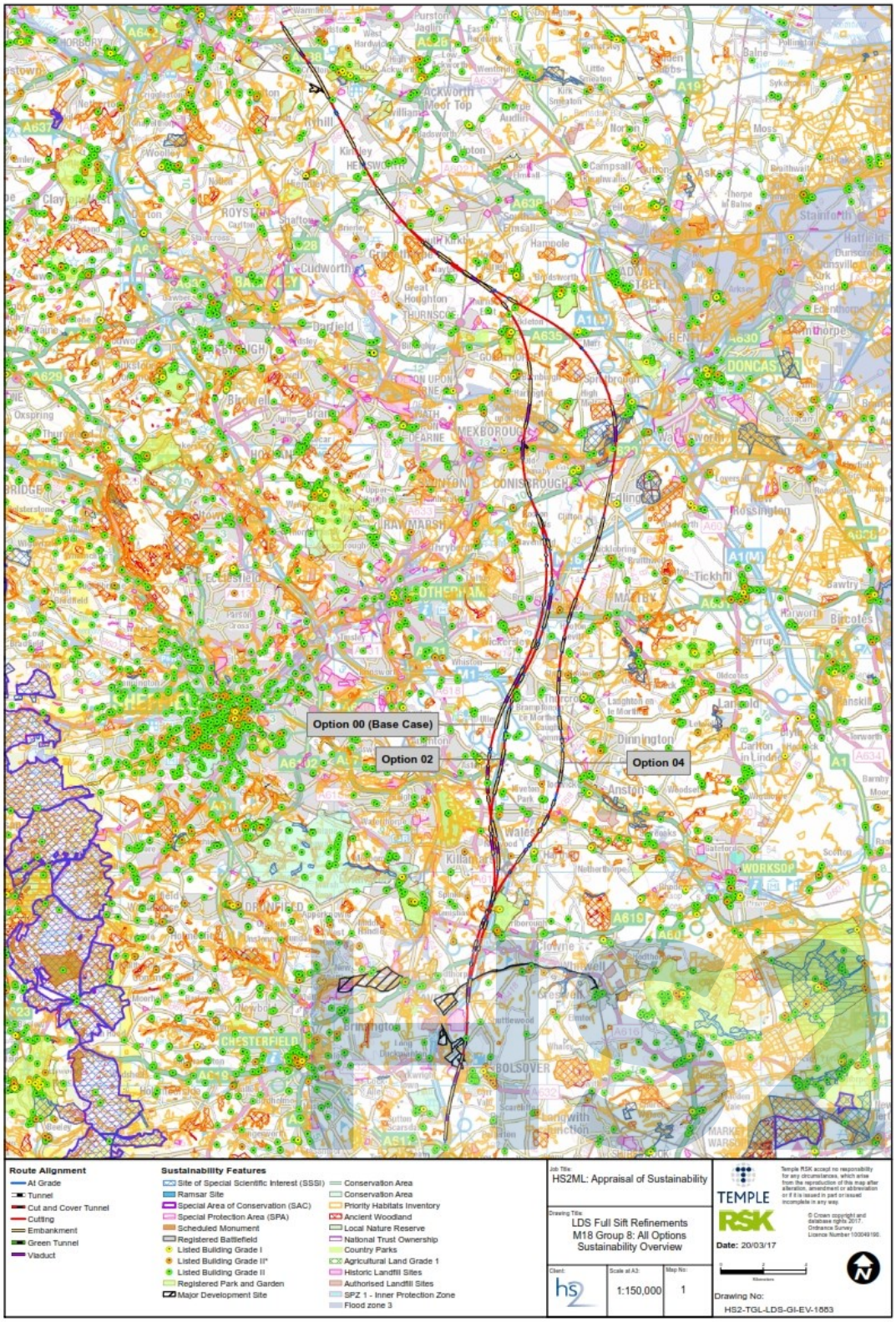
5.3.166 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.167 The preferred option, Option 00, would have major landscape and visual impacts between Barlborough and Frickley, particularly south-east of Sutton Scarsdale as a result of a long embankment and high viaduct over the M1. This option would also have a major impact on the Grade II listed Hickleton Hall Registered Park and Garden, which would otherwise be avoided by Options 02 and 04. All options would pass close to the Grade II listed Bilham Belvedere Summerhouse and Bilham House Farm complex (three Grade II listed buildings). Option 00 would avoid an impact to the Summerhouse, which would otherwise be affected by Option 02.

5.3.168 Option 00 would avoid a number of ancient woodlands, which would be affected by Option 04. Option 02 would have the least impact on ancient woodlands overall. Option 04 would also introduce new impacts to New Edlington Brickpit SSSI (geological) and Sprotbrough Gorge SSSI, which would both be avoided by Options 00 and 02.

5.3.169 Similar to Option 00, Option 02 would have a direct impact on the now completed residential housing at Shimmer in Mexborough (that was a development site at the time of the appraisal), which would be avoided by Option 04. Option 02 would result in additional demolitions, including a cluster of commercial properties at Hellaby, when compared to Options 00 and 04. From a noise perspective, Options 02 and 04 would introduce additional noise impacts from the route being further east of Option 00 at the communities of Kiveton Park, Thurston, Edlington and Marr. Option 02 would increase noise impacts at Bramley, Hellaby and Ravenfield Common.

Figure 114: Local alternatives considered to the east of the M18

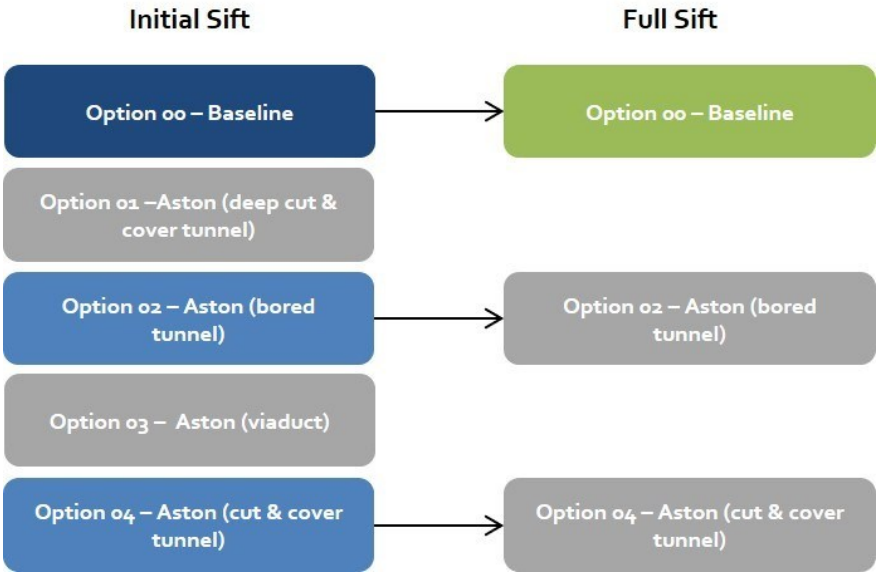


M18 – Aston

5.3.170 This refinement builds upon previous work to reduce impacts of the route through South Yorkshire reported earlier within this section. This refinement focused on approximately 10km of the M18/Eastern route between Killamarsh and Conisbrough Parks on the eastern leg.

5.3.171 This refinement to the M18/Eastern route sought to address key concerns raised during consultation and to avoid impacts at Aston by reviewing the vertical alignment. Five options were considered for this section of route, with two not considered for further progression on the basis of cost, engineering and/or sustainability grounds. The options taken forward in the sift stages are shown in Figure 115 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 116.

Figure 115: Local alternatives considered for the M18 around Aston



5.3.172 The following three options were taken forward to the full sift review following the 2016/2017 public consultation:

- Option 00: the 2016 preferred route would be above ground through Aston;
- Option 02 would have a similar route to Option 00, but the vertical alignment would be amended to avoid the realignment of the A57 and the B6067 with an approximately 2km long bored tunnel underneath the area; and
- Option 04 would be similar route to Option 00, but the vertical alignment would be amended to avoid the highways realignment of the B6067 by lowering the route into an approximately 340m cut and cover tunnel.

5.3.173 HS2 Ltd determined that Option 00 should be retained as the preferred option. This is because the bored tunnel on Option 02 would introduce additional engineering complexity, operational challenges and substantial additional costs. The provision of a tunnel portal would also increase impacts elsewhere, including on the Nickerwood Ancient Woodland and would result in the route being higher at Brampton-en-le-

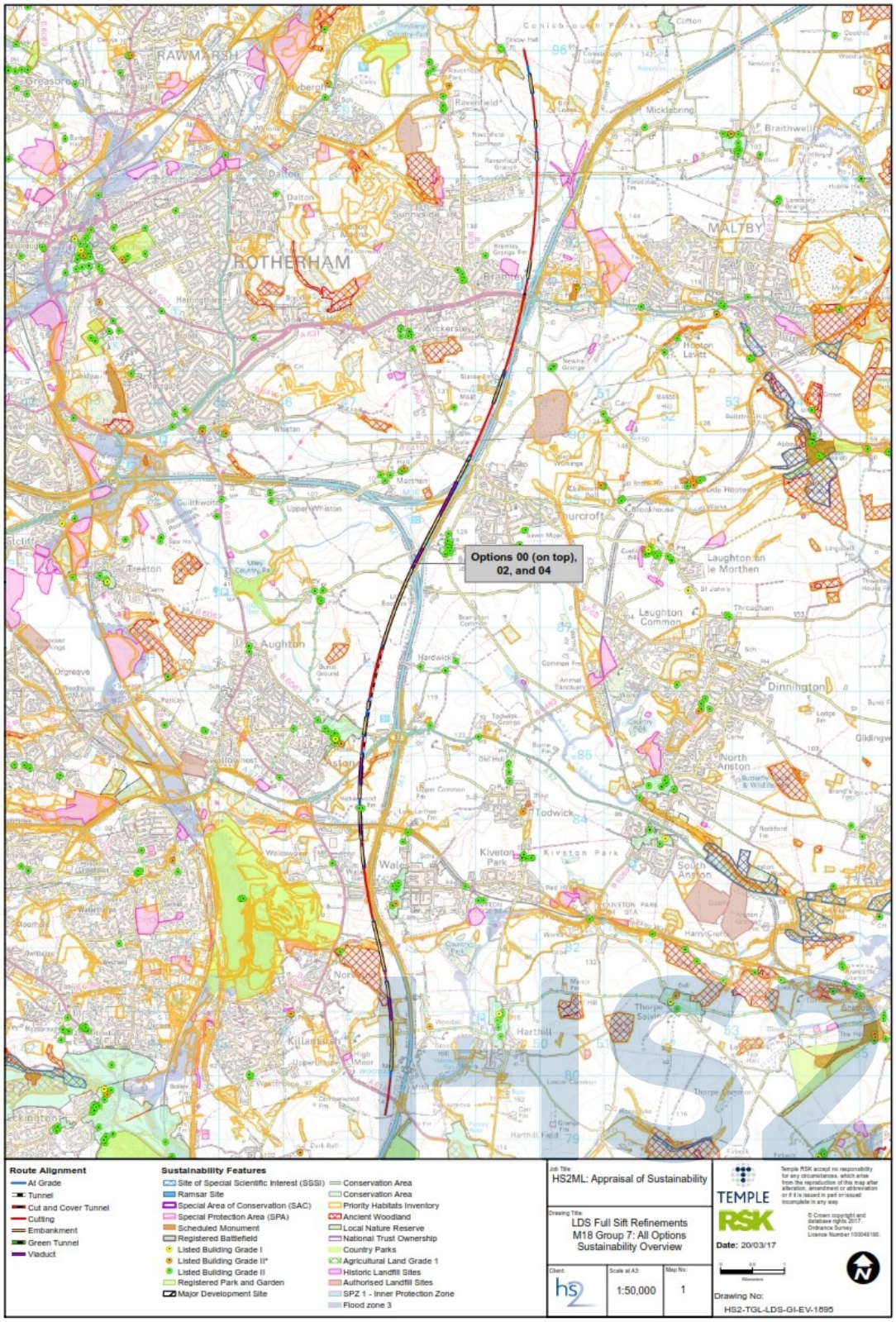
Morthen to cross the M1 / M18 junction, increasing visual impacts here. Option 02 would also result in two watercourse crossings of a floodplain to the north. Option 04 would require a longer permanent realignment of the A57 to cross over the cut and cover tunnel, bringing the A57 closer to residential properties in Aston. Option 04 was not taken forward at this stage as it would result in increased construction impacts and would not remove the requirement to realign the A57, although it was considered that this option could be explored in more detail during design development.

5.3.174 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.175 The preferred option, Option 00, would have moderate landscape and visual impacts overall, with localised major impacts near Norwood and Aston due to landscape fragmentation and visual impacts to recreational users at Hepworth Pond and Aston village, and to residents at Thurcroft. Option 00 would also have major visual impacts where a series of long viaducts would be required to cross over the M18/M1 junction, resulting in the loss of valley side woodland.

5.3.176 Similar to Option 04, Option 00 would have a minor impact on the Aston Conservation Area, which would be avoided on Option 02 where the route would be in tunnel. All options would result in a direct impact on the Grade II listed Nickerwood Farmhouse and associated farm buildings. Similarly, all options would impact on two ancient woodlands (Nor Wood and Nicker Wood).

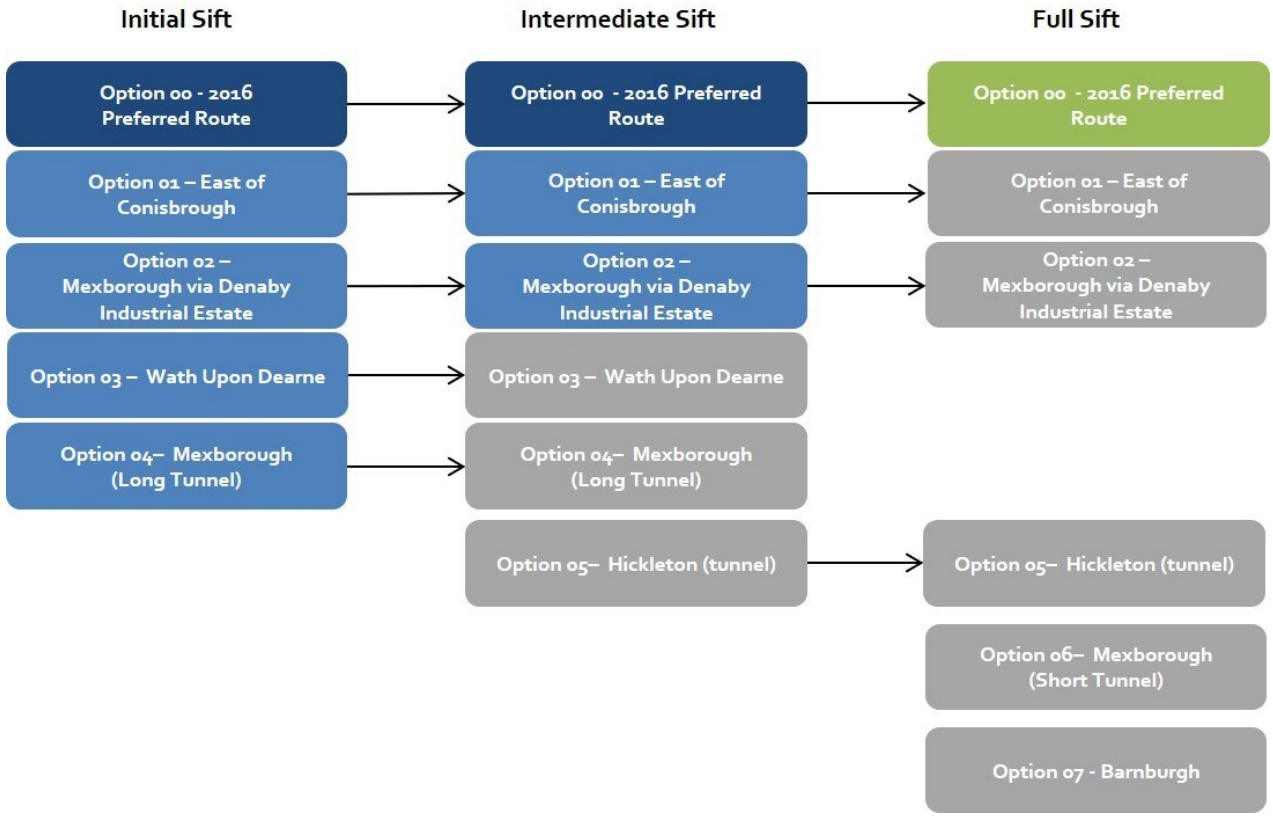
Figure 116: Local alternatives considered for the M18/ Eastern route around Aston



M18 - Mexborough

5.3.177 This refinement covered approximately 25km of the M18/Eastern route. This refinement sought to address key concerns raised during consultation in 2016 and sought to avoid impacts at Mexborough, Barnburgh and Hickleton by moving the HS2 main line both horizontally and vertically. As a result, the focus of this refinement was the section of route between Bramley and Clayton. A total of eight options were proposed for this section of route, with the same five considered at initial and intermediate sift stages. Three of these options were then progressed to a full sift appraisal, along with two additional new options that were identified for development following the intermediate sift, as illustrated below. The options taken forward in the sift stages are shown in Figure 117 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 118.

Figure 117: Local alternatives considered for the M18/ Eastern route around Mexborough



5.3.178 The following six options were taken forward to the full sift review post-consultation in 2016/2017:

- Option 00: the 2016 preferred route, which would run between Conisbrough and Mexborough;
- Option 01 would avoid the Mexborough area as the route would run to the east of Conisbrough, between Conisbrough and Sprotbrough;
- Option 02 would take a route to the east of Shimmer near Mexborough and would require a long viaduct crossing over the River Dearne;

- Option 05 would follow the same route as Option 00 and would pass between Conisbrough and Mexborough, but would adopt a lowered vertical alignment including an approximately 3.5km bored tunnel where the route would approach and pass Hickleton;
- Option 06 would avoid impacts on the communities of Conisbrough and Mexborough by passing under and to the east of both, in an approximately 4.6km bored tunnel. It would follow a similar route to that Option 00 north of Hickleton; and
- Option 07 would reduce the impact at Barnburgh by reducing the height of the embankments east of the village, and would include an approximately 1km long bored tunnel to the north approaching Hickleton.

5.3.179 HS2 Ltd determined that Option 00 be taken forward as the preferred option, with recommendation for further exploratory work during design development to be continued on Option 01 east of Conisbrough. Other options were not progressed on the basis of additional sustainability impacts or due to a combination of cost and engineering considerations.

5.3.180 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.181 The preferred option, Option 00, would have major landscape and visual impacts along much of the route section. This is largely due to significant landscape change and visual intrusion resulting from large embankment and viaduct structures south-east of Sutton Scarsdale, south-east of Bolsover, over the M18 junction with the M1, at Conisbrough and Mexborough, adjacent to Barnburgh Conservation Area and at Frickley. Similar to all other options, Option 00 would have a major impact on the Grade II listed Nickerwood Farmhouse and associated farm buildings. This option would also impact the Bilham Belvedere Summerhouse, however, it would avoid impacts to Woodhouse Farmhouse, which would otherwise result from all other options. Option 00 would have moderate impacts on the setting of four Grade II listed buildings, but would avoid impacts to Butterbusk Farm and Vissitt Manor, which would otherwise be affected by Option 01.

5.3.182 Option 00 would have an impact on four ancient woodlands (High Wood, Nor Wood, Nicker Wood and Hooton Cliff), but would avoid impacts to Farcliff Wood, Pot Ridings Wood, Scabba Wood, Toecrof Little Spring, Barnburgh Cliff, Watchley Crag Wood and Howell Wood. The preferred option would also avoid impacts to New Edlington Brickpit SSSI, Denaby Ings SSSI and Sprotbrough Gorge SSSI, which would be affected by Options 01, 02 and 06. The preferred option would have a direct impact on the now completed residential housing at Shimmer in Mexborough (that was a development site at the time of the appraisal).

5.3.183 Option 01 would also have major landscape and visual impacts throughout this section, largely due to the large structures resulting in significant landscape change and visual intrusion. Option 01 would impact fewer listed buildings than Option 00 and would avoid impacts on the setting of the Grade II* listed Aughton Court and Church of All Saints, and the Barnburgh Conservation Area.

5.3.184 Option 01 would introduce direct impacts to two SSSI (New Edlington Brickpit and Sprotbrough Gorge) and eight ancient woodlands (High Wood, Nor Wood, Nicker Wood, Farcliff Wood, Pot Ridings Wood, Scabba Wood, Toecroft Little Spring and Howell Wood). This option would avoid impacts to the residential housing at Shimmer (that was a development site at the time of the appraisal).

5.3.185 Similar to the preferred option, Option 02 would have major landscape and visual impacts, most notably at Sutton Scarsdale, Bolsover, Conisbrough Parks and Frickley where large intrusive structures would be required. This option would also avoid impacts to the setting of the Grade II* listed Aughton Court and Church of All Saints, and the Barnburgh Conservation Area associated with the preferred option.

5.3.186 Moving the route locally to the east to go through the Denaby Industrial Estate (Option 02) would introduce direct impacts to the Denaby Ings SSSI and five ancient woodlands (High Wood, Nor Woo, Nicker Wood, Hooton Cliff and Barnburgh Cliff). It would also result in a long viaduct over existing infrastructure and the River Don floodplain, introducing new major impacts elsewhere, particularly on the industrial estate and other residential areas. This option would slightly increase overall noise impacts and would result in more commercial demolitions, and was therefore not taken forward.

5.3.187 Option 05 would follow a similar route to the preferred option and therefore would also have major landscape and visual impacts. Compared with the preferred option, Option 05 would be lowered around Barnburgh, reducing landscape and visual impacts at Hickleton and Frickley. This option would reduce impacts to listed buildings, avoiding impacts to the three Grade II listed assets at Bilham House Farm. Option 05 would impact the same four ancient woodlands as the preferred option and would also directly impact the residential housing at Shimmer (that was a development site at the time of the appraisal).

5.3.188 Option 06 would introduce a large section of tunnel under Mexborough, and whilst it would slightly reduce landscape and visual impacts in the area, it would still have a major impact overall. The tunnel portal structures would also introduce major visual impacts to adjacent communities north and south of Mexborough. When compared to the preferred option, this option would introduce a direct impact to the Grade II listed Woodhouse Farmhouse and an impact on the setting of the Grade II listed Vissitt Manor.

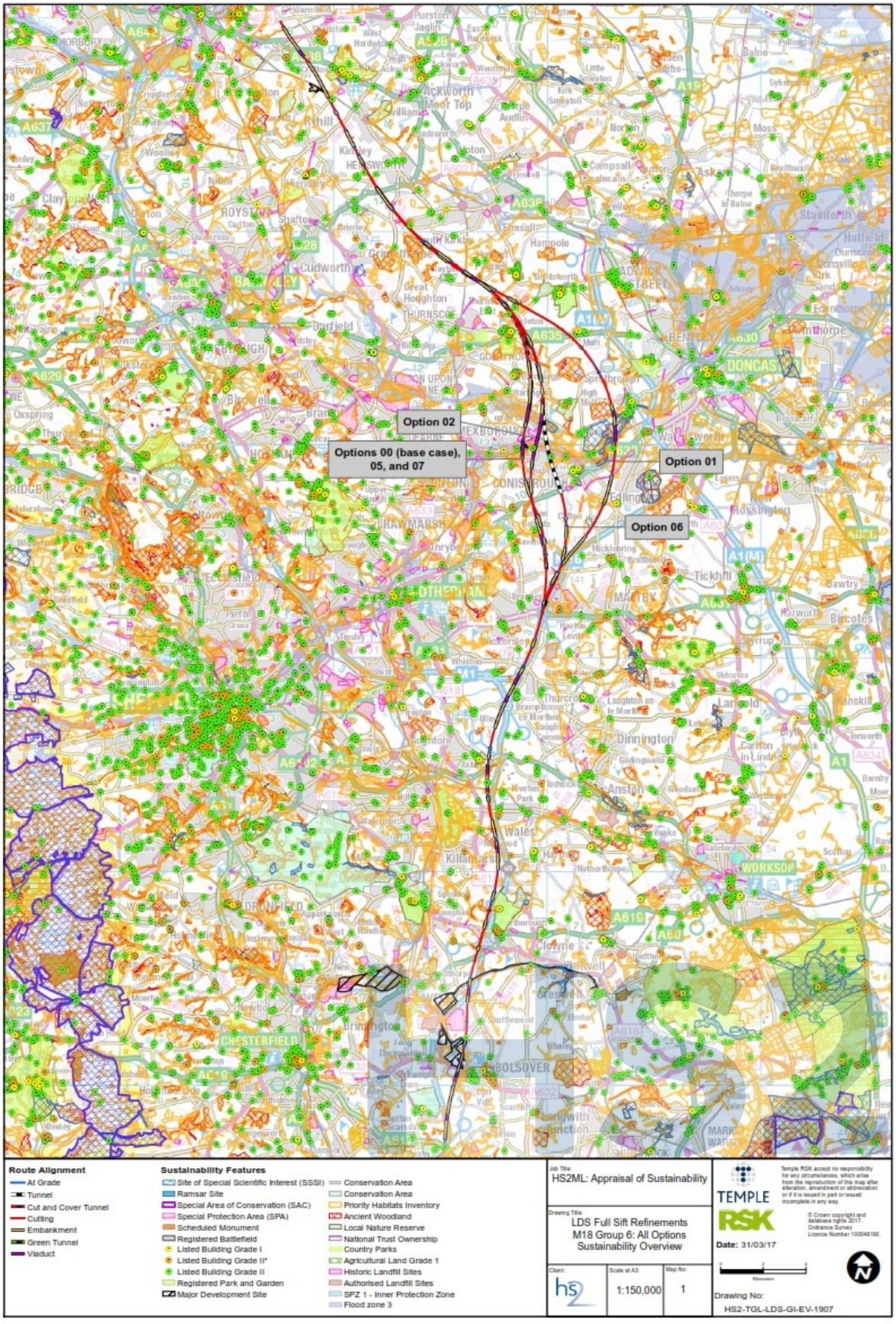
5.3.189 Similar to Option 01, Option 06 would also impact on Denaby Ings SSSI, which would be intersected where the route would be in tunnel. This option would impact High Wood, Nor Wood and Nicker Wood ancient woodlands similar to the preferred option, but would introduce direct impacts on an unnamed ancient woodland west of Barnburgh Cliff and Watchley Crag Wood. This option would avoid a direct impact on the residential housing at Shimmer (that was a development site at the time of the appraisal).

