

ROUTE ENGINEERING REPORT

West Midlands to Leeds

July 2013



Department for Transport

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1 Introduction

1.1 Purpose of this report

1.1.1 This report provides a detailed route description of the Leeds leg of Phase Two of the High Speed Two (HS2) network, including the proposed stations and depots.

1.1.2 The technical requirements for line of route, stations and depot design are outlined in this report; each of the consultants has been following these requirements and guidance.

1.1.3 The historical work undertaken since the start of the route development in 2010 and presented to the public in a series of documents published in January 2013 can be found on the Department for Transport website (<https://www.gov.uk/government/organisations/department-for-transport>). Additional information concerning the scheme can be found on the HS2 Ltd website (www.hs2.org.uk).

1.2 Overview of the route

1.2.1 The route would run from the Hams Hall junction between Phase One and Phase Two of HS2, north of Water Orton in eastern Birmingham, to a new station in central Leeds. It would also connect to the East Coast Main Line (ECML) railway near Church Fenton, south-west of York. The route would:

- follow the M42 and A42 corridor to East Midlands Airport, which the route would pass under in a tunnel;
- pass through Long Eaton with a new station at Toton;
- follow the M1 corridor from Long Eaton to Staveley;
- pass through the Rother Valley towards Sheffield;
- rejoin the M1 corridor north-east of Sheffield with a new station at Meadowhall;
- pass east of Barnsley with tunnels at Hoyland and Ardsley;
- pass between Wakefield and Normanton;
- follow the M1 corridor from Swillington passing north of Garforth;
- continue north east to join the ECML, east of Church Fenton;
- have a junction in the Woodlesford area, with a spur towards central Leeds; and
- have a new station in Leeds at New Lane, with direct access to Leeds City station and the city centre.

1.3 Layout and content of this report

1.3.1 This report is laid out as follows:

- chapter one (this chapter), is introductory;
- chapter two sets out the technical requirements and assumptions underlying our work;
- chapter three describes the Line of Route;
- chapter four describes the stations along the route;
- chapter five describes the infrastructure maintenance depot and the rolling stock depot;
- chapter six discusses ancillary design works;
- chapter seven is a glossary of terms.

2 Design methodology

2.1 Overview

- 2.1.1 The route definition and selection process for Phase Two commenced in Autumn 2010 with the engagement of engineering and environmental consultancies to deliver the necessary technical design and appraisal input. The methodology applied was, in large part, the same as that applied to the route selection between London and the West Midlands, with improvements to the process implemented as necessary following lessons learned from that first phase of the project.
- 2.1.2 The remit was to identify a number of possible route and station options. This involved a process of identification of a long list with subsequent sifting to reduce the options for consideration to a handful of alternatives that meet the remit set by the Government. At each sift, remaining options were developed and refined to a greater level of detail in order to identify the key differences between options. During these final stages, potential locations for the infrastructure maintenance depots and rolling stock depots were also developed and followed a similar sifting process.
- 2.1.3 The scope for the Leeds leg included city centre station options in Leeds and options for stations in South Yorkshire and the East Midlands, including interchange options and city centre options. Connections to the existing ECML will provide routes to the North East.

2.2 Technical requirements for line of route

- 2.2.1 HS2 Ltd has a technical specification, entitled *Options for Phase Two of the high speed rail network: Approach to design*¹, which sets out the engineering operational and performance requirements for the route, and sets out the engineering design parameters.

Alignment design assumptions

- 2.2.2 The alignment development work was generally carried out using Ordnance Survey MasterMap data, supplemented with elevation information from five-metre resolution terrain data and one-metre resolution surface data provided by HS2 Ltd. This mapping has been used to support the alignment design.
- 2.2.3 The alignment design was undertaken in line with a combination of industry standards and best practice:
- HS2 Ltd's *Options for Phase Two of the high speed rail network: Approach to design*;
 - European Standards (the TSI 2002/732/EC - Technical Specification for Interoperability relating to the infrastructure sub-system); and
 - Network Rail Standard, (NR/SP/TRK/0049 - Track Design Handbook).
- 2.2.4 Key alignment parameters from the Project Specification include the following:
- The project shall assume a maximum line speed of 400kph where topographical, train performance and sustainability issues permit;

¹ High Speed Two Ltd, 2012. Options for phase 2 of the High Speed rail network, approach to design. HS2 Ltd, London. Available online at <https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network-approach-to-design>

- The line shall be designed to permit trains to maintain consistently high speeds;
- The maximum achievable turnout speed is assumed to be 230kph;
- The maximum vertical acceleration experienced due to the effect of vertical curvature shall normally be 2.25% of g; in exceptional circumstances, this can be increased to 4.25% of g; and
- The maximum vertical curve radius shall be 56,000m.

The width of the railway

- 2.2.5 For the majority of its length, the new route would be a twin-track railway.
- 2.2.6 The separation between the centre lines of the pair of tracks would be 5.0m where 400kph running was required. The track-bed width shall make provision for overhead line equipment (OHLE), access tracks wherever practicable, staff walkways, drainage and fencing. The normal track-bed width would be 22m wide.
- 2.2.7 For cuttings and embankments, it is assumed that the side slope of the earthworks would be 1:2.5 (two vertical to five horizontal). This is an appropriate design assumption. In practice, it may be possible to use steeper cutting slopes or apply retaining walls to reduce the fence-to-fence dimensions. Elsewhere, shallower cutting and embankment slopes may be required where the ground conditions are less stable.
- 2.2.8 Where tracks enter tunnels in two separate tunnel bores, the distance between tracks would be dependent on the tunnel diameter, but would typically be 21m instead of the usual 5m.
- 2.2.9 Construction of HS2 would require some additional land take beyond the corridor footprint, together with larger discrete areas to act as construction compounds. Larger worksites would also be required at areas of major works including bridges and major structures, and entrances to tunnels.
- 2.2.10 At this early design stage, consideration of construction issues has generally included identifying risks, opportunities and typical working methods and techniques. Given the more constrained nature of the station sites, further work has been undertaken, including initial identification of potential construction boundaries to assess the land take and demolition required.

Geotechnical assumptions

- 2.2.11 As one might expect from a project with such a large geographical scope, the geological conditions across the leg to Leeds are variable.
- 2.2.12 At this early stage of design, a common side slope has been adopted for earth structures. The development of the designs to a greater level of detail, with desk-based and later intrusive geotechnical investigations, may require our assumptions to be modified.
- 2.2.13 The following issues are typical of the influences on route selection:
- subsidence of natural cavities, in particular gypsum;
 - areas with a known history of landslides or unstable ground;

- compressible deposits including alluvium, which poses a settlement risk to loads placed on it;
- shallow mine workings occur widely; although primarily for coal mining, there are also shallow mine workings associated with ironstone, sandstone and gypsum. Deep mine workings are limited to coal – significant lengths of the route cross coal mine workings; and
- backfilled opencast coal sites are very common in the coalfields of Leicestershire, Nottinghamshire, South Yorkshire and West Yorkshire. It is common for landfill cells within the backfill to contain significant contamination.

Structures assumptions

- 2.2.14 Sufficient vertical clearance has been provided within the alignment design where HS2 would cross, or be crossed by, roads and other major obstacles, including rivers, canals and other railways. Short bridges, such as those used to carry the railway over local roads, or roads over the railway, would likely be straightforward single spans. For longer structures, the provision of a viaduct structure has been assumed. In particular, viaducts have been assumed where the designed rail level would be greater than 15m above existing ground level, or where the feature to be spanned is longer than 60m, for example, where HS2 would cross a flood risk zone.

Tunnelling assumptions

- 2.2.15 The range of tunnel configurations used was as follows:
- twin bore, single track tunnels (with cross passages where required);
 - cut and cover tunnels.
- 2.2.16 The tunnelling methods considered were:
- tunnel boring machine (TBM) driven tunnels with precast tunnel linings - the type of machine will depend on the ground conditions; and
 - sequentially excavated tunnels, generally using sprayed concrete lining (SCL) for initial ground support.
- 2.2.17 It is assumed that tunnels would be provided where the topography requires them. The size of tunnel required would be dependent on design speed and length of tunnel. This is subject to an absolute minimum size of 7.25m for each bore of a twin bore tunnel which is determined by the space required to accommodate the train and ancillary equipment, such as the electrification system, emergency walkways, and drains.
- 2.2.18 Vertical intervention shafts would be provided for tunnel ventilation and emergency access and evacuation. Cross passages between twin bore tunnels have been assumed at a spacing of approximately 500m.

Cut and cover tunnels

- 2.2.19 In some locations, cut and cover tunnels are proposed. These would be formed by excavating what would be a normal cutting, constructing a box type of structure and then re-filling over its roof slab to restore the original ground level and surface features such as footpaths or woodland. Such tunnels would be constructed where

a very deep cutting is not economically viable and where a driven tunnel would be impracticable due to the insufficient cover depth to the surface.

- 2.2.20 In some locations, a 'green tunnel' could be used. These would be formed by enclosing the railway (where otherwise it would be in partial cutting or on the surface) with a box type structure, with a landscaped area over the roof. Such tunnels would be constructed as an environmental mitigation for noise, visual intrusion or habitat.

Interfaces with existing transport infrastructure

- 2.2.21 Where HS2 would cross the path of an existing highway or railway, the route alignment design would provide sufficient vertical clearance to permit construction of a new bridge.
- 2.2.22 The route encounters major highways, including motorways. Where HS2 crosses the highway, either above or below, there would often be a requirement to locally modify the highway to accommodate the HS2 structure. Where HS2 crosses beneath the highway, new bridge structures would be incorporated.
- 2.2.23 The routes would also cross existing railway infrastructure, the engineering solutions for many of the crossings would be similar to those described above.
- 2.2.24 There are locations along the routes where significant modifications to the existing railway network would be required, such as closure and diversion of existing lines or the realignment of tracks, so that HS2 would share an existing and possibly widened corridor.
- 2.2.25 Where the HS2 route attempts to follow an existing transport corridor, there would often be a requirement to permanently realign the corridor so that HS2 would share the existing and sometimes widened corridor.

Environmental mitigation

- 2.2.26 For a major project such as this, environmental mitigation would be required. This could include significant earthworks and bunding/screening, planting areas, balancing ponds, replacement facilities, habitat enhancement and noise/visual screens. Initial potential opportunities for environmental mitigation have been identified as part of the iterative design process to date. These matters will be addressed as the design of the scheme is developed.

2.3 Technical requirements for stations

- 2.3.1 The quality of station design will shape the passenger experience of the HS2 network. The station should promote a positive experience of the network through a design that provides passengers with a smooth, convenient and pleasant passage through the station with effective management of pedestrian throughput.
- 2.3.2 The design of stations and their integration with the surrounding built environment should create the opportunity not only to engender positive experiences of the network, but also to act as catalysts for improvements to the surrounding cityscapes.
- 2.3.3 Stations fall into two groups:
- terminal stations, generally in a city centre; and
 - through or intermediate stations on the line of route, of a parkway or interchange nature.
- 2.3.4 The assessment criteria at the highest level considered;
- site availability and fit;
 - integration with line of route options and approaches to city centres;
 - impact upon and integration with existing transport infrastructure;
 - constructability;
 - passenger dispersal;
 - cost;
 - demand (insofar as location will affect it); and
 - a range of sustainability considerations.

Station design

- 2.3.5 The station design encompasses a wide range of criteria. This includes designs that enable train dwell times to match service patterns, considerations of passenger comfort and safety, capitalising on commercial opportunities and working within the confines of the budget. Provision for perturbed situations and future growth must also be considered.
- 2.3.6 Station design and layout will vary across the network depending on station location, operational requirements, land availability, etc., and therefore the design of each station will be unique. However, whilst recognising the constraints of individual sites, all stations on the high speed network should maintain a common style and standard that feels familiar to passengers, regardless of where the station is.
- 2.3.7 Station design will be developed to address the following factors, which are critical to station functionality:
- accommodation of network operational requirements;
 - station capacity planning;
 - functional zoning;

- passenger movements, wayfinding and accessibility;
- safety and security;
- interchange with other transport modes; and
- passenger environment.

Technical requirements

- 2.3.8 The useful length of HS2 station platforms shall be at least 415m and the project shall identify where longer platforms are required. The platforms shall be designed to GC gauge, the height of such platforms being 760mm above rail level.
- 2.3.9 Where interchange facilities with the national rail networks are provided, the platforms shall be designed to UK national railway standards.
- 2.3.10 Platform width shall be determined to accommodate expected passengers flows, with reasonable practicable allowances made for perturbation of peak flows. Design shall also comply with relevant design standards for minimum clearances to fixed infrastructure. Minimum width of platforms has been assumed to be 12m.
- 2.3.11 Tapering at platform ends shall be permitted where there is justifiable reason to do so. Where a taper is applied it should taper from full width to no less than a width of 8m and the radius of platform curvature shall not be less than 1000m radius. The remaining length of the platform shall be straight to facilitate splitting and joining of trains. Platform obstructions shall be kept to a minimum in the tapered section of the platform.
- 2.3.12 The number of platforms required at each station is determined by the operational requirements that drive the timetable, including the necessary turnaround time to meet that timetable. It is further influenced by the length of the route sections, demand requirements and loading factors.

Terminal stations

- 2.3.13 The Leeds terminal station will make provision for five platform faces.
- 2.3.14 The approach alignment design attempts to maximise entry and exit speeds to permit unimpeded acceleration and braking of trains.

Through or intermediate stations

- 2.3.15 The interchange stations on the Leeds leg in South Yorkshire and the East Midlands will make provision for four platform faces each. These stations include two through tracks (one northbound and one southbound) to cater for non-stopping trains travelling through the station at high speed.
- 2.3.16 The through stations require a facility to slow down and stop a train without impeding the passage of a following non-stopping train, and conversely to enable that train to re-join the railway without being impeded by an overtaking train. The lengths of the acceleration and deceleration lines, or stopping lines, are defined by the speed and frequency of the service. Invariably, these lines are much longer than a platform stopping lane would need to be for a slower railway or a railway with a less intense service pattern.

- 2.3.17 The interchange station options therefore incorporate two through running tracks. Platform faces serve lines that run parallel to the through running lines. The interchange stations have four platform faces (i.e. two platforms in each direction).
- 2.3.18 The normal two-track route would widen to four tracks and then to six for a station with four platform faces.

2.4 Technical requirements for depots

- 2.4.1 The route to Leeds would include provision for a rolling stock depot (RSD) and an infrastructure maintenance depot (IMD).
- 2.4.2 The RSD would be used to stable trains overnight, for cleaning and maintenance. The IMD would be used as a base from which to carry out engineering activities to inspect, maintain and renew the infrastructure.
- 2.4.3 The depots would be required to operate for 24 hours, seven days a week.
- 2.4.4 The depots would provide immediate access to the trunk road network to facilitate access by large goods vehicles. Good transport links will allow for a suitable and relatively local workforce; as such, the potential for access by public transport would be considered.

Requirements for rolling stock depots

- 2.4.5 The RSD would be configured for stabling and light maintenance, with heavier maintenance activities carried out at the Washwood Heath depot proposed for Phase One of the HS2 network.
- 2.4.6 The RSD would be positioned with access to the HS2 route, ideally within 10 minutes of the terminus station. Access to the existing rail network to facilitate delivery of rolling stock and other materials by rail is desirable, but not essential.
- 2.4.7 The RSD would be configured to be able to deal routinely with 30 train sets and provide stabling for up to 40 sets in exceptional circumstances. This requirement approximates to a footprint 1000 metres in length and 250m wide: an area of 25 hectares. Each train set is up to 200m long. Each depot would handle a mixture of full GC gauge sets and classic compatible sets.
- 2.4.8 The depot would provide a large covered maintenance building and a range of facilities to enable rolling stock inspection, repair, cleaning, light maintenance, re-watering and replenishing of consumables.
- 2.4.9 The maintenance patterns and flow through the depot will be defined to ensure sufficient capacity remains to move trains around the depot and prevent gridlock.

Requirements for infrastructure maintenance depot

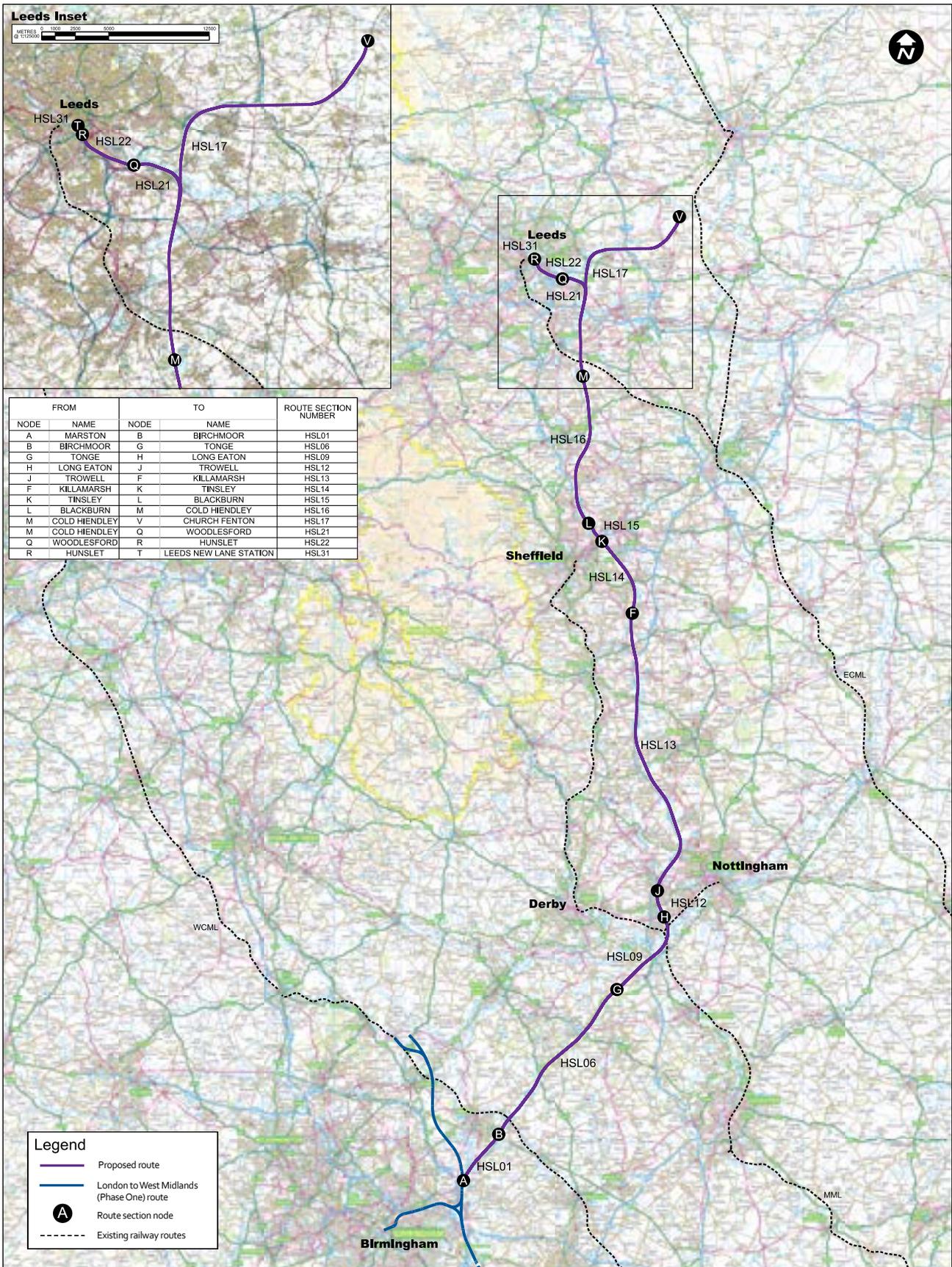
- 2.4.10 The IMD would be configured to support all infrastructure maintenance activities within the route.
- 2.4.11 The IMD would provide a maintenance, servicing and stabling facility both for HS2 on-track plant (including vehicles up to GC gauge, which would be too large to travel on the national rail network) and for HS2 maintenance rescue and recovery locomotives. It would be capable of acting as an incident control centre in the event of a serious accident or incident on the HS2 route.
- 2.4.12 The IMD would ideally be placed close to the mid-point of the respective leg, with direct access to the HS2 route. Access to the existing rail network to facilitate delivery of rolling stock and other materials by rail would be essential.

- 2.4.13 The IMD site would have the potential to be used as a construction depot for the works, thus avoiding additional land take.
- 2.4.14 The depot would be designed to serve both the HS2 route and the existing railway in both directions where possible. This would allow engineering trains to arrive at and depart from the depot with maximum flexibility. A switch and crossing (S&C) assembly area would be provided to enable the pre-assembly of the S&C units to be installed. Areas of storage would be provided with facilities to enable forklift trucks and overhead cranes to handle materials and plant safely. The depot would also store standard components and consumables.
- 2.4.15 The IMD would stable and service/maintain a variety of on-track plant and engineering supply train equipment. It would also provide strategic engineering material stores. HS2 ballast and spoil wagons would need to be able to run on and off the existing rail network, bringing supplies.
- 2.4.16 It is assumed that engineering trains would only operate on HS2 after the last passenger trains have ceased to run, and would return to the IMD before morning train operations commence.
- 2.4.17 Provision would be made for ancillary buildings and facilities such as offices, car parking, incident control rooms, workshops and storage.