5.3.190 Option 06 would introduce additional cost, as it would be in bored tunnel, as well as substantial concerns over its ability to meet HS2 Ltd technical standards. The track gradients required for this tunnel were at exceptional levels, which could affect maintenance requirements over the lifetime of the project, in addition to passenger comfort implications. Any change to make the design compliant would likely to lead

to a significantly longer tunnel which would introduce additional cost implications. Any sustainability improvements at Barnburgh, which the bored tunnel in Option 07 sought to achieve, would be potentially compromised by introducing the large portal structures adjacent to Hickleton.

5.3.191 Option 07 would follow the same route as the preferred route, with a section of tunnel near Barnburgh. However, this option would still have a major landscape and visual impact where the tunnel would introduce new impacts associated with portal structures creating visual intrusion to nearby receptors, such as Hickleton Hall. All other landscape and visual impacts would be the same as the preferred option where the route would be the same. This option would also have similar impacts on listed buildings as the preferred option, however, would introduce a new impact on the setting of the Grade II listed Vissitt Manor. Option 07 would have the same ancient woodland impacts as the preferred option and would also have a direct impact on the residential housing at Shimmer (that was a development site at the time of the appraisal).

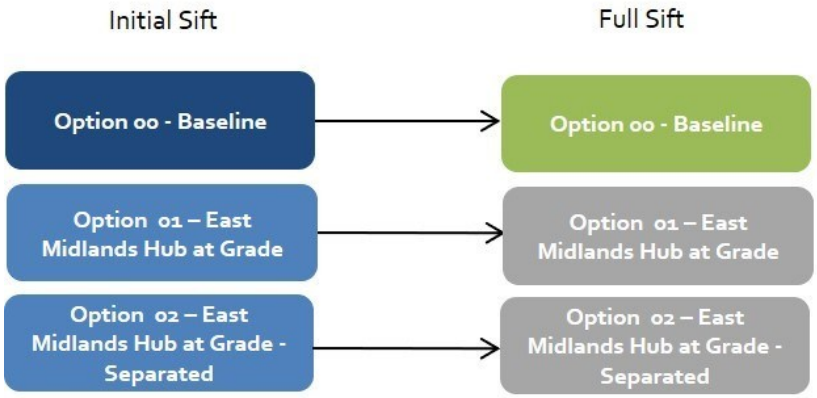
Figure 118: Local alternatives considered for the M18/ Eastern route around Mexborough



M18 - Sheffield spur

5.3.192 This refinement builds upon previous work to explore suitable alternatives to the Sheffield spur. This refinement focused on approximately 10km of the M18/Eastern route north of Toton on the eastern leg. Options developed for this refinement sought to find a more suitable spur connection to the Erewash Valley Line at Stonebroom to provide a link to the MML and serve South Yorkshire using convention compatible trains. Three options were considered for this section of route, all of which were progressed to full sift. The options taken forward in the sift stages are shown in Figure 119 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 120.

Figure 119: Local alternatives considered for the M18 Sheffield spur



5.3.193 The following three options were taken forward to the full sift review following the 2016/2017 public consultation:

- Option 00: the 2016 preferred route would provide a spur from the HS2 main line at Hilcote, which would join the conventional rail network at Stonebroom;
- Option 01: the spur would commence at East Midlands Hub and would connect to the Erewash Valley Line at grade before joining the MML through Chesterfield as far as Sheffield. This option was developed to minimise changes to the HS2 main line and to remain within the existing corridor and reduce demolitions; and
- Option 02: the spur would be the same as Option 01 but would join the Erewash Valley Line via a grade separated junction. This option was developed to tie into the existing Erewash Valley Line fast lines.

5.3.194 HS2 Ltd determined that Option 00 should be taken forward as the preferred option on the basis of both operational performance and notably higher costs with both Options 01 and 02. Both Options 01 and 02 would significantly increase journey time on the route from Long Eaton to Sheffield Midland station, and increase the cost associated with the route through the length of electrification that would be required on the Erewash Valley Line. The options considered at the time of the appraisal did not take into account the potential impacts resulting from works required on Options 01 and 02 to facilitate the operation of HS2 services on the Erewash Valley Line. This would therefore need to be considered as part of ongoing design development.

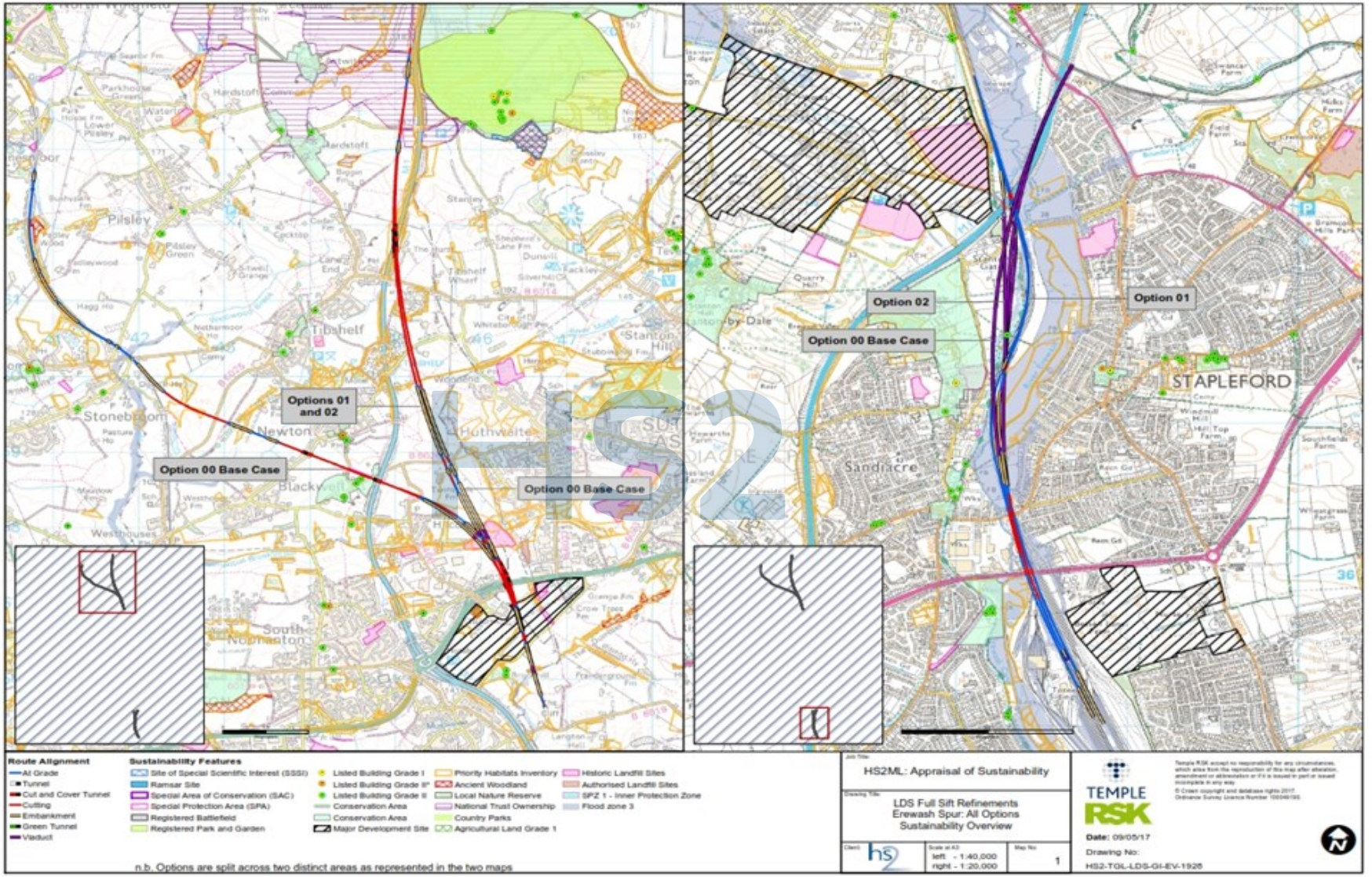
5.3.195 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.196 The preferred option, Option 00, would have visual impacts for residents of Hilcote due to the raised junction associated with the spur, including three viaduct crossings of the Normanton Brook watercourse. There would also be an impact on the setting of the Grade II listed Three Lane End Farmhouse as well as upon Old Blackwell Conservation Area, which would be avoided with both Options 01 and 02. There would be direct impacts on two landfill sites, Blackwell and Cragg Lane, as a result of the spur and the associated connections with the HS2 main line. The preferred option would also directly cross Doe Hill Country Park and the old Doe Hill Colliery (which is the same site as the Country Park).

5.3.197 Option 01 would have increased landscape and visual impacts along the River Erewash due to the intrusive structures within the flat open floodplain, as well as increased impacts on recreational users of the Erewash Canal, when compared with the preferred option. There would be an impact on the Blackwell landfill, although this would be reduced when compared with the preferred option, and in addition, Option 01 would avoid impacts to Cragg Lane landfill. Compared to the preferred option, there would be an increased impact on the Grade II listed Erewash Canal Bridge, which would be surrounded by new infrastructure from the HS2 main line and Erewash connections. If this option were to be taken forward, further investigation would be required to understand flood risk and mitigation as a result of additional structures within the Erewash floodplain, compared with the preferred option, if this option had been taken forward.

5.3.198 Option 02 would introduce major landscape and visual impacts at Stanton Gate, with three high viaducts in proximity to the residential properties and Stanton Gate Conservation Area. There would also be increased visual impacts for recreational users of the Erewash Canal, when compared with the preferred option, as well as a direct crossing of the Stanton Gate Local Nature Reserve. Compared to the preferred option, there would be an increased impact on the Grade II listed Erewash Canal Bridge, similar to Option 01. If this option were to be taken forward, further investigation would be required to understand flood risk and mitigation as a result of additional structures within the Erewash floodplain, compared with the preferred option.

Figure 120: Local alternatives considered for the Sheffield spur



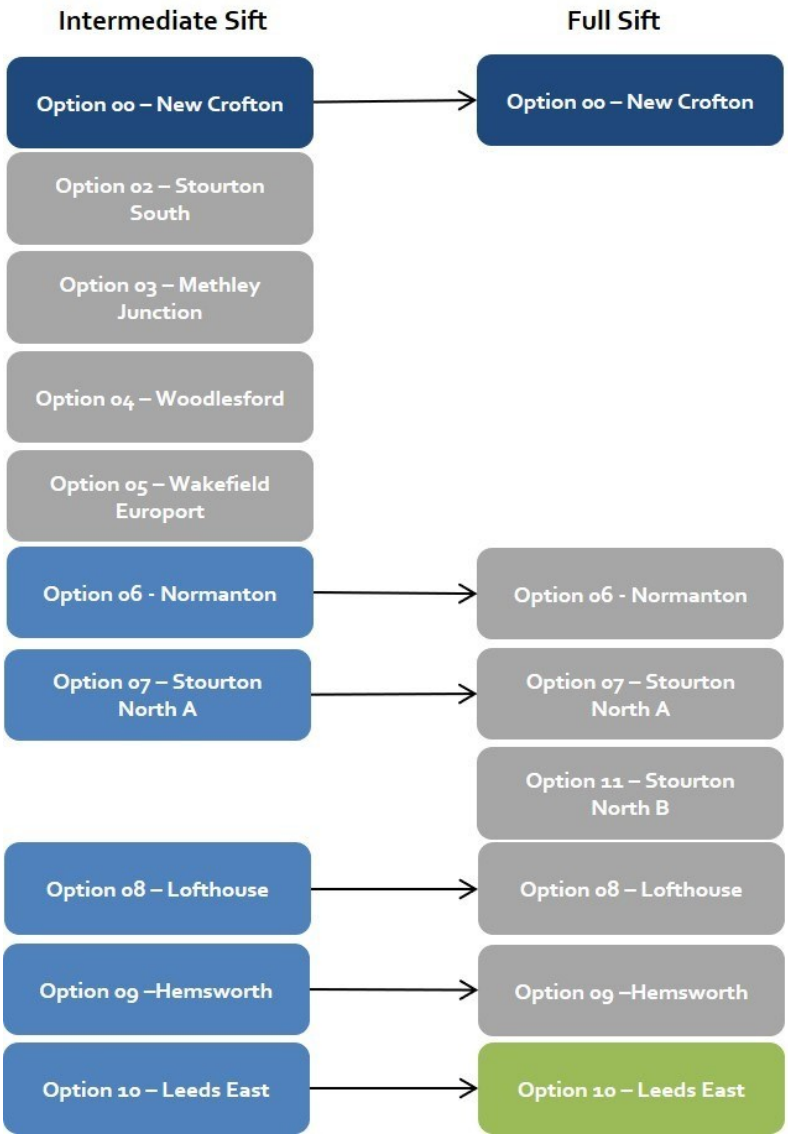
Eastern leg rolling stock depot

5.3.199 Within the *HS2 from Crewe to Manchester, the West Midlands to Leeds and beyond report* (2016), it was announced that further work would be undertaken to consider alternative locations for the RSD proposed at New Crofton in response to concerns raised by the local community. A list of alternative sites were identified based on key design criteria including;

- size of the site (approximately 300,000m²);
- proximity and connectivity to the HS2 main line (north facing junction connection required);
- proximity to the Leeds station (maximum of 10 minutes running time), the termination and origin of the majority of the rolling stock on the eastern leg; and
- brownfield sites in preference to greenfield.

5.3.200 Nine alternatives sites to New Crofton were identified and were considered in an intermediate sift. As part of the intermediate sift exercise, four options were not progressed to a full sift as they were not considered reasonable on the basis of engineering, cost and/or sustainability grounds. A further option was identified for consideration during the full sift, with an alternative layout to that initially proposed at Stourton North, leading to options Stourton A and Stourton B. The options taken forward in the sift stages are shown in Figure 121 and described in the subsequent paragraphs of this section of the report. The locations of the options are shown in Figure 122.

Figure 121: Local alternatives considered for rolling stock depot locations (post 2016/2017 consultation refinement)



5.3.201 The following seven options were taken forward to the full sift review post 2016/2017 consultation:

- Option 00 would be located at New Crofton, as per the 2016 preferred route to Manchester and Leeds;
- Option 06 would be located on a brownfield site between Normanton and Altofts;
- Option 07 would be located at Stourton, approximately 3km from Leeds station on flat, mixed use development land adjacent to the HS2 main line;
- Option 08 would be situated at Lofthouse alongside the Leeds spur;
- Option 09 would be located at Hemsworth, and would be the most southerly of all proposed options. The site would be located alongside the HS2 main line;

- Option 10 would be located at Leeds East, west of Woodlesford on the approach into Leeds station; and
- Option 11 would be located at Stourton, similar to Option 07, but with an alternative operational footprint.

5.3.202 HS2 Ltd determined that Option 10, Leeds East, was the preferred option to be taken forward at this stage of the design phase on the basis of cost, engineering, operational and/or sustainability considerations. The relocation of the RSD from New Crofton to Leeds East reduced many of the community concerns raised during consultation, including noise and visual impacts, although it was recognised that further liaison will be required with local authorities for the Leeds East option due to potential conflict with existing development proposals for the site.

5.3.203 The sustainability impacts of each of the options are set out below with those of the preferred option presented first.

5.3.204 Option 10, the preferred option, at Leeds East would have a direct impact a section of the Gateway 45 development site, part of which is already operational (Temple Green Park and Ride), with further development ongoing. There would also be visual impacts on recreational users of the River Aire, Aire and Calder Navigation Canal and Trans Pennine Trail due to the viaduct crossing as part of the depot approach, as well as some potential landscape fragmentation of the Aire Valley. No demolitions would be required with this option.

5.3.205 Compared to Option 10, the base case Option 00, would have increased landscape and visual impacts for residents to the north and north-east of the depot at Crofton and New Crofton as a result of both the RSD itself and the grade separated connections from the HS2 main line. There would also be a direct impact on the New Crofton Mine development site, together with multiple crossing of the Abbotts Tip historic landfill due the depot connections, which would be avoided by the preferred option.

5.3.206 Option 06 at Normanton would have moderate to localised major visual impacts for residents at Normanton as result of the RSD close to the western edge of the town, and associated grade separated junctions. There would also be an impact on the setting of the Grade II listed Former Newland Hall and Old Stables. There would be a direct impact on the development site at Welbeck Waste Facility from the RSD and depot connections. This option would directly affect land associated with two active landfill sites, which would be avoided by the preferred option.

5.3.207 Option 07 at Stourton would have an increased impact on the development site at Stourton when compared with the preferred option, with both the HS2 main line and RSD impacting on the development site. There would be limited landscape character impacts due to existing largely industrial landscape, but localised visual impacts for residents within proximity to the RSD. Option 07 would also require the diversion of the Fernley Wood Beck, a major river, with the RSD also occupying a large area of existing floodplain, providing an increased risk of fluvial flooding when compared with the preferred option, and requiring floodplain compensation for which there would be limited space. This option would require the demolition of approximately 40 properties, most of which would be commercial, as a result of the RSD footprint.

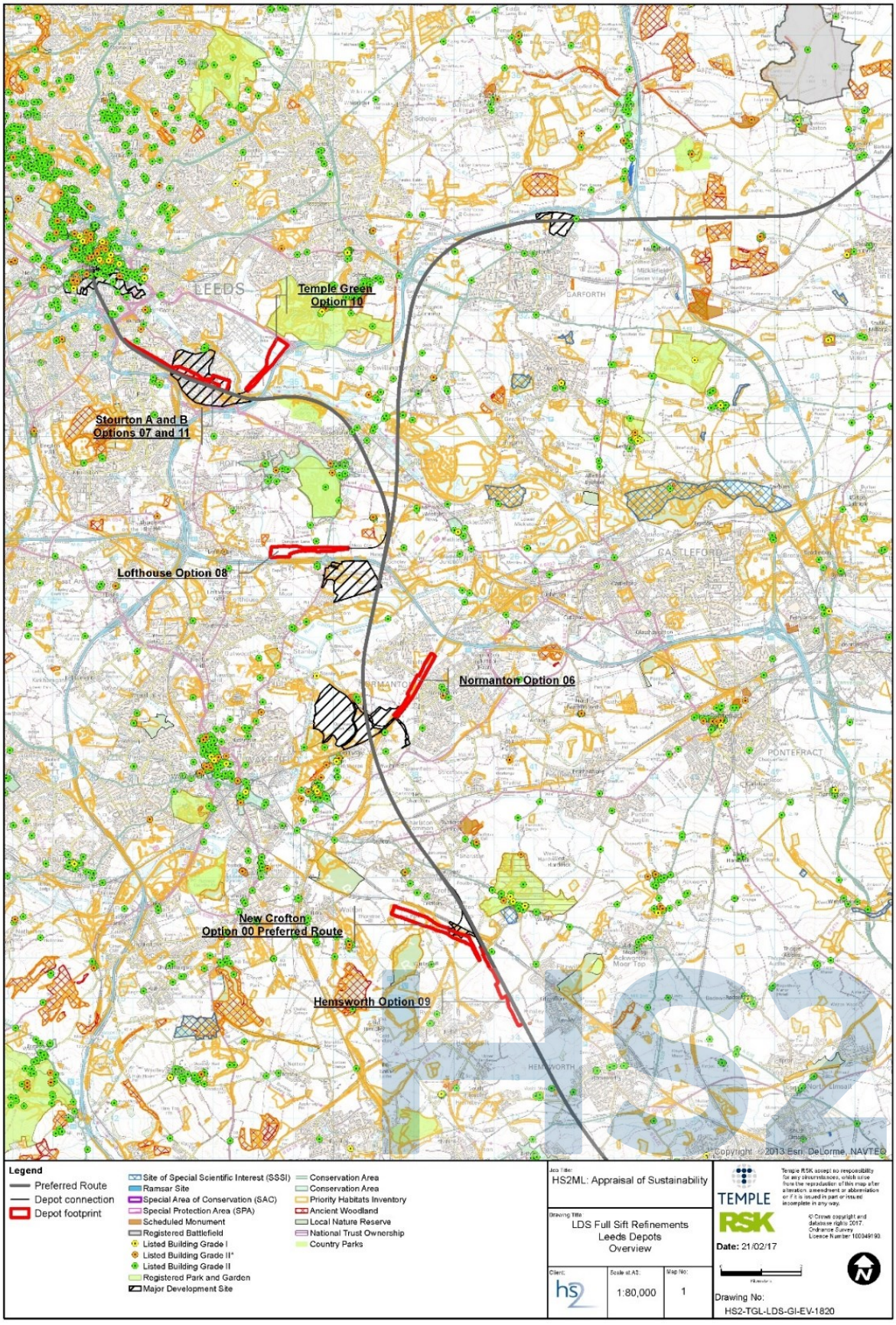
5.3.208 Option 08 would introduce moderate to major landscape character impacts as a result of high embankment over the A642, as well as woodland loss at Moss Carr Wood, when compared with the preferred option. Localised moderate to major visual impacts would affect residents of Ouzlewell Green and Royds Green as well as users of the Trans Pennine Trail and Leeds Country Way as a result of the grade separated depot connections and the RSD itself. There would be impacts on the setting of four Grade II* and Grade II listed buildings, including Clumpcliffe Farmhouse, as well as direct impacts on two historic landfill sites (A642/M62 New Market Interchange and LeeMore Lane landfill).

5.3.209 Option 09 at Hemsworth would introduce moderate to major landscape character and visual impacts predominantly as result of the grade separated depot connections and changes required to the HS2 main line. Sections of deep cuttings and high embankment would create further fragmentation of the existing open farmland landscape when compared with the preferred option. There would be an increased impact on the setting of the Kingsley Moat and Fishponds Scheduled Monument due to its proximity to the RSD, as well as additional land required from the New Crofton Mine development site and Abbots Tipp landfill, when compared with the preferred option.

5.3.210 Option 11 at Stourton, similar to Option 07, would have an increased impact on the Stourton development site when compared with the preferred option, with both the HS2 main line and RSD impacting on the development site. There would be limited landscape character impacts due to existing largely industrial landscape, but localised visual impacts for residents within close proximity to the RSD. The RSD of Option 11 would occupy a large area of existing floodplain, providing an increased risk of fluvial flooding when compared with the preferred option, and require floodplain compensation for which there is limited space. This option would require the demolition of a cluster of commercial properties as a result of the RSD footprint. Whilst lower than Option 07 due to the alternative operational footprint, this would still more than the preferred option, which had no new demolitions.

5.3.211 As a result of this work, HS2 Ltd recommended that the proposed RSD of the eastern leg was relocated from the previously proposed site at New Crofton to the Leeds East site. In July 2017, the Government was minded to agree with this recommendation and launched a public consultation on the proposed relocation. The consultation ran from July 2017 to October 2017.

Figure 122: Local alternatives considered for the rolling stock depot



Eastern leg rolling stock depot (post-consultation)

5.3.212 Following the public consultation on the proposed relocation of the RSD on the eastern leg between July and October 2017, the recommendation to move the RSD to the Leeds East site was reconsidered in light of information received in response to the consultation. This included the appraisal of two alternative RSD locations at an initial sift level, and the undertaking of technical work to identify opportunities for reorienting the RSD within proposed site boundary. In addition, consideration was given to Crofton and Leeds East as the sites for the RSD.

5.3.213 The appraisal of alternative sites at Ryhill and Ossett, which had been suggested by respondents to the consultation, identified that these sites should not be progressed further due to operational, environmental and community impacts demonstrating a major worsening when compared to the Leeds East site.

5.3.214 Work was also undertaken to address comments received in response to the consultation, which requested HS2 Ltd consider whether the RSD could be reoriented within the wider site to reduce impacts on the proposed development area. This work identified that it would not be feasible to reorient the RSD, without impacting directly on the A63 and, in some instances, the operational Yorkshire Water treatment site.

5.3.215 Therefore, following a further consideration of the decision between the Leeds East site and the previously proposed Crofton site, it was decided that the Leeds East site should be confirmed, based on the operational improvements and reduction in impacts on communities.

6 Local alternatives considered since July 2017

6.1 Introduction

6.1.1 Since July 2017, as part of the design development process, a series of potential amendments to the July 2017 announced scheme have been identified and reviewed within workshops attended by engineering, construction, planning and environmental specialists. During the workshops, a comparison was conducted of each design option, which included consideration of:

- engineering requirements: the degree of design complexity of the alternatives and the impact this would have on construction durations;
- cost: whether the alternatives would be more cost effective or incur additional costs; and
- potential environmental impacts: whether the alternatives would have more or fewer potential environmental impacts (e.g. Sound, noise and vibration and Landscape and visual).

6.1.2 The comparison also considered, as appropriate, feedback provided through stakeholder engagement during the development of the Proposed Scheme to date.

6.1.3 Design development of the scheme is ongoing but the following sections detail the reasonable local alternatives studied since July 2017 and the main reasons for selecting the option to be taken forward into the Proposed Scheme as reported in the working draft ES. The environmental impacts of the option selected (which form part of the Proposed Scheme) are then presented, followed by the environmental impacts of the alternative options compared to those of the Proposed Scheme. Other considerations are also noted including engineering requirements and cost. In some cases, a preliminary appraisal of options has been undertaken, whereby options have been considered in terms of whether they are reasonable against environmental, technical and design criteria, and should, therefore, be progressed for further consideration. All dimensions in the following sections are approximate.

6.1.4 In considering the environmental impacts, all environmental topics have been taken into account, however, only those topics where there is a potential impact are reported. During the preparation of the EIA, alternatives were appraised against the baseline scheme[52]. However, in accordance with the EIA Directive[53] (2014/52/EU) that was implemented by the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 that came into force on 16 May 2017, the comparison is presented against the Proposed Scheme. Detailed assessment of the Proposed Scheme is presented in the relevant Volume 2, Community area reports.

[52] For the purpose of the comparative analysis, the appraisal of the local alternatives was undertaken against a selected baseline option, to determine if the alternative is environmentally better or worse than the baseline. The baseline option is frequently the scheme as announced by the Government in July 2017.
[53] Official Journal of the European Union, *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment*.

6.1.5 The Government confirmed in July 2018 that the Proposed Scheme should include the electrification of the section of the MML between Clay Cross and Sheffield Midland Station. HS2 Ltd's consideration of the design of the proposed electrification of this section of the MML is at an earlier stage of development and the outcome of the environmental assessment of the likely significant effects of these works will be reported in the formal ES. Therefore, any local alternatives for the works in the MML01 Danesmoor to Brierley Bridge and MML02 Unstone Green to Sheffield Station areas are not included in the working draft ES. Any alternatives considered by HS2 Ltd for the works in the MML01 Danesmoor to Brierley Bridge and MML02 Unstone Green to Sheffield Station areas will be reported in the formal ES.

6.2 Community area MA01 - Hough to Walley's Green

Crewe tunnel vent shaft location options

6.2.1 As part of the design development process since July 2017, consideration has been given to the location of vent shafts required for Crewe tunnel.

6.2.2 The Proposed Scheme would include vent shafts at two locations on the surface along the alignment of the Crewe tunnel. Each vent shaft would include a headhouse, which would contain ventilation equipment and access lifts and stairs.

6.2.3 As part of the development of the design, further work is being undertaken to consider the location of the vent shafts to optimise the operation of the Proposed Scheme and to seek to reduce potential environmental impacts. A potential location to the south of Crewe Station has been identified for a vent shaft for the southern section of the Crewe tunnel. A potential location at a site to the east of Middlewich Street in Crewe has been identified for a vent shaft for the northern section of the Crewe tunnel.

6.2.4 Further studies will be carried out to consider the vent shaft locations to be included in the Proposed Scheme and the outcome of these studies will be reported in the formal ES.

6.3 Community area MA02 - Wimboldsley to Lostock Gralam

Cheshire salt plain lowering of alignment (south)

6.3.1 As part of the design development process since the announcement of the preferred route in July 2017, consideration has been given to a 7.2km section of route where it would pass on embankments (Coppenhall embankment, Minshull Vernon embankment, Walley's Green embankment and Clive Green embankment) from Burnt Covert near Minshull Vernon, north of Crewe through to Wimboldsley. This section of the route would be on embankment and the opportunity to reduce the height was considered to reduce the volume of earthworks, associated construction traffic and likely environmental impacts. Reducing the embankment heights would also provide an opportunity to realign the A530 Nantwich Road closer to its current alignment.

6.3.2 The following two options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Baseline option: route would pass on embankment (Coppenhall embankment, Minshull Vernon embankment, Walley's Green embankment and Clive Green embankment), which would be between 3m and 8m in height. The A530 Nantwich Road would be realigned 1.2km south of its current alignment and Clive Green Lane would be realigned 4m south of its current alignment; and
- Option A: route would pass on embankment (Coppenhall embankment, Minshull Vernon embankment, Walley's Green embankment and Clive Green embankment), which would be between 1m and 7m in height. The A530 Nantwich Road would be realigned 50m south of its current alignment reducing the length of the realignment by 1.5km and Clive Green Lane would be realigned 40m north of its current alignment.

6.3.3 Table 6 provides a summary of the outcomes of the preliminary appraisal of the alternative option described above.

Table 6: Consideration of local alternatives for route of the Proposed Scheme through Cheshire salt plain (south)

Option	Outcome of analysis	Further action / considerations
Baseline option	• Greater overall landscape and visual impacts on receptors north of Coppenhall Moss, Wimboldsley and along the Shropshire Union Canal (from greater embankment height), and on receptors around Minshull Vernon (from greater embankment height and presence of A530 Nantwich Road realignment) compared with the Proposed Scheme. • Overall greater impacts on the setting of historic environment receptors compared with the Proposed Scheme due to higher embankments. Greater impacts on setting of Grade II listed Park House Farm and Minshull Vernon Moated House Scheduled Monument due to higher embankments and presence of the A530 Nantwich Road realignment. Less impact on Grade II listed Park Farm due to Clive Green Lane realignment being further to the south than the Proposed Scheme. • Potential for greater impacts overall compared to the Proposed Scheme due to direct impacts on ponds and potential great crested newt habitat during construction and due to the larger footprint of the embankments and greater length of A530 Nantwich Road realignment. • Longer duration of impacts from construction traffic compared to the Proposed Scheme, such as noise and air quality impacts for receptors close to proposed construction routes due to the greater material volumes required for larger embankments. • Less road traffic-related air and noise impacts during operation for receptors fronting onto the A530 Nantwich Road at Walley's Green due to the realignment of the A530 compared with the Proposed Scheme as the realigned A530 would be up to 700m further east from these receptors than at present. However, those receptors closer to the realigned A530 Nantwich Road (Parkfield and Park Hall Farm) would experience greater traffic-related impacts during operation compared with the Proposed Scheme. • Greater traffic-related noise and air quality impacts during operation compared to the Proposed Scheme for residential	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action / considerations
	receptors at Stanthorne Park Mews and Lea Head Cottages as the realignment of Clive Green Lane would be closer by up to 70m. • The realignment of the A530 Nantwich Road would also result in greater loss and severance of agricultural land (due to the greater length of the alignment), community severance for those living Walley's Green (due to increased distance to travel to facilities to the east of the alignment), socio-economic impacts on the Verdin Arms public house from potential reduction in business and longer journey times for road users using the A530 during operation compared with the baseline option. • Higher costs due to substantially more imported fill and construction materials to construct higher embankments compared to the Proposed Scheme. Longer construction programme compared to the Proposed Scheme. • This option would present a more complex construction process compared to the Proposed Scheme due to the greater height of bridges and highway embankments required to cross the A530 Nantwich Road and Clive Green Lane.	
Option A (the Proposed Scheme)	• Lower landscape and visual impacts overall compared to the baseline option due to lower embankment heights and because the realigned A530 Nantwich Road would be further from receptors in and around Minshull Vernon and in much closer proximity to the current alignment. There may be slighter greater impacts from the realignment of Clive Green Lane compared with the baseline option due to loss of screening and the road realignment being in closer proximity to Park Farm. • Overall less impact on the setting of the historic environment receptors due to the reduced embankment heights compared with the baseline. Less impact on the setting of historic environment receptors (Grade II listed Park House Farm and Minshull Vernon Moated House Scheduled Monument) due to lower embankment heights and the realignment of the A530 Nantwich Road being located much further north compared to the baseline option. Greater impacts on the setting of Grade II listed Newfield Hall and Summerhouse due to the increased height and change in location of the A530 Nantwich Road realignment compared with the baseline option. Slightly greater impacts on the setting of Grade II listed Park Farm due to the realignment of Clive Green Lane moving further north compared with the baseline option. • Potential for slightly less impact on ecology during construction of the embankments when compared to the baseline option due to the smaller embankment footprint and shorter realignment of the A530 Nantwich Road. However, there would be greater impacts on ecology from the realignment of Clive Green Lane as this would result in the loss of two areas of woodland compared with the baseline option. • Shorter duration of impacts from construction traffic such as noise and air quality impacts for receptors close to proposed construction routes compared to the Proposed Scheme due to the smaller material volumes required for reduced embankments compared with the baseline option.	This is the selected option taken forward into the Proposed Scheme.

Option	Outcome of analysis	Further action / considerations
	• Greater traffic-related operational impacts compared to the baseline option on receptors close to the A530 Nantwich Road in Walley's Green. However, traffic-related impacts on Parkfield and Park Hall Farm would not occur during operation. • Less traffic-related noise and air quality operational impacts on Stanthorne Park Mews and Leahead Cottages due to increased distance to the realigned Clive Green Lane under the Proposed Scheme when compared with the baseline option. However, the realigned Clive Green Lane would be closer to Park House Farm with potentially greater impacts on this receptor. • The realignment of the A530 Nantwich Road under the Proposed Scheme would result in less loss and severance of agricultural land due to the much shorter alignment, less community severance, fewer socio-economic impacts and shorter journey times for car users during operation compared to the baseline option. • The smaller volume of construction materials required for the Proposed Scheme would result in lower costs and a shorter construction programme compared to baseline option. • This option would present a less complex construction process compared to the baseline option due to lower bridges and associated highway approach embankments.	

6.3.4 Option A was taken forward into the Proposed Scheme. Compared with the baseline option, Option A would reduce alignment height by between 2m and 5m and would likely reduce the level of adverse impacts on landscape and visual receptors, and on the historic environment. However, for Option A, the realigned A530 Nantwich Road would be closer to, and have greater traffic related impacts on, receptors around Walley's Green. Option A would be less complex to construct and would cost less than the baseline option due to the smaller volumes of construction material required and less complex highways realignments. As a result, the duration of construction impacts, particularly traffic-related impacts, for Option A, would also be shorter than the baseline option.

Crewe north rolling stock depot

6.3.5 As part of the design development process since July 2017, consideration has been given to the layout of the Crewe north RSD and rail connections between the depot, the HS2 main line and the WCML.

6.3.6 The Proposed Scheme would include a RSD, which would be 60ha in area, and occupy land between the existing WCML and the route of the HS2 main line in the south of the Wimboldsley to Lostock Gralam area, 625m north-east of Walley's Green. The RSD would function as an operational and maintenance hub for the rolling stock that would be deployed to operate on the western leg of the Proposed Scheme. The RSD would serve as an operational and maintenance hub for the Proposed Scheme's passenger rolling stock, with provision for some stabling of infrastructure maintenance trains. Activities undertaken at the RSD would include train servicing

(interior and exterior cleaning, refilling water tanks and emptying of controlled emission toilets) and light and heavy maintenance. The RSD would be operational 24 hours a day, seven days a week.

6.3.7 As part of the development of the design, further work is being carried out to consider the RSD layout and the connections to the HS2 main line to be included in the Proposed Scheme and the outcome of these studies will be reported in the formal ES.

Crewe north rolling stock depot connection

6.3.8 In this area the route of the Proposed Scheme would include a 6km long connection to the depot at Crewe north from the HS2 main line between the crossing of the Shropshire Union Canal and the Marshall's Gorse area near Rudheath, on the south-eastern edge of Northwich.

6.3.9 As part of the design development process, consideration of the potential impacts of the height of the embankments (Clive Green embankment, Stanthorne embankment, Dane Valley embankment, Whatcroft embankment, Billinge Green embankment and Marshall's Gorse embankment) along this section on construction material volumes and to environmental and traffic impacts on local receptors. As a result, changes have been incorporated into the Proposed Scheme, which would include increasing the height of the HS2 main line by up to 5m to allow the reception tracks, which diverge from, and connect to, the HS2 main line into and out of the Crewe north RSD to pass beneath, rather than over the HS2 main line. Elsewhere in this section of route, the height of embankments has been reduced by up to 5m. The changes in height would also reduce the length of the realignment of the A533 Bostock Road and the A54 Middlewich Road. Changes to the layout of the Crewe north RSD could result in the HS2 main line vertical alignment being altered in this area.

6.3.10 Further studies will be carried out to consider the vertical alignment along this section should there be changes to Crewe north RSD layout. Any changes would be included in the Proposed Scheme and the outcome of these studies would be reported in the formal ES.

Lowering alignment between Lostock Green and Lostock Gralam

6.3.11 As part of the design development process since the announcement of the preferred route in July 2017, further consideration has been given to a 5km section of the route at the crossing of the A530 King Street south-east of Rudheath on the eastern outskirts of Northwich, to the north of Smoker Brook and Leonard Wood. The opportunity to reduce the height of the embankments (Rudheath embankment, Lostock Gralam embankment and Pickmere embankment) was considered in order to reduce the volume of earthworks, therefore reducing the associated construction traffic and other potential environmental impacts. In addition, the height of the viaducts in this section would also reduce as a consequence.

6.3.12 The following two options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Baseline option: the route would pass on sections of embankment (Rudheath embankment up to 17m in height, Lostock Gralam embankment up to 17m in

height and Pickmere embankment up to 12m in height) and viaducts (Wade Brook viaduct up to 21m in height and Smokers Brook viaduct up to 24m in height). The A556 would be realigned to the west of the HS2 main line, on a separate embankment 1m high; and

- Option A: the route would pass on embankments (Rudheath embankment up to 11m in height, Lostock Gralam embankment up to 14m in height and Pickmere embankment up to 10m in height), and viaducts (Wade Brook viaduct up to 18m in height and Smokers Brook viaduct up to 23m in height). The A556 would be realigned 70m to the west of the HS2 main line, on a separate embankment 4m high.

6.3.13 Table 7 provides a summary of the outcomes of the preliminary appraisal of the alternative option described above.

Table 7: Consideration of local alternatives for route of the Proposed Scheme between Lostock Green and Lostock Gralam

Option	Outcome of analysis	Further action / considerations
Baseline option	• Greater severance of agricultural land compared to the Proposed Scheme due to the realignment of the A530 King Street. • Greater potential impact on unknown buried archaeological remains due to the larger area of land required compared to the Proposed Scheme. • Greater impacts on the setting of Grade II listed Park Farmhouse, and Shippon and Barn at Park Farmhouse in Lostock Green, as well as non-designated assets (Robin Hood Cottage, 43 Birches Lane, Poplar Grove, Grove Cottage in Lostock Green and Melvin Holme south of Lostock Green) due to the increased height of the Rudheath embankment compared to the Proposed Scheme. • Greater impacts on the landscape character and setting on Lostock Green as well as visual impacts compared to the Proposed Scheme due to the higher vertical alignment being more prominent and harder to screen through landscape planting. • Greater geotechnical risks associated with the proximity to the Lostock Lime Beds to the west compared to the Proposed Scheme. • Greater construction impacts (noise, dust, traffic) on local communities along site haul routes compared to the Proposed Scheme due to the increased volume of construction vehicle movements required to import embankment fill material. • Greater cost and construction duration compared to the Proposed Scheme.	This option will not be subject to further consideration.
Option A (the Proposed Scheme)	• Less severance of agricultural land compared to the baseline option due to the more southerly realignment of A530 King Street. • Less impact on unknown archaeological remains due to the smaller earthworks footprint when compared to the baseline option. • Lower impacts on the setting of Grade II listed Park Farmhouse, and Shippon and Barn at Park Farmhouse in Lostock Green, as well as non-designated assets (Robin Hood Cottage, 43 Birches Lane,	This is the selected option taken forward into the Proposed Scheme.

Option	Outcome of analysis	Further action / considerations
	Poplar Grove, Grove Cottage in Lostock Green and Melvin Holme south of Lostock Green) due to the lower height of the Rudheath embankment). • Lower landscape character and setting impacts on Lostock Green as well as visual impacts due to the vertical alignment being lower and easier to screen through landscape planting in some places. • Fewer geotechnical risks associated with the proximity to the Lostock Lime Beds as the reduction in embankment height and associated reduction in footprint would increase clearances between the Proposed Scheme and the Lime Beds. • Lower construction impacts (noise, dust, traffic) on local communities along construction haul routes due to the reduced volume of heavy good vehicle movements required to import embankment fill material. • Reduced construction cost and construction duration.	

6.3.14 Option A was taken forward into the Proposed Scheme. Compared with the baseline option, Option A would be lower by an average height of 9m with a maximum reduction of 12m at the approximate location of where the Proposed Scheme would first cross the existing A556 Chester Road alignment, close to Cookes Lane. The lower heights of the viaducts and embankments for Option A would have lower likely adverse landscape and visual impacts for local residential receptors at Lostock Green and those to the west of the existing A556 Chester Road. Option A would also have olower adverse impacts on the setting of Grade II listed Park Farmhouse, and Shippon and Barn at Park Farmhouse in Lostock Green as well as non-designated assets (Robin Hood Cottage, 43 Birches Lane, Poplar Grove and Grove Cottage in Lostock Green, and Melvin Holme south of Lostock Green). Option A would also have less potential for impacts on unknown archaeology due a smaller footprint and lower geotechnical risks associated with the proximity of Lostock Lime Beds. A lower volume of construction materials required would result in less construction traffic, and therefore, reduce associated likely noise and air quality impacts. Overall, Option A would likely have lower adverse environmental impacts during construction, would be less complex to construct, cost less and take less time to build.

6.4 Community area MA03 – Pickmere to Agden and Hulseheath

Proposed auto-transformer feeder station location

6.4.1 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the location of an auto-transformer feeder station at Hoo Green, which would supply electrical power from the National Grid network to the Proposed Scheme. The auto-transformer feeder station would house the electrical equipment that would protect and control the power supply to the Proposed Scheme. The auto-transformer feeder station would be

required at the start of a neutral section[54] along the route of the Proposed Scheme at a location with a potential grid supply point to provide grid connection to existing electrical infrastructure.

6.4.2 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 1A: the auto-transformer feeder station would be located immediately to the south of the A50, on the east side of the Proposed Scheme, near Hoo Green. The auto-transformer feeder station would be located adjacent to the Hoo Green cutting, at ground level, within an area of existing agricultural fields. The grid supply point would be located 100m south of the auto-transformer feeder station also on the east side of the Proposed Scheme, at ground level, 100m east of the Proposed Scheme within existing agricultural fields;
- Option 1B (variant of 1A): the auto-transformer feeder station would be located 200m south of the A50, and adjacent to the east side of the Proposed Scheme, near Hoo Green. The auto-transformer feeder station would be located adjacent to the Hoo Green cutting, at ground level, within an area of existing agricultural fields. The grid supply point would be located 100m north-east of the auto-transformer feeder station, also on the east side of the Proposed Scheme, at ground level, 100m east of the Proposed Scheme within existing agricultural fields;
- Option 1D (variant of 1A): the auto-transformer feeder station would be located 200m south of the A50, on the east side of the Proposed Scheme, near Hoo Green. The auto-transformer feeder station would be located adjacent to the Hoo Green cutting, at ground level, within an area of existing agricultural fields. The grid supply point would be located 100m east of the auto-transformer feeder station, also on the east side of the Proposed Scheme, at ground level, 100m east of the HS2 main line, within existing agricultural fields; and
- Option 4B: the auto-transformer feeder station would be located to the west of the Proposed Scheme, at the foot of the Heyrose embankment, in an area of land between the HS2 main line, Arley Brook and Heyrose Golf Club. The grid supply point would be located 400m west of the auto-transformer feeder station, adjacent to the existing Budworth Road, 300m south-west of Arley Brook.

6.4.3 Table 8 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

[54] A neutral section is an insulated section that prevents two differing electrical sections from touching, by introducing an electrical clearance (an earth section)

Table 8: Consideration of local alternatives for the location of the auto-transformer feeder station at Hoo Green

Option	Outcome of analysis	Further action/considerations
Option 1A	• Increased community, noise and air quality impacts compared to the Proposed Scheme due to being closer to sensitive receptors in Hoo Green, which would be less than 100m from the auto-transformer feeder station. • Greater impact on historic environment compared to the Proposed Scheme due to closer proximity to heritage assets (Mere Court Hotel and Legh Cottage – Grade II listed, and a scheduled monument at Hough Hall). • Temporary landscape and visual impacts would likely result from this option on the residents of Hoo Green, however, impacts would be similar to the Proposed Scheme as there would be no impact on users of Heyrose Golf Club and on the residents of Heyrose Farm and Yew Tree Farm. • Similar land requirements, construction complexity, construction programme, and construction and maintenance costs to the Proposed Scheme.	This option will not be subject to further consideration.
Option 1B	• Increased community, noise and air quality impacts compared to the Proposed Scheme due to being closer to sensitive receptors in Hoo Green, which would be less than 100m from the grid supply point location. • Greater impact on historic environment compared to Proposed Scheme due to closer proximity to heritage assets (Mere Court Hotel and Legh Cottage – Grade II listed, and a scheduled monument at Hough Hall). • Temporary landscape and visual impacts would likely to result from this option on the residents of Hoo Green, however, impacts would be similar to the Proposed Scheme as there would be no impact on users of Heyrose Golf Club and on the residents of Heyrose Farm and Yew Tree Farm. • Similar land requirements, construction complexity, construction programme, and construction and maintenance costs to the Proposed Scheme.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
Option 1D (the Proposed Scheme)	• Lower air quality, community and noise impacts compared to the other options due to the increased distance of 300m from sensitive residential receptors in Hoo Green. • Lower impacts on the historic environment compared to other options due to greater distance from heritage assets (Mere Court Hotel and Legh Cottage – Grade II listed, and a scheduled monument at Hough Hall). • Temporary landscape and visual impacts would likely result from this option on the residents of Hoo Green, however, impacts would be similar to Options 1A and 1B, and lower when compared to Option 4B, as there would be no impact on users of Heyrose Golf Club and on the residents of Heyrose Farm and Yew Tree Farm. • Similar land required to Options 1A and 1B. However, less land required than Option 4B. • Similar construction complexity, construction programme, and construction and maintenance costs to the Proposed Scheme.	This is the selected option taken forward into the Proposed Scheme.
Option 4B	• Increased community, noise and air quality impacts compared to the Proposed Scheme due to being closer to sensitive receptors at Yew Tree Farm. • Larger area of land required than for the Proposed Scheme due to the permanent loss of one hole at Heyrose Golf Club, but it is expected that the course would remain open during construction and operation as the hole could be provided elsewhere. • Greater landscape and visual impacts compared to the Proposed Scheme due to impacts on users of Heyrose Golf Club and on the residents of Heyrose Farm and Yew Tree Farm. • Greater impact on historic environment compared to the Proposed Scheme due to closer proximity to heritage assets. • Similar construction complexity, construction programme, and construction and maintenance costs to the Proposed Scheme.	This option will not be subject to further consideration.

6.4.4 Option 1D was taken forward into the Proposed Scheme. When compared to the other options, Option 1D would be further away from sensitive residential receptors at Hoo Green and would, therefore, have reduced impacts air quality, community, landscape and noise impacts at Hoo Green. The auto-transformer feeder station and grid supply point would be located further away from the nearest heritage assets (Grade II listed Mere Court Hotel and Legh Cottage and a scheduled monument at Hough Hall), and therefore, would have lower impacts on the historic environment than the other options. Option 1D would have similar technical and engineering complexities to the other options.

Highway alignment at Pickmere Lane

6.4.5 As part of the design development process since July 2017, consideration has been given to the design of the highway diversions at Pickmere Lane, Flittogate Lane and School Lane to reduce potential adverse impacts on residents of Pickmere.

6.4.6 The Proposed Scheme would pass on an embankment (Pickmere embankment), north-east of the village of Pickmere. The existing highway network would be disrupted by the Proposed Scheme, resulting in Budworth Road being closed, and Pickmere Lane, Flittogate Lane and School Lane being diverted to maintain connectivity to the east and west of the Proposed Scheme.

6.4.7 As part of the development of the design, further work is being undertaken to consider the location and the design of highway diversions and could result in the HS2 main line vertical alignment being altered in this area or the extension of the Arley Brook viaduct to allow the realigned highways to pass beneath the viaduct.

6.4.8 Further studies will be carried out to consider any changes to be included in the Proposed Scheme and the outcome of these studies would be reported in the formal ES.

Highway alignment at Peacock Lane

6.4.9 As part of the design development process since July 2017, consideration has been given to the design of highway diversions and to reduce potential adverse impacts on residents of High Legh and Hulseheath.

6.4.10 The Manchester spur would diverge from the HS2 main line at High Legh and would pass in cutting (High Legh cutting) to the east of High Legh with the Manchester spur passing on embankment (Hulseheath embankment) to the west of Hulseheath. The existing highway network would be disrupted by the route of the Proposed Scheme (comprising both the HS2 main line and Manchester spur in this area), resulting in Peacock Lane, Throwler Lane and Back Lane being diverted to maintain connectivity to the east and west of the Proposed Scheme.

6.4.11 Further studies will be carried out to consider the location and the design of highway diversions and could result in the HS2 main line vertical alignment being altered in this area. Any changes would be included in the Proposed Scheme and the outcome of these studies would be reported in the formal ES.

6.5 Community area MA04 – Broomedge to Glazebrook

Manchester Ship Canal crossing – horizontal realignment

6.5.1 As part of the design development process since July 2017, consideration has been given to impacts on receptors at Hollins Green and on Hollinfare Cemetery.

6.5.2 The Proposed Scheme would pass on a 2km long viaduct (Manchester Ship Canal viaduct) up to 28m high across the Manchester Ship Canal. The viaduct would pass to the east of the settlement of Hollins Green and would be less than 5m from the boundary of Hollinfare Cemetery.

6.5.3 As part of the development of the design, further work is being undertaken to consider the horizontal alignment of the Proposed Scheme in this area with a view to moving the route further east away from Hollins Green.

6.5.4 Further studies will be carried out to consider the alignment of the route to be included in the Proposed Scheme and the outcome of these studies will be reported in the formal ES.