3 Line of route

3.1 Route sections

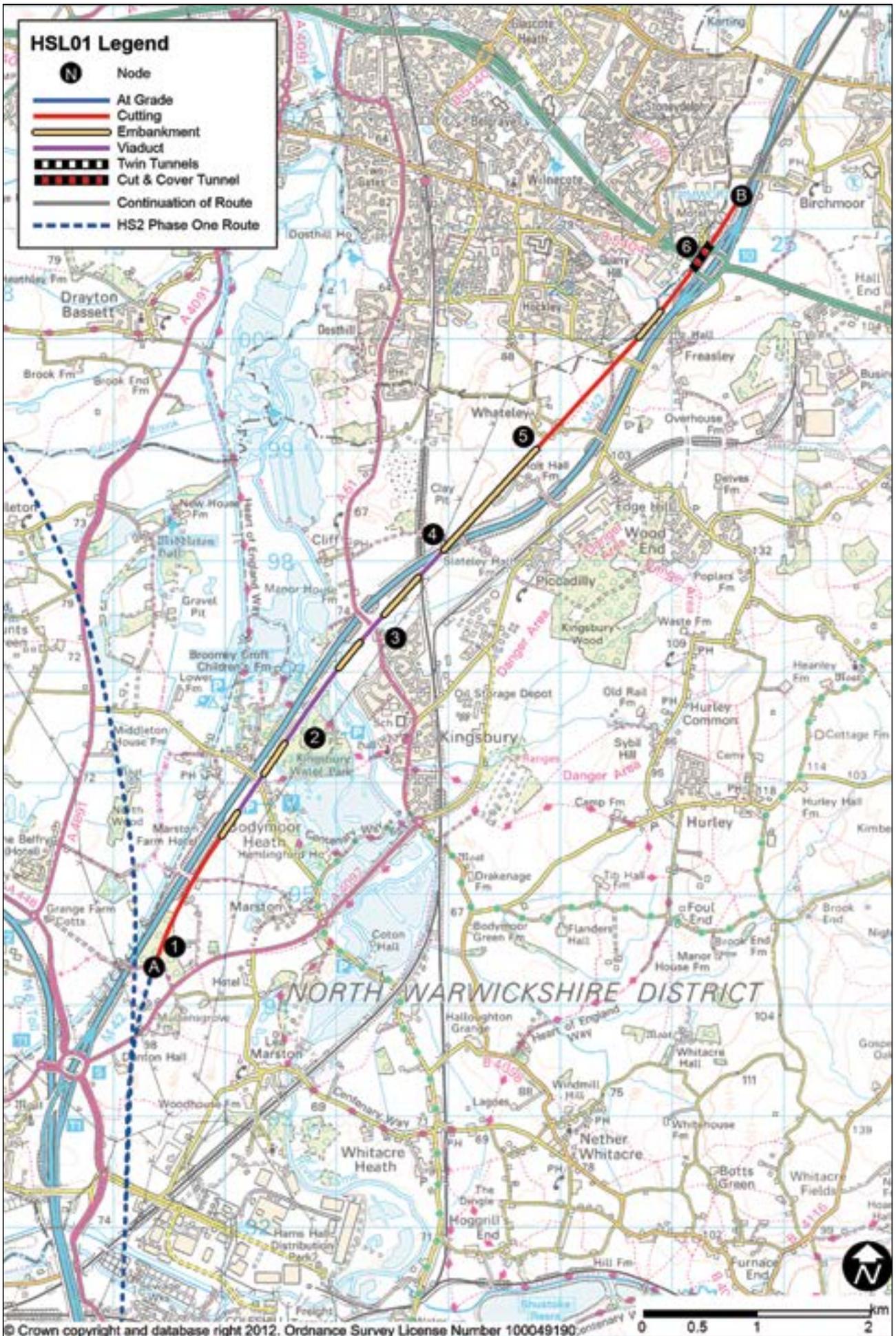
- 3.1.1 This chapter describes a series of individual route sections, which combine to form a continuous route from Marston in eastern Birmingham to Leeds and the ECML near Church Fenton. The text also makes reference to station locations in the East Midlands and South Yorkshire.
- 3.1.2 The main line of Phase One will run north-south to the west of Coleshill in Warwickshire on its way to the West Coast Main Line connection near Lichfield. At Coleshill, a triangular 'delta' junction will be provided to include a spur to central Birmingham. The northern apex of this triangular junction is the starting point for the route described in this report.
- 3.1.3 The key plan on the following page presents the individual route sections and provides the reader with the guide to the layout of the rest of this chapter. Each route section has a reference number, such as 'HSL01', covering a discrete geographical length. The report describes these sections. The total length of individual route sections is subdivided in order to allow a piece of text to be read against a map on the opposite page; typically, each map presents about 10km-12km of route.
- 3.1.4 The plan also shows that the route sections run between 'nodes'. Thus, readers can identify the location that interests them as being (for instance) 'between Node A and Node B'. These node letters appear in the title of the chapter. A node defines the beginning (and/or the end) of each of the sections into which the line of route is divided. Each section of line of route, running from one node to another, is uniquely identified with a reference number. The locations of these nodes have been chosen in order to easily appraise the line of route.



3.1.5 The plans show features of interest - each marked as a number in brackets. This allows the reader to study the route and refer to the corresponding section of text.

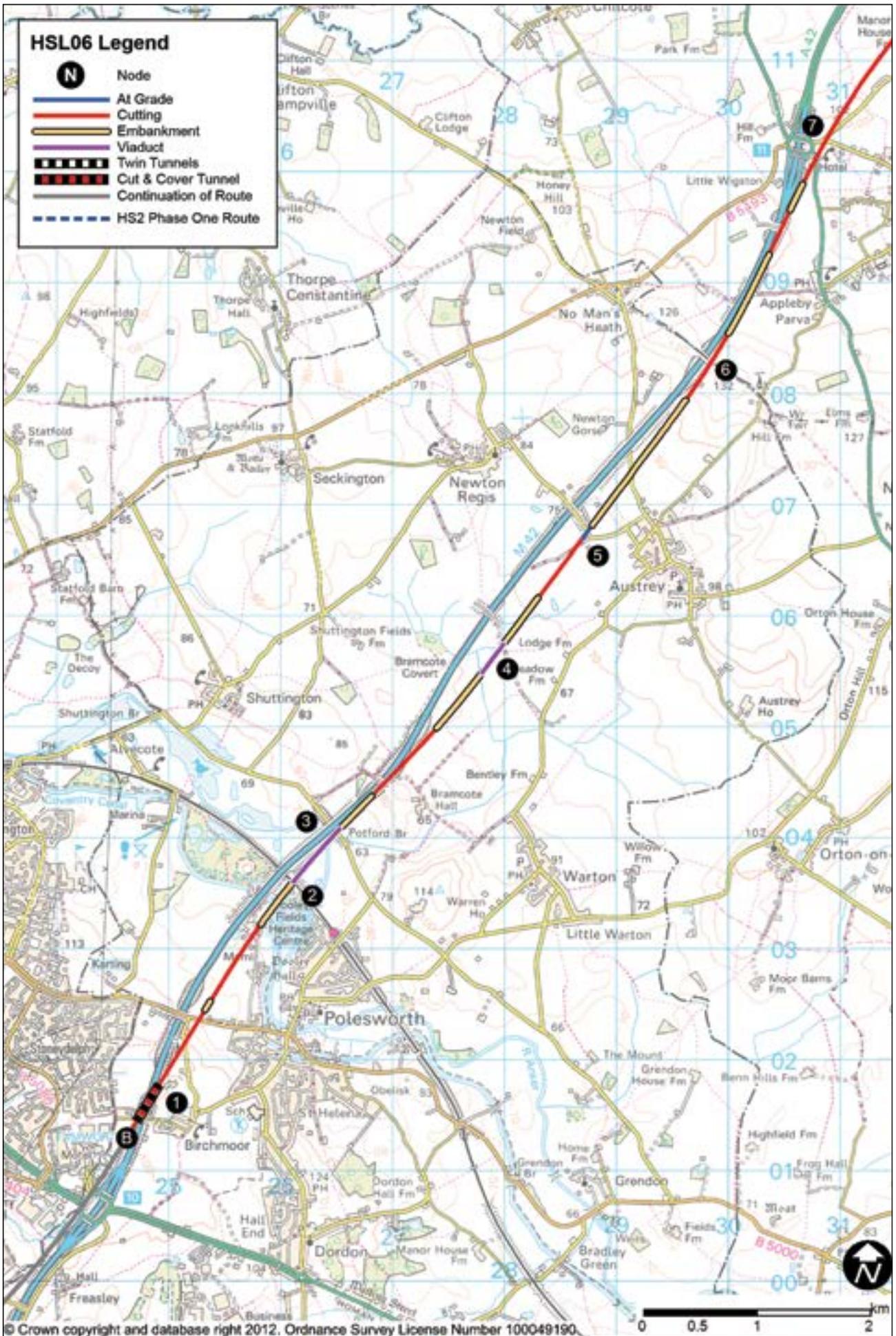
3.1.6 The route sections are:

- HSL01: Marston (A) to Birchmoor (B)
- HSL06: Birchmoor (B) to Tonge (north of Measham) (G)
- HSL09: Tonge (G) to Long Eaton (H)
- HSL12: Long Eaton (H) to Trowell (J)
- HSL13: Trowell (J) to Killamarsh (F)
- HSL14: Killamarsh (F) to Tinsley (K)
- HSL15: Tinsley (K) to Blackburn (L)
- HSL16: Blackburn (L) to Cold Hiendley (M)
- HSL17: Cold Hiendley (M) to Church Fenton (V)
- HSL21: Cold Hiendley (M) to Woodlesford (Q)
- HSL22: Woodlesford (Q) to Hunslet (R)
- HSL31: Leeds New Lane station (R to T)



3.2 HSLo1: Marston (A) to Birchmoor (B)

- 3.2.1 The route section between Marston and Birchmoor would be 8.8km long and would start the West Midlands to Leeds leg of HS2. The route would connect to Phase One north of the spurs into Birmingham city centre. At Birchmoor, the route would continue north along HSLo6, to Tonge.
- 3.2.2 The route would commence at Marston Lane (1) and run in a cutting up to 9m deep alongside the M42's southerly side, passing over a floodplain and Bodymoor Heath Road on viaduct. The design speed would be 270kph, rising to 400kph. There would be a short section on embankment, 9m in height, before another viaduct over part of Kingsbury Water Park (2), the River Tame and its floodplain, with potentially difficult ground conditions.
- 3.2.3 Having crossed the Tame, there would be another embankment section, and the route would start to rise to pass over the A51 (3) and a further floodplain on viaduct, of up to 15m in height.
- 3.2.4 North of the A51, the route would have to substantially gain height in order to pass over the M42 at almost exactly the location where the motorway passes over the Derby to Birmingham railway (4). At this point, the new route would cross to the northern side of the M42. The construction of the viaduct may require complex temporary works on the motorway, exacerbated by its proximity to the railway. At this multiple crossing point, the route would typically be 18m above ground level.
- 3.2.5 Now on the north-west side of the M42, the route cannot follow the more sinuous alignment of the motorway, and would head in a relatively straight line towards the easterly fringe of Tamworth and towards Junction 10 of the M42. At its maximum, the route would be 400m from the motorway.
- 3.2.6 North from Whateley (5), the route would descend with the terrain, and would pass between Tamworth and Junction 10. New bridges would be required to carry Whateley Road and Overwoods Road over the route. Junction 10 would have to be extensively rebuilt on the western side of the M42 (6). Extensive temporary motorway works would be expected. North of Junction 10, the route would enter a deep cutting, of typically 10m-17m depth, to pass below the M42.

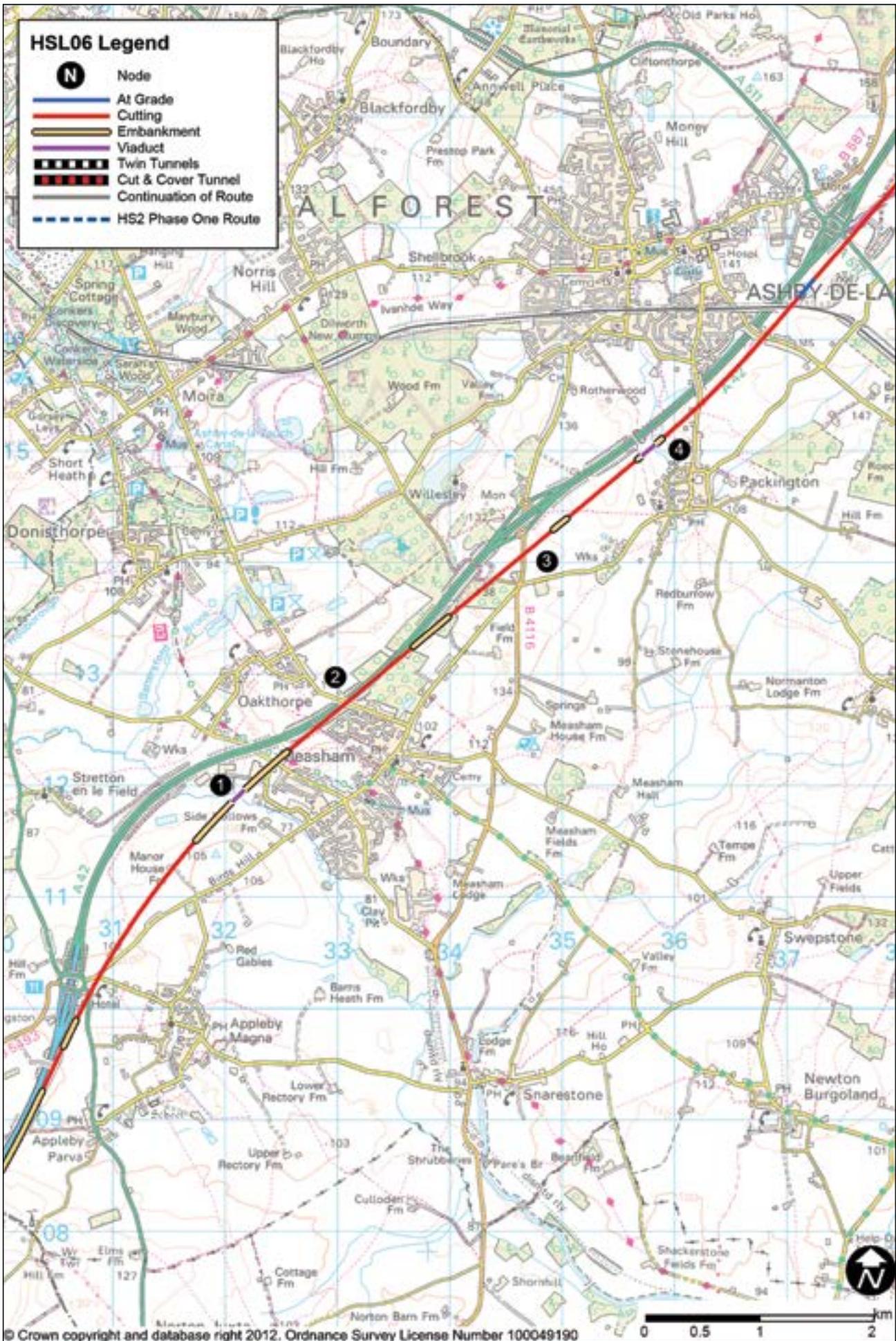


3.3 HSLo6: Birchmoor (B) to Tonge (north of Measham) (G)

3.3.1 This route section between Birchmoor and Tonge will be 28.2km long. The section of route connecting to Birchmoor from the south will be HSLo1 from Marston. At Tonge, the route will continue north along HSLo9 to Long Eaton. The route section will cross the northern end of the Warwickshire Coalfield, where coal may be present at relatively shallow depth

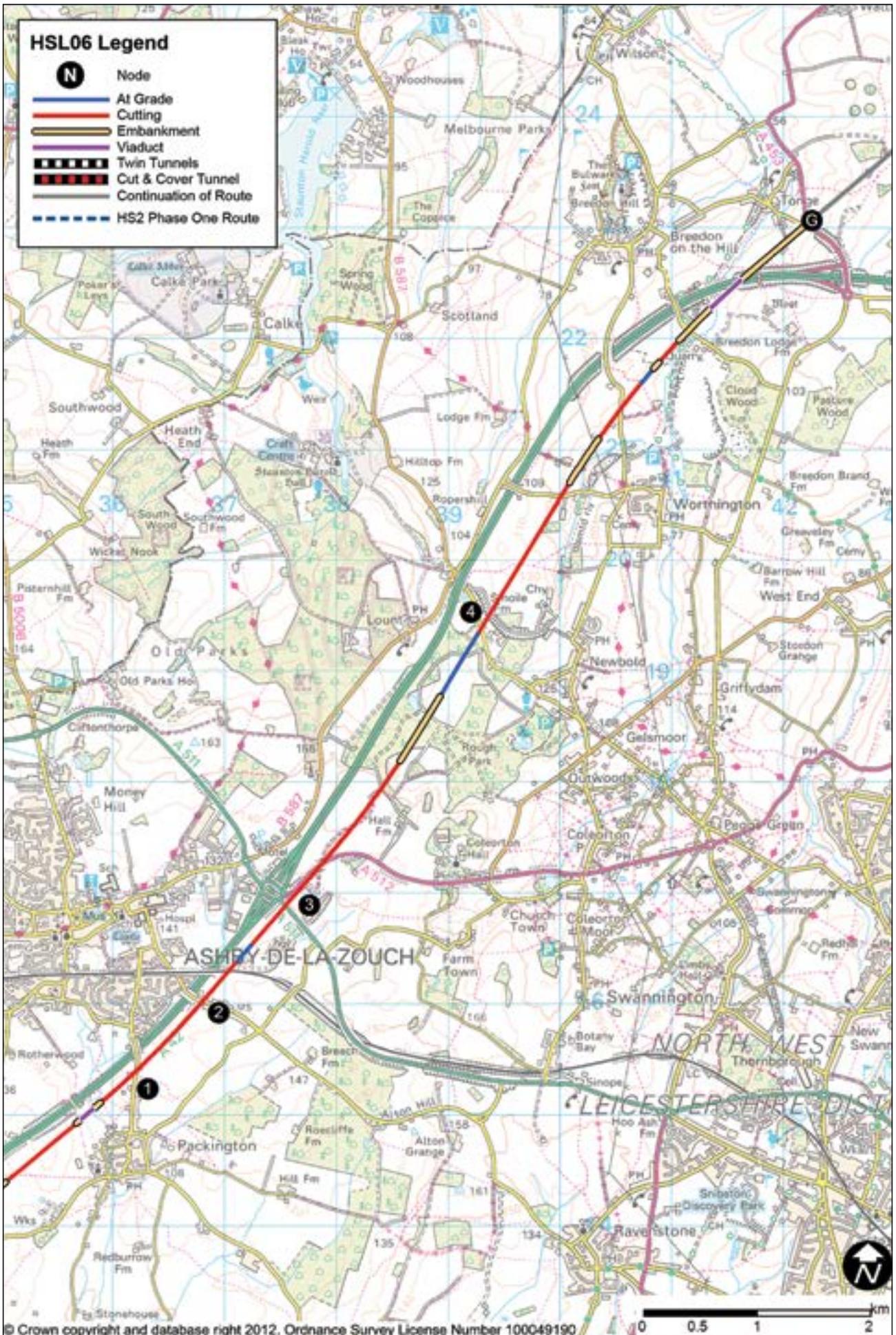
Birchmoor to Appleby Parva

- 3.3.2 The route will cross the M42 immediately north of Green Lane (1). Green Lane will have to be replaced, involving temporary closure. The route will pass below the M42 in a box structure. Extensive temporary motorway works are expected. This crossing point will be close to Birchmoor.
- 3.3.3 The route will then pass below the B5000, which will have to be raised on its present alignment by about 4m to provide clearance. The route will be approximately at existing ground level just north of the B5000.
- 3.3.4 While still broadly following the M42 corridor, the route will not be able to closely follow its more sinuous course in view of the design speeds required.
- 3.3.5 The route will cross the Coventry Canal about 10m above the canal's level, and then it will cross the West Coast Main Line railway (2) north-west of Polesworth, about 100m east of where the M42 crosses that railway. The high speed line will be at about the same level as the M42, affording the same clearance over the railway as currently exists at the M42 crossing.
- 3.3.6 The route will then pass onto a viaduct (3) to carry it over the River Anker, its floodplain and Linden Lane, at a typical height of about 16m above ground. Immediately north of Linden Lane, the route will briefly follow the motorway boundary. The route will then deviate from the motorway, heading towards Austrey Meadows, crossing the floodplain on a 310m length viaduct (4), about 7m above ground.
- 3.3.7 The route will pass west of the edge of Austrey (5), close to ground level. The route will rise with the terrain, being on embankment and bridging over No Man's Heath Lane, about 8m above ground. It will then enter a deep cutting at the crest of the hill (6), to a maximum cutting depth of about 13m. This is the hill through which the M42 cuts, with its arched bridge at the summit.
- 3.3.8 As the motorway swings towards M42 Junction 11 (7), the railway will broadly follow its course, and will pass below the A444 Atherstone Road and Tamworth Road in cutting typically 12m deep. Both these roads will be diverted to accommodate the railway, all west of Appleby Magna.