6.6 Community area MA05 – Risley to Bamfurlong

Culcheth highway alternatives

6.6.1 As part of the design development process since July 2017, consideration has been given to the design of the highway realignments and diversions at Culcheth and to reducing potential adverse impacts on local residents and users of the highways. At present there are two highway routes to access Culcheth from the south and west; Wigshaw Lane and the A574 Warrington Road.

6.6.2 The Proposed Scheme would require the permanent realignment of the A574 Warrington Road to the west of its existing alignment, and the permanent closure of Wigshaw Lane. Users of Wigshaw Lane would be diverted to cross the Proposed Scheme via the A574 Warrington Road, with realignments to Glaziers Lane and construction of a new northern link road parallel to the Culcheth Linear Park forming the connection between Wigshaw Lane and the A574 Warrington Road north of the Proposed Scheme.

6.6.3 As part of the development of the design, further work is being undertaken to consider the overall highway configuration in this location, taking into account direct impacts on local receptors as a consequence of highway diversions and operational impacts upon highway users including non-motorised users.

6.6.4 Further studies will be carried out to consider the location and the design of the highway diversions to be included in the Proposed Scheme and the outcome of these studies will be reported in the formal ES.

Lily Lane junction

6.6.5 As part of the design development process since July 2017, consideration has been given to reducing potential environmental impacts while providing a connection from the HS2 main line to the WCML, which would reduce the impact upon the operation of that WCML.

6.6.6 The Proposed Scheme would connect to the WCML via a grade separated junction, which would necessitate realignment of the north and southbound WCML fast lines. The realignment of the northbound fast line would be minor and within the existing conventional rail corridor. The realignment of the southbound fast line would be outside of the existing conventional rail corridor.

6.6.7 As part of the development of the design, further work is being undertaken to consider the junction configuration, with a view to further reduce the area of land required, impacts on agricultural land holdings and disruption to the WCML.

6.6.8 Further studies will be carried out to consider the configuration of the Lily Lane junction to be included in the Proposed Scheme and the outcome of these studies will be reported in the formal ES.

A573 Wigan Road highway realignment

6.6.9 As part of the design development process since July 2017, consideration has been given to impacts on agricultural land holdings, access and landscape and visual impacts as a result of the realignment of the A573 Wigan Road.

6.6.10 The Proposed Scheme would require the A573 Wigan Road, which is located to the north of Golborne, to be realigned to the east over the Proposed Scheme. Lightshaw Lane would need to be realigned further north to connect with the realigned A573 Wigan Road.

6.6.11 As part of the development of the design, further work is being undertaken to consider alternative highway alignment options for the A573 Wigan Road, which seek to reduce land requirements, severance of agricultural land holdings and landscape and visual impacts. Alternative highway options will be considered in the context of options for the WCML junction at Lily Lane to identify an overall solution for the area.

6.6.12 Further studies will be carried out to consider the alignment of the A573 Wigan Road included in the Proposed Scheme and the outcome of these studies will be reported in the formal ES.

6.7 Community area MA06 – Hulseheath to Manchester Airport

Highway alignment at Mobberley Road

6.7.1 As part of the design development process since July 2017, consideration has been given to the design of highway diversions to reduce potential adverse impacts on residents of Ashley.

6.7.2 The Proposed Scheme would pass south of the village of Ashley on the Ashley embankment and would require the closure of Ashley Road, and the diversion of Lamb Lane and Mobberley Road.

6.7.3 As part of the development of the design, further work is being undertaken to consider the construction and engineering options in this area.

6.7.4 Further studies will be carried out to consider the location and the design of highway diversions and could result in the HS2 main line vertical alignment being altered in this area. Any changes would be included in the Proposed Scheme and the outcome of these studies would be reported in the formal ES.

Manchester Airport High Speed station

6.7.5 As part of the design development process since July 2017, consideration has been given to the permanent layout of the Manchester Airport High Speed station, the location of the car park and the provision for a potential connection to the Metrolink.

6.7.6 The Proposed Scheme would include a shared concourse with Metrolink, situated at the north end of the station. The concourse would be located at ground level, above the station platforms. A multi-storey car park would be located to the east of the route of the Proposed Scheme.

6.7.7 As part of the development of the design, further work is being undertaken to consider the location and configuration of the station platforms and the location of the shared concourse with Metrolink to improve pedestrian flow through the station and reduce intermodal journey times. The location and form of the car park is also being considered to ensure optimal connection with the station building to reduce walk time and enhance pedestrian circulation.

6.7.8 An important element of the ongoing design development is consideration of designs for how to accommodate up to four platforms, which would allow use of the Manchester spur by Northern Power Rail services; an outcome sought by local authorities and regional and local transport bodies. Further studies will be carried out to consider the construction and engineering options at the Manchester Airport High Speed station to be included in the Proposed Scheme and the outcome of these studies will be reported in the formal ES.

6.8 Community area MA07 – Davenport Green to Ardwick

Manchester tunnel vent shaft location

6.8.1 As part of the design development process since July 2017, further consideration has been given to the location of vent shafts required for the Manchester tunnel.

6.8.2 The Proposed Scheme would include vent shafts in four locations along the Manchester tunnel. Each vent shaft would include a tunnel headhouse, which would contain ventilation equipment and an associated evacuation area.

6.8.3 As part of the development of the design, further work is being undertaken to consider the location of the vent shafts to optimise the operation of the Proposed Scheme and to reduce environmental impacts. Four potential sites for the location of vent shafts have been identified along the Manchester tunnel near: Altrincham Road; Palatine Road; Wilmslow Road and Lytham Road. These indicative locations are subject to ongoing assessment along with other sites within their vicinity.

6.8.4 Further studies will be carried out to consider the locations to be included in the Proposed Scheme and the outcome of these studies will be reported in the formal ES.

Ardwick Depot and Manchester Piccadilly High Speed station approach

6.8.5 As part of the design development process since July 2017, consideration has been given to the location of the Manchester tunnel north portal and associated route of the Ardwick cutting and Piccadilly viaduct.

6.8.6 As part of the Proposed Scheme, the Manchester tunnel north portal would connect with the Ardwick cutting, which in turn would connect to the Piccadilly viaduct and Manchester Piccadilly High Speed station.

6.8.7 As part of the development of the design, further work is being undertaken to consider reducing potential impacts on the existing Ardwick Depot, local community and sensitive receptors.

6.8.8 Further studies will be carried out to consider the route around Ardwick Depot and the outcome of these studies will be reported in the formal ES.

6.9 Community area MA08 – Manchester Piccadilly Station

Manchester Piccadilly High Speed station

6.9.1 As part of the design development process since July 2017, consideration has been given to the permanent layout of the proposed Manchester Piccadilly High Speed station.

6.9.2 The Manchester Piccadilly High Speed station would include a shared concourse with Metrolink, situated at north end of the station. The concourse would be located at ground level, below the station platforms.

6.9.3 As part of the development of the design, further work is being undertaken to consider the location of the station platforms and connections with Metrolink, the existing Manchester Piccadilly Station and surrounding area including New Sheffield Street so as to improve pedestrian flow through the station and reduce intermodal journey times.

6.9.4 Further consideration will be given to the construction and engineering options at the proposed Manchester Piccadilly High Speed station and the outcome of these studies will be reported in the formal ES.

6.10 Community area LA01 – Lea Marston to Tamworth

Proposed auto-transformer feeder station and grid supply point locations

6.10.1 During the design development process since the announcement of the preferred route in July 2017, consideration has been given to the location of an auto-transformer feeder station in Lea Marston, which would supply electrical power from the National Grid network to the Proposed Scheme. The auto-transformer feeder station would house the electrical equipment that would protect and control the power supply to the Proposed Scheme. The auto-transformer feeder station would be required at the start of a neutral section[55] along the route of the Proposed Scheme at a location with a potential grid supply point to provide grid connection to existing electrical infrastructure.

6.10.2 The following three options were taken forward in October 2017 to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option A1.0: the auto-transformer feeder station would be located east of the route of the Proposed Scheme, adjacent to the realigned Bodymoor Heath Road in Bodymoor Heath, and would require 3.5km of incoming feeder cables from Hams Hall 132kV National Grid substation;
- Option A1.1: the auto-transformer feeder station would be located east of the route of the Proposed Scheme and north of Marston Lane in Lea Marston, and

[55] A neutral section is an insulated section that prevents two differing electrical sections from touching, by introducing an electrical clearance (an earth section)

would require 2km of incoming feeder cables from Hams Hall 132kV National Grid substation; and

- Option A1.2: the auto-transformer feeder station would be located north-west of the M42 junction 9, to the west of the route of the Proposed Scheme, the M42 and the Birmingham to Fazeley Canal. This option would require the construction of a new grid supply point adjacent to the west of the auto-transformer feeder station, which would provide very short incoming connections.

6.10.3 Table 9 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 9: Consideration of local alternatives for an auto-transformer feeder station in the Lea Marston to Tamworth area

Option	Outcome of analysis	Further action/considerations
Option A1.0	• Smaller area of broadleaved woodland habitat loss compared to the Proposed Scheme. • Less likelihood of impact on non-designated heritage assets (ridge and furrow ploughing in the two fields adjacent to Mullensgrove Farm in Lea Marston) compared to the Proposed Scheme. • Greater visual impacts for recreation receptors along Warwickshire Footpath M22 compared to the Proposed Scheme. • Potential greater risk of groundwater contamination compared to the Proposed Scheme. • Similar technical and engineering complexities, construction programme and costs to the Proposed Scheme.	This option will not be subject to further consideration
Option A1.1 (the Proposed Scheme)	• Larger area of broadleaved woodland lost compared to alternative options. • Greater potential for impacts on non-designated heritage assets (ridge and furrow ploughing in the two fields adjacent to Mullensgrove Farm in Lea Marston) compared to Option A1.0, but less potential to affect non-designated heritage assets compared to Option A1.2. • Fewer landscape character impacts and fewer visual impacts on recreational users of Warwickshire Footpath M22 and the cycleway/towpath of the Birmingham and Fazeley Canal compared to the alternative options. • Fewer technical and engineering complexities compared to Option A1.2 though similar technical and engineering complexities compared with Option A1.0. • Similar construction programme compared to the alternative options. • Similar costs compared to Options A1.0, and would cost less than Option A1.2.	This is the selected option taken forward into the Proposed Scheme

Option	Outcome of analysis	Further action/considerations
Option A1.2	• Larger area of pond habitat lost at Cuttle Mill Fishery compared to the Proposed Scheme. • Larger area of agricultural land (quality unknown) lost compared to the Proposed Scheme. • Greater difficultly providing vehicular access for maintenance of the auto-transformer feeder station and grid supply point compared to the Proposed Scheme. • Greater risk of flooding from surface water and potential to increase flood risk elsewhere compared to the Proposed Scheme. • Greater landscape character impacts and visual impacts to users of the cycleway/towpath of the Birmingham and Fazeley Canal compared to the Proposed Scheme. • Similar technical and engineering complexities to the Proposed Scheme, although an additional site for the grid supply point of similar area as the auto-transformer feeder station would require preparation for this option compared to the Proposed Scheme. • Higher construction and maintenance costs for the grid supply point (which would have a similar footprint to that of the auto-transformer feeder station site) compared to cabling from existing Hams Hall substation for the Proposed Scheme. • Similar construction programme to the Proposed Scheme.	This option will not be subject to further consideration

6.10.4 Option A1.1 was taken forward into the Proposed Scheme. Whilst Option A1.0 would have less adverse impacts on broadleaved woodland and pond habitats and reduced potential to impact the non-designated heritage assets (ridge and furrow ploughing in the two fields adjacent to Mullensgrove Farm in Lea Marston) when compared to Option A1.1, Option A1.0 (in comparison to Option A1.1), would have a greater visual impact upon nearby recreational receptors using Warwickshire Footpath M22. Option A1.2, in comparison to Option A1.1, would have a greater cost associated with the construction and maintenance of the new grid supply point and a greater impact on the environment including greater landscape and visual impacts, greater loss of agricultural land and increased flood risk.

Proposed auto-transformer feeder station - further refinement

6.10.5 During the design development process since completion of the October 2017 sift (see above), further consideration has been given to the location of an auto-transformer feeder station following development of the interface of Phase One with Phase 2b.

6.10.6 The following two options were taken forward in April 2018 to a further detailed appraisal that followed engagement with the appointed Phase One construction contractors on their design, engineering and construction feasibility, cost and environmental impacts:

- Option A1.1: the preferred auto-transformer feeder station option identified in the previous sift in October 2017 would be located to the east of the route of the Proposed Scheme and north of Marston Lane, in Lea Marston, and would

require 2km of incoming feeder cables from Hams Hall 132kV National Grid substation; and

- Option A1.3: the auto-transformer feeder station would be located to the east of the route of the Proposed Scheme and west of the A4097 Kingsbury Road in Lea Marston, 300m north of Option A1.1.

6.10.7 Table 10 provides a summary of the outcomes of the preliminary appraisal of Option A1.1 and Option A1.3 described above.

Table 10: Consideration of local alternatives for an auto-transformer feeder station in the Lea Marston to Tamworth area – April 2018

Option	Outcome of analysis	Further action/considerations
Option A1.1	• Similar environmental constraints to Option A1.3. • Less ability to achieve compliant neutral section[56] gradients compared to the Proposed Scheme and less ability to provide sufficient neutral section clearance compared to the Proposed Scheme. • The location of this option would conflict with the location of a proposed balancing pond for the emerging Phase One detailed design at the Phase One/Phase 2b interface. • Similar construction programme and cost compared to the Proposed Scheme.	This option will not be subject to further consideration
Option A1.3 (the Proposed Scheme)	• Similar environmental constraints to Option A1.1. • Greater ability to achieve compliant neutral section gradients compared to Option A1.1 and greater ability to provide sufficient neutral section clearance compared to Option A1.1. • Avoids a conflict with the location of the Proposed Scheme and the location of a proposed Phase One balancing pond for the emerging Phase One detailed design at the Phase One/Phase 2b interface. • Similar construction programme and cost compared to Option A1.1.	This is the selected option taken forward into the Proposed Scheme

6.10.8 In April 2018, Option A1.3 was taken forward into the Proposed Scheme. Whilst Option A1.1 and Option A1.3 have very few differences in terms of environmental factors, Option A1.3 was chosen as it would better achieve compliant neutral section gradients, provide sufficient neutral section clearance and would avoid conflicting with the proposed Phase One balancing pond located at the interface with Phase 2b.

[56] A neutral section is a section of insulated overhead wire which provides a physical separation between two separate powered sections of overhead line.

6.11 Community area LA02 – Birchmoor to Austrey

Route section alternatives

6.11.1 The strategic, route-wide and route corridor alternatives to the Proposed Scheme and local alternatives considered prior to July 2017 are presented in Volume 1, Introduction and methodology and in the Alternatives report as a supporting document to the working draft ES. The local alternatives considered for the Proposed Scheme within the Birchmoor to Austrey area since the route announcement in July 2017 are described in this section.

6.11.2 In this area, the route of the Proposed Scheme would be carried on viaducts and embankments, in cuttings and through tunnels.

6.11.3 As part of the design development process since July 2017, consideration has been given to the impact of the Proposed Scheme on local residents of the Birchmoor to Austrey area and environmental receptors. This includes agricultural holdings, Alvecote Pools SSSI, Pooley Country Park, Polesworth Abbey (a scheduled monument), Bramcote Brook and Bramcote Covert Ancient Woodland.

6.11.4 Further consideration will be given to the construction and engineering options in this area, including design and construction methods and alternative engineering options. Further studies are ongoing and will be reported in the formal ES.

6.12 Community area LA03 - Appleby Parva to Ashby-de-la-Zouch

Route section alternatives

6.12.1 The strategic, route-wide and route corridor alternatives to the Proposed Scheme and local alternatives considered prior to July 2017 are presented in Volume 1, Introduction and methodology and in the Alternatives report as a supporting document to the working draft ES. The local alternatives considered for the Proposed Scheme within the Appleby Parva to Ashby-de-la-Zouch area since the route announcement in July 2017 are described in this section.

6.12.2 In this area, the route of the Proposed Scheme would be carried on viaducts and embankments, in cuttings and through tunnels.

6.12.3 As part of the design development process since July 2017, consideration has been given to the impact of the Proposed Scheme on local residents of the Appleby Parva to Ashby-de-la-Zouch area and environmental receptors. This includes agricultural holdings, the River Mease SAC/SSSI, Parker's Wood and Fiveways Wood, which are part of the National Forest, the Old Rectory and Park Farm (both of which are Grade II listed buildings), and Gilwiskaw Brook.

6.12.4 Further consideration will be given to the construction and engineering options in this area, including design and construction methods and alternative engineering options. Further studies are ongoing and will be reported in the formal ES.

6.13 Community area LA04 – Coleorton to Kegworth

Route section alternatives

6.13.1 The strategic, route-wide and route corridor alternatives to the Proposed Scheme and local alternatives considered prior to July 2017 are presented in Volume 1, Introduction and methodology and in the Alternatives report as a supporting document to the working draft ES. The local alternatives considered for the Proposed Scheme within the Coleorton to Kegworth area since the route announcement in July 2017 are described in this section.

6.13.2 In this area, the route of the Proposed Scheme would be carried on viaducts and embankments, in cuttings and through tunnels.

6.13.3 As part of the design development process since July 2017, consideration has been given to the impact of the Proposed Scheme on local residents of the Coleorton to Kegworth area and environmental receptors. This includes agricultural holdings, Lount Meadows SSSI, Breedon Cloud Wood and Quarry SSSI, Pasture and Asplin Woods SSSI, areas of ancient woodland including Breedon Cloud Wood and Pasture and Asplin Woods, Breedon Lodge Farmhouse and Cottage (Grade II listed building), and Diseworth Brook.

6.13.4 Further consideration will be given to the construction and engineering options in this area, including design and construction methods and alternative engineering options. Further studies are ongoing and will be reported in the formal ES.

6.14 Community area LA05 – Ratcliffe-on-Soar to Long Eaton

Proposed auto-transformer feeder station and grid supply point locations

6.14.1 During the design development process since the announcement of the preferred route in July 2017, consideration has been given to the location of an auto-transformer feeder station in the south of the Ratcliffe-on-Soar to Long Eaton area, which would supply electrical power from the National Grid network to the Proposed Scheme. The auto-transformer feeder station would house the electrical equipment that would protect and control the power supply to the Proposed Scheme. The auto-transformer feeder station would be required at the start of a neutral section[57] along the route of the Proposed Scheme at a location with a potential grid supply point to provide grid connection to existing electrical infrastructure.

[57] A neutral section is an insulated section that prevents two differing electrical sections from touching, by introducing an electrical clearance (an earth section)

6.14.2 The following three options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 1: the auto-transformer feeder station would be located 1km north-east of junction 24 of the M1 in Kegworth, immediately to the west of the route of the Proposed Scheme and south-west of Ratcliffe-on-Soar Power Station and Redhill Marina. This option would require the construction of a new grid supply point, located immediately to the west of the auto-transformer feeder station, providing a direct incoming feeder cable connection to supply electrical power to the auto-transformer feeder station;
- Option 2: the auto-transformer feeder station would be located immediately to the east of junction 24 of the M1, to the west of the route of the Proposed Scheme and between the A453 Remembrance Way and the A6 Derby Road. There are four possible options for a new grid supply point throughout the Kegworth area, with feeder cable connections ranging from 1.7km to 2.6km in length to connect to this auto-transformer feeder station, including:
  - an option (grid supply point 1) in the same location as the grid supply point in Option 1, located 1km north-east of junction 24 of the M1 in Kegworth, which would require a feeder cable route 1.7km in length along the route of the Proposed Scheme;
  - an option (grid supply point 2) south of the Ratcliffe-on-Soar Power Station, east of Kegworth Road and adjacent to the A453 Remembrance Way, which would require a feeder cable route 2.6km in length along the A453 corridor (this is the preferred grid supply point option taken forward into the Proposed Scheme);
  - an option (grid supply point 3) south of the Ratcliffe-on-Soar Power Station, east of Kegworth Road and 500m south of the A453 Remembrance Way, which would require a feeder cable route 2.6km in length along the A453 corridor; and
  - an option (grid supply point 4) immediately north-west of junction 24A of the M1 and north of the A50 Derby Southern Bypass, which would require a feeder cable route 2km in length along the M1 corridor.
- Option 3: the auto-transformer feeder station would be located 11km to the south of Kegworth on land between the route of the Proposed Scheme and the A42, 800m north of Worthington in the Coleorton to Kegworth area (Community Area LA04). This option would require the construction of a new grid supply point immediately to the south of the auto-transformer feeder station, which would provide incoming feeder cable connections 550m in length.

6.14.3 Table 11 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 11: Consideration of local alternatives for an auto-transformer feeder station in the Ratcliffe-on-Soar to Long Eaton area

Option	Outcome of analysis	Further action/considerations
Option 1	• Greater potential for flooding impacts in comparison to the Proposed Scheme due to location within River Soar floodplain (Flood Zones 2 and 3). • Similar impact on watercourses as the Proposed Scheme as the auto-transformer feeder cable would cross the River Soar floodplain (Flood Zones 2 and 3). • Greater impact on historic environment during operation in comparison with the Proposed Scheme due to potential impact on the setting of the Roman site at Redhill Scheduled Monument. • Greater impact on landscape character compared with the Proposed Scheme due to location of the auto-transformer feeder station within an open floodplain. • Similar impact on agricultural land as the Proposed Scheme as the auto-transformer feeder station would directly impact arable fields. • Protecting infrastructure from flood events during construction would necessitate increased traffic movements in the local area, however, fewer traffic impacts overall when compared to the Proposed Scheme. • The grid supply point would be located further away from residential receptors in Ratcliffe-on-Soar, and would have less noise, landscape and visual impacts on these receptors, compared with grid supply point 2 of the Proposed Scheme. • Better performing option for railway systems in comparison to the Proposed Scheme as the grid supply point and auto-transformer feeder station would be located adjacent, requiring short incoming feeder cables. • Greater cost than the Proposed Scheme due to the requirement to protect infrastructure from flooding.	This option will not be subject to further consideration.
Option 2 (the Proposed Scheme)	• Less potential for flooding impact compared to Option 1 and Option 3 due to location outside of the River Soar floodplain. • Greater potential for impact on watercourses in comparison to Option 3 as the feeder cables would need to cross the River Soar floodplain (Flood Zones 2 and 3). Similar impacts compared to Option 1. • Fewer impacts on the setting of the Roman site at Redhill Scheduled Monument during operation in comparison to the alternative options. • Less impact on landscape character in comparison to Option 1 and similar to Option 3 due to location of the auto-transformer feeder station in the M1 corridor. • Less impact on agricultural land when compared to Option 3, and similar impact when compared to Option 1. • New access required for the A6 would have greater traffic impacts when compared to Option 1 and Option 3.	This is the selected option taken forward into the Proposed Scheme

	• Longer incoming feeder cable than Option 1 and Option 3. Land requirements for feeder cables would be greater than Option 1 and Option 3 to connect the GSP to the ATFS. • Reduced railway systems performance in comparison to Option 1 due to length of incoming feeder cables required. • Lower cost when compared to Option 1 and similar cost to Option 3 as the Proposed Scheme would remove the requirement to provide flood protection.	
	Grid supply point 1: • Greater potential for flood impacts than grid supply point 2 (the Proposed Scheme) as the grid supply point is located within the River Soar floodplain. • Fewer impacts on watercourses compared to grid supply point 2 (the Proposed Scheme) as the feeder cables would not need to cross the River Soar. • Fewer noise, landscape and visual impacts on residential receptors when compared to grid supply point 2 (the Proposed Scheme) due to distance from nearest communities.	This option will not be subject to further consideration.
	Grid supply point 2: • Avoids potential flood impacts associated with grid supply point 1 as the grid supply point is located outside the River Soar floodplain. • Greater potential for impact on watercourses in comparison to grid supply point 1, grid supply point 3 and grid supply point 4 as the feeder cables would need to cross the River Soar floodplain (Flood Zones 2 and 3). • Greater noise, landscape and visual impacts on residential receptors as the grid supply point would be located closer to Ratcliffe-on-Soar than grid supply point 1 and grid supply point 4; similar to grid supply point 3.	This is the selected option taken forward into the Proposed Scheme
	Grid supply point 3: • Similar to grid supply point 2 (the Proposed Scheme), this option avoids potential flood impacts associated with the grid supply point as it is located outside the River Soar floodplain. • Similar potential for impact on watercourses to grid supply point 2 (the Proposed Scheme) as the feeder cables would not need to cross the River Soar (Flood Zones 2 and 3). • Similar noise, landscape and visual impacts on residential receptors as grid supply point 2 (the Proposed Scheme) due to distance from Ratcliffe-on-Soar.	This option will not be subject to further consideration.
	Grid supply point 4: • Similar to grid supply point 2 (the Proposed Scheme), this option avoids potential flood impacts associated with the grid supply point as it is located outside the River Soar floodplain. • Fewer impacts on watercourses compared to grid supply point 2 (the Proposed Scheme) as the feeder cables would not need to cross the River Soar.	This option will not be subject to further consideration.

	• Fewer noise, and landscape and visual impacts on residential receptors when compared to grid supply point 2 (the Proposed Scheme) due to distance from nearest communities.	
Option 3	• Less potential for flooding impacts compared to Option 2 as this option would be located outside of the River Soar floodplain. • Cabling works between the auto-transformer feeder station and the grid supply point would less likely to impact watercourses than the Proposed Scheme due to location outside of the River Soar floodplain. • Greater impact on historic environment during operation in comparison with the Proposed Scheme due to potential impact on the setting of Mill House Farm (Grade II) listed buildings. • Similar impact on landscape character as the Proposed Scheme due to location of the auto-transformer feeder station in the M1 corridor. • Greater loss of agricultural land in comparison with the Proposed Scheme due to the positioning of the auto-transformer feeder station and the grid supply point over five arable fields. • Site access via Worthington Lane and/or Doctor's Lane would necessitate more traffic movements in the local area, however, fewer traffic impacts overall than the Proposed Scheme. • Fewer impacts on residential receptors as the grid supply point would be located further away from Ratcliffe-on-Soar than grid supply point 2 of the Proposed Scheme. • Reduced railway systems performance in comparison to the Proposed Scheme due to length of incoming feeder cables required. • Marginally higher cost compared to the Proposed Scheme due to requirement for additional road access.	This option will not be subject to further consideration.