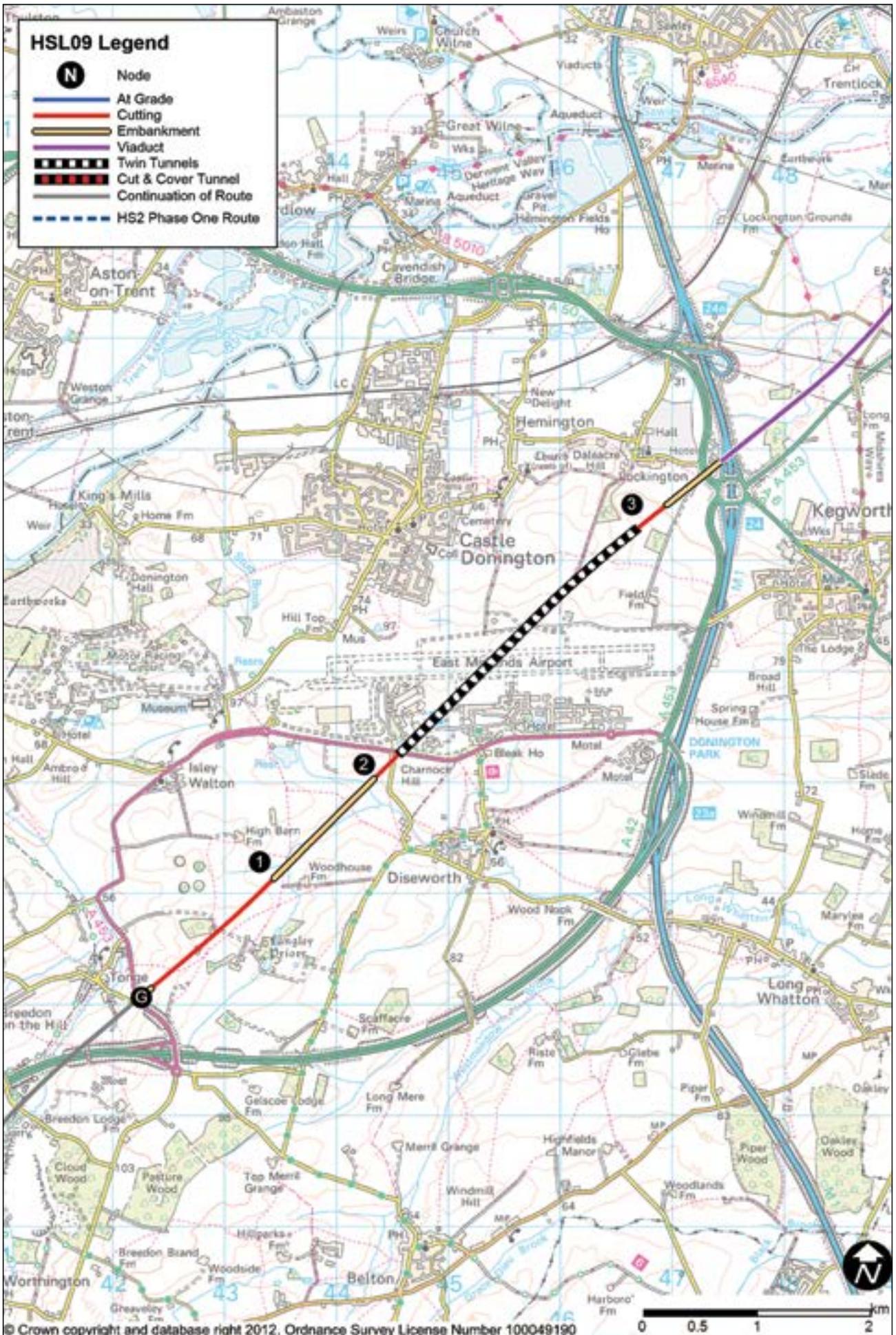
Appleby Parva to Packington

- 3.3.9 The route will descend to cross the River Mease (1) and its floodplain on a viaduct of 145m length and 19m height. The main river channel is about 5m in width.
- 3.3.10 The route will then pass the westerly edge of Measham, rejoining the A42 corridor. It will cross over Repton Road, with Huntingdon Way realigned to Burton Road. The route will then rise, to the level of the A42, passing over Burton Road, using a retaining wall along its eastern boundary to minimise property effects at Measham.
- 3.3.11 The route will pass under New Street, adopting the alignment and position of the A42, which will have to be re-aligned laterally to the west by a maximum of 90m (2) and over a distance of 2.9km. The A42 realignment will have consequential effects on the roads it crosses, such as Burton Road and New Street. The route will lie to the north-west of the existing A42 noise and landscape bunding, which will be retained (the road effectively having moved away by a maximum distance of 90m).
- 3.3.12 This section of the route will cross an area of opencast coal workings, and underground mineworkings may be present.
- 3.3.13 From Measham northwards, and for the next 8 miles (13km), the route will follow the A42 rather more closely, typically lying 300m to its south-east. It will be in cutting, of depth about 14m, to pass under Willesley Road and the B4116 (3), which will remain at their present levels. There will be a shallow embankment before the route passed into another cutting, before a viaduct (4) of 130m length over a floodplain where Vicarage Road will have to be raised on its existing alignment to pass over the route west of Packington.



Packington to Tonge

- 3.3.14 By now closely paralleling the A42 on its eastern side, the route will pass under Ashby Road (1), which will remain at its present level. In shallow cutting, the route will pass under Leicester Road (2) and under the Leicester to Burton railway, which will remain at its present level.
- 3.3.15 The route will then pass close to the A42's junction with the A511 and the A512, affecting the eastern side of the roundabout (3). The railway will be at the A42's level. A new easterly side roundabout junction will be created, involving the realignment of the A512 and the A511. The railway will be typically 12m below ground in this location.
- 3.3.16 The route would then run north-eastwards, crossing Melbourne Road (4) at the road's present level, so that the road would have to be raised on its present alignment to pass over the railway. The route would then cross under Long Hedge Lane, which would have to be raised.
- 3.3.17 Continuing to run broadly parallel to the A42, about 300m to its east in a mix of shallow cutting and embankment, the route would pass in cutting under Breedon Lane, which would need to be raised slightly. The route would then pass over Stocking Lane and onto a 360m viaduct, up to 16m high, to pass over a floodplain and the A42. The route would then be on embankment of between 8m and 15m height to cross the A453 to the immediate east of Tonge.
- 3.3.18 Much of this section of the route would cross backfilled opencast coal sites and potentially shallow mineworkings.



3.4 HSLog: Tonge (G) to Long Eaton (H)

- 3.4.1 The route section between Tonge and Long Eaton would be 14.2km long. The section of route connecting to Tonge from the south would be HSLo6 from Birchmoor. At Long Eaton, the route would continue north along HSL12 to Trowell. This route section would take the route through the Toton area, to provide a station there.

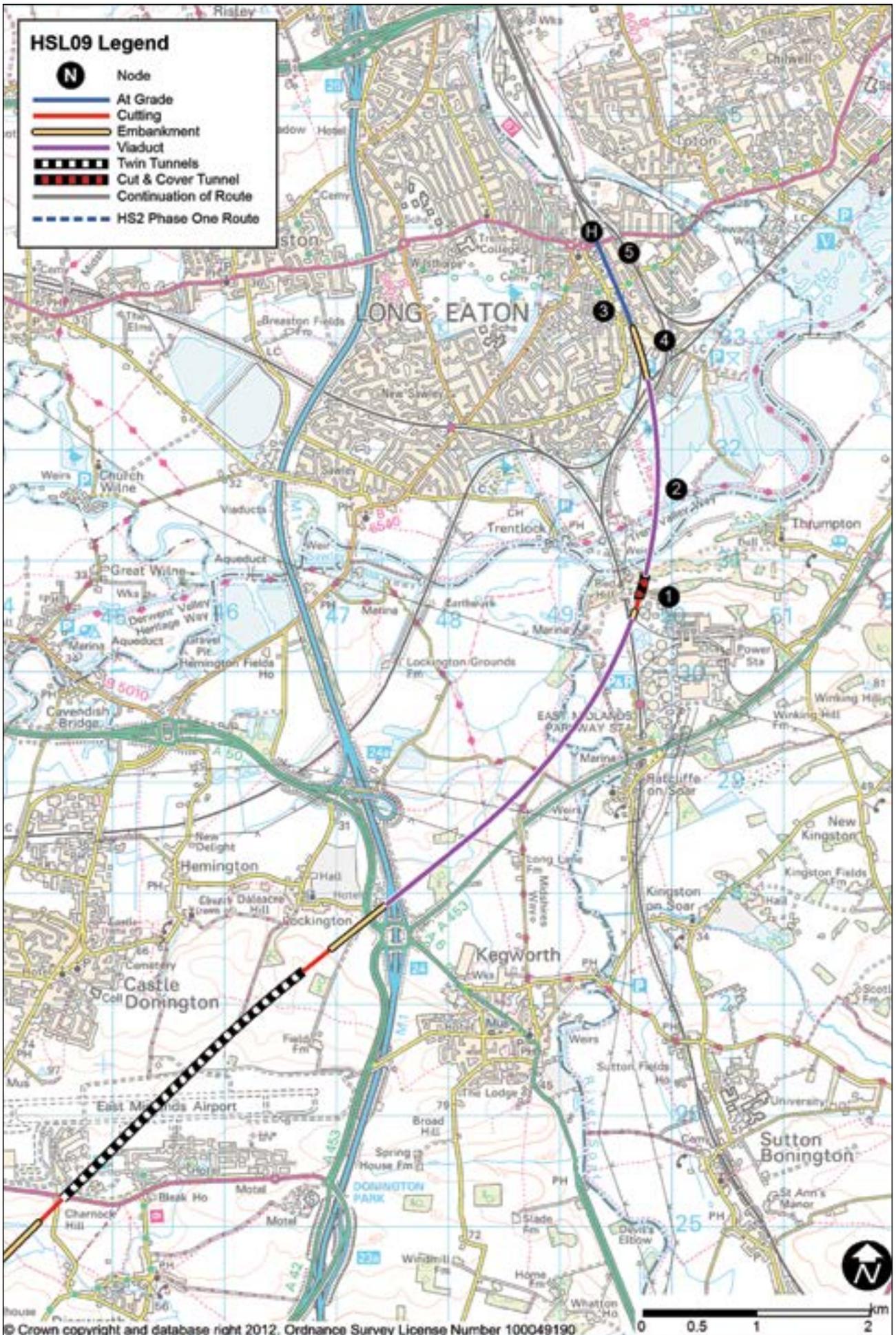
Tonge to Kegworth

- 3.4.2 From Tonge, continuing to head in a north-easterly direction, the new high speed railway would leave the A42 corridor.
- 3.4.3 The route would enter a cutting up to 14m deep, and then would pass onto an embankment of 5m height near Woodhouse Farm (1). The route would then cross Diseworth Brook twice, before descending into cutting then tunnel to pass under East Midlands Airport. At the tunnel's southern portal (2), just south of the A453, the route would be about 17m below ground.
- 3.4.4 The tunnel would be 3.0km in length. It would consist of twin tunnels, meaning that there would be two tunnels, one carrying the northbound track, and the other the southbound. In plan, the route would pass under the hangars and apron facilities, and to the immediate west of the terminal buildings, before passing almost exactly under the mid-point of the main runway. The north-easterly tunnel exit portal (3) would be immediately north of the proposed East Midlands Gateway. One ventilation shaft would be needed for this tunnel and would be located immediately north of the airport boundary.
- 3.4.5 The tunnel would pass through Mercia Mudstone, and it is not expected that ground settlement would be an issue, as the depth of the proposed tunnel would typically be 36m under the runway. Groundwater issues may be of concern.



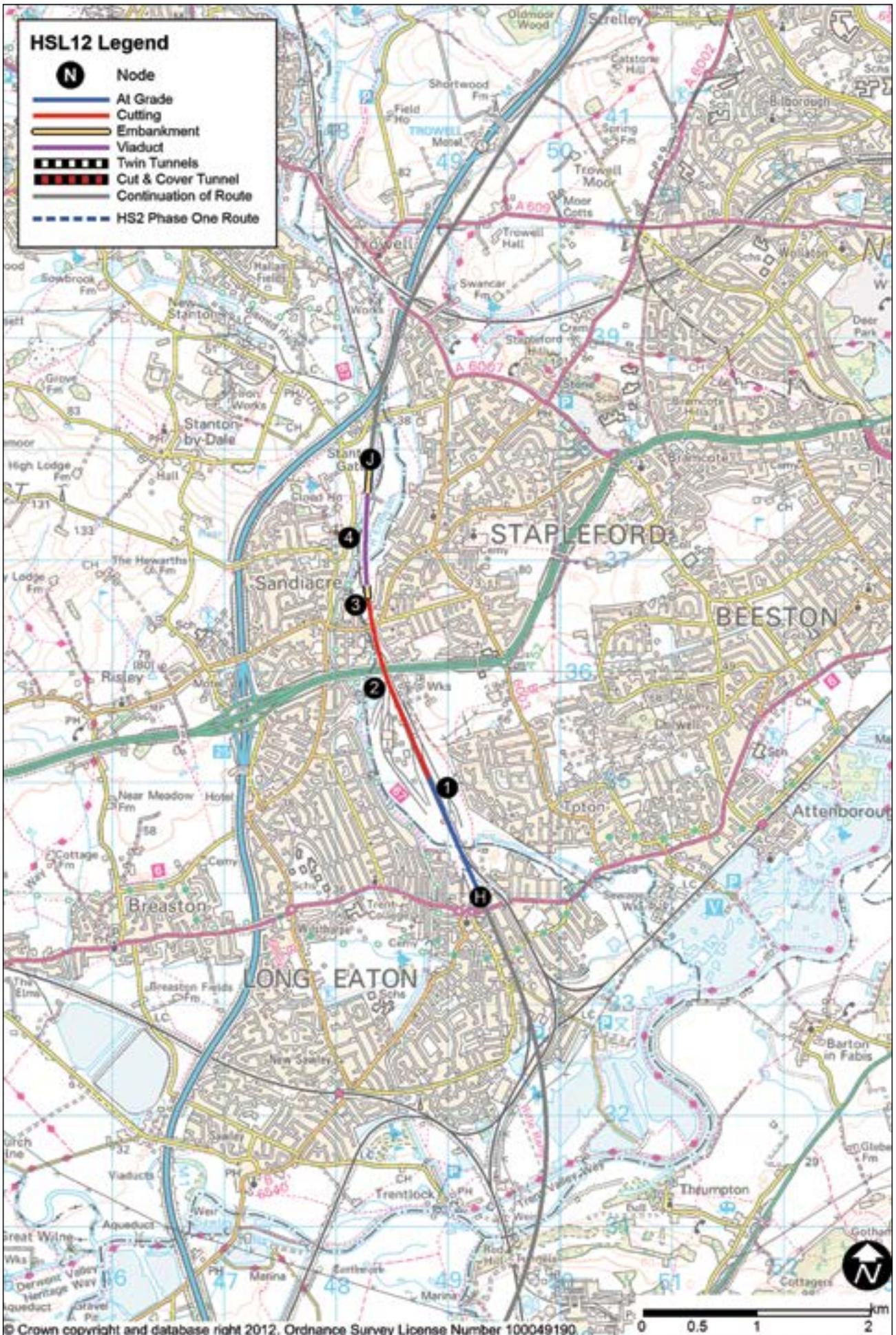
Kegworth to Red Hill

- 3.4.6 North of the tunnel exit portal (1), the route would rise to pass over the A50 (2) on a bridge. After a section of embankment there would be a 3.4km viaduct (3), which would carry the route over Junction 24 of the M1's slip roads at a height of 11m over the motorway, and up to 14m high over Ratcliffe Lane, the River Soar and its floodplain near Ratcliffe Lock, the access to Redhill Farm, the Midland Main Line (4) and the rail access to Ratcliffe-on-Soar power station.
- 3.4.7 The construction of a viaduct may require complex temporary works on the motorway, exacerbated by the proximity of Junction 24 of the M1 and its slip roads. The viaduct would also be founded in difficult ground conditions and construction access to the site of the viaduct would be constrained.
- 3.4.8 The design speed would reduce from 400kph to 320kph on the first part of the viaduct, and then reduce further to 275kph, near the Midland Main Line, due to the tight radius required as the route curves northwards towards Long Eaton.



Red Hill to Long Eaton

- 3.4.9 The route would pass through the escarpment of Red Hill at a depth of 20m. There are beds of gypsum at shallow depth in this area, which may be affected by dissolution and hence could present a subsidence risk. After excavating the cutting, a 200m cut and cover tunnel (1) would be created to reinstate the ridge of the hill.
- 3.4.10 Immediately north of the north escarpment of Red Hill, the route would pass onto a second viaduct (2) 1.7km long, to pass over another series of obstacles: the River Trent and its floodplain, the canalised cut-off near Cranfleet Farm, a lake west of Pasture Lane, Trent Lane, the Meadow Lane Junction to Trent South Junction railway (the high-level lines), and the Trent South Junction to Nottingham railway. This viaduct would typically be 15m above ground.
- 3.4.11 At the north end of the viaduct, the route would descend to run almost north-south through Long Eaton along, and at the level of, the present two-track railway that runs north from Trent East Junction towards Toton Yard (3). The closure of these 'low-level' lines to existing rail traffic would involve consequential widening works on the existing 'high-level' lines to the east, from two tracks to four.
- 3.4.12 The existing level crossings at Main Street (4) and Station Road (5) would be closed. Alternative east-west connections would be put in place, possibly involving major highways works. The design of these will be established in collaboration with the local authority and interested stakeholders.
- 3.4.13 The A6005 Nottingham Road is elevated above the existing railway, but its bridge would be realigned at a higher level to allow the larger gauge high speed trains to pass underneath. North of the A6005, the route would widen from two tracks to four, with the extra tracks forming deceleration lines to, and acceleration lines from, the proposed East Midlands Hub station at Toton.



3.5 HSL12: Long Eaton (H) to Trowell (J)

3.5.1 This route section between Long Eaton and Trowell would be 4.1km long and would contain the proposed East Midlands Hub station at Toton. The section of route connecting to Long Eaton from the south would be HSLog from Tonge. At Trowell, the route would continue north along HSL13 to Killamarsh. This route would broadly follow the M1 corridor.

3.5.2 Immediately north of Nottingham Road, the high speed alignment would widen from two tracks to four and then six, with the outside four tracks forming the acceleration and deceleration lines leading into the station platforms.

The station

3.5.3 The station (1) would provide a new transport interchange for the East Midlands. In addition to the four HS2 platforms, four new platforms would be provided on modified existing rail infrastructure to distribute passengers to and from Derby, Leicester, Nottingham and beyond. Details of the station and associated facilities are provided in section 4.1 below.

3.5.4 In the vicinity of the station and Toton Yard, the existing Trent Junction to Chesterfield (Erewash Valley) line would be diverted to pass through the proposed new station on the modified existing network, and this line would lie to the east of the high speed alignment along this length. Trains from the high-level lines would also be able to bypass the new station by utilising the new rail flyover that passes over the high speed alignment, and rejoining the Trent Junction to Chesterfield line alongside Sandiacre after passing through Toton Yard.

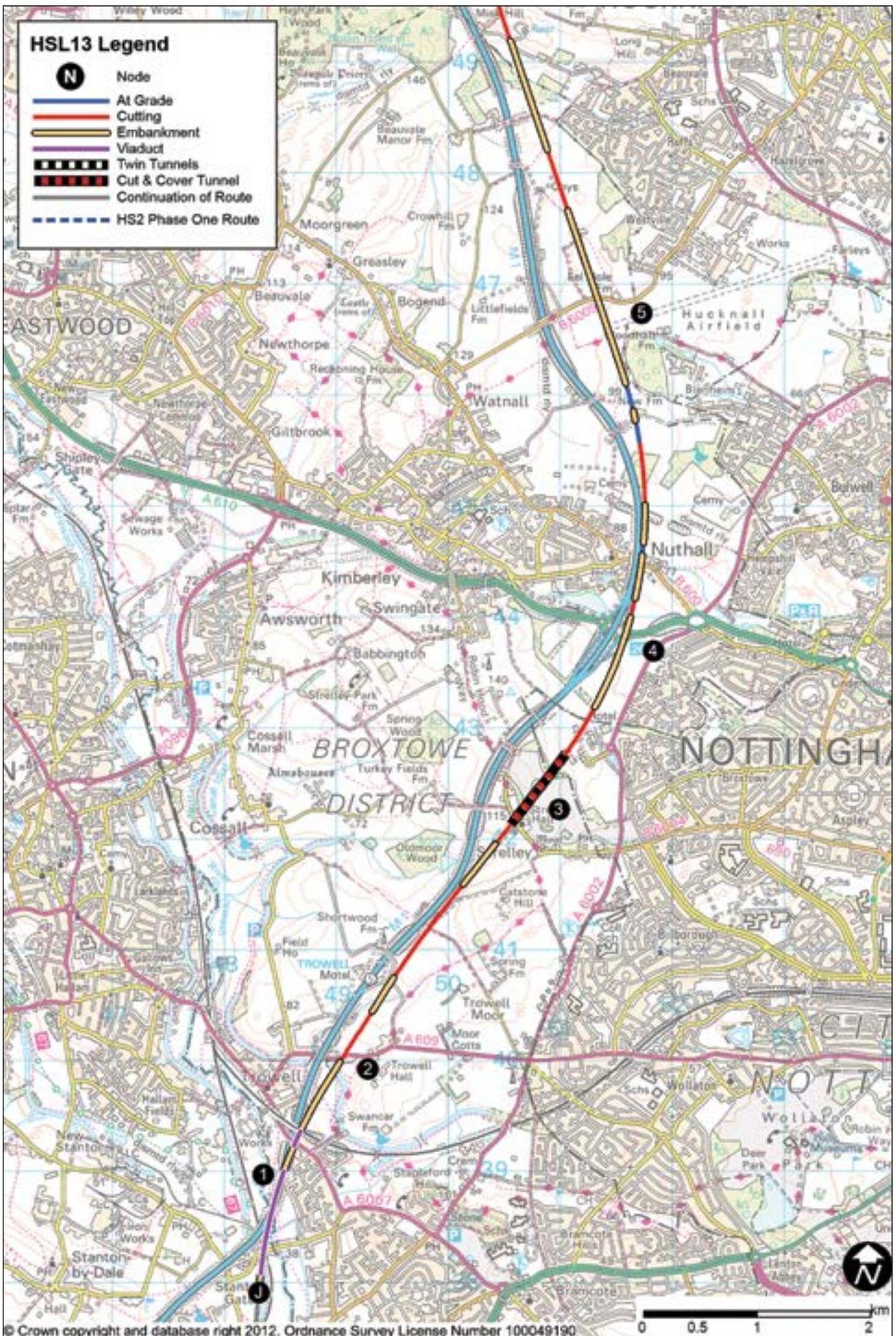
Toton station to Trowell

3.5.5 North of Toton, the high speed route would reduce from six tracks to four and then two tracks, and it would then pass under the bridge carrying the A52 Brian Clough Way over the current railway (2). The extent of the alteration of the lateral positioning of existing lines, as well as the introduction of HS2, would require that the existing bridge be demolished and replaced. As the A52 could not be closed for the duration required to achieve these works, either a new permanent off-line bridge would be constructed or a temporary off-line diversion and associated temporary structure would be needed.