6.14.4 Option 2 was taken forward into the Proposed Scheme. Option 3 would be located outside the floodplain of the River Soar, and therefore, would not require flood protection or compensation. Option 2 would also have fewer adverse impacts on the setting of historic assets including Mill House Farm (Grade II) listed buildings north-east of Worthington, and the Roman site at Redhill Scheduled Monument north-east of the M1 junction 24. The Proposed Scheme, in comparison to Option 1 and Option 3, would have a lower cost associated with the construction and maintenance of the grid supply point and would have less landscape and visual impacts due to location of the auto-transformer feeder station close to the M1 junction 24. Option 2 would also impact less agricultural land than Option 3. Option 2 would be located further away from residential receptors than Option 1 and Option 3, and therefore, would be less likely to adversely affect sensitive receptors as a result of noise, landscape and visual impacts.

A52 Brian Clough Way realignment

6.14.5 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the route of the Proposed Scheme where it would pass under the A52 Brian Clough Way in Sandiacre. The current A52 Brian Clough Way overbridge spanning the existing conventional railway does not provide sufficient span or headroom to accommodate the Proposed Scheme, the Erewash Valley Line and the associated overhead line equipment. The A52 Brian Clough Way overbridge would be reconstructed and a new roundabout constructed to the east of the route of the Proposed Scheme. Ongoing design development has allowed refinement of the construction methods and design of the A52 Brian Clough Way realignment. Opportunities to reduce disruption to the existing road network and maintain operational capacity have been considered.

6.14.6 The following six options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 0: the A52 Brian Clough Way overbridge would be reconstructed. A new ground level roundabout would be constructed online to the east of the route of the Proposed Scheme. This roundabout would provide access to East Midlands Hub station and Bessell Lane;
- Option A: the A52 Brian Clough Way overbridge would be reconstructed off-line and realigned permanently. A new online ground level roundabout to the east of the Proposed Scheme would be constructed;
- Option B: a compact grade separated junction on the A52 Brian Clough Way with the overbridge constructed off-line and realigned permanently;
- Option C: a compact grade separated junction on the A52 Brian Clough Way with the overbridge constructed off-line and realigned permanently. Traffic on the new station access would have priority and the existing Bessell Lane would be a minor road;
- Option D: the existing A52 Brian Clough Way would be realigned to the south of its existing alignment in a cutting 8m deep. A new 'dumbbell' roundabout[58] would be constructed at the existing ground level, comprising the existing roundabout to the north of the realigned A52 Brian Clough Way and a new roundabout to the south; and
- Option E: the A52 Brian Clough Way would be realigned further south-east of the existing Bardills roundabout. A new 'dumbbell' roundabout would be constructed at existing ground level, comprising the existing roundabout to the north of the realigned A52 Brian Clough Way and a new roundabout to the south.

[58] A 'dumbbell' roundabout is configured as a pair of roundabouts to create a type of diamond interchange.

6.14.7 Table 12 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 12: Consideration of local alternatives for route of the Proposed Scheme under the A52 Brian Clough Way in Sandiacre

Option	Outcome of analysis	Further action/considerations
Option 0	• Similar impact on agricultural land compared to the Proposed Scheme. • Similar direct impact on Archers Field Recreation Ground amenity area compared to the Proposed Scheme. • Less habitat loss (hedgerows, trees, woodland area) along the existing A52 Brian Clough Way compared to the Proposed Scheme. • Potential for visual impacts on residential receptors and recreational uses of the Erewash Canal (Erewash Borough Council green belt and Erewash Borough Council green corridor) and Sustrans cycle route, similar to the Proposed Scheme. • Greater potential for impact on road traffic during peak times (morning and evening) at the roundabout junction in comparison with the Proposed Scheme. • Temporary traffic management and subsequent speed restrictions would result in higher levels of congestion and delays, similar to the Proposed Scheme. • Greater technical and engineering complexity compared to the Proposed Scheme due to requirement to construct over the existing A52 Brian Clough Way and the restrictions on access. • Would avoid the demolition of commercial properties on Palmer Drive required for the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Lower cost compared to the Proposed Scheme.	This option will not be subject to further consideration
Option A	• Similar impact on agricultural land compared to the Proposed Scheme. • Similar direct impact on Archers Field Recreation Ground amenity area compared to the Proposed Scheme. • Less habitat loss (hedgerows, trees, woodland area) along the existing A52 Brian Clough Way compared to the Proposed Scheme. • Potential for visual impacts on residential receptors and recreational uses of the Erewash Canal (Erewash Borough Council green belt and Erewash Borough Council green corridor) and Sustrans cycle route, similar to the Proposed Scheme. • Greater impact on road traffic during peak times (morning and evening) at the roundabout junction in comparison with the Proposed Scheme.	This option will not be subject to further consideration

Option	Outcome of analysis	Further action/considerations
	• Temporary traffic management and subsequent speed restrictions would result in higher levels of congestion and delays, similar to the Proposed Scheme. • Greater technical and engineering complexity compared to the Proposed Scheme due to requirement to construct over the existing A52 Brian Clough Way and the restrictions on access. • Would avoid the demolition of commercial properties on Palmer Drive required for the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Similar cost as the Proposed Scheme due to increased engineering complexity and the requirement for greater flood compensation areas.	
Option B (the Proposed Scheme)	• Impact on agricultural land similar to Option 0, Option A, Option C and less impact when compared to Option D and Option E. • Direct impact on Archers Field Recreation Ground amenity area, similar to Option 0 and Option A, however, fewer community impacts overall when compared to Option C, Option D and Option E. • Greater habitat loss (hedgerows, trees, woodland area) along the existing A52 Brian Clough Way than Option 0, Option A, Option D and Option E, however, similar to Option C. • Potential for visual impacts on residential receptors and recreational uses of the Erewash Canal (Erewash Borough Council green belt and Erewash Borough Council green corridor) and Sustrans cycle route, similar to Option 0, Option A and Option C, however, lower impacts when compared to Option D and Option E. • Less impacts on road traffic during peaks times (morning and evening) at the junction in comparison with other options. • Temporary traffic management and subsequent speed restrictions would result in similar levels of congestion and delays as Option 0, Option A and Option C, and less than Option D and Option E. • Less technical and engineering complexity compared to Option 0 and Option A due to less disruption to the A52 Brian Clough Way, however, greater complexity when compared to Option C, Option D and Option E. • Demolition of commercial properties on Palmer Drive, similar to Option C and Option D. These demolitions would be avoided by Option 0, Option A and Option E. • Shorter construction programme in comparison to Option 0 and Option A, however, longer than other options. • Lower cost than Option C, Option D and Option E, however, greater cost than Option 0 and similar cost to Option A.	This is the selected option taken forward into the Proposed Scheme

Option	Outcome of analysis	Further action/considerations
Option C	• Impact on agricultural land similar to the Proposed Scheme. • Greater impact on Archers Field Recreation Ground and industrial units north of the A52 Brian Clough Way when compared to the Proposed Scheme as a result of a larger construction footprint. • Habitat loss (hedgerows, trees, woodland area) along the existing A52 Brian Clough Way, similar to the Proposed Scheme, however, greater than Option 0, Option A, Option D and Option E. • Potential for visual impacts on residential receptors and recreational uses of the Erewash Canal (Erewash Borough Council green belt and Erewash Borough Council Green Corridor) and Sustrans cycle route, similar to the Proposed Scheme. • Greater impact on road traffic during peak times (morning and evening) at the roundabout junction in comparison with the Proposed Scheme. • Temporary traffic management and subsequent speed restrictions would result in higher levels of congestion and delays, similar to the Proposed Scheme. • Less technical and engineering complexity compared to the Proposed Scheme due to the avoidance of access restrictions during construction. • Greater number of commercial properties on Palmer Drive to be demolished compared with the Proposed Scheme. • Shorter construction programme in comparison to the Proposed Scheme. • Greater cost than the Proposed Scheme.	This option will not be subject to further consideration.
Option D	• Greater impact on agricultural land compared to the Proposed Scheme due to severance of agricultural properties to the west of the existing A52 Brian Clough Way. • Greater impact on Archers Field Recreation Ground amenity area compared to the Proposed Scheme as a result of the larger construction footprint. • Less habitat loss (hedgerows, trees, woodland area) along the existing A52 Brian Clough Way compared to the Proposed Scheme. • Greater visual impacts on residential receptors compared to the Proposed Scheme as a result of greater intrusion in an agricultural area. • Greater impact on road traffic during peak times (morning and evening) at the roundabout junction in comparison with the Proposed Scheme. • Temporary traffic management and subsequent speed restrictions would result in higher levels of congestion and delays than the Proposed Scheme.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	• Less technical and engineering complexity compared to the Proposed Scheme due to the avoidance of access restrictions during construction. • Demolition of commercial properties on Palmer Drive, similar to the Proposed Scheme. • Shorter construction programme in comparison to the Proposed Scheme. • Greater cost than the Proposed Scheme.	
Option E	• Greater impact on agricultural land compared to the Proposed Scheme due to islanding of agricultural properties to the west of the existing A52 Brian Clough Way. • Greater impact on Archers Field Recreation Ground amenity area compared to the Proposed Scheme as a result of the larger construction footprint. • Less habitat loss (hedgerows, trees, woodland area) along the existing A52 Brian Clough Way compared to the Proposed Scheme. • Greater visual impacts on residential receptors compared to the Proposed Scheme as a result of greater intrusion in an agricultural area. • Greater impacts on road traffic during peak times (morning and evening) at the roundabout junction in comparison with the Proposed Scheme. • Temporary traffic management and subsequent speed restrictions would result in higher levels of congestion and delays than the Proposed Scheme. • Less technical and engineering complexity compared to the Proposed Scheme due to the avoidance of access restrictions during construction. • Would avoid the demolition of commercial properties on Palmer Drive required for the Proposed Scheme. • Shorter construction programme in comparison to the Proposed Scheme. • Greater cost than the Proposed Scheme.	This option will not be subject to further consideration.

6.14.8 Option B was taken forward into the Proposed Scheme. The Proposed Scheme would have a lower capital cost than options that require full realignment of the A52 Brian Clough Way. Although Option B would be more costly than Option 0, it would provide sufficient operational capacity, which would not be provided by Option 0 and Option A.

6.14.9 Option B would have fewer impacts on existing residential, commercial and recreational receptors as well as limiting construction within flood zone areas around the East Midlands Hub station in comparison with other options that include a full

realignment of the A52 Brian Clough Way and a new 'dumbbell' junction (Option D and Option E).

6.14.10 Option B would also limit construction activities to the areas surrounding the East Midlands Hub station compared to Option D and Option E. Options D and E would introduce new environmental impacts to the west of the A52 Brian Clough Way including additional severance of land.

6.15 Community area LA06 - Stapleford to Nuthall

Strelley tunnel

6.15.1 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the route of the Proposed Scheme where it would pass Strelley. The route of the Proposed Scheme would pass under Strelley Hall in tunnel, before passing through Nottingham Business Park in deep cutting. Ongoing design development has allowed refinement of the design and construction methods for the Strelley tunnel.

6.15.2 The following three options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 0: the route would pass under Strelley Main Street in cut and cover tunnel that would be 810m in length, emerging in the Nottingham Business Park. The cut and cover tunnel would be up to 30m in depth through the Strelley Conservation Area;
- Option A: the route would pass under the Strelley Conservation Area in twin bored tunnels for a distance of 900m between Strelley Main Street and Nottingham Business Park. The structure would consist of two parallel circular tunnels with an internal diameter of 9m at a depth of up to 23m; and
- Option B: the route would pass under the Strelley Conservation Area following a similar alignment to the bored tunnels (Option A) between Strelley Main Street and Nottingham Business Park. This option would adopt mined tunnelling methods to construct two parallel tunnels, similar to Option A, to a depth of up to 23m over a distance of 900m.

6.15.3 Table 13 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 13: Consideration of local alternatives for route of the Proposed Scheme through Strelley

Option	Outcome of analysis	Further action/considerations
Option 0	• Greater visual impacts on Strelley Conservation Area and associated listed buildings compared to the Proposed Scheme as a result of the large structures associated with the southern portal. • Similar ecological impacts to Strelley Hall Park Local Wildlife Site and Nottingham City Local Wildlife Site compared to the	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	Proposed Scheme. Confirmation required from survey and desk based information to confirm disturbance to protected species. • Greater risk of encountering potentially contaminated material compared to Proposed Scheme due to requirement to excavate large volumes of material. • Greater quantity of material requiring handling and removal compared to the Proposed Scheme arising from construction of deep cutting and other excavation works. • Greater traffic impacts during construction compared to the Proposed Scheme resulting from a higher volume of material handling associated with the cut and cover tunnel. • Would require more commercial demolitions in Strelley around the southern and northern tunnel portals compared to the Proposed Scheme. • Greater community impacts when compared to the Proposed Scheme as a result of the realignment of Main Street during construction, affecting access to businesses and local residents and impacting on local traffic. • Construction duration would be longer compared to the Proposed Scheme due to the requirement to realign Main Street. • Larger construction area required when compared to the Proposed Scheme as Option o requires significant cut depth and excavation during construction.	
Option A	• Similar visual impacts to Strelley Conservation Area and associated listed buildings compared to the Proposed Scheme. • Similar impact on Strelley Hall Park Local Wildlife Site and Nottingham City Local Wildlife Site compared to the Proposed Scheme, with potential loss of deciduous woodland and grassland habitat. • Similar impacts on land quality compared to Proposed Scheme, due to less likelihood of encountering contamination resulting from less surface material exposure. • Bored tunnel would require less material handling and removal than the Proposed Scheme. • Traffic impacts during construction similar to the Proposed Scheme resulting from material handling associated with the bored tunnel. • Would require a number of demolitions at the northern end of the tunnel, similar to the Proposed Scheme. • Fewer community impacts associated with the realignment of Main Street, which would remain on its current alignment, similar to the Proposed Scheme. • Construction duration would be longer compared to the Proposed Scheme due to the timescales required for bored tunnelling techniques.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	• Larger construction area required when compared to the Proposed Scheme as Option A would require the use of tunnel boring machines.	
Option B (the Proposed Scheme)	• Less visual impacts on Strelley Conservation Area and associated listed buildings in comparison to Option A, and fewer in comparison to Option 0. • Similar impact on Strelley Hall Park Local Wildlife Site and Nottingham City Local Wildlife Site compared to Option 0 and Option A, with potential loss of deciduous woodland and grassland habitat. • Less impact on land quality compared to Option 0 due to reduced likelihood of encountering contamination resulting from less surface material exposure, and similar impact compared to Option A. • Lower volume of material requiring handling and removal when compared to Option 0, and similar to Option A. • Fewer traffic impacts during construction compared to Option 0, and similar to Option A. • Would avoid commercial demolitions in Strelley around the southern and northern tunnel portals associated with Option 0, however, similar to those required for Option A. • Would avoid community impacts associated with the realignment of Main Street required for Option 0, similar to Option A. • Shorter construction programme (by using four excavation faces) compared to Option 0 and Option A. • Smaller construction area required compared to Option 0 and Option A as the Proposed Scheme would use conventional excavation plant and equipment.	This is the selected option taken forward into the Proposed Scheme

6.15.4 Option B was taken forward into the Proposed Scheme. The environmental considerations compared to Option A are similar, however, the methodology to construct Option B would require less land during construction and also during operation. This would cause less disruption to the Strelley Conservation Area, Strelley Hall Park Local Wildlife Site and Nottingham City Local Wildlife Site. Whilst the cost of Option B would be greater than Option 0 and Option A, the option would require fewer demolitions and would avoid the need to realign Main Street in Strelley. Further, Option B would have a shorter construction programme and therefore shorter duration of construction related environmental impacts compared to Option 0 and Option A.

6.16 Community area LA07 – Hucknall to Selston

Audrey Wood

6.16.1 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the route where it would

pass through a deep valley containing tributary 2 of the Beauvale Brook and over an area of woodland known as The Dumbles, which is adjacent to the M1, and south of the A608 Mansfield Road. Alternative options for crossing the valley in this location have been considered and opportunities to reduce impacts on the surrounding area and maintain the historic alignment of Weavers Lane have been considered.

6.16.2 The following seven options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 0: the route would pass on an embankment (known as the Audrey Wood embankment) that would be 850m long and up to 26m high. On the west side, a 180m long retaining wall up to 15m high would be required to prevent the embankment encroaching onto the M1. This option would require an underbridge for the realignment of Weavers Lane and a culvert for tributary 2 of Beauvale Brook;
- Option A: the route would pass on a 220m long viaduct (known as the Audrey Wood viaduct) with 15m high full height abutments[59], with diversion and underbridge for the realignment of Weavers Lane;
- Option B: the route would pass on a 450m long viaduct (known as the Audrey Wood viaduct) with 10m high full height abutments;
- Option C: the route would pass on a 630m long viaduct (known as the Audrey Wood viaduct) with 6m high full height abutments;
- Option D: the route would pass on a 450m long viaduct (known as the Audrey Wood viaduct) with bank seat abutments[60];
- Option E: the route would pass on a 515m long viaduct (known as the Audrey Wood viaduct) with a 15m high abutment at the southern end and a 6m high abutment at the northern end; and
- Option F: the route would pass on a 420m long viaduct (known as the Audrey Wood viaduct) with a 15m high abutment at the southern end and a 10m high abutment at the northern end.

6.16.3 Table 14 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

[59] A full height abutment is a structural element providing transition from an embankment to a structure which additionally forms a vertical wall retaining the approach embankment from track level to existing ground. Taller abutments allow approach embankments to be extended further thus reducing the overall length of a bridge or viaduct.
[60] A structural element providing transition from an embankment to a structure. A bank seat is positioned at the top of the approach embankment which slopes down towards the centre of the bridge or viaduct.

Table 14: Consideration of local alternatives for route of the Proposed Scheme through Audrey Wood

Option	Outcome of analysis	Further action/considerations
Option 0	• Greater loss of agricultural land and area of deciduous woodland, designated as priority habitat compared to the Proposed Scheme. • Greater impacts on the setting of the Grade II* Annesley Hall Registered Park and Garden and the realignment of the historic route of Weavers Lane, compared to the Proposed Scheme. • Greater impacts on landscape compared to the Proposed Scheme due to the increase land requirements and woodland lost. • Greater hydrological impacts and flood risk compared to the Proposed Scheme due to culverting of the tributary 2 of Beauvale Brook and infilling of a fishpond. • The presence of the embankment would interrupt ecological connectivity within Audrey Wood II Local Wildlife Site, along tributary 2 of Beauvale Brook and within Audrey Wood, compared to the Proposed Scheme, which would allow connectivity to be maintained underneath the viaduct. • Greater land requirement compared to the Proposed Scheme due to the greater width of the embankment compared to the viaduct structure. • Greater quantities of materials compared to the Proposed Scheme, and as such, would have greater adverse impacts on local air quality, traffic, noise during construction. • Lower operational noise levels compared to the Proposed Scheme, with a reduction in noise levels along embankments. • Shorter construction period compared to the Proposed Scheme. • Construction of an embankment up to 26m high would be more complex and would require ground stabilisation due to the gradient of the valley slopes, which would create more stress on the culvert. Would require a 180m long retaining wall along the western side of the embankment to prevent encroachment onto the M1. • Lowest health and safety risk compared to alternatives considered, as no working at height. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration.
Option A	• Greater impact on agricultural land compared to the Proposed Scheme, with a greater area of agricultural land required for the approach embankments. • Greater impacts on the historic environment compared to the Proposed Scheme due to the realignment of Weavers Lane, which provides a historical routeway into the Grade II* Annesley Hall Registered Park and Garden. • Slightly greater landscape impacts compared to the Proposed Scheme, with a shorter viaduct resulting in greater woodland loss. • Similar hydrological impacts to the Proposed Scheme, with no requirement to construct a culvert on tributary 2 of Beauvale Brook or infill the fishpond.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	• Slightly greater ecological impacts compared to the Proposed Scheme due to a slight increase in woodland lost. However, this option would still allow ecological connectivity to be maintained within Audrey Wood II Local Wildlife Site and along tributary 2 of Beauvale Brook underneath the viaduct. • Similar noise impacts compared to the Proposed Scheme. • Greater land requirement compared to the Proposed Scheme, with a shorter structure requiring longer approach embankments. • Requires the import of larger quantities of material compared to the Proposed Scheme, and as such, would have greater adverse impacts on local air quality, traffic and noise during construction. • Shorter construction period compared to the Proposed Scheme. • Similar technical, engineering complexities and similar health and safety risks during construction when compared to the Proposed Scheme. • Lower cost compared to the Proposed Scheme.	
Option B	• Similar impact on agricultural land compared to the Proposed Scheme, with the approach embankments resulting in a similar loss of agricultural land. • Similar impacts on historic environment as the Proposed Scheme, with no requirement to alter the historic alignment of Weavers Lane, which is a historic routeway into the Annesley Hall Grade II* Registered Park and Garden. • Similar landscape impacts compared to the Proposed Scheme, with the two viaducts resulting in a similar amount of woodland loss. • Similar hydrological impacts as the Proposed Scheme, with no requirement to construct the culvert on tributary 2 of Beauvale Brook or infill the fishpond. • Similar ecological impacts to the Proposed Scheme as it would result in a similar amount of woodland loss and would allow ecological connectivity to be maintained within Audrey Wood II Local Wildlife Site and along tributary 2 of Beauvale Brook, underneath the viaduct. • Similar noise impacts compared to the Proposed Scheme. • Similar land requirement compared to the Proposed Scheme, with a similar sized structure having a similar length of approach embankments. • Similar volume of material required for approach embankments compared to the Proposed Scheme. • Slight increase in construction period compared to the Proposed Scheme, increasing the duration of temporary impacts during construction. • Similar technical and engineering complexities and similar health and safety risks during construction to the Proposed Scheme. • Same costs as the Proposed Scheme.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
Option C	• Less impact on agricultural land compared to the Proposed Scheme, with the longer viaduct reducing the length of approach embankments on agricultural land. • Similar impacts on historic environment as the Proposed Scheme, with no requirement to alter the historic alignment of Weavers Lane, which is a historic routeway into the Annesley Hall Grade II* Registered Park and Garden. • Slightly lower landscape impacts compared to the Proposed Scheme, with a longer viaduct reducing the amount of woodland loss. • Similar hydrological impacts as the Proposed Scheme, with no requirement to construct a culvert on tributary 2 of Beauvale Brook or infill the fishpond. • Similar ecological impacts as the Proposed Scheme as it would allow ecological connectivity to be maintained within Audrey Wood II Local Wildlife Site and along tributary 2 of Beauvale Brook, underneath the viaduct. • Similar noise impacts to the Proposed Scheme. • Slightly less land required compared to the Proposed Scheme, with a longer structure having a reduced length of approach embankments. • Smaller volume of material required for approach embankments compared to the Proposed Scheme. • Greatest reductions in permanent land required for the viaduct structure compared to the Proposed Scheme. • Longest construction period compared to all other alternative options, increasing the duration of temporary impacts during construction. • Similar technical and engineering complexities and similar health and safety risks during construction to the Proposed Scheme. • Higher costs compared to all other alternative options.	This option will not be subject to further consideration.
Option D	• Similar impact on agricultural land compared to the Proposed Scheme with the approach embankments resulting in a similar loss of agricultural land. • Similar impacts on historic environment as the Proposed Scheme, with no requirement to alter the historic alignment of Weavers Lane, which is a historic routeway into the Annesley Hall Grade II* Registered Park and Garden. • Lower visual impacts compared with the Proposed Scheme due to bank seat, which would provide more screening of the abutments. • Similar hydrological impacts to the Proposed Scheme, with no requirement to construct a culvert on tributary 2 of Beauvale Brook or infill the fishpond. • Similar woodland loss compared to the Proposed Scheme and ecological connectivity would be maintained within Audrey Wood II	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	Local Wildlife Site and along tributary 2 of Beauvale Brook underneath the viaduct. • Similar noise impacts to the Proposed Scheme. • Similar land requirement compared to the Proposed Scheme, with a similar sized structure having a similar length of approach embankments. • Requires the import of slightly larger quantities of material compared to the Proposed Scheme, and as such, would have greater adverse impacts on local air quality, traffic and noise during construction. • Slightly longer construction period compared to the Proposed Scheme, increasing the duration of temporary impacts during construction. • Similar technical and engineering complexities and similar health and safety risks during construction to the Proposed Scheme. • Slightly higher costs compared to the Proposed Scheme.	
Option E	• Less impact on agricultural land compared to the Proposed Scheme, with the longer viaduct reducing the length of approach embankments on agricultural land. • Similar impacts on historic environment as the Proposed Scheme, with no requirement to alter the historic alignment of Weavers Lane, which is a historic routeway into the Annesley Hall Grade II* Registered Park and Garden. • Slightly lower landscape impacts compared to the Proposed Scheme, with a longer viaduct reducing the amount of woodland loss. • Similar hydrological impacts as the Proposed Scheme, with no requirement to construct a culvert on tributary 2 of Beauvale Brook or infill the fishpond. • Similar ecological impacts as the Proposed Scheme as it would allow ecological connectivity to be maintained within Audrey Wood II Local Wildlife Site and along tributary 2 of Beauvale Brook, underneath the viaduct. • Similar sound, noise and vibration impacts to the Proposed Scheme. • Smaller volume of material required for approach embankments, compared to the Proposed Scheme. • Longer construction period compared to the Proposed Scheme, increasing the duration of temporary impacts during construction. • Similar technical and engineering complexities and similar health and safety risks during construction to the Proposed Scheme. • Higher costs compared to the Proposed Scheme.	This option will not be subject to further consideration.
Option F (the Proposed Scheme)	• Less impacts on agricultural land compared to Options 0 and A and similar impacts to Options B and D. The Proposed Scheme would	This is the selected option taken forward into the Proposed Scheme.

Option	Outcome of analysis	Further action/considerations
	have greater impacts on agricultural land compared to Options C and E. • Lower impacts on historic environment compared to Option 0 and A, as there would be no requirement to alter the historic alignment of Weavers Lane, which is a historic routeway into the Annesley Hall Grade II* Registered Park and Garden. Similar impacts to Options B, C, D and E. • Greater visual permeability and less visually intrusive within the landscape compared to Option 0. Greater landscape impacts compared to Option 0 and A due to increased woodland loss, but reduced woodland loss compared to Option C and E. However, similar landscape impacts to Options B and D. • Less hydrological impacts on tributary 2 of Beauvale Brook compared to Option 0, however, similar impacts to Options A, B, C, D and E. • Less ecological impacts compared to Option 0 as the viaduct would allow ecological connectivity to be maintained underneath the structure. Similar impact on ecological connectively within Audrey Wood II Local Wildlife Site and along tributary 2 of Beauvale Brook as Options A, B, C, D and E. There would be less woodland loss compared to Option 0 and Option A, but greater woodland loss for Options C and E. Similar woodland loss for Options B and D. • Greater noise levels during operation compared to Option 0. Similar impacts as Options A, B, C, D and E. • Longer construction period compared to Option 0 and Option A increasing the duration of temporary impacts during construction, however, a reduction over Options B, C, D and E. • Similar technical and engineering complexities compared to Options A, B, C, D and E and a reduction in complexities compared to Option 0. Greater health and safety risk during construction compared to Option 0 due to working at height, but similar to Options A, B, C, D and E. • Lower cost compared to Option 0, C, D and E, but a higher than for Option A. Same cost as for Option B.	

6.16.4 Option F was taken forward into the Proposed Scheme. This option would maintain the historic alignment of Weavers Lane, avoid the requirement to construct a culvert on tributary 2 of Beauvale Brook, require less land overall and smaller loss of deciduous woodland priority habitat, as well as maintaining ecological connectivity compared to Option 0 and Option A and would be similar to Options B, C, D and E.

6.16.5 Although Option A would provide an overall cost saving and would have a shorter construction programme, it would require diversion of the existing route of Weavers Lane, which is a historical routeway into the Grade II* Annesley Hall Registered Park and Garden. Option F when compared to Options B, C, D and E was considered the most cost-effective viaduct solution to cross over Weavers Lane.

Erewash and mineral railway viaduct

6.16.6 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the route of the Proposed Scheme where it would pass through the relatively deep Erewash Valley, through which the River Erewash and the Sutton Junction to Pye Bridge Railway (and the out of use spur) pass. There would be a viaduct crossing the valley in this location and opportunities to reduce potential adverse impacts from the crossing were considered.

6.16.7 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 0: the route would pass on a 440m long viaduct (known as the Erewash and mineral railway viaduct), with a 14m high abutment at the southern end and a 22m high abutment at the northern end, spanning the River Erewash, the Sutton Junction to Pye Bridge Railway (and the out of use spur) and Kirkby Footpath 17. The main spans would be 42m;
- Option A: the route would pass on a 950m long and a 30m high embankment with an underbridge provided for the Sutton Junction to Pye Bridge Railway (and out of use spur) and an underbridge spanning the River Erewash and Kirkby Footpath 17;
- Option B: the route would pass on a 510m long viaduct (known as the Erewash and mineral railway viaduct) with a 14m high abutment at the southern end and a 10m high abutment at the northern end. It would span the Sutton Junction to Pye Bridge Railway (and out of use spur), the River Erewash and Kirkby Footpath 17. The main spans would be 40m long; and
- Option C: the route would pass on a 305m long viaduct (known as the Erewash and Mineral Railway viaduct) with a 20m high abutment at the southern end and a 22m high abutment at the northern end. It would span the Sutton Junction to Pye Bridge Railway (and out of use spur), the River Erewash and Kirkby Footpath 17. The span would be 40m long.

6.16.8 Table 15 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 15: Consideration of local alternatives for route of the Proposed Scheme through Erewash River and Mineral Railway

Option	Outcome of analysis	Further action/considerations
Option 0	• Similar impact on two areas of priority habitat compared to the Proposed Scheme with viaduct piers located within an area of deciduous woodland habitat and semi-improved grassland. • Slightly greater landscape impacts compared to Proposed Scheme, with the viaduct not centred over the valley and largest difference between abutments heights of all options. Additionally, the difference between the heights of either end of the embankment would be less noticeable than that Proposed Scheme.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	• Similar hydrological impacts compared to the Proposed Scheme, however, greater impacts on groundwater due to a larger number of viaduct piers. • Similar earthworks and traffic impacts compared to the Proposed Scheme. • Greater area of land required for the viaduct structure compared to the Proposed Scheme. • Similar technical and engineering complexities to the Proposed Scheme. • Similar health and safety risks during construction, compared to the Proposed Scheme. • Longer construction duration which would, increase the duration of temporary impacts during construction.	
Option A	• Larger area lost overall from two areas of priority habitat (an area of deciduous woodland habitat and semi-improved grassland), compared to the Proposed Scheme, with the embankment requiring a larger area of land. • Greater impacts on landscape due to removal of trees and loss of views for nearby receptors, including nearby residential properties, rural businesses, and users of Kirkby Footpath 17 and the M1 compared to the Proposed Scheme. • Greater hydrological impacts due to an increased overall flood risk and Water Framework Directive impacts compared to the Proposed Scheme due to the culverting of the River Erewash. • More earthworks and traffic movements and Kirkby Footpath 17 would need to be temporarily diverted or closed, compared to the Proposed Scheme. • Greater area of land required for the embankment structure compared to the Proposed Scheme due to the width of the embankment. • Slightly more complexity in design due to the need for the structure to carry the River Erewash and potential for settlement issues associated with the high embankment in a steep sided valley compared to the Proposed Scheme. • Shorter construction duration compared to the Proposed Scheme, reducing the duration of temporary impacts during construction. • Slightly lower health and safety risks due to the removal of working at height, compared to the Proposed Scheme. • Greater costs compared to the Proposed Scheme.	This option will not be subject to further consideration.
• Option B	• Similar habitat loss overall from two areas of priority habitat compared to the Proposed Scheme, due to the location of viaduct piers within an area of deciduous woodland habitat and semi-improved grassland. • Less visual impact to landscape topography compared to the Proposed Scheme. However, the structure would be visible to nearby receptors including nearby residential properties, rural	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	businesses and users of Kirkby Footpath 17 m and the M1, compared to the Proposed Scheme. • Similar hydrological impacts compared to the Proposed Scheme, however, greater impacts on groundwater due to a greater number of viaduct piers. • Less earthworks and lower traffic impacts compared to the Proposed Scheme due to a reduction of material required for the approach embankments, which would require fewer traffic movements. • Slightly less land required for the viaduct structure due to a reduction in the length of the approach embankments compared to the Proposed Scheme. • Similar technical and engineering complexities to the Proposed Scheme. • Longest construction period compared to the Proposed Scheme, increasing the duration of temporary impacts during construction. • Similar health and safety risks during construction, compared to the Proposed Scheme. • Greater cost compared to the Proposed Scheme.	

Option	Outcome of analysis	Further action/considerations
Option C (the Proposed Scheme)	• Similar impacts at two areas of priority habitat; with viaduct piers located within an area of deciduous woodland habitat and semi-improved grassland compared to the Option 0 and Option B. Smaller overall area of priority habitats lost compared to Option A. • Slightly lower landscape and visual impacts from nearby receptors, including residential properties, rural businesses, and users of Kirkby Footpath 17 and the M1 compared to the alternative options. The Proposed Scheme would provide a less noticeable structure, with similar abutment heights on both sides and the structure centred over the valley. • Fewer potential impacts on groundwater during construction due to fewer viaduct piers and reduced long term impact to the floodplain of the River Erewash, compared to the alternative options. • Greater earthworks and lower traffic impacts compared to Option 0 and Option B, however, an improvement over Option A. • Less land required for the viaduct structure compared to Option A, with the viaduct having a reduced width compared to the embankment. Slightly greater land requirement compared to Option 0 and Option B, with the Proposed Scheme having longer approach embankments. • Similar technical and engineering complexities to the Option 0 and Option B, and a slightly less technical and engineering complexities compared to Option A. • Longer construction period compared to Option A, however, a shorter construction period compared to Option 0 and Option B. • Increased health and safety risks during construction compared to Option A due to the need for working at height, but similar to Option 0 and Option B. • Lower cost compared to other alternative options.	This is the selected option taken forward into the Proposed Scheme.

6.16.9 Option C was taken forward into the Proposed Scheme. Option C would require less land from the two areas of priority habitat and would maintain ecological connectivity along the Erewash Valley, and have less impacts on groundwater and flood risk, compared to the other alternatives considered. Option C would also provide a similar design to Option 0 but with reduced cost and less visual impact than the Proposed Scheme.

6.17 Community area LA08 – Pinxton to Newton and South Normanton

Sheffield spur dive under

6.17.1 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the northbound section of the Sheffield spur to allow it to pass under the HS2 main line. Alternative options in this location, near Cartwright Lane cutting, have been considered and opportunities to reduce the impacts of the structure, associated infrastructure and maintenance requirements were considered.

6.17.2 The following three options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 0: the spur would be in a 520m long cut and cover tunnel from south of the A38 Alfreton Road to beyond the HS2 main line crossing;
- Option A: the spur would pass through a 220m dive under structure[61] within an open cut with a 1 in 3.5 slope; and
- Option B: the spur would pass through a 220m dive under structure with a retaining wall along the eastern side of the northbound spur.

6.17.3 Table 16 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 16: Consideration of local alternatives for route of the Proposed Scheme through the divergence of the Sheffield spur and HS2 main line

Option	Outcome of analysis	Further action/considerations
Option 0	• Less land required for the cut and cover tunnel structure compared to the Proposed Scheme due to a reduction in the width of the cutting. • Lower landscape and visual impacts compared to the Proposed Scheme, with the cut and cover tunnel being covered and screened by the cutting for the HS2 main line. • Slightly lower air quality and noise impacts during construction compared to the Proposed Scheme due to a shorter construction duration and lower earthwork volumes. • Greater potential for disturbance to nearby receptors, including residents along Cartwright Lane, users of Sutton-in-Ashfield Footpath 41, Wincobank Farm and Berristow Farm once operational, as a result of the jet fan ventilation and other mechanical equipment necessary for the tunnel during operation compared to the Proposed Scheme. • Relatively complex cut and cover box within significant excavation compared to the Proposed Scheme, requiring escape stairs, a mechanical and electrical building, fit out, and access roads at each portal. • Greater health and safety risks due to the complex construction techniques compared to the Proposed Scheme. • Shorter construction period than the Proposed Scheme. • Higher costs compared to the Proposed Scheme.	This option will not be subject to further consideration.
Option A (the Proposed Scheme)	• Greater area of land required for the dive under structure and material waste generation due to greater width of the cutting, compared to the alternative options.	This option has been taken forward into the Proposed Scheme.

[61] A railway junction at which one or more diverging or converging tracks in a multiple-track route pass under a structure containing other tracks on the route to avoid conflicting train movements.

Option	Outcome of analysis	Further action/considerations
	• Slightly greater landscape and visual impacts due to wider cutting and a greater loss of hedgerows compared to the alternative options. • Slightly worse air quality and noise impacts during construction compared to the options, attributed to an increased construction duration and earthwork volumes compared to the alternatives considered. • Less disturbance to local receptors, including residents along Cartwright Lane, users of Sutton-in-Ashfield Footpath 41, Wincobank Farm and Berristow Farm, once operational due to reduced maintenance requirements and jet fan ventilation and other mechanical equipment not required compared to Option 0, but similar to Option B. • Simpler construction method and no requirement for access road, escape stairs, mechanical and electrical fit out, headhouse and reduced maintenance requirements compared to the Option 0, but similar to Option B. • Less health and safety requirements compared to the Option 0 and similar requirements to Option B. • Longest construction period of all options considered (increase of 20 weeks) compared to the alternative options. • Lower cost compared to the options, particularly Option 0.	
Option B	• Less land required for the dive under structure and less waste material generation compared to the Proposed Scheme due to reduced cutting width required. • Slightly lower landscape and visual impacts compared to the Proposed Scheme due to slightly less land requirements. • Slightly lower air quality and noise impacts on receptors along Cartwright Lane compared to the Proposed Scheme, attributed to a reduced construction duration and amount of earthwork volumes. • Similar disturbance to receptors, including residents along Cartwright Lane, users of Sutton-in-Ashfield Footpath 41, Wincobank Farm and Berristow Farm, as the Proposed Scheme once operational, would have reduced maintenance requirements with jet fan ventilation and other mechanical equipment not required. • Similar access and maintenance requirements to the Proposed Scheme. • Shorter construction period compared to the Proposed Scheme. • Similar health and safety risks as the Proposed Scheme. • Lower construction costs compared to the Proposed Scheme.	This option has not been included in the Proposed Scheme presented in this report.

6.17.4 Option A was taken forward into the Proposed Scheme. Whilst Option A would require a greater area of land for the dive under structure, take longer to construct and would have greater landscape and visual impacts when compared to Option 0, Option A could be constructed using a simpler construction method and would cost

less to construct. Option A would also reduce the long term maintenance requirements and disturbance to nearby land holders associated with the mechanical and electrical equipment associated with Option 0.

6.17.5 Option B would require slightly less land than Option A, but would otherwise be a similar structure to Option A. However, the extent and cost of utility diversions for either option, including for an above ground gas installation along Cartwright Lane, are currently unknown. Further studies will be carried out to consider Option A and B as the design develops, the outcome of which will be reported in the formal ES.

Sheffield spur alignment (falls within LA08, LA09 and LA10)

6.17.6 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the route of the Sheffield spur. The route of the Sheffield spur would provide a link from the HS2 main line to the existing conventional rail network, connecting to either the Erewash Valley Line or MML, providing for services to Sheffield and Chesterfield. The Sheffield spur would cross the Pinxton to Newton and Huthwaite area, as well as the Stonebroom to Clay Cross area (LA09) and the Tibshelf to Shuttlewood area (LA10).

6.17.7 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 0: the spur would provide a link between the HS2 main line near Pinxton to the Erewash Valley Line near Danesmoor. The Sheffield spur would run in a south-east to north-west direction for 9.5km and would pass the communities of Hilcote, Old Blackwell, Blackwell, Stonebroom, Morton and Danesmoor;
- Option 3: the spur would provide a link between the HS2 main line near Huthwaite to the Erewash Valley Line near Church Hill. The spur would run in an east to west direction for 8km and would pass the communities of Newton, Tibshelf, Stonebroom, Morton and Danesmoor;
- Option 4: the spur would provide a link between the HS2 main line near Tibshelf to the Erewash Valley Line near Church Hill. The spur would run in an east to west direction for 7.5km and would pass the communities of Tibshelf, Hardstoft, Pilseley, Lower Pilsley, Danesmoor and Church Hill; and
- Option 5: the spur would provide a link between the HS2 main line near Tibshelf to the MML near Grassmoor. The spur would run in a south-east to north-west direction for 11km and would pass the communities of Tibshelf, Hardstoft, Astwith, Holmewood, North Wingfield and Grassmoor.

6.17.8 Table 17 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 17: Consideration of local alternatives for the alignment of the Sheffield spur

Option	Outcome of analysis	Further action/considerations
Option 0 (the Proposed Scheme)	• Reduced magnitude of adverse impacts on the National Trust Hardwick Hall estate compared to Options 4 and 5, which includes the Grade I listed Hardwick Old Hall and the Grade I listed Hardwick Hall, several Grade II listed assets, a Grade I registered park and gardens and a scheduled monument. Greater adverse impacts on historic environment than Option 3 due to impacts to Old Blackwell Conservation Area and Newton Conservation Area, but similar impact on the Grade I listed Church of St. Lawrence in North Wingfield. • Reduced landscape and visual impacts compared to the alternative options. Compared with Option 3, there would be reduced landscape and visual impacts for users of the Silverhill Trail National Cycle Network (NCN) route 67, a traffic-free cycle route and part of the Phoenix Greenways network and properties along Newtonwood Lane. There would be a greater impact on the views from the Old Blackwell Conservation Area and Newton Conservation Area compared to Options 3, 4 and 5. There would be less landscape and visual impacts compared Options 4 and 5 due to the spur running through a less open, agricultural landscape and there would be worsening of views from Hardwick Hall estate. • Fewer ecological impacts compared to Option 5, avoiding direct impacts on Avenue Washlands wetlands nature reserve, but greater impacts compared to Option 4 affecting more areas of ancient woodland and priority habitat. Similar impacts to Option 3, with remodelling of the Erewash Valley Line affecting Padley Wood Ancient Woodland and the Derbyshire Wildlife Trust reserve at North Wingfield, which is known to support water voles and pockets of priority habitat, some of which are designated as local wildlife sites. • Less impacts on Grade 3 agricultural land compared to Options 4 and 5, however, greater loss of agricultural land, farms and their access compared to Option 3. • Lower air quality and noise impacts compared to the alternative options, attributed to less earthworks, construction plant and construction traffic. • Greater land quality impacts compared to the alternatives considered, with the route constructed through Blackwell and Cragg Lane historic landfill sites; the latter of which is known to contain a high risk for contaminated land and hazardous waste. • Less traffic impacts compared to Options 4 and 5 and similar impacts to Option 3. Notable impacts relate to temporary off-line diversion of the M1 with disruption to the motorway and trunk road networks (A38, B6014) and other local roads. • Less community impacts compared to the Options 4 and 5, affecting fewer communities and inter-connected villages, however, would directly affect Old Blackwell, Blackwell, Newton and Stonebroom. Impacts on these villages associated with this option would be greater than Option 3. Direct impacts to the Doe Hill Community Park would be similar to Option 3, which is not impacted by Options 4 and 5. This option does not require the demolition of community facilities, including the Pilsley Cricket	This is the selected option taken forward into the Proposed Scheme.

Option	Outcome of analysis	Further action/considerations
	Club, associated with Option 4, nor does it impact The Avenue Washlands wetlands nature reserve associated with Option 5. • Fewer total demolitions compared to Option 5, however, more demolitions compared to Option 3 and 4. • Similar works required to remodel and increase the number of tracks (from four to six) along a 5km section of the Erewash Valley Line and MML and provide overhead line electrification to the Erewash Valley Line used by HS2, compared to Options 3 and 4. There would be a need to remodel the existing rail junction in the Clay Cross area. Greater remodelling work required compared to Option 5. • Shorter route length compared with Options 3 and 4, but a longer route length compared to Option 5. Corresponding journey times would be shorter than under Option 3, but longer than under Options 4 and 5. • Similar health and safety risks during construction compared to the Options 3 and 4, however, increased risks compared to Option 5. • Similar construction period and complexities compared to Option 3. Shorter overall construction period and reduced construction complexities when compared with Options 4 and 5. • Less overall cost compared to the alternatives considered.	
Option 3	• Less impact upon the historic environment when compared to the Proposed Scheme as this option would avoid impacts on the Old Blackwell Conservation Area and the Newton Conservation Area and the listed buildings within them. Impacts to the Hardwick Hall estate would be broadly similar to the Proposed Scheme. • Overall there would be greater landscape and visual impacts compared to the Proposed Scheme, with greater impacts on properties along Newtonwood Lane and users of the Silverhill Trail NCN route 67 as a result of utilising the disused railway corridor for the spur. However, there would be improvements to views from the Old Blackwell Conservation Area and the Newton Conservation Area when compared to the Proposed Scheme. • Similar ecological impacts to the Proposed Scheme. Similar impacts on the Padley Wood Ancient Woodland and the nature reserve at North Wingfield. Slightly greater impacts to priority habitats between Tibshelf and Newton, including designated local wildlife sites compared to the Proposed Scheme. • Fewer impacts on agricultural land compared to the Proposed Scheme as the spur would be shorter in length and constructed across less agricultural land, utilising the disused mineral railway line. • Slightly greater air quality and noise impacts compared to the Proposed Scheme, attributed to more earthworks, construction plant and construction traffic. • Less impacts associated with land quality compared to the Proposed Scheme as would avoid impacts on Blackwell and Cragg Lane historic landfill sites.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	• Whilst the route would reduce complexity of local road crossings, construction traffic may put pressure on the local road network. Overall the impacts for traffic are considered to be broadly similar to the Proposed Scheme. • Less community impacts compared to the Proposed Scheme, with no impacts on the communities of Old Blackwell, Blackwell or Newton. Use of the redundant railway cutting would provide a degree of separation from Tibshelf and Newton, however, would result in realignment of Sliverhill Trail NCN route 67 and a further 11 PRoW. Impacts to Doe Hill Community Park and Saw Pit Industrial Estate would be similar to the Proposed Scheme. • Fewer demolitions compared to the Proposed Scheme. • Similar remodelling works required to the Erewash Valley Line compared to the Proposed Scheme. • Longer route length compared to the Proposed Scheme, however, a small increase in journey time. • Similar health and safety risks during construction compared to the Proposed Scheme. • Similar construction period and complexities compared to the Proposed Scheme. • Slightly higher costs compared to the Proposed Scheme.	
Option 4	• Greater impacts on the historic environment compared to the Proposed Scheme due to impacts on the Grade I listed Hardwick Hall and National Trust Hardwick Hall estate due to an increased in the vertical alignment of the HS2 main line. Direct impact on the setting of the Hardsoft Conservation Area, however, avoids impacts on the Old Blackwell Conservation Area and the Newton Conservation Area associated with the Proposed Scheme. Similar impacts on the Grade I listed Church of St Lawrence compared to the Proposed Scheme. • Greater landscape and visual impacts compared to the Proposed Scheme as the spur would cross through a significantly more open, agricultural landscape. The spur would affect a larger number of residential areas, as well as users of the Five Pits trail, which would have greater impacts than the Proposed Scheme. There would be a greater impact on views from the Hardwick Hall estate. • Fewer impacts on ecology compared to the Proposed Scheme, with no impacts on Padley Wood Ancient Woodland and similar impacts on the nature reserve at North Wingfield. The spur would cross fewer areas of priority habitats compared to the Proposed Scheme. However, the increase in the length of spur would require the greater loss of hedgerows and would cross a greater area of habitats, compared to the Proposed Scheme. • Greater impacts on farms and agricultural land resulting in a greater loss of hedgerows, compared to the Proposed Scheme, due to longer length of the spur.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	• Greater air quality and noise impacts compared to the Proposed Scheme, attributed to more earthworks, construction plant and construction traffic. • Less impact associated with land quality compared to the Proposed Scheme as would avoid impacts on Blackwell and Cragg Lane historic landfill sites. • Greater impacts with regards to traffic and transport in comparison to the Proposed Scheme arising from construction traffic on the local road network due the significant increase in earthworks. Whilst this option would require less road re-alignments in comparison to the Proposed Scheme, there would be a major worsening for users of the B6014 Mansfield Road as a result of temporary closure for at least 18 months. • Greater community impacts compared to the Proposed Scheme, including the direct and indirect impacts on the communities of Pilsley, Lower Pilsley and Hardsoft, leading to connectively issues during construction. This option would require demolition of several community facilities, including the Pilsley Cricket Club and would affect a total of eight PRoW. No impact to Doe Hill Community Park, unlike the Proposed Scheme. • Fewer residential demolitions compared to the Proposed Scheme. However, there would be more industrial demolitions and demolition of several community facilities, including the Pilsley Cricket Club. • Similar remodelling works to the Erewash Valley Line required compared to the Proposed Scheme. • Longer route length compared to the Proposed Scheme, however a small reduction in journey time. • Similar health and safety risks during construction compared to the Proposed Scheme. • Increased construction period and construction complexities when compared to the Proposed Scheme. • Slightly higher cost compared to the Proposed Scheme.	
Option 5	• Greater impacts on the historic environment compared to the Proposed Scheme due to impacts on the Grade I listed Hardwick Hall and National Trust Hardwick Hall estate due to an increased vertical alignment of the HS2 main line. Direct impact on the Astwith Conservation Area and realignment of the historic road, Branch Lane. However, avoids impacts on the Old Blackwell Conservation Area and Newton Conservation Area associated with the Proposed Scheme. Similar impact to the Proposed Scheme on the Grade I listed Church of St. Lawrence. • Greater landscape and visual impacts compared to the Proposed Scheme as the spur would cross through a more open, agricultural landscape. The spur would affect a larger number of residential areas, as well as users of the Five Pits trail, which would have a greater impact than the Proposed Scheme. • Greater ecological impacts compared to the Proposed Scheme, with impacts on the Avenue Washlands wetlands nature reserve,	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
	which is known to support European protected species. This would sever a local wildlife site east of Hardsoft, require the greater loss of hedgerows and would cross a greater area of habitats compared to the Proposed Scheme. However, there would be no impacts on Padley Wood Ancient Woodland and no impacts on the nature reserve at North Wingfield. The spur would cross fewer areas of priority habitats compared to the Proposed Scheme. • Greater impact on agricultural land, including affecting more Grade 3 agricultural land, and would affect a greater number of farms and agricultural land parcels, compared to the Proposed Scheme, due to longer length of the spur. • Greater air quality and noise impacts compared to the Proposed Scheme, attributed to more earthworks, construction plant and construction traffic. • Less impact associated with land quality compared to the Proposed Scheme as would avoid impacts on Blackwell and Cragg Lane historic landfill sites. • Greater traffic and transport impacts compared to the Proposed Scheme due to additional impacts on the A6175 and the B6039 resulting in disruption to the local road network. Realignment would be required for Chesterfield Road and Hagg Hill Road, connecting the community of North Wingfield with Holmewood and creating some individual property isolation south of Grassmoor. • Greater community impacts compared to the Proposed Scheme, including the severance of communities and inter-connected villages, including Hardsoft, Astwith, Holmewood, North Wingfield, Church Hill and Grassmoor. Severance impacts for Astwith, Stainsby, Holmewood, Temple Normanton and Grassmoor, with 21 PRoW affected. No impacts to Doe Hill Community Park, unlike the Proposed Scheme. • Greater number of residential and industrial demolitions compared to the Proposed Scheme. • No remodelling works required on the Erewash Valley Line. Less remodelling works required on the MML, with no need increase the number of existing Network Rail tracks or remodel existing rail junction in the Clay Cross area, compared to the Proposed Scheme. This would require the provision of a single span bridge over the four track MML. • Shorter length of spur compared to the Proposed Scheme, with a reduction in journey times. • Slightly lower health and safety risks during construction compared to the Proposed Scheme. • Increased construction period and construction complexities when compared to the Proposed Scheme. • Substantially higher costs compared to the Proposed Scheme.	