3.5.6 North of the A52, the River Erewash would require diversion over approximately 100m to avoid conflict with the realigned existing lines.

3.5.7 Further north from the A52, Derby Road crosses the existing lines (3). There is insufficient vertical clearance under this structure to accommodate the new high-speed lines, and the horizontal positions of the high speed and realigned existing lines would conflict with the supports of the existing structure. The structure would therefore have to be demolished and replaced about 2m higher.

3.5.8 North of Derby Road, the route would rise in level, climb out of the Erewash Valley, and swing eastwards to run parallel to the M1, north of Stanton Gate. About 550m north of Derby Road, the route would cross the River Erewash, the Erewash Canal and the realigned existing Erewash rail lines, on a 780m viaduct (4).

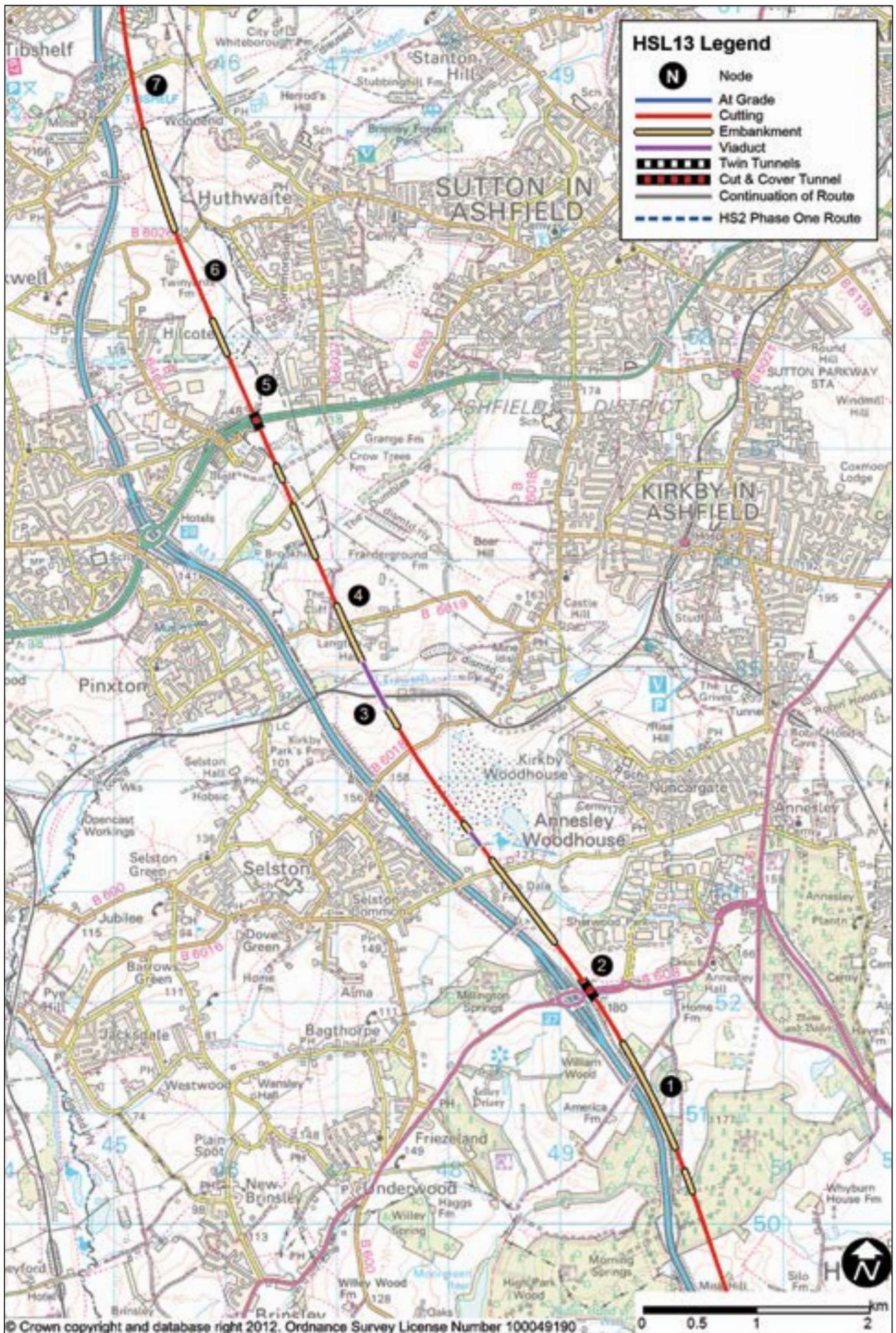


3.6 HSL13: Trowell (J) to Killamarsh (F)

3.6.1 The route section between Trowell and Killamarsh would be 44.3km long. The section of route connecting to Trowell from the south would be HSL12 from Long Eaton. This route would broadly follow the M1 corridor towards Killamarsh. At Killamarsh, the route would continue north along HSL14, which passes the Tinsley (M1) viaduct, with a station at Sheffield Meadowhall.

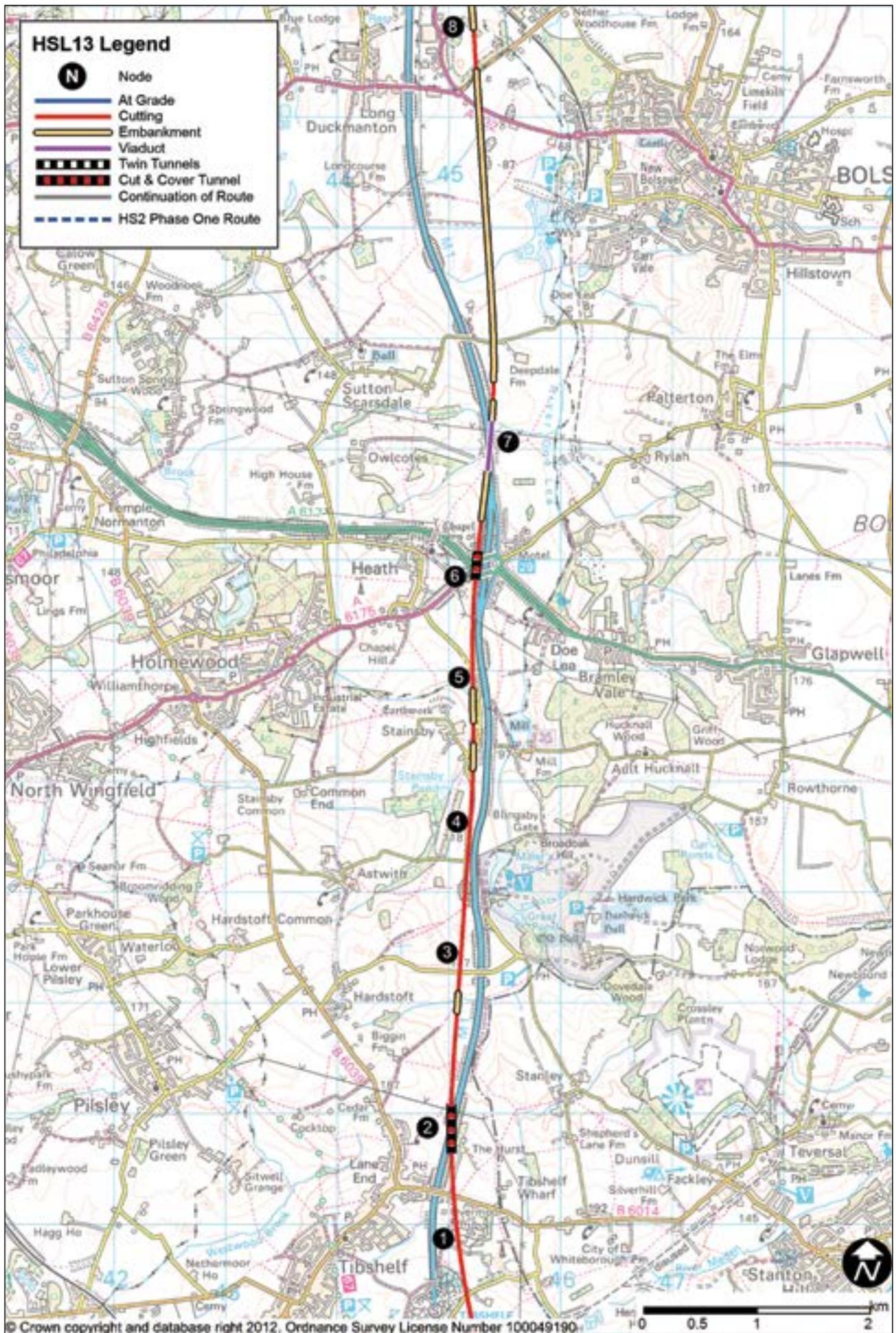
Trowell to Misk Hill

- 3.6.2 For 5.0km until Junction 26 of the M1, the route would broadly follow the south-eastern side of the motorway. The M1 (1) would be realigned over a length of 1.7km, moving about 125m west of its present position to accommodate the high speed line.
- 3.6.3 The route would then cross the A609 Nottingham Road (2), which would be realigned. The line speed would rise to 300kph from the 275kph applied through Toton. The route would enter a cutting up to 6m deep, before following the rising ground levels.
- 3.6.4 The route would pass under Main Street in Strelley to the west of the church and, in doing so, enter a 770m long cut and cover tunnel (3) created by enclosing the railway in a box structure and re-filling above the roof to restore the original ground surface. The route would emerge from the tunnel at Nottingham Business Park and bear northwards to run alongside the M1. It would pass over the A610 to the east of Junction 26 of the M1 (4).
- 3.6.5 For the next 1.2km, the route would run very closely alongside the M1, requiring sections of retaining wall between the railway and motorway to allow for minor differences in level. It would pass over the B600 Nottingham Road, immediately adjacent to and at the same level as the M1.
- 3.6.6 The route would continue northwards and climb out of the valley, passing through New Farm Wood and to the west of Bulwell Wood. The speed would then increase to 400kph. The route would follow the motorway on its eastern side for about 10km, with up to 500m between the high speed line and the M1, due to the sinuosity of the motorway corridor. A bridge would be required to pass over the B6009 Long Lane (5) which would remain in its present position.



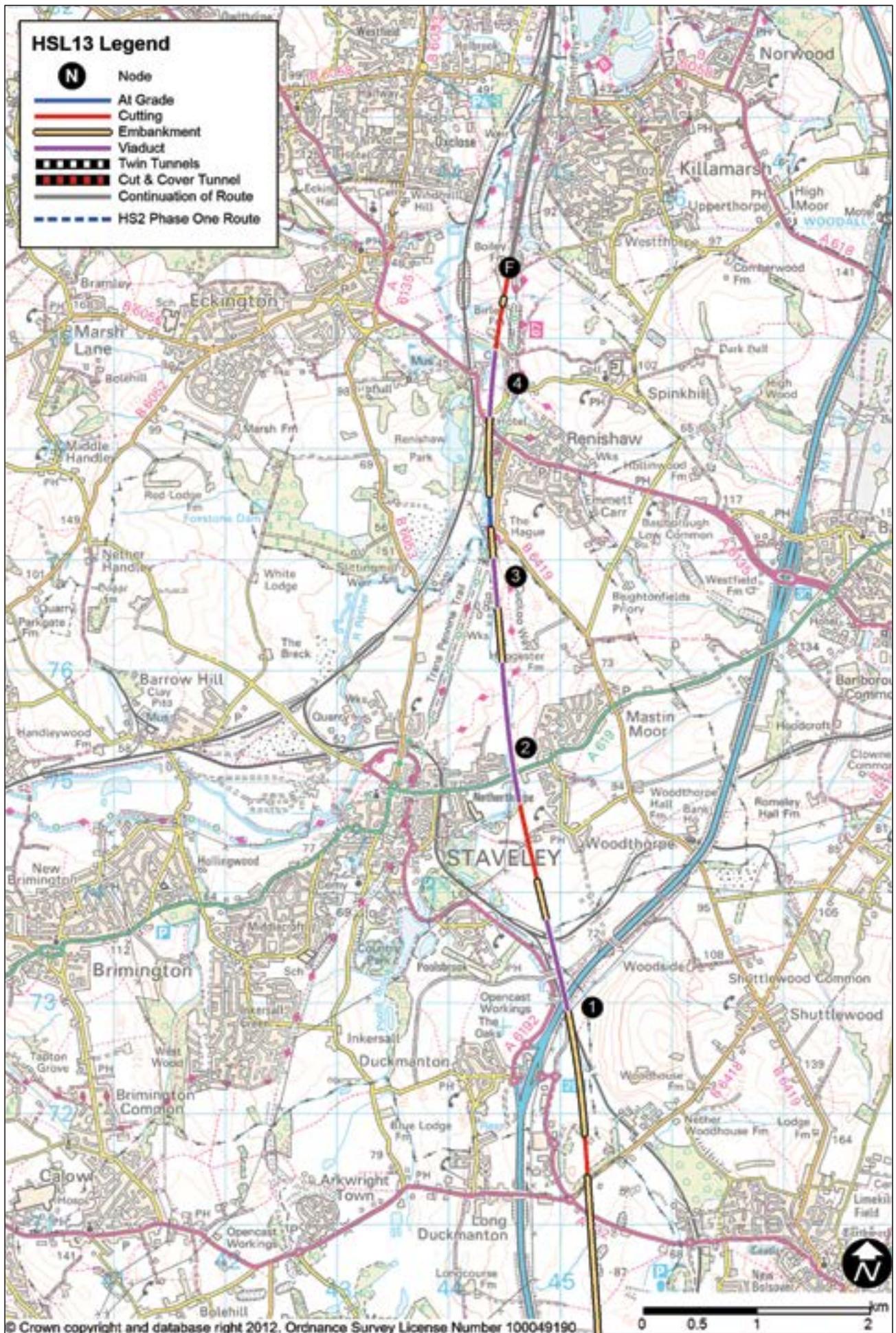
Misk Hill to Tibshelf

- 3.6.7 The route would continue to rise and follow the M1, passing through two sections of deep cutting at Misk Hill and Park Forest, with local depths of up to 19m and 23m respectively. It would then closely follow the motorway (1) again at The Dumbles, about 1.2km south of Junction 27 of the M1. On the approach to the motorway junction, the route would pass into cutting, typically 12m deep.
- 3.6.8 Just east of Junction 27 of the M1 (2), the route would pass under the A608. The route would then diverge from the motorway to the east, as it would be unable to follow the curvature of the motorway at 400kph.
- 3.6.9 The route would continue on embankment up to 19m high, and would then pass over Salmon Lane. There would be a viaduct to carry the route over Bogs Farm SSSI. It would then enter a cutting typically 8m deep, passing under Park Lane. The route would use a viaduct (3), of 450m length and up to 35m in height, to cross the valley bottom, the railway and the floodplain, with the new railway being at a higher level than the M1.
- 3.6.10 There would be an embankment, followed by a bridge over the B6019 (4), which would remain at its present position and level. A shallow cutting of depth up to 8m would be followed by a bridge over Maghole Brook, while Brookhill Lane would be diverted and raised to pass over the route.
- 3.6.11 The route would pass in cutting to the immediate east of a large retail unit, before passing below the A38 (5) at a depth of 23m.
- 3.6.12 The route would pass between the industrial/warehousing areas between Wincobank Farm and Export Drive, and would cross a floodplain and historic landfill site, before passing east of Hilcote (6) in cuttings up to 8m deep. The route would pass under the B6026 Huthwaite Lane, which would be raised slightly.
- 3.6.13 The route would rise with the landscape, passing to the immediate east of Tibshelf Motorway Services Area (7) which would be protected by a retaining wall to minimise land take, and under Newtonwood Lane.
- 3.6.14 Much of this route section would be affected by underground and opencast coal mineworkings.



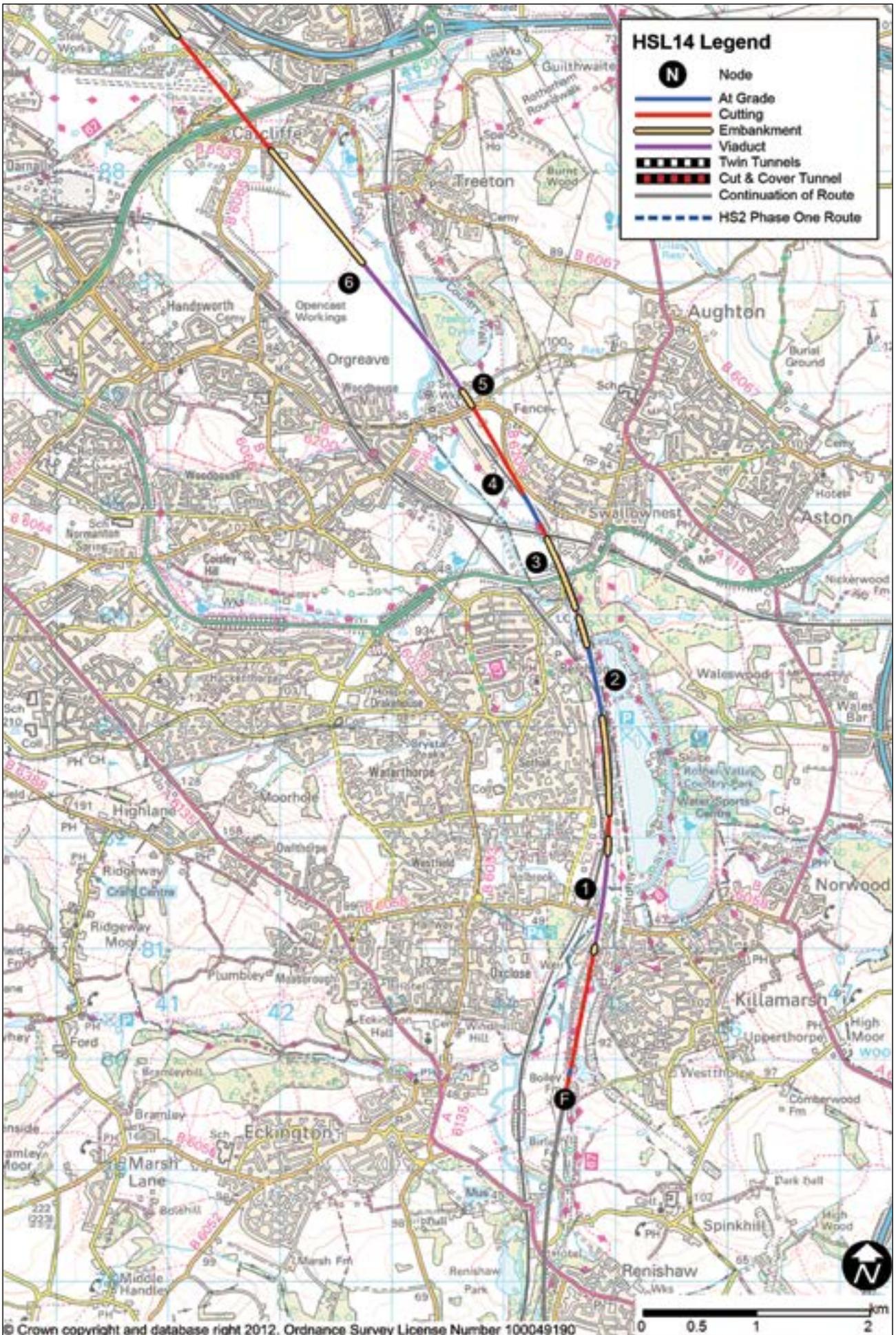
Tibshelf to Long Duckmanton

- 3.6.15 In a cutting up to 18m deep, at the crest of a vertical curve, the route would pass through some commercial premises south of the B6014 Mansfield Road in the Overmoor Farm area (1) before passing under the B6014.
- 3.6.16 The route would now cross to the western side of the M1, passing below the motorway (2) about 600m north of Mansfield Road. The route would be 8m below the level of the motorway, which would likely be temporarily re-aligned to the west. For the next 6.0km, the route would run relatively close to the M1's western side. Apart from a short length of about 100m south of Deep Lane, the route would be in continuous cutting, at depths of between 2m and 26m. The route would then pass under Deep Lane (3), which would remain on its present line and level.
- 3.6.17 From Deep Lane to Stainsby, the route would partially use the alignment of Mill Lane, running almost north-south along its alignment (4). Mill Lane would be diverted over a length of about 3.0km. The route would be at or just below the M1's level along this length. To the immediate east of the village of Stainsby, the route would be in cutting of 15m depth, before an 8m embankment to cross the watercourse.
- 3.6.18 Immediately north of Stainsby (5), the route would enter a cutting as the ground levels rise. It would pass below Junction 29 of the M1 (6) which would be extensively but temporarily reconfigured on its western side to incorporate the connections to the A617 and the A6175.
- 3.6.19 The route would then re-cross to the east side of the M1, bridging over it (7) on a viaduct 370m long and up to 14m in height. The route would then cross Palterton Lane.
- 3.6.20 The route would run to the east of the Markham Vale Environment Centre (8), about 150m east of the roundabout junction of the A632, the A6192 and the B6418. New bridges would be required to carry the route over the A632 and the B6418. There would be a cutting up to 19m deep to the north of these crossings, passing through an area of made ground.
- 3.6.21 Much of this route section would be affected by underground and opencast coal mineworkings.



Long Duckmanton to Killamarsh

- 3.6.22 North of Long Duckmanton, the route's longitudinal profile would remain level, but the falling ground would involve an embankment between 11m and 16m high, and then an 810m viaduct, as the railway once again crosses the M1 to pass to its western side (1). The construction of the viaduct may require complex temporary works on the motorway.
- 3.6.23 From this point, the motorway starts to climb rapidly towards Junction 30, and the new route would therefore diverge from the M1 corridor until north of Meadowhall and the Chapeltown area.
- 3.6.24 The railway would pass into a 12m cutting under Bridle Road, which would be unaffected, and it would then pass to the immediate east of the Riverdale Park area of Netherthorpe.
- 3.6.25 While passing between Netherthorpe and Mastin Moor (2), the route would use a 1.3km viaduct, 7m high, to cross the River Doe Lea and its floodplain, at the same time affecting the A619 Worksop Road, which would have to be raised, itself on viaduct, to pass over the railway's viaduct. There would be a short embankment near the sewage works, before a second viaduct (3) of 420m over part of the River Doe Lea floodplain. This section of route would have additional connections to the proposed Infrastructure Maintenance Depot, which is described in section 5.1 below.
- 3.6.26 The route would run to the west of Renishaw, at about ground level, just avoiding the B6419 Hague Lane, at The Hague. It would rise to pass over A6135 Main Road, before passing onto a 520m viaduct (4) over the River Rother's meander, its floodplain and Spinkhill Lane. It would then run north in continuous cuttings between 7m and 12m deep, towards Rother Valley Country Park.
- 3.6.27 Much of this route section would be affected by underground and opencast coal mineworkings.



3.7 HSL14: Killamarsh (F) to Tinsley (K)

3.7.1 The route section between Killamarsh and Tinsley would be 12.4km long. The section of route connecting to Killamarsh from the south would be HSL13 from Trowell. At Tinsley the route would continue north along HSL15 to Blackburn, with a station at Meadowhall.

Killamarsh to Catcliffe

3.7.2 West of Killamarsh, the design speed would fall to 350kph in order to minimise impacts on the Rother Valley Country Park. The route would pass onto an 850m viaduct (1) to cross the B6058 and the River Rother floodplain.

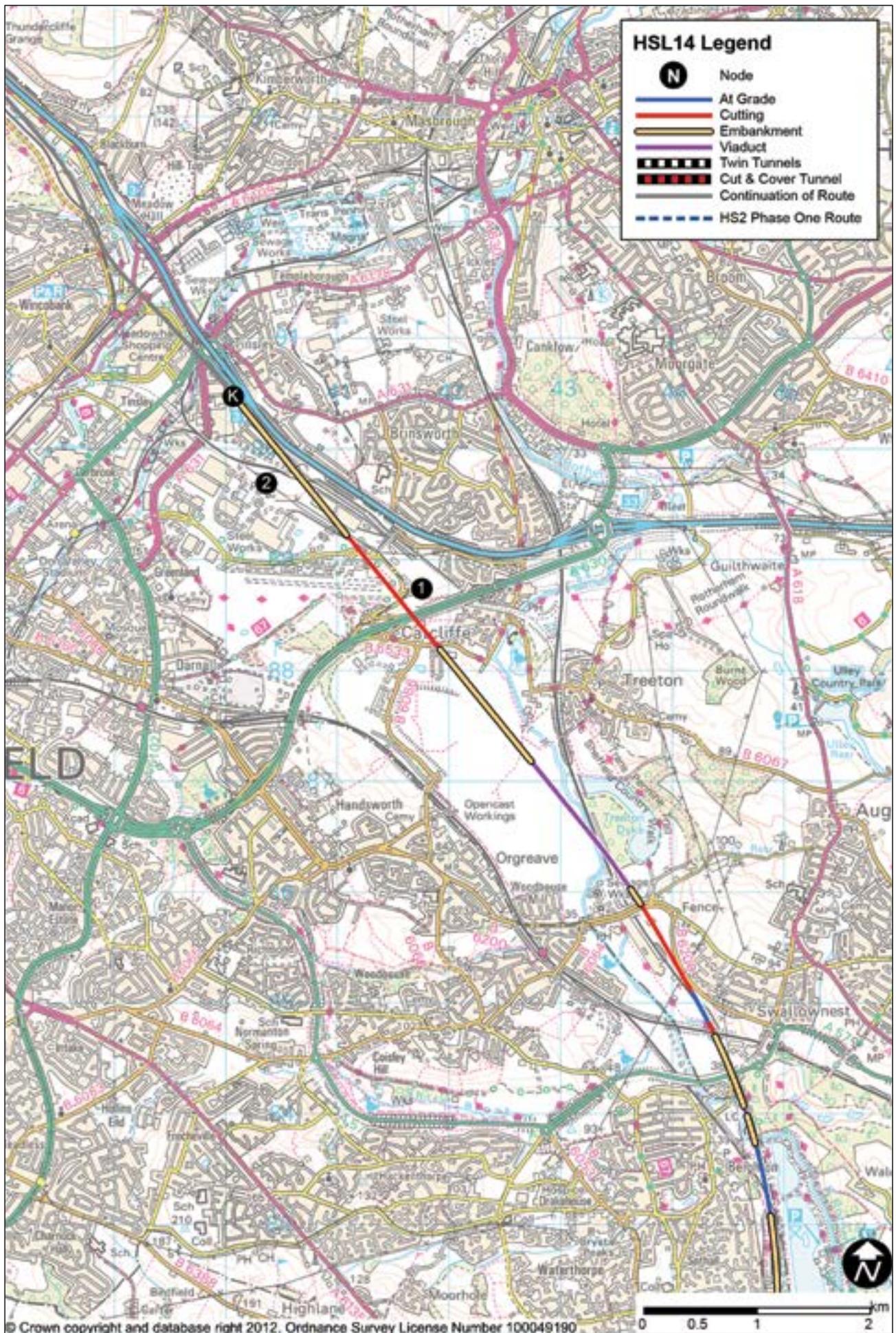
3.7.3 The route would then adopt the alignment of the existing Chesterfield to Rotherham Railway, which would have to be slewed (2) approximately 30m westwards and over a length of 3.4km towards Holbrook, Sothall and Beighton to accommodate the route. The slewed existing railway and the new route would be at the level of the existing railway.

3.7.4 North of the Rother Valley Country Park, the route would remain at ground level, and the Network Rail lines would still be slewed to the west, but running in very close proximity. The new route would adopt the position of the existing Chesterfield to Rotherham railway, requiring the diversion of the A57 Worksop Road (3). Further north, the route would pass under the Sheffield to Worksop line, and a new bridge would be required. The route would then adopt an independent alignment, and the Network Rail lines would remain in their current position.

3.7.5 This section would cross areas affected by shallow coal mining.

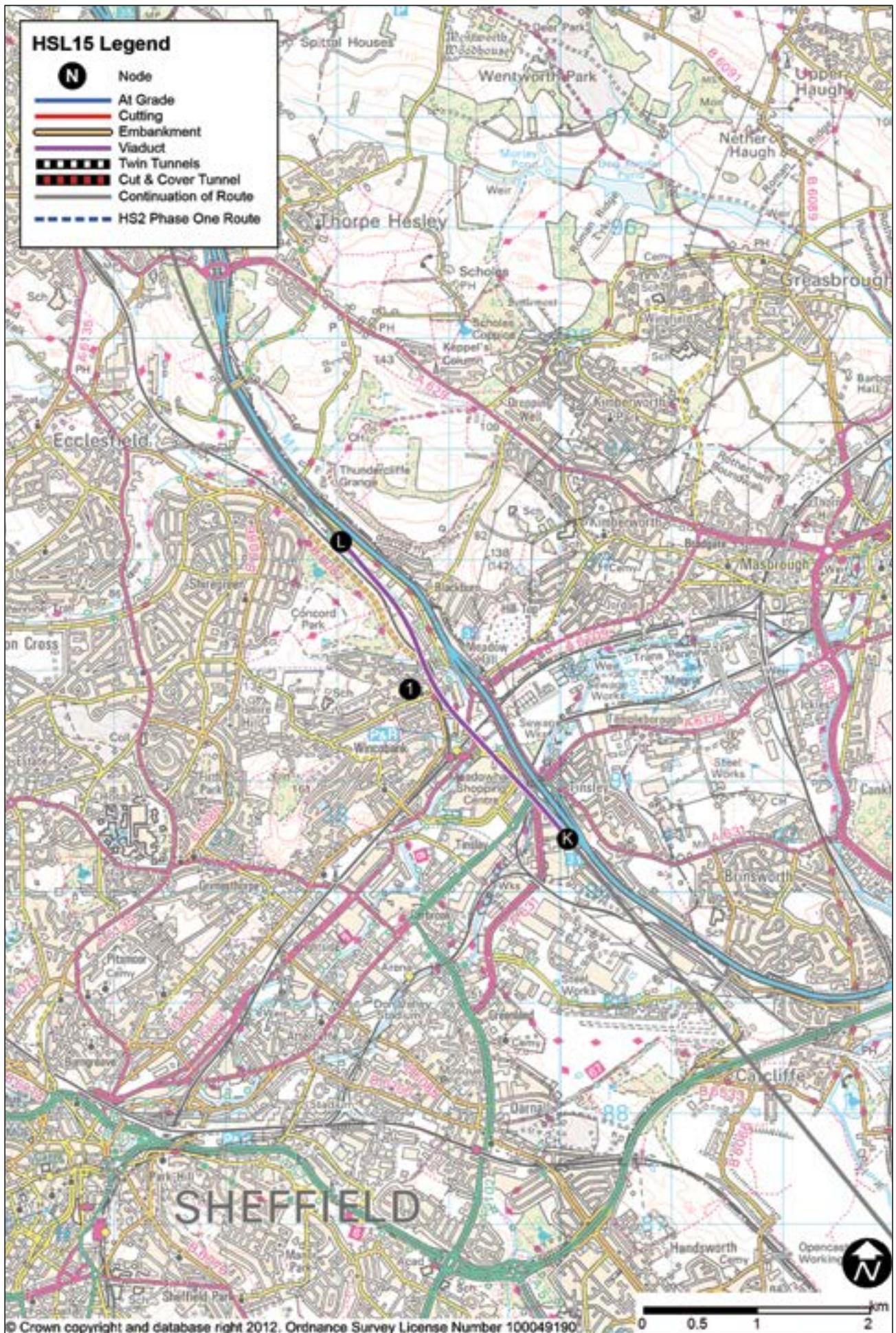
3.7.6 The route would be located along the alignment (4) of the B6200. This would bring the railway very close to housing at Haigh Moor Way. A new bridge would be required to carry the B6200 Retford Road over the railway at a higher level to accommodate HS2 trains, resulting in extensive re-modelling of the local road network.

3.7.7 North of Retford Road (5), there would be a 1.5km viaduct over the River Rother floodplain and the Chesterfield to Rotherham railway. The viaduct would typically be 8m above ground level. The route would then pass onto an embankment up to 7m high (6). A new bridge will be required for Poplar Way to cross over the route. The route would pass through the Waverley Major Development site on the former Orgreave Colliery site.



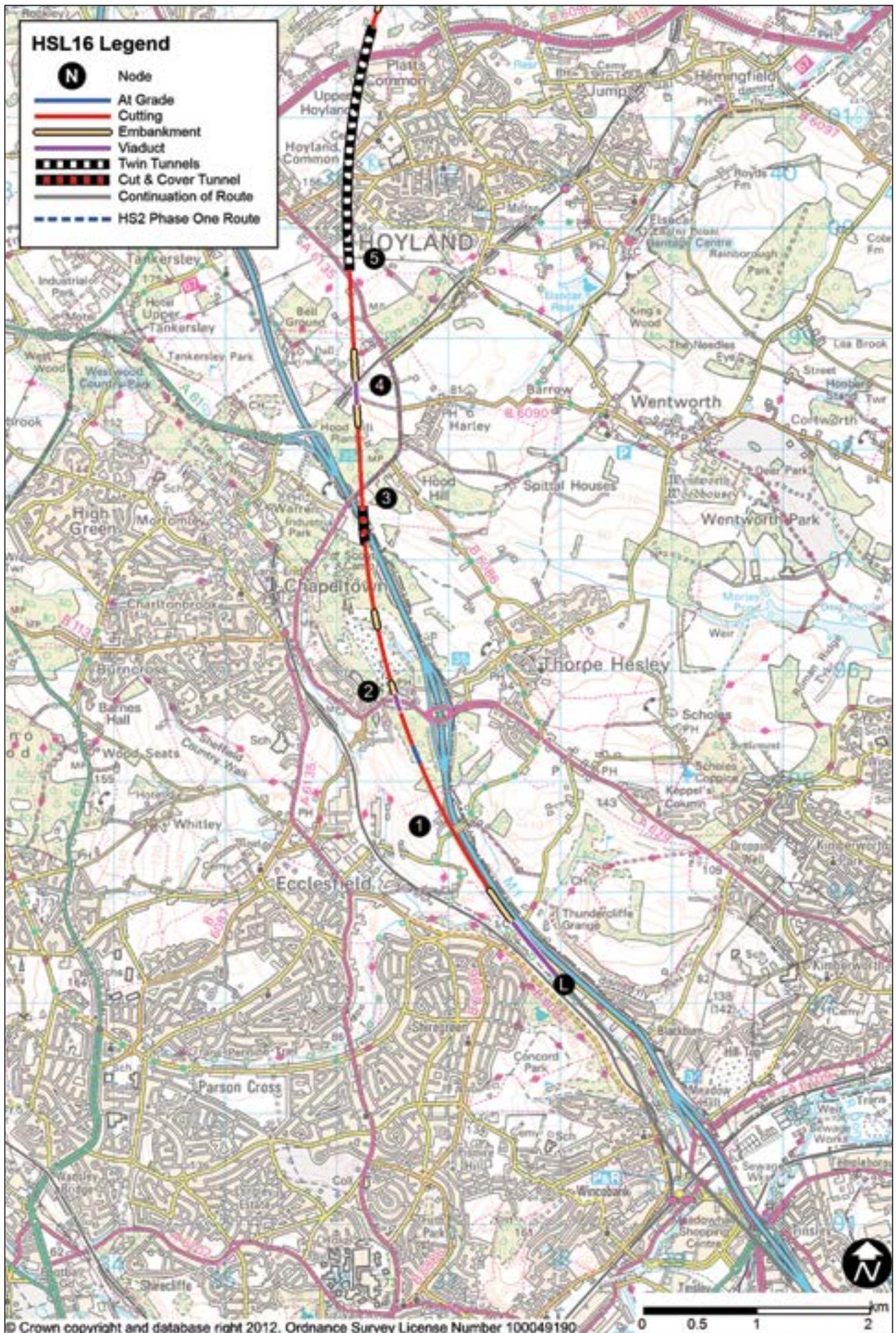
Catcliffe to Tinsley

- 3.7.8 The route would enter a 23m deep cutting to pass beneath the A630 Sheffield Parkway (1) and, twice, under Europa Link. The route would emerge from cutting and would then pass on embankment along the site of the former Tinsley Marshalling Yard (2).
- 3.7.9 This section would cross areas affected by shallow coal mining and backfilled opencast sites, but would avoid most of the opencast areas. There are also likely to be areas affected by ground contamination, for example, around the Outokumpu steelworks at the north end of this section.



3.8 HSL15: Tinsley (K) to Blackburn (L)

- 3.8.1 This route section between Tinsley and Blackburn would be 3.4km long. The section of route connecting to Tinsley from the south would be HSL14 from Killamarsh. At Blackburn, the route would continue north along HSL16 to Cold Hiendley. This route section would contain the proposed Sheffield Meadowhall station, which is described in section 4.2.
- 3.8.2 For this route, north of Tinsley, the route would be on a viaduct (1) 4.0km long and up to 22m high across the Don Valley - this being at a comparable level to the M1 as it runs across its Tinsley viaduct. The route would widen from two tracks to four, and then to six at the station location. North of the station, the route would revert to four tracks, then two.
- 3.8.3 The HS2 viaduct would run about 110m to the south-west of the M1 viaduct, crossing a series of obstacles: the A631 Shepcote Lane and A6178 Sheffield Road south of M1 Junction 34's southern roundabout; the Sheffield and Tinsley Canal; existing railways; the South Yorkshire Supertram route; Meadowhall Way; part of the Meadowhall Shopping Centre's car park; the River Don and its floodplain; Alsing Road; the Sheffield to Rotherham railway; the A6109 Meadowhall Road south of M1 Junction 34's northern roundabout; the Sheffield to Barnsley railway and Fife Street.
- 3.8.4 The route would run along the alignment of the abandoned railway from Blackburn Junction to Wakefield and parallel to the existing Sheffield to Barnsley railway and B6082 Ecclesfield Road.

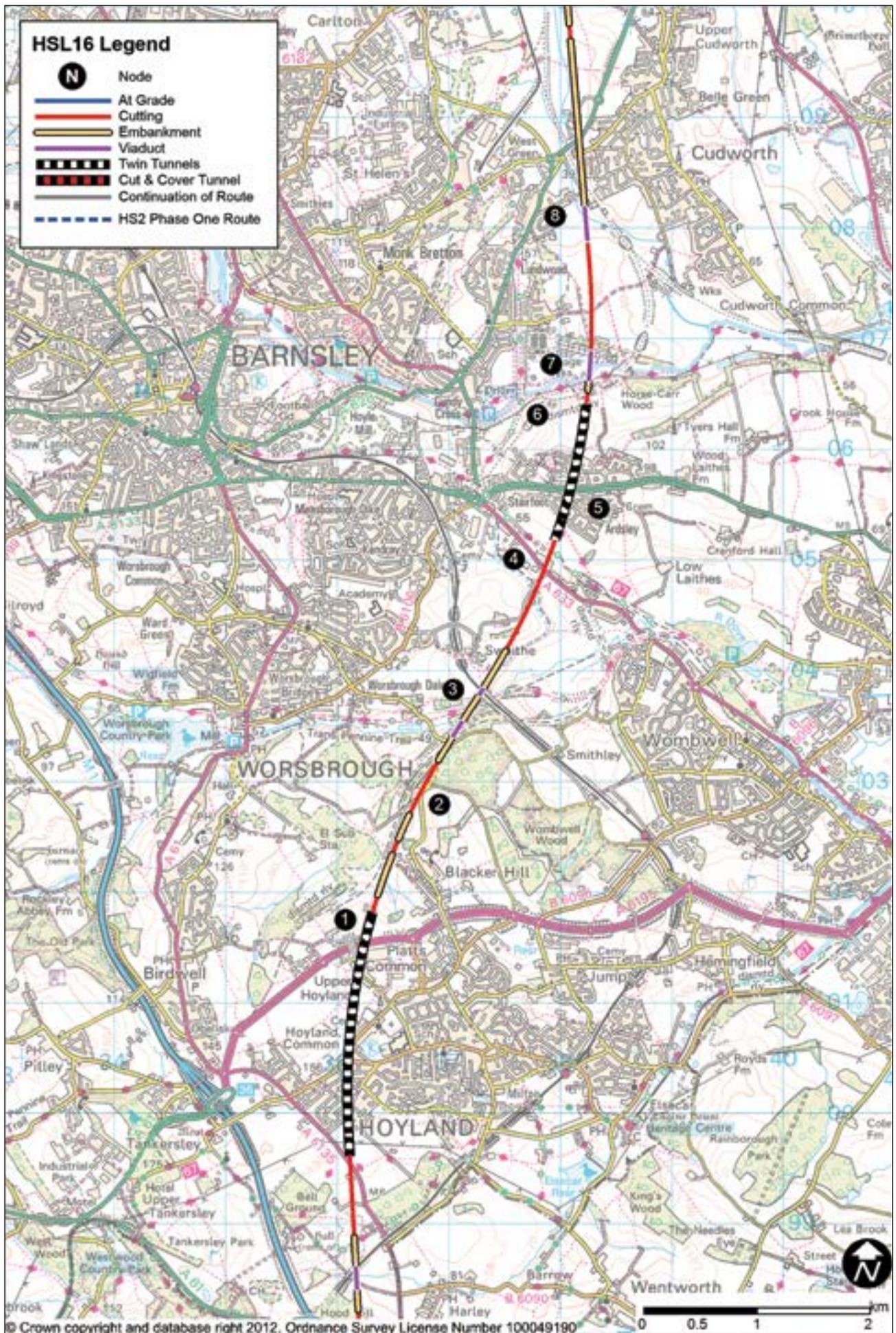


3.9 HSL16: Blackburn (L) to Cold Hiendley (M)

- 3.9.1 The route section between Blackburn and Cold Hiendley would be 23.1km long. The section connecting to Blackburn from the south would be HSL15 from Tinsley. North of Cold Hiendley, the layout would be designed with spurs to York and the ECML (HSL17 via Garforth), and a spur to Leeds (HSL21 via Woodlesford).