6.17.9 Option 0 was taken forward into the Proposed Scheme. Option 3 was considered to have broadly similar impacts on the Hardwick Hall estate and on ecological receptors,

and would take a similar duration to construct compared to Option 0. Option 3 would also have a slightly lesser impact on the setting of the two conservation areas, two historic landfill sites, agricultural land and local communities, and would result in fewer demolitions compared to Option 0. However, Option 3 would result in greater landscape and visual impacts, including on users of the Silverhill Trail NCN route 67, slightly greater air quality and noise impacts attributed to greater earthworks, construction plant and construction traffic and would result in longer journey times for users, as well as an increase in the costs compared to Option 0.

6.17.10 Options 4 and 5 would result in greater impacts on the setting of the Grade I listed Hardwick Hall and National Trust Hardwick Hall estate, greater landscape and visual impacts, increased impacts on farms and agricultural land and a greater impact on community facilities, compared to Option 0. Furthermore, these options would also result in a longer construction programme, increase in length of the spur and more complex construction, more disruption to existing infrastructure and an increase in costs compared to Option 0. However, Option 5 would require less remodelling of the MML and existing rail junction in the Clay Cross area, which would have less of an impact compared to the Proposed Scheme.

6.18 Community area LA09 – Stonebroom to Clay Cross

Route section alternatives

6.18.1 The strategic, route-wide and route corridor alternatives to the Proposed Scheme and local alternatives considered prior to July 2017 are presented in Volume 1, Introduction and methodology and in the Alternatives report as a supporting document to the working draft ES. The local alternatives considered for the Proposed Scheme within the Stonebroom and Clay Cross area since the route announcement in July 2017 are described in this section.

6.18.2 In this area, the route of the Proposed Scheme would be carried on embankments and in cuttings.

6.18.3 As part of the design development process since July 2017, consideration has been given to the impact of the Proposed Scheme on local residents of the Stonebroom to Clay Cross area, environmental receptors including: Tibshelf Sidings Local Wildlife Site; Padley Wood Local Wildlife Site; Padley Wood Ancient Woodland; sections of Rykneld Street Roman road Scheduled Monument; and the Grade II* listed Church of Holy Cross in Morton.

6.18.4 Further consideration will be given to the construction and engineering options in this area, including design and construction methods, and alternative engineering options. Further studies are ongoing and will be reported in the formal ES.

6.19 Community area LA10 – Tibshelf to Shuttlewood

Heath cut and cover tunnel

6.19.1 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the route where it would pass Heath. The route of the Proposed Scheme would pass to the east of Heath in cutting, before passing under the M1 junction 29. Design options were available for the Heath cut and cover tunnel. These options presented opportunities to simplify the construction methods, create smaller structures, and reduce the disruption to the exiting road network. The length of the tunnel would be 170m.

6.19.2 The following five options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option O (the route announced in July 2017): a cut and cover tunnel with piled concrete walls (the baseline option). Option O would consist of a reinforced concrete box structure with piled walls. The total length of the tunnel would be 170m, and the width of the tunnel would be 17m with a central wall between the rail tracks. The maximum height of the cutting required would be 16m. The roof of the tunnel could be a cast in-situ slab or use precast beams;
- Option A: a cut and cover tunnel in the form of a concrete box formed in-situ with a central wall. Option A would comprise the use of temporary methods of soil support and bottom up construction of a reinforced concrete box structure. The geometry of the tunnel would be as described for the baseline option, Option O;
- Option B: a cut and cover tunnel in the form of a prefabricated concrete box jacked into place. Option B would comprise a combination of jacked box and cut and cover tunnel. The total length of the jacked box is assumed to be 50m and the cut and cover tunnel 120m. The jacked box section could be installed as either one box, 17m wide, or two boxes side by side, each 8.5m wide;
- Option C: a cut and cover tunnel in the form of a concrete box formed in-situ without a central wall. Option C would be similar to both Options O and A. However, no central wall would be constructed between the tracks. The concrete box would be 170m in length, 22m wide and 16m in height; and
- Option D: a retained cut with piled concrete walls, crossed by two single span overbridges, requiring elongation of the existing motorway junction. The proposed spans over the HS2 main line would be 23m in length, and a bridge deck 1.4m in depth made from either concrete or steel beams.

6.19.3 Table 18 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 18: Consideration of local alternatives for the route of the Proposed Scheme through Heath

Option	Outcome of analysis	Further action/considerations
Option O	• Less land required compared to the Proposed Scheme. • Similar air quality, water resources and flood risk, landscape and visual, and ecology impacts compared to the Proposed Scheme. • Marginally fewer historic environment impacts compared to the Proposed Scheme. • Greater disruption to vehicles using M1 junction 29 during construction compared to the Proposed Scheme. • Less opportunity to improve permanent traffic flows from the junction reconfiguration compared to the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Higher costs compared to the Proposed Scheme.	This option will not be subject to further consideration
Option A	• Less land required compared to the Proposed Scheme. • Similar air quality, water resources and flood risk, and landscape and visual impacts compared to the Proposed Scheme, but overall marginally greater ecology impacts than the Proposed Scheme due to increased hedgerow removal. • Marginally fewer historic environment impacts compared to the Proposed Scheme. • Similar disruption to vehicles using M1 junction 29 during construction as the Proposed Scheme. • Less opportunity to improve permanent traffic flows from the junction reconfiguration compared to the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Higher costs compared to the Proposed Scheme.	This option will not be subject to further consideration
Option B	• Less land required compared to the Proposed Scheme. • Similar air quality, water resources and flood risk, landscape and visual impacts compared to the Proposed Scheme, but overall marginally fewer ecology impacts than the Proposed Scheme due to less hedgerow removal. • Marginally fewer historic environment impacts compared to the Proposed Scheme. • Less disruption to vehicles using M1 junction 29 during construction compared to the Proposed Scheme. • Less opportunity to improve permanent traffic flows from the junction reconfiguration compared to the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Higher costs compared to the Proposed Scheme.	This option will not be subject to further consideration

Option	Outcome of analysis	Further action/considerations
Option C	• Less land required compared to the Proposed Scheme. • Similar air quality, water resources and flood risk, landscape and visual impacts compared to the Proposed Scheme, but overall marginally fewer ecology impacts than the Proposed Scheme due to less hedgerow removal. • Marginally fewer historic environment impacts compared to the Proposed Scheme. • Greater disruption to vehicles using M1 junction 29 during construction compared to the Proposed Scheme. • Less opportunity to improve permanent traffic flows from the junction reconfiguration compared to the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Higher costs compared to the Proposed Scheme.	This option will not be subject to further consideration
Option D (the Proposed Scheme)	• Greater land required compared to the alternative options. • Similar air quality, water resources and flood risk, landscape and visual, ecology and biodiversity impacts compared to alternative options, although marginally greater impacts on ecology when compared to Option B and Option C. • Increased potential for impacts on historic environment through disturbance of unrecorded archaeological remains associated with the village of Heath. • Less disruption to vehicles using the M1 junction 29 during construction compared to alternative options (apart from Option O and Option B), as the permanent extended junction would be constructed as part of the temporary works. • Greater opportunity to improve permanent traffic flows from the junction reconfiguration compared to alternative options. • Shorter construction programme (as two structures can be constructed in parallel) compared to the alternative options. • Overall a simplified construction method and reduced temporary works, compared to alternative options, with lowest costs and lowest programme risk.	This is the selected option carried into the Proposed Scheme

6.19.4 Option D was taken forward into the Proposed Scheme. Option O would have similar environmental impacts, while Option A would result in more hedgerow removal and as a result, greater ecology and biodiversity impacts, compared to the Proposed Scheme. Both Options O and A would cost more to construct than the Proposed Scheme. Options B and C would have fewer environmental impacts overall, but this was not considered sufficient to justify the disproportionately higher cost, particularly when the community connectivity benefits of Option D in relation to the footpaths through the junction are taken into account.

6.19.5 All options would require temporary realignment of junction 29 of the M1 to allow its continued use by traffic, and this would be likely to result in the loss of trees to the west that screen the junction from the area around Heath. In all cases, replacement planting would be considered.

6.19.6 Options O, A, B and C would sever an underpass on the west side of the existing motorway roundabout that links footpaths west of the M1 with footpaths east of the M1, both north and south of the A617, forming an important community link. These options would require replacement of the underpass with at-grade crossings or a raised footbridge, resulting in visual impacts, whereas the permanent realignment of the highway for Option D means that it would enable the replacement of the underpass similar to the existing underpass.

6.19.7 Option D would be open cut, whereas the other options would be covered over to form a cut and cover type tunnel. However, as trains would be in a vertical-sided cut between 12m and 15m deep, it is unlikely that any difference in noise or visual impact would be significant. Option D would also require the permanent highway infrastructure to be 60m closer to properties in Heath, as result of the junction extension. Option D would provide a greater opportunity to improve the permanent traffic flows from the junction reconfiguration.

6.20 Community area LA11 – Staveley to Aston

Route section alternatives

6.20.1 The strategic, route-wide and route corridor alternatives to the Proposed Scheme and local alternatives considered prior to July 2017 are presented in Volume 1, Introduction and methodology and in the Alternatives report as a supporting document to the working draft ES. The local alternatives considered for the Proposed Scheme within the Staveley to Aston area since the route announcement in July 2017 are described in this section.

6.20.2 In this area, the route of the Proposed Scheme would be carried on viaducts, embankments and in cuttings.

6.20.3 As part of the design development process since July 2017, consideration has been given to the impact of the Proposed Scheme on local residents of the Staveley to Aston area, and environmental receptors including: Crabtree Wood SSSI; Norbriggs Flash Local Nature Reserve; Romeley Wood Ancient Woodland; Pools Brook Country Park; Rother Valley Country Park Local Wildlife Site; Standing Cross Scheduled Monument in Barlborough; Grade I listed Church of All Hallows in Harthill; Grade II listed building at Nickerwood Farmhouse, and the Grade I listed Barlborough Hall.

6.20.4 Further consideration will be given to the construction and engineering options in this area, design and construction methods, and alternative engineering options. Further studies are ongoing and will be reported in the formal ES.

6.21 Community area LA12 – Ulley to Bramley

Proposed auto-transformer feeder station and grid supply point locations

6.21.1 During the design development process since the announcement of the preferred route in July 2017, consideration has been given to the location of an auto-transformer feeder station at Thurcroft, which would supply electrical power from the National Grid network to the Proposed Scheme. The auto-transformer feeder station would house the electrical equipment that would protect and control the power supply to the Proposed Scheme. The auto-transformer feeder station would be required at the start of a neutral section[62] along the route of the Proposed Scheme at a location with a potential grid supply point to provide grid connection to existing electrical infrastructure.

6.21.2 The following three options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option A: the auto-transformer feeder station and grid supply point would be located in proximity to each other within an area of existing agricultural fields, on the west side of the route of the Proposed Scheme, adjacent to Thurcroft. The auto-transformer feeder station and grid supply point would be positioned north of the triangle of land formed by the M18/M1 junction, with the auto-transformer feeder station lying close to the route of the Proposed Scheme, and the grid supply point near to the existing overhead power lines adjacent to Morthern Hall Lane. Access to the sites would be from the B6060 Morthern Road;
- Option B (the Proposed Scheme): the grid supply point would be in the same location as for Option A to connect to the existing overhead power lines adjacent to Morthen Hall Lane. The auto-transformer feeder station would be located within an area of existing agricultural fields within the triangle of land formed by the M18/M1 junction. The auto-transformer feeder station would be located against the high embankment to enable good access to the HS2 main line. Access to the auto-transformer feeder station would be from an upgraded Bramley/Wood Lane. Access to the grid supply point would be from the B6060 Morthen Road; and
- Option C: the auto-transformer feeder station and grid supply point would be located outside of the triangle of land formed by the M18/M1 junction, north of the B6060 Morthen Road, within an area of existing agricultural fields, on the west side of the route of the Proposed Scheme.

6.21.3 Table 19 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

[62] A neutral section is an insulated section that prevents two differing electrical sections from touching, by introducing an electrical clearance (an earth section)

Table 19: Consideration of local alternatives for Thurcroft auto-transformer feeder station

Option	Outcome of analysis	Further action/considerations
Option A	• Similar likelihood of impacts on non-designated and designated heritage assets compared to the Proposed Scheme. • Similar ecology and biodiversity impacts to Proposed Scheme. • Similar construction noise impacts from grid supply point at Morthern Hall Farm and residential properties on opposite side of Morthern Road to Proposed Scheme. • Increased construction noise impacts from auto-transformer feeder station at Morthen Hall Farm and at residential properties on opposite side of Morthen Road to the Proposed Scheme. • Similar agricultural impacts to the Proposed Scheme with regard to loss of agricultural land. • Greater landscape and visual impacts from the auto-transformer feeder station compared to the Proposed Scheme. • Similar technical and engineering complexities to the Proposed Scheme. • Shorter construction programme to the Proposed Scheme. • Lower cost compared to the Proposed Scheme.	This option will not be subject to further consideration.
Option B (the Proposed Scheme)	• Similar likelihood of impacts on non-designated and designated heritage assets as Option A, and less likelihood of impacts on non-designated and designated heritage assets compared to Option C. • Similar ecology and biodiversity impacts compared to the alternative options. • Similar construction noise impacts from grid supply point at Morthen Hall Farm and residential properties on opposite side of Morthen Road to Option A. • Less construction noise impacts from auto-transformer feeder station compared to alternative options, due to greater distance to residential areas. • Similar agricultural impacts to alternative options with regard to loss of agricultural land. • Less landscape and visual impacts from the auto-transformer feeder station compared to alternative options. • Fewer technical and engineering complexities to Option C, despite the need for longer cable connection between grid supply point and auto-transformer feeder station. • Longest construction programme compared to the alternative options. • Higher cost compared to Option A, but reduced cost compared to Option C.	This is the selected option taken forward into the Proposed Scheme.

Option	Outcome of analysis	Further action/considerations
Option C	• Greater likelihood of impacts to the setting of a Grade II listed building to the west of the auto-transformer feeder station compared to the Proposed Scheme. • Similar ecology and biodiversity impacts to the Proposed Scheme. • Greater construction noise impacts from auto-transformer feeder station and grid supply point at Moat Farm and residential properties on Moat Lane/Green Lane compared to Proposed Scheme. • Similar agricultural impacts to the Proposed Scheme with regard to loss of agricultural land. • Greater landscape and visual impacts from the auto-transformer feeder station compared to the Proposed Scheme. • Greater technical and engineering complexities compared to the Proposed Scheme. • Greater cost of construction for the auto-transformer feeder station and grid supply point compared to Proposed Scheme due to modifications required to existing electrical infrastructure. • Similar construction programme to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration.

6.21.4 Option B was taken forward into the Proposed Scheme. Overall Option B was the preferred option because, compared to the other options, the auto-transformer feeder station component would have least visibility, fewer construction noise impacts compared to alternative options. Option C would have an increased likelihood to impact on a Grade II listed building to the west of the auto-transformer feeder station and grid supply point than Options A and B. Option C would have more technical and engineering complexities and greater cost to construct than Options A and B.

Bramley cut and cover tunnel

6.21.5 During the design development process since the announcement of the preferred route in July 2017, further consideration has been given to the route of the Proposed Scheme where it would pass Bramley. The route of the Proposed Scheme would need to pass Bramley and under Sandy Lane in a deep cutting, before passing under the M18 junction 1 in a cut and cover tunnel. Design options were available for the Bramley cut and cover tunnel. These options presented opportunities to simplify the construction method, create smaller structures, and reduce the disruption to the existing road network.

6.21.6 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option O: the route would pass to the east of Bramley, in a cut and cover tunnel constructed with piled walls. The structure would be 110m in length, 17m in width and up to 14.5m in height;

- Option A: the route would pass to the east of Bramley, in a cut and cover tunnel constructed using a 'bottom up' sequence for the box structure. The structure would be 110m in length, 17m in width and up to 14.5m in height;
- Option B: the route would pass to the east of Bramley, in a cut and cover tunnel constructed using a jacked box method for the box structure. The structure would be 85m in length, 17m in width and up to 12m in height; and
- Option C: the route would pass to the east of Bramley, in a retained cut with two individual overbridges, each with a single span over the route of the Proposed Scheme, and concrete piled wall abutments. The overbridges would each be 22.5m in length, with one 23m in width and the second 19m in width. Both overbridges would be up to 7m above track level. A concrete retaining wall would be required between the two overbridges on the west side of the route of the Proposed Scheme, 75m in length and up to 12.5m in height.

6.21.7 Table 20 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 20: Consideration of local alternatives for route of the Proposed Scheme through Bramley

Option	Outcome of analysis	Further action/considerations
Option O	• Similar air quality, water resources and flood risk, landscape and visual, historic environment, and ecology impacts compared to the Proposed Scheme. • Less land required for construction compared to the Proposed Scheme. • Longer period over which traffic congestion and delays would occur at M18 junction 1 compared to the Proposed Scheme. • Less opportunity to improve traffic flows and throughput following junction reconfiguration compared to the Proposed Scheme. • Greater technical and engineering complexities compared to the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration
Option A	• Similar air quality, water resources and flood risk, landscape and visual, historic environment, and ecology impacts compared to the Proposed Scheme. • Less land required for construction compared to the Proposed Scheme. • Longer period over which traffic congestion and delays would occur at M18 junction 1 compared to the Proposed Scheme. • Less opportunity to improve traffic flows and throughput following junction reconfiguration compared to the Proposed Scheme. • Greater technical and engineering complexities compared to the Proposed Scheme.	This option will not be subject to further consideration

Option	Outcome of analysis	Further action/considerations
	• Longer construction programme compared to the Proposed Scheme. • Greater cost compared to the Proposed Scheme.	
Option B	• Similar air quality, water resources and flood risk, landscape and visual, historic environment, and ecology impacts compared to the Proposed Scheme. • Less land required for construction compared to the Proposed Scheme. • Longer period over which traffic congestion and delays would occur at M18 junction 1 compared to the Proposed Scheme. • Less opportunity to improve traffic flows and throughput following junction reconfiguration compared to the Proposed Scheme. • Greater technical and engineering complexities compared to the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration
Option C (the Proposed Scheme)	• Similar air quality, water resources and flood risk, landscape and visual, historic environment, and ecology impacts compared to alternative options. • Largest area of land required for construction compared to the alternative options. • Shorter period over which traffic congestion and delays would occur at M18 junction 1 compared to alternative options. • Greater opportunity to improve traffic flows and throughput following junction reconfiguration compared to alternative options. • Fewer technical and engineering complexities compared to alternative options. • Shorter construction programme compared to alternative options. • Lower cost compared to the other alternative options.	This is the selected option taken forward into the Proposed Scheme

6.21.8 Option C was taken forward into the Proposed Scheme. This option required the most land for construction, but would use a simplified construction method, which would require less time and complexity to construct, when compared to the alternative tunnel options. Disruption to vehicles using M18 junction 1 would be less as the permanent extended junction would be constructed as part of the temporary works. Furthermore, the two overbridges would be constructed offline and would be independent structures, so they could be completed in parallel to reduce the construction period. The permanent reconfiguration of the junction would require additional land to be acquired permanently. This would potentially include part of the adjacent hotel car park, which would have the potential to impact on the business operations at that location (car parking). However, an area of grassland adjacent to the hotel was identified at the time of the appraisal as a potential site for future hotel parking. Overall, a simplified construction method, smaller structures and reduced

temporary works mean that Option C was seen as the most cost-effective option with the lowest construction risk.

6.22 Community area LA13 – Ravenfield to Clayton

Sheffield Northern spur

6.22.1 During the design development process since the announcement of the route in July 2017, further consideration has been given to the connection of the Dearne Valley Line to the HS2 main line via the Sheffield Northern spur at Clayton. The connection is required to allow conventional compatible trains to run from Sheffield Midland Station onto the HS2 main line towards Leeds and the North. Design options available for this connection (Clayton junction) presented opportunities to optimise the operational performance of the junction, simplify the construction methods, create smaller structure and reduce the environmental impacts.

6.22.2 The following four options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option O: a grade separated junction where the northbound spur line would pass above the HS2 main line and the existing conventional Network Rail lines. Sheffield Northern spur (southbound) would diverge from a section of the Clayton north embankment, and continue onto the Frickley embankment. The Clayton viaduct, 950m in length and up to 20m in height, would carry the Sheffield Northern spur (southbound) over the HS2 main line, Dearne Valley Line existing railway, and pass onto the Church Field Road embankment, 14m in height. The Sheffield Northern spur (southbound) would then run in the Thurnscoe cutting to connect with the Dearne Valley Line at Thurnscoe. The Sheffield Northern spur (northbound) would diverge from a section of the Clayton north embankment in south-west direction, and then pass into the Church Field Road cutting, 3.2km in length and up to 19m in depth, to connect with the Dearne Valley Line at Thurnscoe;

- Option A: a flat junction arrangement where the northbound spur line would pass beneath the HS2 main line. Sheffield Northern spur (southbound) would diverge from a section of the Clayton north embankment and continue onto the Frickley cutting, which would carry the Sheffield Northern spur (southbound) under the HS2 main line, Dearne Valley Line existing railway, and pass under Church Field Road. The Sheffield Northern spur (southbound) would then run in the Thurnscoe cutting to connect with the Dearne Valley Line at Thurnscoe. The Sheffield Northern spur (northbound) would diverge from a section of the Clayton north embankment in south-west direction, and then pass into the Church Field Road cutting, 3.2km in length, and up to 19m in depth to connect with the Dearne Valley Line at Thurnscoe;

- Option B (the Proposed Scheme): a grade separated junction, similar to Option O, where the Sheffield Northern spur (northbound) would pass above the HS2 main line and the conventional Network Rail lines. Sheffield Northern spur (southbound) would diverge from a section of the Clayton north embankment

and continue onto the Frickley embankment. The Clayton viaduct, 950m in length and up to 20m in height, would carry the Sheffield Northern spur (southbound) over the HS2 main line, Dearne Valley Line existing railway, and pass onto the Church Field Road embankment, 14m in height. The Sheffield Northern spur (southbound) would then run in the Thurnscoe cutting to connect with the Dearne Valley Line at Thurnscoe. The Sheffield Northern spur (northbound) would diverge from a section of the Clayton North embankment in south-west direction, and then pass into the Church Field Road cutting, 3.2km in length and up to 19m in depth, to connect with the Dearne Valley Line at Thurnscoe; and

- Option C: a split-level option where the junction would be grade separated at the connection with the conventional Network Rail lines, and with retaining walls between the spur lines and the 40m deep cutting carrying the HS2 main lines. Sheffield Northern spur (southbound) would diverge from a section of the Clayton north embankment and continue onto the Frickley embankment. The Clayton viaduct, 950m in length and up to 20m in height, would carry the Sheffield Northern spur (southbound) over the HS2 main line, Dearne Valley Line existing railway, and pass onto the Church Field Road embankment, 14m in height. The Sheffield Northern spur (southbound) would then run in the Thurnscoe cutting to connect with the Dearne Valley Line at Thurnscoe. The Sheffield Northern spur (northbound) would diverge from a section of the Clayton north embankment in south-west direction, and then pass into the Church Field Road cutting, 3.2km in length and up to 19m in depth, to connect with the Dearne Valley Line at Thurnscoe.