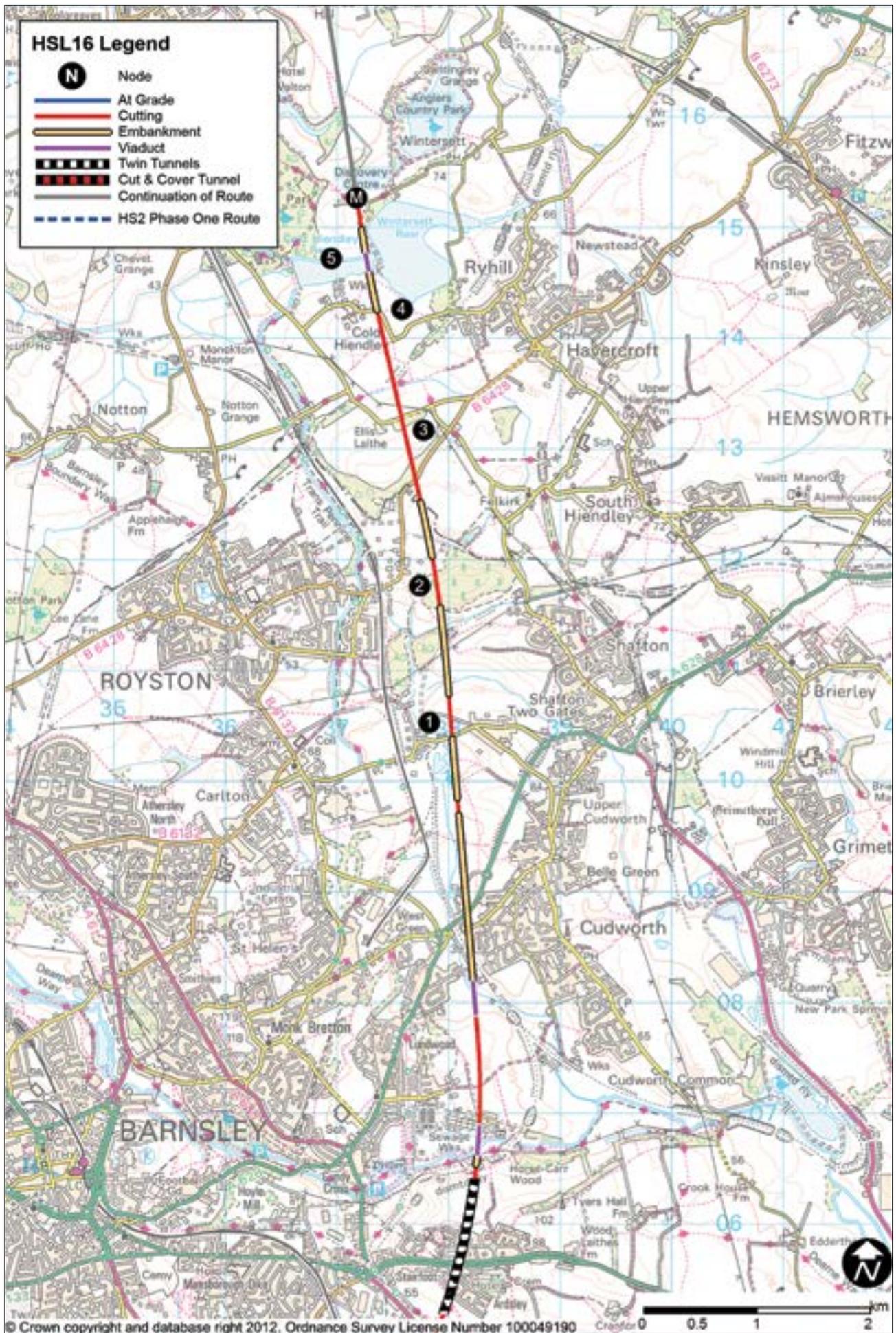
Blackburn to Hoyland

- 3.9.2 With a design speed of 360kph, the route would continue on the last 700m of the 4.0km viaduct parallel to the M1 and the Sheffield to Barnsley railway, and pass over Blackburn Brook floodplain and Deep Lane.
- 3.9.3 North of Deep Lane, the route would climb out of the Don Valley, close to existing ground levels, passing just under Jumble Lane (1). The route would then pass to the west of Smithy Wood, and over Cowley Hill (2) some 280m west of Junction 35 of the M1. All this length of route would be on difficult terrain, and there could be complex earthworks stability issues to consider, along with contamination from former industrial uses.
- 3.9.4 The route would then turn north through another area of former mine workings and landfill sites, with potential contamination issues. The route would pass through Hesley Wood, then under the M1 about 250m south of the A6135, east of Warren (3). Construction would be complicated by the proximity to the existing bridge carrying the A6135 over the motorway and temporary realignment/reconfiguration of the M1 Junction 35A. The route would then descend in cutting, before a 200m viaduct over the Sheffield to Barnsley railway line (4) just north-east of Black Lane. The maximum height of the viaduct would be about 15m.
- 3.9.5 The landscape from this point north continues to be challenging, but the route would head towards the lower-lying land of the Dearne Valley. Approaching Hoyland, the route would be in cutting under the A6135 at Hoyland Common, where the route would be about 18m below ground.
- 3.9.6 The route would then enter Hoyland Tunnel (5), whose southern portal would be 200m north of the crossing of the A6135. The twin tunnels would be 2.2km in length, meaning that there would be two tunnels, one carrying the northbound track, and the other the southbound. In plan, the tunnels would pass under Upper Hoyland near Lower Sycamore Farm.



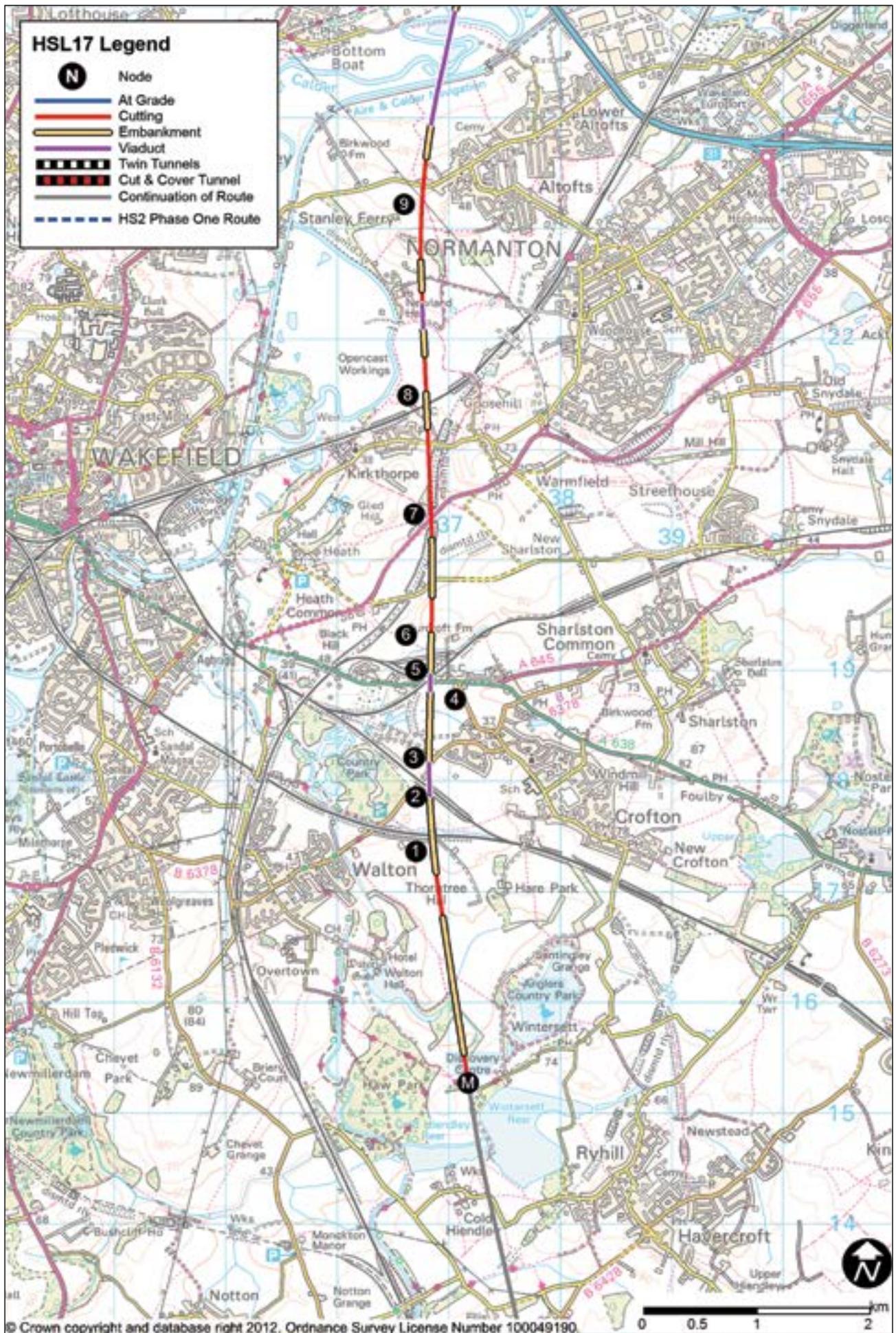
Hoyland to Cudworth

- 3.9.7 The northern tunnel exit portal would lie 200m north of the A6195 Dearne Valley Parkway, near Bank Plantation. No ventilation/intervention shafts would be required for a tunnel of this length. Mineworkings and opencast sites may affect the tunnel and its portals.
- 3.9.8 From the north portal (1) of Hoyland Tunnel, the route would involve short embankments of 8m height then 3m height, before passing below Woodhead Lane and Wentworth Road (2) in a cutting up to 11m deep, near the bottom of the valley to the west of Wombwell Wood.
- 3.9.9 The route would cross an area including the River Dove and its floodplain on a combination of embankment up to 21m high and a 135m long viaduct. The route would then run on embankment up to 13m high and a bridge over the Sheffield to Barnsley railway (3). The route would pass to the immediate east of Swaithe Hall in a cutting up to 20m in depth.
- 3.9.10 The route would fall into cutting, to pass under a realigned A633 (4) south of Stairfoot Business Park. The A633 would remain at its present level.
- 3.9.11 The route would then enter Ardsley Tunnel (5). The tunnel would be 1.2km in length. It would consist of twin tunnels, meaning that there would be two tunnels, one carrying the northbound track, and the other the southbound. The southern portal in the land south of St. Paul's Parade is likely to prove challenging due to the proximity of residential properties, and being located in an area of active landfill. Therefore, special ground improvement measures may be needed to allow the tunnel boring machines to start their drive. In plan, the tunnels would pass beneath Ardsley under Roehampton Rise and Kendal Grove, at a depth of between 27m and 59m. The northern tunnel exit portal (6) would be about 380m north of Horse Carr View, with the track level being about 25m below ground.
- 3.9.12 The route would then cross the River Dearne (7) and its floodplain on a pair of single-track viaducts, each 240m long, about 16m above the valley floor. The route would then pass to the east of the sewage works, before entering a cutting up to 12m deep to pass east of Lundwood.
- 3.9.13 The route would emerge at ground level, and then pass onto a 240m viaduct, 17m high, to cross the Small Bridge Dike (8) floodplain. It would then continue on embankment up to 13m in height, and bridge over Barnsley Road and the A628, which would both remain at their present positions.



Cudworth to Cold Hiendley

- 3.9.14 The route would use an embankment to pass to the east of Carlton Marsh Nature Reserve. The route would then pass under a diverted Shaw Lane (1), which would be raised to pass over the route.
- 3.9.15 North of Shaw Lane, the route would enter a short cutting up to 11m deep, then run on embankment up to 15m high locally, crossing over Cudworth Dyke. The route would then pass through a tip (disused) in a localised cutting of 22m depth (2). The ground is likely to be contaminated. In this area, the route would run about 500m east of the former Midland Railway line from Wath-upon-Dearne to Normanton.
- 3.9.16 The route would pass below an unaffected B6428, immediately east of Royston and the electricity sub-station, continuing into cutting of up to 26m depth. The route would pass below an unaffected Church Lane (3) in a cutting of 11m depth.
- 3.9.17 The route would then run at ground level or in cuttings up to 8m deep, approaching the Cold Hiendley Reservoir and the Winterset Reservoir. It would pass under a diverted Ryhill Pits Lane (4). The route would be very close to Croftfield House.
- 3.9.18 The route would then cross Cold Hiendley Reservoir (5), about 50m west of the dam wall between it and Winterset Reservoir. A 140m viaduct would be used to cross the reservoir.

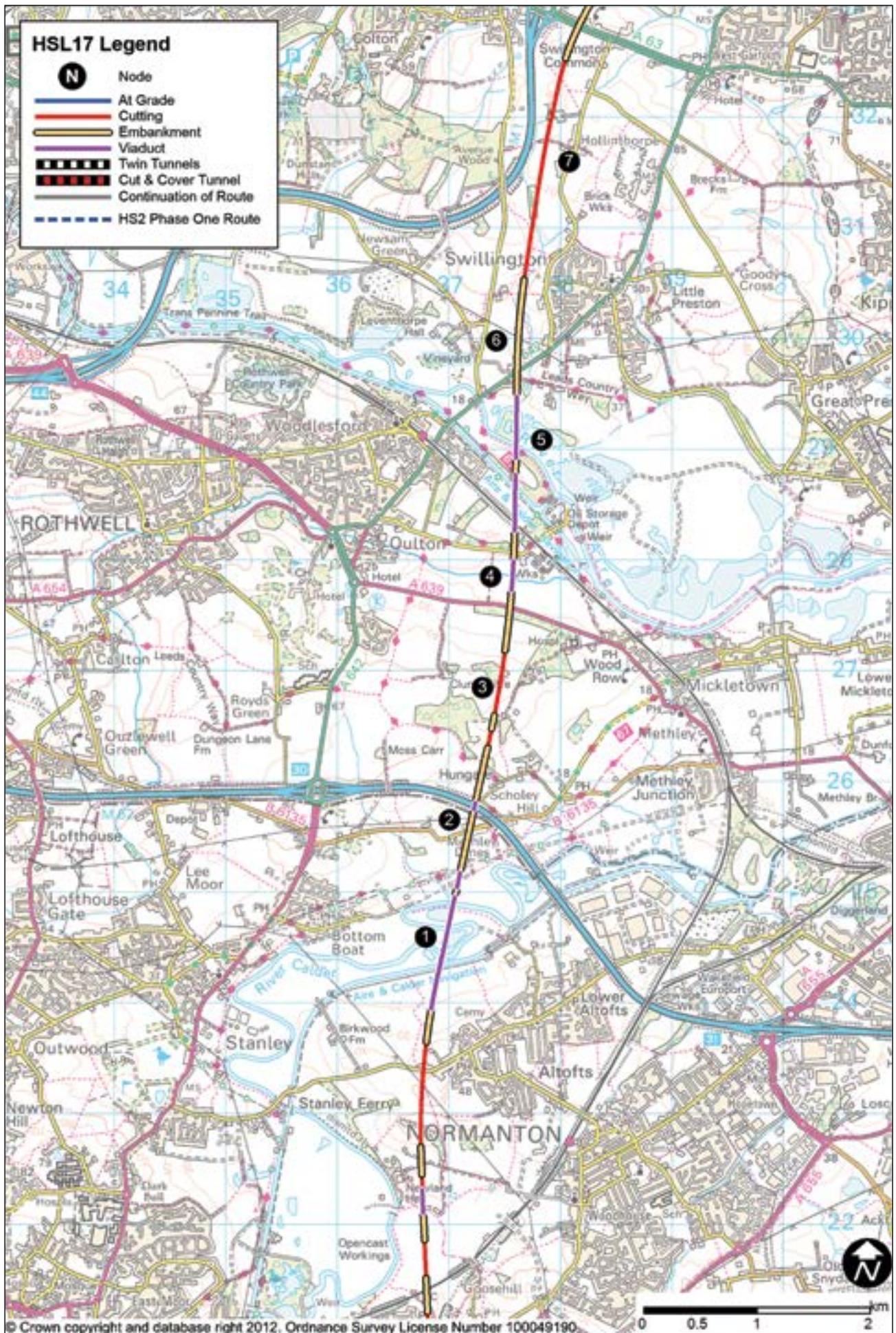


3.10 HSL17: Cold Hiendley (M) to Church Fenton (V)

- 3.10.1 This route section between Cold Hiendley and Church Fenton would be 34.1km long. The section of route from the south would be HSL16 from Blackburn. The route would run north of Garforth and, at its northern end, would connect into the section of existing railway between Church Fenton and Ulleskelf, to provide the onward connection to the ECML.
- 3.10.2 This section of route would contain the proposed Rolling Stock Maintenance Depot at New Crofton, as described in section 5.2.
- 3.10.3 This route would be combined with a spur into Leeds City Centre via Woodlesford (HSL21).

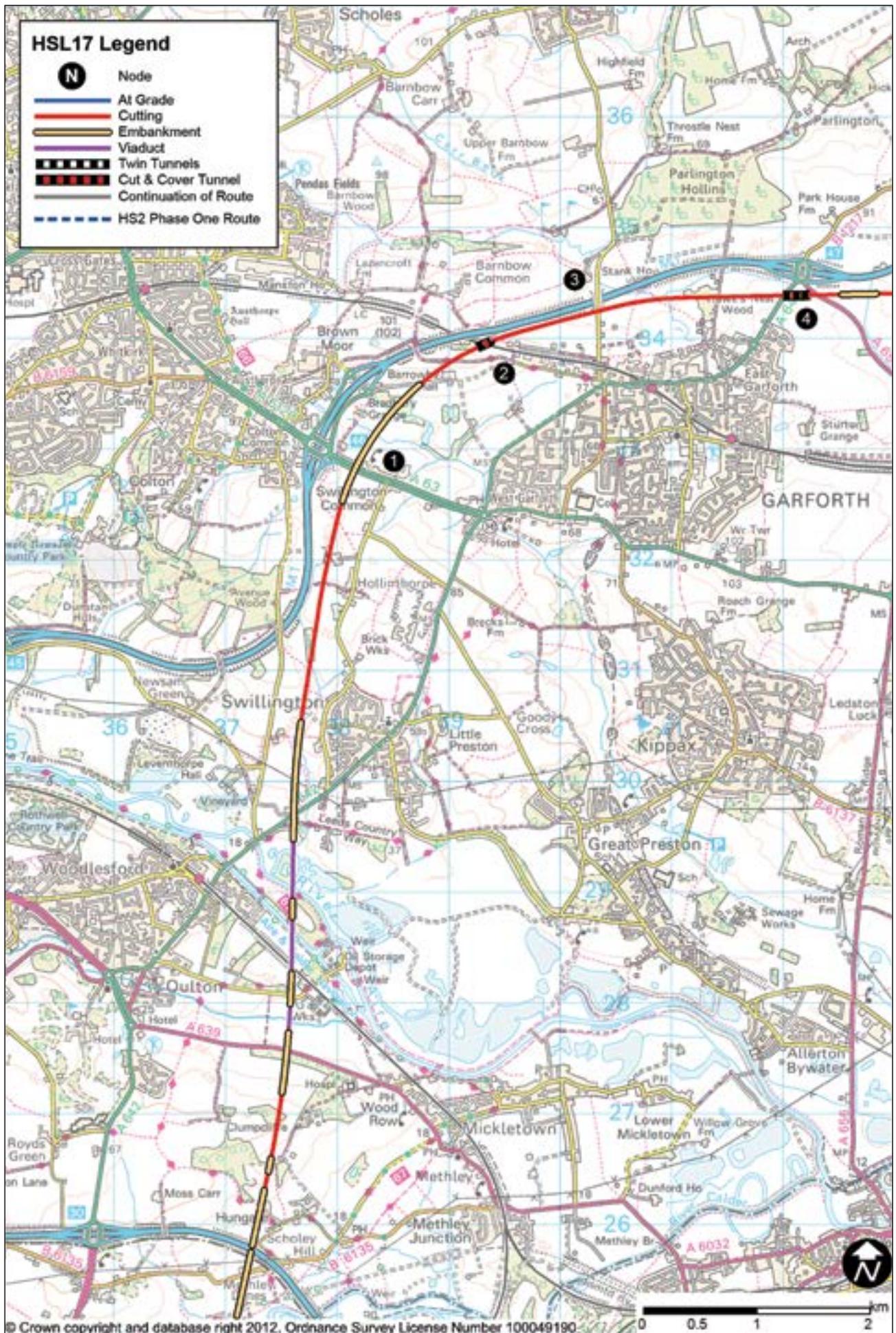
Cold Hiendley to Altofts

- 3.10.4 North from Cold Hiendley Reservoir, the route would descend into a shallow cutting, and then embankment, to run east of Walton Hall and west of Anglers Country Park. It would then pass onto a series of embankments and bridges over the next 3.0km, typically 12m but up to 22m in height, to cross a series of obstacles: the Doncaster-Leeds railway (1); the Hare Park Junction to Crofton West Junction railway (2); B6378 Shay Lane (3); A638 Doncaster Road (4) and the Crofton East Junction to Crofton West Junction railway (5) at the point where they already cross; the Crofton East Junction to Oakenshaw South Junction railway and the Train Maintenance Facility (6).
- 3.10.5 The route would then enter cutting, up to 12m deep, west of Burcroft Farm. It would pass under Hell Lane, which would be realigned to pass over the route, and then onto a shallow embankment, 4m high, before a shallow cutting passing below the A655 (7), which would be realigned to pass over the route. The cutting would increase to 11m depth, and the route would pass under a realigned Kirkthorpe Lane/Warmfield Lane. The route would pass onto an embankment 8m high, bridging the Wakefield Kirkgate to Normanton railway (8), which would be unaffected.
- 3.10.6 After a short cutting up to 9m deep, the route would approach the valley of the River Calder, crossing a section of floodplain on a viaduct up to 15m high. The route would then pass into a cutting typically 14m deep to pass under Birkwood Road (9), which would remain. The route would lie at the south-western edge of Altofts.