6.22.3 Table 21 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 21: Consideration of local alternatives for Sheffield Northern spur

Option	Outcome of analysis	Further action/considerations
Option O	• Similar number of demolitions required at Robin Hill Lane compared to the Proposed Scheme. • Less likelihood of impacts on designated heritage assets (South Kirkby Camp Scheduled Monument and Grade II listed Vissitt Manor) compared to the Proposed Scheme. • Less visual impacts on sensitive receptors, including those associated with Howell Wood; the settlement of South Kirkby; Avenue Farm; Brierley Boarding Kennels; and businesses at the junction between Common Road and Southmoor Road, compared to the Proposed Scheme. • Less construction and/or operational visual, noise and air quality impacts on nearby sensitive receptors compared to the Proposed Scheme. • Similar water resources and flood risk impacts to the Proposed Scheme. • Reduced operational performance compared to the Proposed Scheme.	This option will not be subject to further consideration

Option	Outcome of analysis	Further action/considerations
	• Similar technical and engineering complexities to the Proposed Scheme. • Similar construction programme compared to the Proposed Scheme. • Similar cost compared to the Proposed Scheme.	
Option A	• Similar number of demolitions required at Robin Hill Lane compared to the Proposed Scheme. • Option would require the demolition of the Grade II listed building, Vissitt Manor, similar to the Proposed Scheme. • Similar impacts on the setting of South Kirkby Camp Scheduled Monument compared to the Proposed Scheme. • Similar construction and/or operational, noise and air quality impacts on nearby sensitive receptors compared to the Proposed Scheme. • Similar visual impact on sensitive receptors, including those associated with Howell Wood; the settlement of South Kirkby; Avenue Farm; Brierley Boarding Kennels; and businesses at the junction between Common Road and Southmoor Road, compared to the Proposed Scheme. • Similar construction and/or operational visual, noise and air quality impacts on nearby sensitive receptors compared to the Proposed Scheme. • Similar water resources and flood risk impacts to the Proposed Scheme. • Reduced operational performance compared to the Proposed Scheme. • Fewer technical and engineering complexities to the Proposed Scheme. • Similar construction programme compared to the Proposed Scheme. • Lower cost compared to the Proposed Scheme.	This option will not be subject to further consideration
Option B (the Proposed Scheme)	• Similar number of demolitions required at Robin Hill Lane compared to alternative options. • Option would require the demolition of the Grade II listed building, Vissitt Manor, similar to Option A and Option C. Impacts on the setting of South Kirkby Camp Scheduled Monument compared to the Option O. • Increased visual impact on sensitive receptors, including those associated with Howell Wood; the settlement of South Kirkby; Avenue Farm; Brierley Boarding Kennels; and businesses at the junction between Common Road and Southmoor Road, compared to Option O. However, similar visual impacts to Option A and less visual impacts compared to Option C.	This is the selected option taken forward into the Proposed Scheme

Option	Outcome of analysis	Further action/considerations
	• Similar construction and/or operational, noise and air quality impacts on nearby sensitive receptors compared to Option A, but less than for Option C. • Similar water resources and flood risk impacts to the alternative options. • Better operational performance compared to alternative options. • Similar technical and engineering complexities to Option O. Greater technical and engineering complexities compared to Option A. Less technical and engineering complexities compared to Option C. • Similar construction programme compared to alternatives options. • Similar cost compared to Option O. Greater cost compared to Option A. Lower cost compared to Option C.	
Option C	• Similar number of demolitions required at Robin Hill Lane compared to the Proposed Scheme. • Option would require the demolition of the Grade II listed building, Vissitt Manor, similar to the Proposed Scheme. Similar impacts on the setting of South Kirkby Camp Scheduled Monument compared to the Proposed Scheme. • Greater visual impacts on sensitive receptors, including those associated with Howell Wood; the settlement of South Kirkby; Avenue Farm; Brierley Boarding Kennels; and businesses at the junction between Common Road and Southmoor Road compared to the Proposed Scheme. • Greater construction and/or operational, noise and air quality impacts on nearby sensitive receptors compared to the Proposed Scheme. • Similar water resources and flood risk impacts to the Proposed Scheme. • Reduced operational performance compared to the Proposed Scheme. • Greater technical and engineering complexities to the Proposed Scheme. • Similar construction programme compared to the Proposed Scheme. • Greater cost compared to the Proposed Scheme.	This option will not be subject to further consideration

6.22.4 Option B was taken forward into the Proposed Scheme. Overall, Option B would have similar environmental impacts compared to the other options. It was selected as the preferred option because it would have better operational performance compared to Options O, A and C, as it is grade separated and would therefore remove conflicting crossing movements, which would increase capacity and provide improved timetable flexibility. In addition, Option B would provide improved operational performance by

allowing HS2 trains to sufficiently accelerate and decelerate before joining and after leaving the Sheffield Northern Spur, which would avoid disrupting the services on the HS2 main line.

6.23 Community area LA14 – South Kirkby to Sharlston Common

Route section alternatives

6.23.1 The strategic, route-wide and route corridor alternatives to the Proposed Scheme and local alternatives considered prior to July 2017 are presented in Volume 1, Introduction and methodology and in the Alternatives report as a supporting document to the working draft ES. The local alternatives considered for the Proposed Scheme within the South Kirkby to Sharlston Common area since the route announcement in July 2017 are described in this section.

6.23.2 In this area, the route of the Proposed Scheme would be carried on viaduct, embankments, and in cuttings.

6.23.3 As part of the design development process since July 2017, consideration has been given to the impact of the Proposed Scheme on local residents of the South Kirkby to Sharlston Common area, and environmental receptors including: Anglers Country Park Local Nature Reserve; Manface Quarry Local Wildlife Site; Sharlston Common Local Wildlife Site; Nostell Priory Farm Scheduled Monument; Sharlston Common coal and ironstone workings Scheduled Monument; Grade I listed Church of All Saints in South Kirkby; and Wragby Conservation Area.

6.23.4 Further consideration will be given to the construction and engineering options in this area, design and construction methods, and alternative engineering options. Further studies are ongoing and will be reported in the formal ES.

6.24 Community area LA15 – Warmfield to Rothwell and Swillington

Proposed auto-transformer feeder station and grid supply point locations

6.24.1 During the design development process since the announcement of the preferred route in July 2017, consideration has been given to the location of an auto-transformer feeder station at Bottom Boat, which would supply electrical power from the National Grid network to the Proposed Scheme. The auto-transformer feeder station would house the electrical equipment that would protect and control the power supply to the Proposed Scheme. The auto-transformer feeder station would be located at the start of a neutral section[63] along the route of the Proposed Scheme, at a location with a potential grid supply point to provide grid connection to existing electrical infrastructure.

[63] A neutral section is an insulated section that prevents two differing electrical from touching, by introducing an electrical clearance (an earth section)

6.24.2 The following six options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option 1A – Bottom Boat A: the auto-transformer feeder station would be located to the east of the HS2 main line and south of the M62 and the B6135 Newmarket Lane at Methley Lanes. The grid supply point would be located on Saville Park Farm to the west of the proposed River Calder viaduct and south of the M62 and to the north of the B6135 Newmarket Lane. Access to both of these sites would be taken from the B6135 Newmarket Lane. Both the auto-transformer feeder station and the grid supply point would be located adjacent to the proposed River Calder Viaduct. The auto-transformer feeder station would provide power supply to both the HS2 main line and the Leeds spur;

- Option 1B – Bottom Boat B: the auto-transformer feeder station would be located to the west of the proposed Scholey Hill embankment and north of the M62. The grid supply point would be in the same location as for Option A. Access to the auto-transformer feeder station would be taken from Hungate Lane, and for the grid supply point from the B6135 Newmarket Lane. The auto-transformer feeder station would provide power supply to both the HS2 main line and the Leeds spur;

- Option 1C – Bottom Boat C (the Proposed Scheme): the auto-transformer feeder station and grid supply point would be located to the west of the proposed River Calder viaduct, south of the M62 and north of the B6135 Newmarket Lane. Access to both of these sites would be from the B6135 Newmarket Lane. Both the auto-transformer feeder station and the grid supply point would be located adjacent to the proposed River Calder viaduct. The auto-transformer feeder station would provide power supply to both the HS2 main line and the Leeds spur;

- Option 2A – Altofts A: the auto-transformer feeder station and grid supply point would be located to the south-west and west of Altofts respectively, and to the west of the proposed Normanton embankment. The auto-transformer feeder station would be located on agricultural land east of the River Calder, adjacent to Newland Hall and close to Newland Lane. The grid supply point would be located on agricultural land adjacent, and to the south of Birkwood Road. Access to both of these sites would be from Birkwood Road;

- Option 2B – Altofts B: the auto-transformer feeder station and grid supply point would be located to the south-west of Altofts and east of the proposed Normanton embankment. The auto-transformer feeder station would be located on agricultural land to the east of the River Calder, adjacent to Newland Hall and to the north of Newland Lane. The grid supply point would be located on agricultural land adjacent to some woodland to the north of Newland Lane. Access to both of these sites would be from Birkwood Road; and

- Option 3 – Swillington: the auto-transformer feeder station and grid supply point would be located on the site of a disused landfill site north of Jinny Moor

Lane and east of Bullerthorpe Lane. Both sites would be located to the west of Swillington, and the proposed Swillington embankment. Access to both of these sites would be from Bullerthorpe Lane.

6.24.3 Table 22 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 22: Consideration of local alternatives for Bottom Boat auto-transformer feeder station and grid supply point

Option	Outcome of analysis	Further action/considerations
Option 1A	• Greater landscape and visual impacts on views from the Trans Pennine Trail and Leeds Country Way compared to the Proposed Scheme. • No impact on non-designated and designated heritage assets as for the Proposed Scheme. • Greater water resources and flood risk impacts compared to the Proposed Scheme. • Similar ecology, water resources and flood risk, air quality, traffic and transport, health, socio-economic, agriculture, forestry and soils, land quality and waste and material resources impacts to the Proposed Scheme. • Greater noise impacts on properties at Methley Lanes compared to the Proposed Scheme. • Marginally more construction complexity compared to the Proposed Scheme. • Marginally longer construction programme to the Proposed Scheme. • Lower cost compared to the Proposed Scheme.	This option will not be subject to further consideration.
Option 1B	• Greater landscape and visual impacts on views from the Trans Pennine Trail, Leeds Country Way and Moss Carr Wood compared to the Proposed Scheme. • No impact on non-designated and designated heritage assets as for the Proposed Scheme. • Similar ecology and biodiversity, water resources and flood risk, air quality, sound noise and vibration, community, traffic and transport, health, socio-economic, agriculture, forestry and soils, land quality and waste and material resources impacts to the Proposed Scheme. • Marginally more construction complexity compared to the Proposed Scheme. • Marginally longer construction programme to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
Option 1C (the Proposed Scheme)	• Lower landscape and visual impacts compared to alternative options. • No impact on non-designated and designated heritage assets. • Similar ecology and biodiversity, water resources and flood risk, air quality, sound noise and vibration, community, traffic and transport, health, socio-economic, agriculture, forestry and soils, land quality and waste and material resources impacts to alternative options. • Marginally less construction complexity compared to the Proposed Scheme. • Marginally shorter construction programme to the alternative options. • Higher cost compared to Option 1A, but reduced cost compared to alternative options.	This is the selected option taken forward into the Proposed Scheme.
Option 2A	• Greater landscape and visual impacts on the Newland Park estate and Newland Hall compared to the Proposed Scheme. • Greater impacts to scheduled monuments (Newland Preceptory and Henge on Birkwood Common) and listed buildings at Newland Hall compared to the Proposed Scheme. • Similar ecology and biodiversity, water resources and flood risk, air quality, sound noise and vibration, community, traffic and transport, health, socio-economic, agriculture, forestry and soils, land quality and waste and material resources impacts to the Proposed Scheme. • More construction complexity to the Proposed Scheme. • Longer construction programme to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration.
Option 2B	• Greater landscape and visual impacts on the Newland Park estate and Newland Hall and longer distance views from Normanton compared to the Proposed Scheme. • Greater impacts to a scheduled monument (Newland Preceptory) and listed buildings at Newland Hall compared to the Proposed Scheme. • Similar ecology and biodiversity, water resources and flood risk, air quality, noise, community, traffic and transport, health, socio-economic, agriculture, forestry and soils, land quality and waste and material resources impacts to the Proposed Scheme. • More construction complexity to the Proposed Scheme. • Longer construction programme to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration.

Option	Outcome of analysis	Further action/considerations
Option 3	• Greater landscape and visual impacts on Gamblethorpe Farm compared to the Proposed Scheme. • Greater impacts to a scheduled monument near Gamblethorpe Cottage and Grade II* listed Leventhorpe Hall compared to the Proposed Scheme. • Similar ecology and biodiversity, water resources and flood risk, air quality, sound noise and vibration, community, traffic and transport, health, socio-economic, agriculture, forestry and soils, land quality and waste and material resources impacts to the Proposed Scheme. • More construction complexity compared to the Proposed Scheme. • Longer construction programme to the Proposed Scheme. • Greater cost compared to the Proposed Scheme.	This option will not be subject to further consideration.

6.24.4 Option 1C was taken forward into the Proposed Scheme. Overall, Option 1C was the preferred option because, compared to the other options, the auto-transformer station and grid supply point components would have lower landscape and visual impacts compared to alternative options. Option 1C would have no impact on scheduled monuments and listed buildings compared to Options 2A, 2B and 3. Option 1C would have higher costs than Option 1A, but fewer construction complexities and a shorter construction programme compared to alternative options.

Review of the Woodlesford tunnel southern portal location

6.24.5 During the design development process since the announcement of the route in July 2017, further consideration has been given to the location of the Woodlesford tunnel southern portal and its interaction with the historical landfill site at Armitage Quarry. The route of the Proposed Scheme would pass through the historical landfill at Armitage Quarry. This route could not be constructed without excavating large volumes of potentially hazardous material from the landfill. Design options were considered for the relocation of the Woodlesford tunnel southern portal to reduce the risks associated with disturbance and removal of landfill material.

6.24.6 The following two options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option O: the southern portal of the bored tunnel would start in natural ground at the assumed boundary of the landfill, with the approach to the tunnel being in a 70m long cut and cover section and a 150m long porous portal. Given the potentially hazardous nature of the materials in the landfill, Option O assumes that the whole landfill would need to be excavated, dewatered and backfilled with suitable material to ensure structural stability; and
- Option 1: a horizontal shift of the southern portal of the Woodlesford tunnel towards the east by 50m to avoid the deep hazardous landfill. The portal would include the addition of a cut and cover tunnel to the southern portal to make

tunnelling viable; and modification to the vertical and horizontal alignment at the northern end of the Woodlesford tunnel to provide sufficient vertical clearance for the HS2 main line below the Hallam Line.

6.24.7 Table 23 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 23: Consideration of local alternatives for the location of the Woodlesford tunnel southern portal

Option	Outcome of analysis	Further action/considerations
Option O	• Greater potential for contaminated land impacts compared to the Proposed Scheme. • Potential for greater construction air quality impacts due to the removal of hazardous landfill material. • Greater operational noise impacts on residents in Woodlesford due to the proximity of the tunnel portal. • Larger area of woodland lost at Water Haigh woodland. Water Haigh Woodland Park would be partly reinstated by backfilling of the top of the cut and cover tunnel, thus moving the open section of the route further from Woodlesford community. • Potential for greater impacts to water resources compared to the Proposed Scheme as wider area would require drainage. • No demolitions would be required. • Greater traffic movements and higher emissions from construction vehicles required to transport hazardous waste from the landfill compared to the Proposed Scheme. • Similar access impacts to marina on Fleet Lane and waste water treatment works to the Proposed Scheme. • More technical and engineering complexity compared to the Proposed Scheme. • Shorter construction programme compared to the Proposed Scheme. • Overall higher cost compared to the Proposed Scheme due to more hazardous landfill material needing removal.	This option will not be subject to further consideration
Option 1 (the Proposed Scheme)	• Lower potential for contaminated land impacts compared to Option O. • Lower operational air quality and noise impacts compared to Option O. • Smaller loss of woodland at Water Haigh Woodland Park and less visual impacts compared to Option O. • Greater environmental impacts on mature woodland to the east of Eshald Lane, the Woodlesford Conservation Area, access on Fleet Lane and the West Riding County Football Association grounds, compared to Option O. • Some construction activities may be closer to residential buildings and construction noise affect a greater number of properties, compared to Option O.	This is the selected option taken forward into the Proposed Scheme

Option	Outcome of analysis	Further action/considerations
	• Less risk of impacts to water resources as smaller area would require drainage compared to Option O. • Demolition of two buildings would be required compared to none for Option O. • Fewer traffic movements and lower emissions from construction vehicles required to transport waste from the landfill compared to Option O. • Similar access impacts to marina on Fleet Lane and waste water treatment works compared to Option O. • Less technical and engineering complexity to the Proposed Scheme. • Longer construction programme compared to the Proposed Scheme. • Overall cost would be lower compared to Option O due to less landfill material needing removal.	

6.24.8 Option 1 was taken forward into the Proposed Scheme. Option 1 would avoid the hazardous landfill at Armitage Quarry and overall give rise to slightly lower environmental impacts. Option 1 would also cost less than Option O. Option 1 would also result in less hazardous waste material being excavated from the landfill with reductions in associated environmental issues such as landfill gas and leachate, litter, odour and air quality. The demolition of two properties would be required to construct the Proposed Scheme. However, the options will be revisited when the exact boundary of the landfill site has been determined from detailed ground investigations.

6.25 Community area LA16 - Garforth and Church Fenton

Great North Road and A1(M) northbound and southbound crossing (formerly Daniel Hartley's Wood cut and cover tunnel)

6.25.1 During the design development process since the announcement of the route in July 2017, consideration has been given to the route of the Proposed Scheme where it would cross the Great North Road and the A1(M) near Micklefield, Leeds. At this location, the A1(M) northbound and southbound carriageways diverge so that the A1(M) northbound carriageway can rise and cross over the M1. The route of the Proposed Scheme would need to pass under the A1(M) carriageways. Design options were considered for the Great North Road and the A1(M) northbound and southbound crossing. These options presented opportunities to simplify the construction method, create smaller structures, and reduce disruption to the existing road network.

6.25.2 The following five options were taken forward to a more detailed appraisal where engineering and construction feasibility, cost and environmental impacts were considered:

- Option O: a cut and cover tunnel, which would consist of a reinforced concrete box tunnel structure with a central dividing wall. The total length of the tunnel would be 115m. Retaining walls would be provided at the ends of the tunnel

structure. The roof slab, base slab and wall thicknesses would all be 1m. The vertical clearance provided from top of rail to soffit of the box would be 8m. The external dimensions of the box structure would be 17m in width and 11m in height;

- Option A: an overbridge across the Great North Road and a reinforced concrete box tunnel below the A1(M). The dimensions of the box tunnel structure would be the same as Option O. The dimensions of this overbridge would be 18m in length and 15m in width. A jacked box in open cut would be a possible construction method for the tunnel structure. The length of this jacked box would be 67m, which could be jacked from either one end or both ends. The Great North Road overbridge could be a single span concrete structure;
- Option B: three overbridges. This option would comprise three overbridges, one for each of the highway crossings, with a three-span arrangement and would comprise concrete beams and a reinforced concrete slab. Two of the overbridges would have main spans of 25m and side spans of 20m, and the third, a main span of 24m and side spans of 20m;
- Option C: three overbridges. This option would comprise three overbridges, one for each of the highway crossings, with a single span arrangement. Similar to Option B, Option C would consist of three overbridges, one for each of the highway crossings. Each bridge would have a single span arrangement and would comprise concrete beams and a reinforced concrete slab. Similar to Option B, two of the overbridges would have main spans of 25m and side spans of 20m, and the third, a main span of 24m and side spans of 20m. The bridges in Option C are assumed to span over a retained cut. This retained cut would reduce the amount of permanent excavation that would be required to carry the route through the A1(M)/Great North Road corridor. It is assumed that a pile wall would be used to form the walls of the retained cut; and
- Option D: two, three span overbridges. This option would consist of two, three span overbridges; one overbridge for the Great North Road and one overbridge for both the A1(M) northbound and southbound carriageways. Similar to Option B, one of the overbridges would have main spans of 25m and side spans of 20m, and the second, a main span of 24m and side spans of 20m. Each bridge would comprise concrete beams and a reinforced concrete slab.

6.25.3 Table 24 provides a summary of the outcomes of the preliminary appraisal of the alternative options described above.

Table 24: Consideration of local alternatives for the Great North Road and A1(M) northbound and southbound crossing

Option	Outcome of analysis	Further action/considerations
Option O	• Larger area of land required compared to the Proposed Scheme. • Similar tree line and hedgerow loss compared to the Proposed Scheme.	This option will not be subject to further consideration

Option	Outcome of analysis	Further action/considerations
	• Similar potential for indirect impacts on Hook Moor Wood SSSI compared to the Proposed Scheme. • Similar volume of excavated material from construction compared to the Proposed Scheme. • More complex construction method and a resulting longer construction period compared to the Proposed Scheme. • Greater disruption to local communities compared to the Proposed Scheme due to longer period of temporary diversions/traffic management on the Great North Road, the A1(M) northbound and the A1(M) southbound. • Similar impacts on health and safety compared to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	
Option A	• Larger area of land required compared to the Proposed Scheme. • Similar tree line and hedgerow loss compared to the Proposed Scheme. • Similar potential for indirect impacts on Hook Moor Wood SSSI compared to the Proposed Scheme. • Similar volume of excavated material from construction compared to the Proposed Scheme. • More complex construction method and a resulting longer construction period compared to the Proposed Scheme. • Greater disruption to local communities compared to the Proposed Scheme due to longer period of temporary diversions/traffic management on the Great North Road, the A1(M) northbound and the A1(M) southbound. • Greater impacts on health and safety compared to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration
Option B	• Similar land requirements compared to the Proposed Scheme. • Similar tree line and hedgerow loss compared to the Proposed Scheme. • Similar potential for indirect impacts on Hook Moor Wood SSSI compared to the Proposed Scheme. • Similar volume of excavated material from construction compared to the Proposed Scheme. • More complex construction method, which would mean longer construction period, compared to the Proposed Scheme. • Greater disruption to local communities compared to the Proposed Scheme due to longer period of temporary diversions/traffic management on the Great North Road, the A1(M) northbound and the A1(M) southbound.	This option will not be subject to further consideration

Option	Outcome of analysis	Further action/considerations
	• Similar impacts on health and safety compared to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	
Option C (the Proposed Scheme)	• Less land and excavation required compared to alternative options as each overbridge has a single span. • Similar tree line and hedgerow loss compared to alternative options. • Similar potential for indirect impacts on Hook Moor Wood SSSI compared to alternative options. • A simplified construction method would be possible through the use of an embedded retaining wall. Importantly this means that the construction programme would be shortened and temporary diversions/traffic management on the Great North Road, the A1(M) northbound and the A1(M) southbound reduced. This in turn would reduce disruption to local communities. • The overbridges would avoid the need for additional safety/evacuation systems and a drainage pump, which would be required for the tunnel options. • Less disruption to local communities compared to alternative options due to shorter period of temporary diversions/traffic management on the Great North Road, the A1(M) northbound and the A1(M) southbound. • Similar impacts on health and safety compared to alternative options. • Lowest cost compared to alternative options.	This is the selected option taken forward into the Proposed Scheme
Option D	• Similar land and excavation requirements compared to the Proposed Scheme. • Similar tree line and hedgerow loss compared to the Proposed Scheme. • Similar potential for indirect impacts on Hook Moor Wood SSSI compared to the Proposed Scheme. • More complex construction method, and longer construction period, compared to the Proposed Scheme. • Greater disruption to local communities compared to the Proposed Scheme due to longer period of temporary diversions/traffic management on the Great North Road, the A1(M) northbound and the A1(M) southbound. • Similar impacts on health and safety compared to the Proposed Scheme. • Higher cost compared to the Proposed Scheme.	This option will not be subject to further consideration

6.25.4 Option C was taken forward into the Proposed Scheme. Overall, Option C (three overbridges with a single span arrangement) was the preferred option because compared with the other options, it would require less land, would be less complex

and would cost less to construct. This in turn would allow a shorter construction period and less disruption to the local community. In addition, there would be a lower risk of major accidents during construction. Options B, C and D would potentially give rise to lower environmental impacts compared to Option O and Option A, due to less land requirements and less loss of habitat, however, Option C would broadly have the same environmental impacts as Options B and D.

6.26 Community area LA17 – Stourton to Hunslet

Route section alternatives

6.26.1 The strategic, route-wide and route corridor alternatives to the Proposed Scheme and local alternatives considered prior to July 2017 are presented in Volume 1, Introduction and methodology and in the Alternatives report as a supporting document to the working draft ES. The local alternatives considered for the Proposed Scheme within the Stourton to Hunslet area since the route announcement in July 2017 are described in this section.

6.26.2 In this area, the route of the Proposed Scheme would be carried on embankments and in cuttings.

6.26.3 As part of the design development process since July 2017, consideration has been given to the impact of the Proposed Scheme on local residents of the Stourton to Hunslet area, and environmental receptors including: the Aire and Calder Navigation Canal; Halton Moor Local Nature Reserve; Temple Newsam Estate Wood Local Wildlife Site; Middleton Park shaft mounds Scheduled Monument; Grade II* listed Garden Gate public house; and Grade II* listed Hunslet Mill.

6.26.4 Further consideration will be given to the construction and engineering options in this area, design and construction methods, and alternative engineering options. Further studies are ongoing and will be reported in the formal ES.

6.27 Community area LA18 - Leeds Station

Route section alternatives

6.27.1 The strategic, route-wide and route corridor alternatives to the Proposed Scheme and local alternatives considered prior to July 2017 are presented in Volume 1, Introduction and methodology and in the Alternatives report as a supporting document to the working draft ES. The local alternatives considered for the Proposed Scheme within the Leeds Station area since the route announcement in July 2017 are described in this section.

6.27.2 In this area, the route of the Proposed Scheme would be carried on viaducts and embankments and terminate at Leeds Station.

6.27.3 As part of the design development process since July 2017, consideration has been given to the impact of the Proposed Scheme on local residents of the Leeds Station area, and environmental receptors including: Humber Estuary SAC and SPA; Humber Estuary SSSI; Grade II listed Victoria Bridge; Grade II listed Concourse of London Midland and Scottish Railway; Leeds City Centre Conservation Area; and Canal Wharf Conservation Area.

6.27.4 Further consideration will be given to the construction and engineering options in this area, design and construction methods, and alternative engineering options. Further studies are ongoing and will be reported in the formal ES.

6.28 Community areas MML01 – Danesmoor to Brierley Bridge and MML02 – Unstone Green to Sheffield Station

6.28.1 HS2 Ltd's consideration of the design of the proposed electrification of this section of the MML is at an early stage of development. Local alternatives for the works in the MML01 Danesmoor to Brierley Bridge and MML02 Unstone Green to Sheffield Station areas will be reported in the formal ES.

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