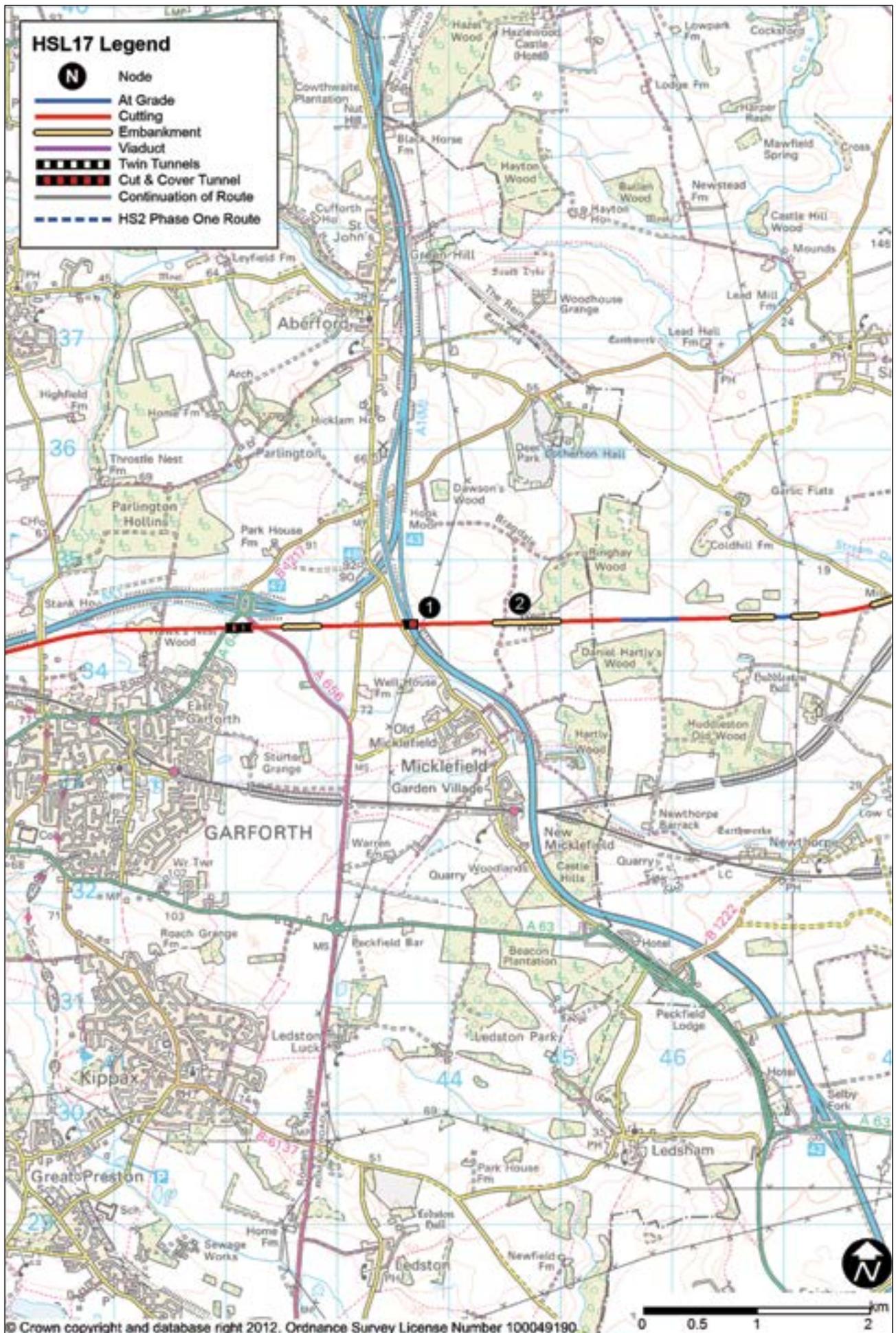
Altofts to Swillington

- 3.10.7 After emerging from cutting just north of Top Farm, the route would use a 1.0km viaduct (1), up to 20m high, to pass over the Aire and Calder Navigation, and multiple crossings of the River Calder and its floodplain.
- 3.10.8 The route would then rise on an embankment of 17m maximum height, with bridges and viaducts over Newmarket Lane, and over the M62 (2), which would remain as existing. North of the M62, the route would return to ground level at The Rookery, and would then enter a cutting up to 10m deep through Clumpcliffe Covert (3).
- 3.10.9 The route would use an embankment up to 19m high and a bridge to pass over A639 Methley Lane (4), which would remain, over Oulton Beck floodplain, and over Fleet Lane, which would also remain.
- 3.10.10 The route would be elevated over the next couple of kilometres, with viaducts 255m, 505m and 555m long and up to 27m high, to carry the route over Oulton Beck, the Leeds to Normanton railway, the Aire and Calder Navigation, the River Aire and its floodplain, and the A642 Wakefield Road (5), before returning to the rising ground level.
- 3.10.11 The route would then rise out of the Aire Valley, on a shallow embankment, passing to the eastern edge of Grimblethorpe Farm and to the west of Swillington (6). It would then enter cutting, typically 8m but up to 13m deep, at Woodside Farm. North-west of Swillington, the route would run in close proximity to the M1 for 500m close to Hollinhorpe Farm (7).



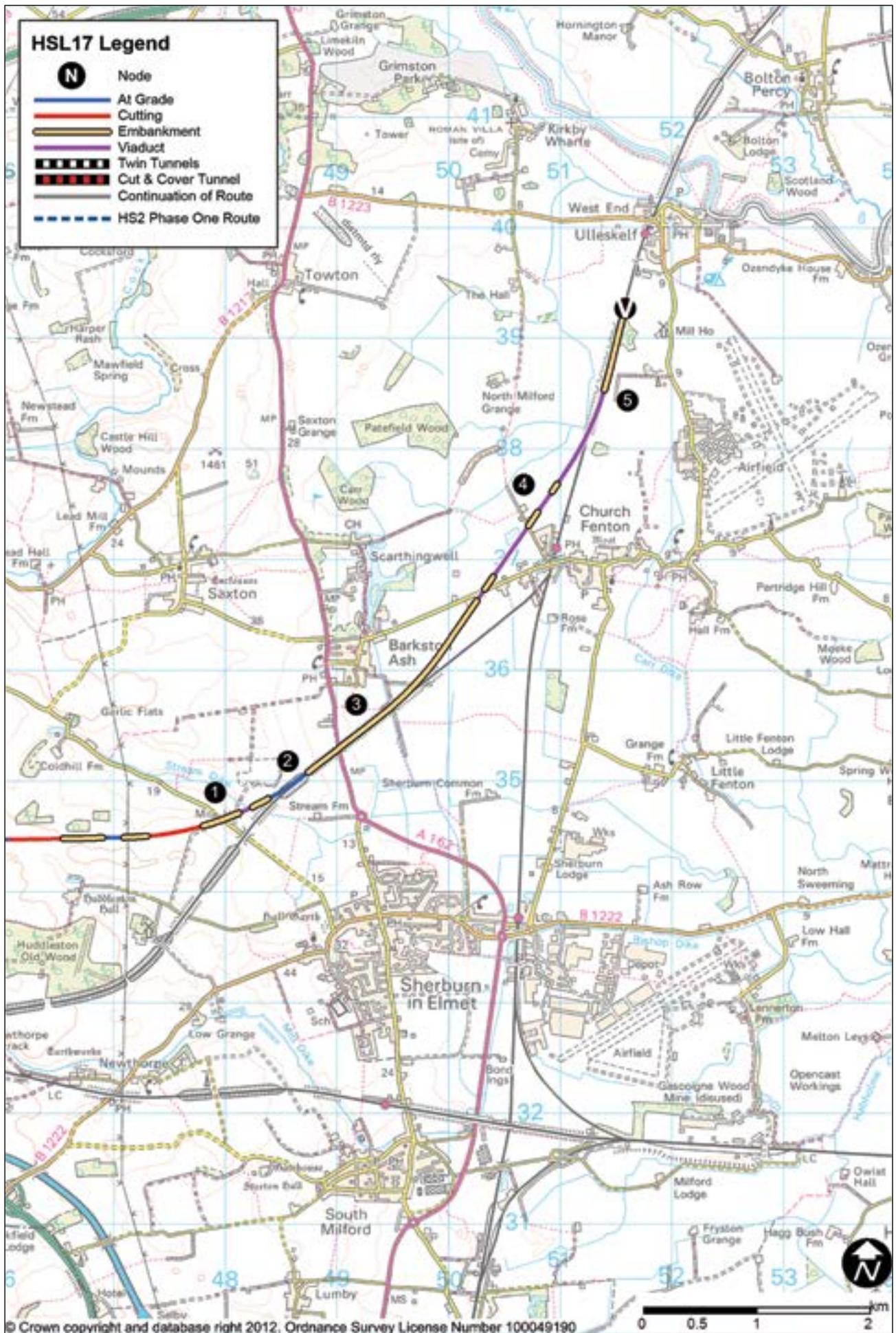
Swillington to Garforth

- 3.10.12 The route would cross over the A63 Selby Road (1), which would remain at its present level, about 200m east of Junction 46 of the M1.
- 3.10.13 The route would then swing eastwards, at 230kph, to follow the curve of the M1 in cutting, passing below the Leeds to York railway (2), which would remain at its present level. It would then run immediately adjacent to the M1's southern boundary, broadly at the motorway's level, between the railway and Barwick Road (3), which would have to be elevated to pass over both HS2 and the M1. Through this section, the route would closely follow the M1 for 3.5km.
- 3.10.14 The route would then follow the rising ground towards M1 Junction 47 (4). It would pass immediately to the south of the junction, at the M1's level, so the approaches from the south (A642 and A656) would be bridged over the railway to tie to the existing roundabout, which would remain at its current level.



Garforth to Huddleston Old Wood

- 3.10.15 The route would then descend to pass below the Roman Road, and below the Great North Road and A1(M) north of Old Micklefield and south of Hook Moor, in cutting. The A1(M) would have to be temporarily realigned during construction of the structure used to carry the railway under the A1(M) (1).
- 3.10.16 The route would then emerge at ground level some 600m east of the motorway, near Weet Wood (2), and would run east for 3.0km in a series of shallow embankments and cuttings.



Huddleston Old Wood to Church Fenton

- 3.10.17 The route would head east, at ground level, crossing over Mile Hill (1) and a floodplain on viaduct, then on an embankment at a maximum height of 17m, before turning north-east to run parallel to the existing railway between Micklefield and Church Fenton, on its northerly side and at a similar level (2).
- 3.10.18 It would cross the A162 (3) on a localised embankment and bridge, passing south of Barkston. Unable to follow the existing railway through Church Fenton because of curvature, property and the station, the route would pass on a shallow embankment to its west, crossing Common Lane on a viaduct. It would then run onto three sections of viaduct with a total length of a 1.7km (4), typically between 9m and 12m high, interspersed with short sections of embankment, to pass over Sandwath Lane within 100m of Sandwath Drive, over Dorf's Dyke floodplain, and over the Church Fenton to Ulleskelf section of existing railway, in order to return to ground on the railway's eastern side (5). The alignment of the existing railway would have to be altered to accommodate the new route arriving from the west.
- 3.10.19 Further modifications to the existing railway between the tie-in point and Colton Junction (at the ECML) were described in the report entitled "High Speed Two Limited, Engineering Options Report, West Midlands to Leeds", (HS2-ARP-000-RP-RW-00007, March 2012).



3.11 HSL21: Cold Hiendley (M) to Woodlesford (Q)

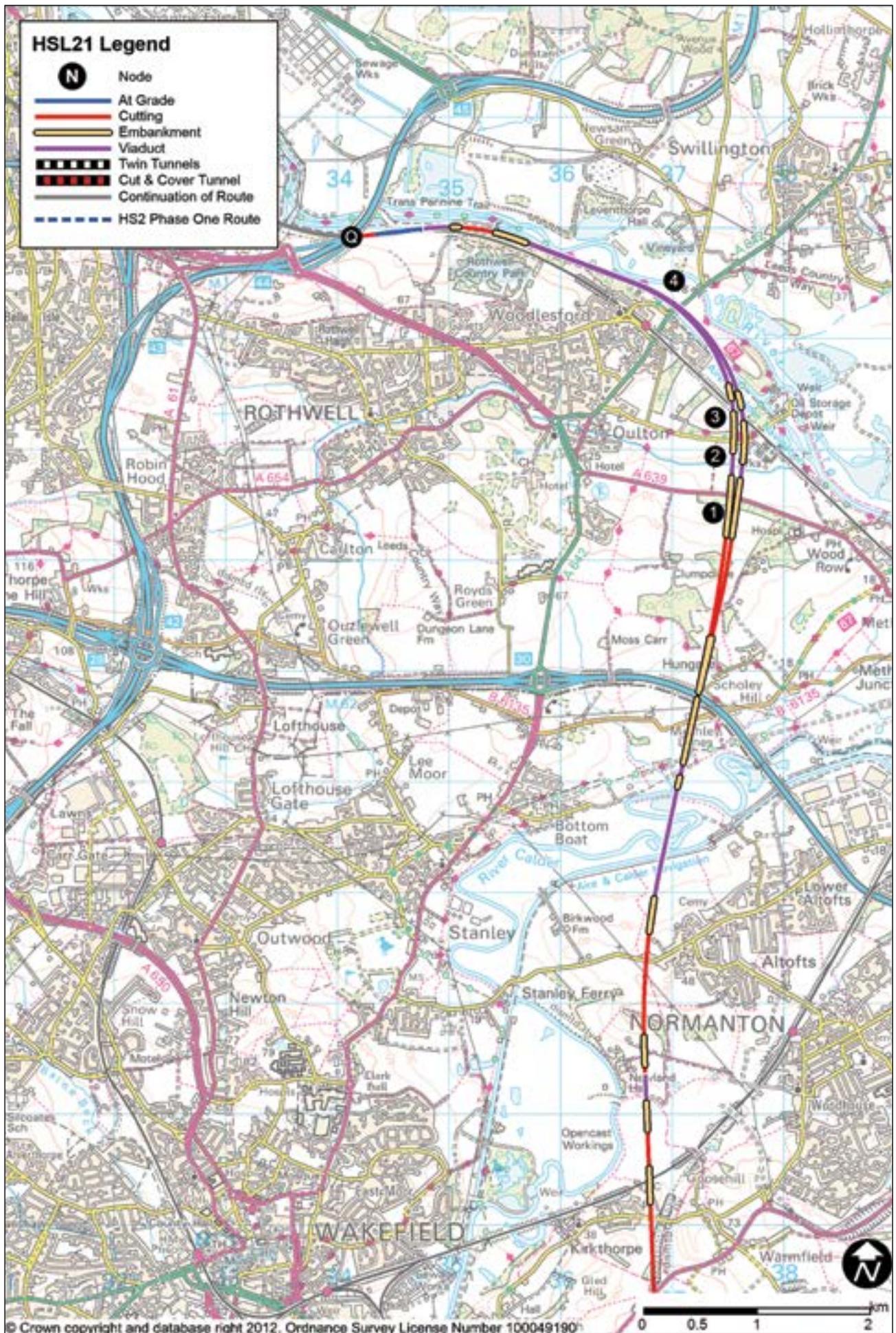
3.11.1 The route section between Cold Hiendley and Woodlesford would be 17.3km long. The section of route connecting to Cold Hiendley from the south would be HSL16 from Blackburn. At Woodlesford, the route would continue north along HSL22 to Hunslet and a new station in central Leeds.

3.11.2 This section of route would contain the proposed Rolling Stock Maintenance Depot at New Crofton. See section 5.2 below.

3.11.3 This route would be combined with a spur to the ECML via Garforth (HSL17).

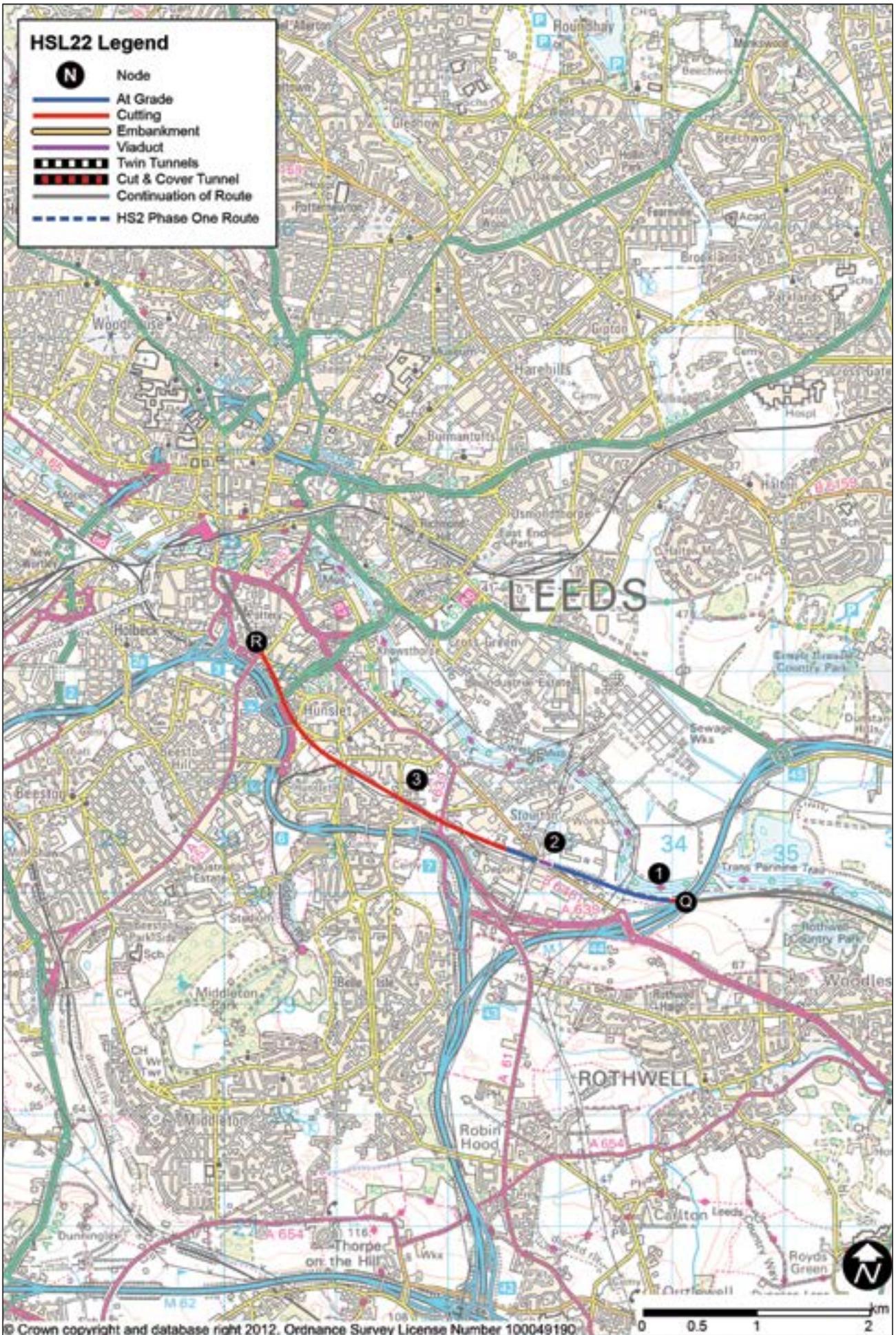
Cold Hiendley to Kirkthorpe

3.11.4 North from Winterset Reservoir, the route would be identical to that described for HSL17 in section 3.10, between Walton Hall and Kirkthorpe.



Kirkthorpe to Woodlesford

- 3.11.5 Between the north-east of Kirkthorpe and the M62 crossing, the route would be identical to HSL17.
- 3.11.6 North of the M62 crossing, the line speed would reduce to 230kph, and the route would pass over A639 Methley Lane, which would remain (1). There would be a northbound single-track spur towards Leeds diverging west from the main line. A southbound single-track spur, from Leeds, would pass under the main line and merge with it near Clumpcliffe.
- 3.11.7 North of Methley Lane, the route passes over Oulton Beck and its floodplain (2), and Fleet Lane, and the Normanton to Leeds railway (3), all of which would remain. There would be separate single track viaduct structures for the northbound and southbound links, and the southbound link would pass under the main line. The line speed would fall further to 180kph due to the tight radius curve. There would then be another viaduct, initially as a split structure, merging into single structure as the track separation reduces to the standard spacing (4). The viaduct would be 2.3km long and up to 14m high, to take the spurs over the Aire and Calder Navigation, the Aire floodplain, and the A642 Aberford Road / Wakefield Road, north-east of Woodlesford.
- 3.11.8 The route would then run in a narrow neck of land immediately south of the Aire and Calder Navigation. Throughout the whole of this length north-east of Woodlesford, the route would be running linearly along water bodies, with restricted working space, and with difficult construction access.



3.12 HSL22: Woodlesford (Q) to Hunslet (R)

- 3.12.1 This route section between Woodlesford and Hunslet would be 4.7km long. The section of route connecting to Woodlesford in the south would be HSL21 from Cold Hiendley. At Hunslet, the route would continue north along HSL22 to Leeds New Lane station. This station is described in section 4.3.
- 3.12.2 The high speed tracks would pass under the M1 (1) on the formation of, and using the existing bridge span through it passes, the current Leeds to Woodlesford railway line. The Network Rail tracks would be diverted, over a total length of 2.1km, around 60m south.
- 3.12.3 Immediately west of the M1 crossing, the high speed tracks would move northwards (2) and leave the Network Rail formation, allowing the Network Rail tracks to return to their current alignment. This would allow the eastern approach to Stourton Freightliner Terminal to be preserved.
- 3.12.4 For the remainder of the route into Leeds, the high speed tracks would run parallel with the Network Rail tracks on their northern side (3). It would not be possible to run at exactly the same elevation due to the additional headroom required for the new rolling stock, and the need for electrification, leading to a level difference of up to 4m. The A639 (Wakefield Road), Pepper Road, Balm Road, Beza Street, Hillidge Road and the slip roads from the M621 to the A61 would be rebuilt on their current alignments with new bridges to span both the Network Rail and high speed tracks.
- 3.12.5 With the high speed tracks on the north side of the existing rail corridor, rail access to the two or three existing sidings and rail facilities on the northern side of this corridor would be severed.
- 3.12.6 As the tracks approach the station, they would diverge from the Network Rail corridor, approximately following the former rail approach to Hunslet Goods Yard, and would climb up to the station throat, at a line speed of 110kph and then 80kph.



East Midlands Hub station – location and footprint

4 Stations

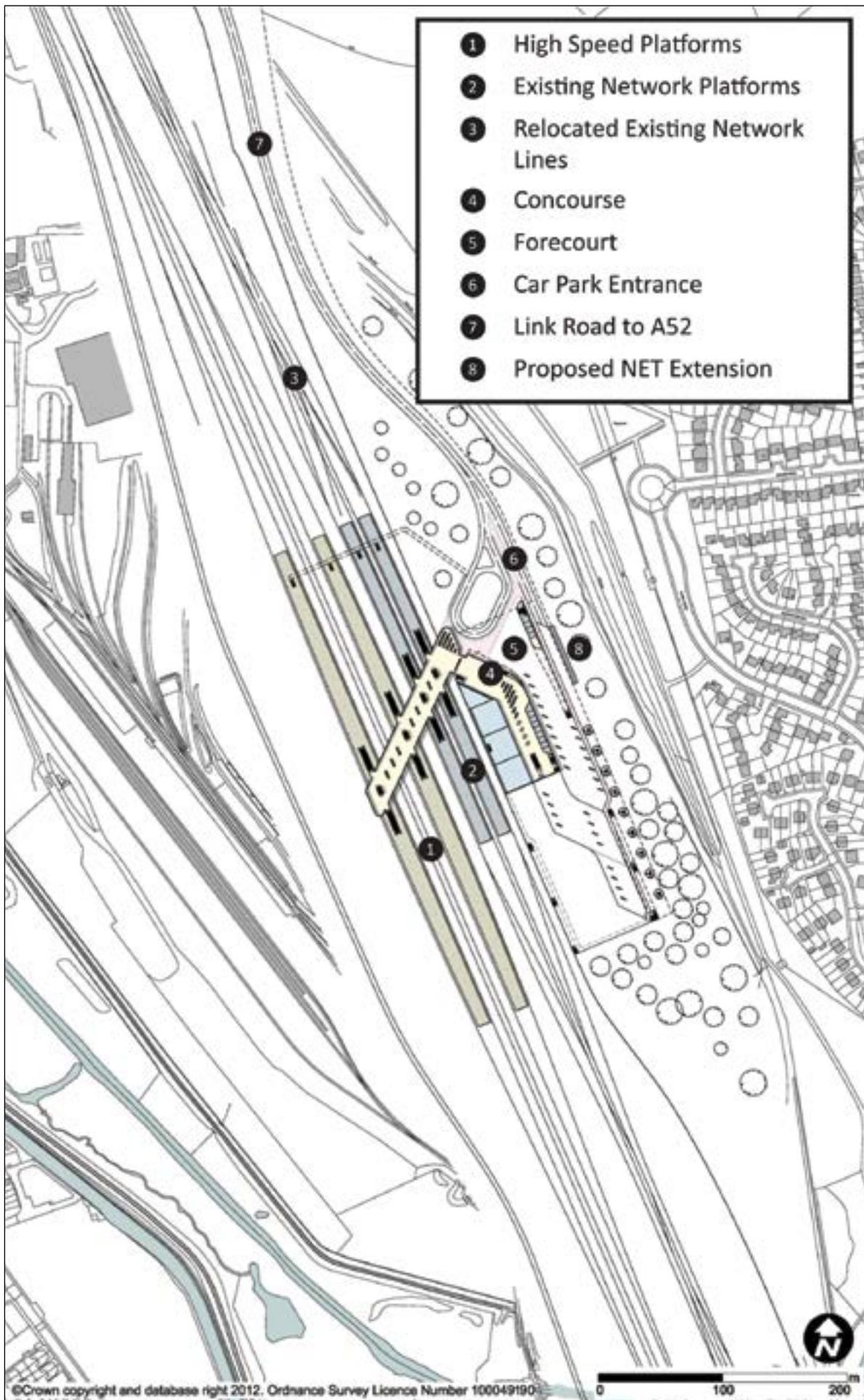
4.1 East Midlands Hub station at Toton

Route overview

- 4.1.1 Through Long Eaton, the new route would approach the East Midlands Hub station at Toton along the line of the existing low-level, two-track railway that runs north from Trent East Junction; it would run at the same level, but would replace it. The existing level crossings at Main Street and Station Road would be closed. Alternative east-west connections would be put in place involving major highway works. As the new route would take over the position of the low-level lines, the high-level lines to the east would be widened from a two-track to a four-track route between Meadow Lane Junction and the station. This would involve embankment, retaining wall and structural works along a 1.0km length of the high-level lines. A new connecting length of route would be necessary in the Meadow Lane area to allow trains from the Derby and Trent direction to access these high-level lines.
- 4.1.2 North of the A6005 overbridge, which would be replaced, the alignment would widen from two tracks to four, with the extra tracks forming deceleration lines to, and acceleration lines from, the proposed station.
- 4.1.3 The station is described below, and would involve alterations to Network Rail facilities in the area and the depot connections to the west of the station, as described in section 3.5 above.
- 4.1.4 North of Toton, the route would narrow from six tracks, to four, to two, passing under the A52 Brian Clough Way. The existing bridge would be demolished and replaced.

Station location and existing site

- 4.1.5 East Midlands Hub would be a new station on the site of the Toton Yard, approximately 11km southwest of Nottingham city centre. It would lie to the east of the M1 and north of Long Eaton, 14km east of Derby and 40km north of Leicester.
- 4.1.6 The site is bounded to the north by A52 Brian Clough Way, by the existing rail facilities to the west and south, and by fields and residential development to the east. Toton Yard is extensive and mostly flat, with a sharp rise in level to the east. Much of the site is designated as Green Belt.
- 4.1.7 Large parts of Toton Yard are occupied by sidings. The yard also contains the Traction Maintenance Depot and a Network Rail infrastructure maintenance facility. These lie largely to the west of the proposed station and, apart from changes to rail and road access routes, these facilities would not be significantly affected.



Station description

Platforms

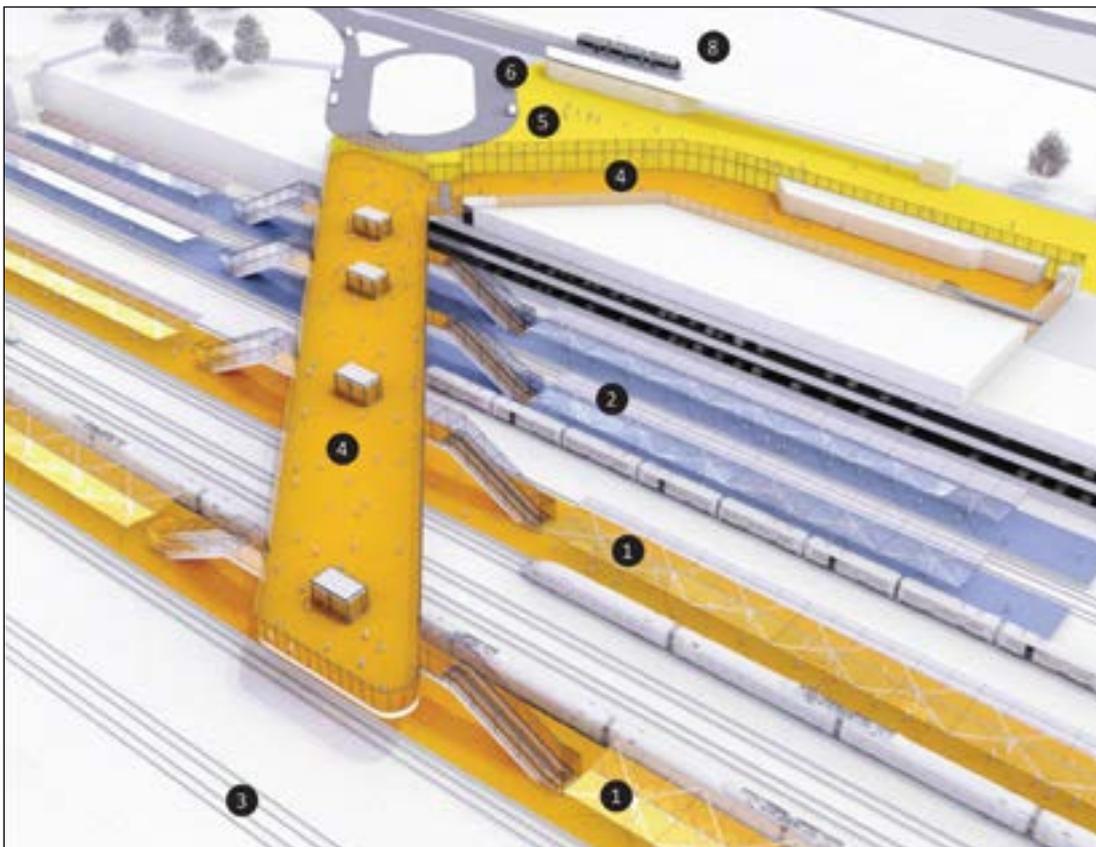
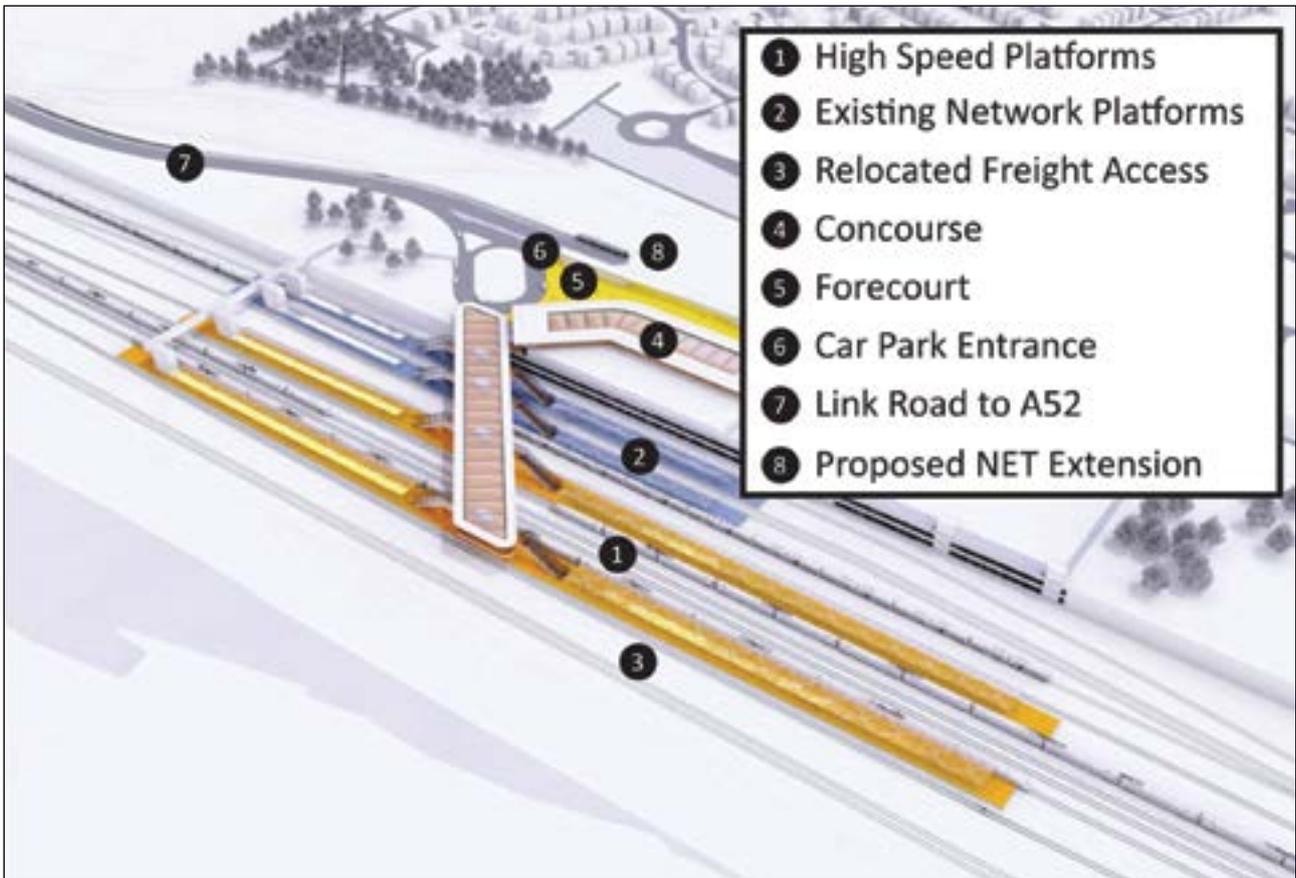
- 4.1.8 In total, the station would have eight platforms. For the high speed route, there would be four platforms for stopping services, and two through lines for non-stopping trains. The four platform faces would comprise two island platforms, one for northbound services and one for southbound services. The high speed platforms would be 415m long and 12m wide.
- 4.1.9 To facilitate change with the existing rail network, four platform faces would be provided alongside the high speed station, allowing interchange for passengers to reach the wider East Midlands region, including Derby, Nottingham and Leicester via the existing rail network.
- 4.1.10 Reflecting the topography of the site, the station platforms would be located at existing yard level, and the station entrance, concourse and forecourt would be at a raised level, similar to the higher ground to the east.

Concourse

- 4.1.11 The station concourse would be at an upper level. The concourse would extend over the modified existing network and the high speed lines, and provide access to each platform by escalators and lifts. Escape bridges would be provided at the ends of the platforms to the north.

Forecourt and car park

- 4.1.12 The station site is west of Banks Road. Advantage is taken of the space between the platforms and the raised ground to the north of Banks Road to locate the station's two-level car park. This effectively puts the car park and station in a dip relative to the residential area around Banks Road, shielding the area from the station.
- 4.1.13 The forecourt would be on top of the car park, next to the concourse and its level. Vehicle access to the car park would be via the lower level. The drop-off for taxis, buses, cars and the extension of the Nottingham Express Transit would be at forecourt level.



East Midlands Hub station – layout diagrams

Accessibility

- 4.1.14 Vehicle access to the station would be from a new junction on the A52. The link road to the station would minimise land acquisition by keeping close to the edge of the existing sewage treatment works immediately south of the A52 and east of the yard. A connection to this road would provide access to the commercial properties on Bessell Lane, north of the A52.
- 4.1.15 Connecting to the A52 would provide a direct link to Nottingham and Derby, as well as to Junction 25 of the M1, which is 1.9km away and would provide highway access to Leicester and the wider region.

Intermodal interchange

- 4.1.16 The station would have major road access and car parking provision, and would also be well connected to public transport.
- 4.1.17 In addition to the high speed platforms, the station would include four platform faces to allow direct passenger interchange to services on the existing rail network. While there are currently no passenger services to the site, these platforms (and other changes to the rail infrastructure in the area) would mean that the station could be served by trains to and from the East Midlands region, including Derby, Nottingham and Leicester.
- 4.1.18 It is likely that the Nottingham Express Transit Line 3, Phase II scheme would be extended by 1.0km across Toton Lane to the station site. This would provide a direct interchange between the high speed rail station, Nottingham city centre, the residential areas of Beeston and Chilwell, the University of Nottingham and the Queen's Medical Centre. The tram stop would be located in the forecourt, connecting directly to the concourse.
- 4.1.19 Modifications to the local and regional bus network would be required in order to provide an expanded service to a station at Toton. Bus bays would be incorporated into the station forecourt layout. Pick-up and drop-off bays for taxis and private vehicles would also be located in the forecourt directly outside the station entrance. The site would have ample space for provision of short-term and long-term parking in a multi-storey configuration beneath the forecourt.



East Midlands Hub station – intermodal options

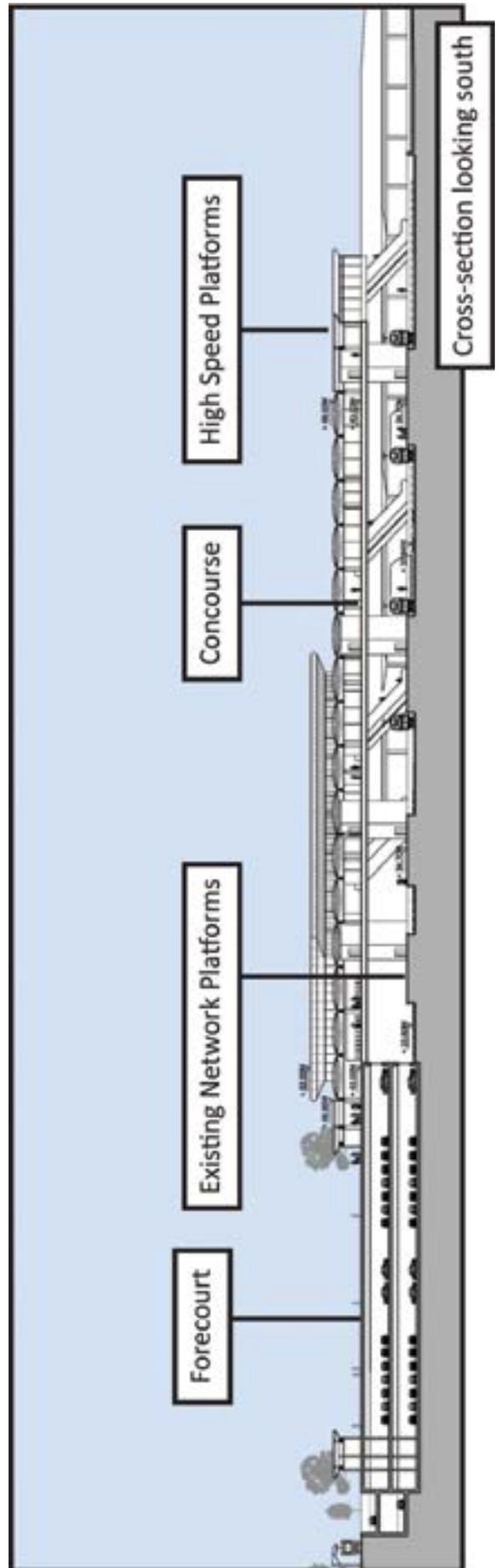
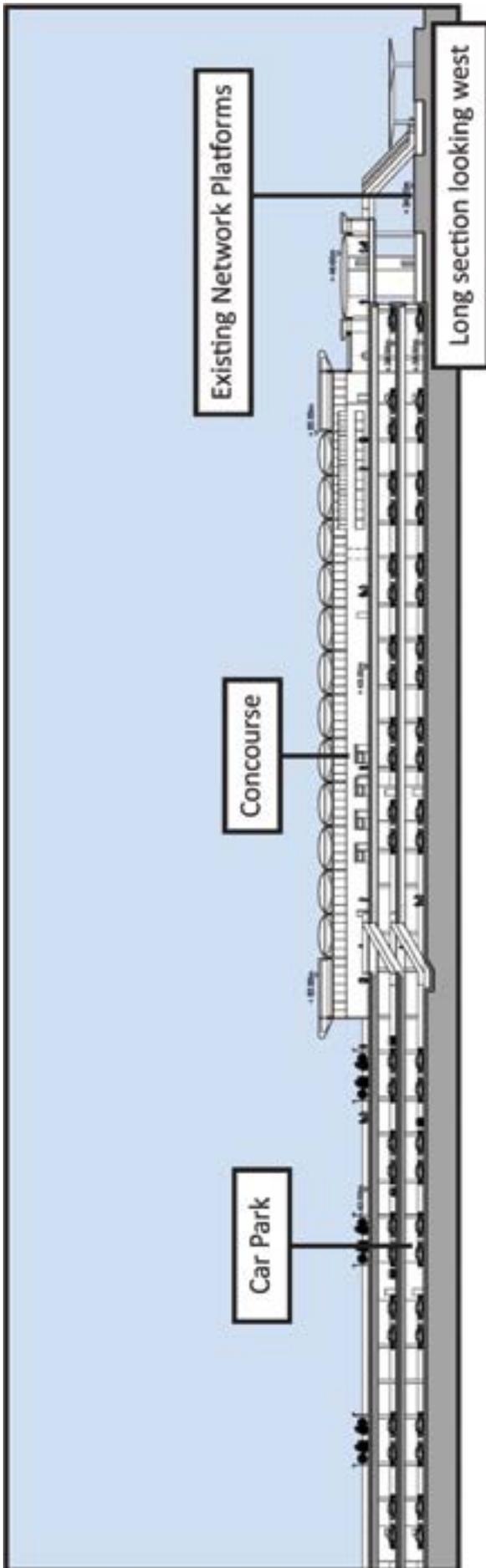
Site constraints

4.1.20 Constraints at the East Midlands Hub would include:

- maintaining the operation of existing lines, including the freight and maintenance facilities at Toton Yard;
- providing infrastructure with sufficient capacity to allow new passenger services to operate from the existing rail network to access East Midlands Hub station, while minimising residential impacts in Long Eaton;
- achieving an adequate design speed (up to 275kph) for the high speed tracks, while following the existing rail corridor through Long Eaton and Sandiacre; and
- minimising the impact of the station and railway on the adjoining suburban areas.

Constructability

- 4.1.21 As well as the high speed line and station works, there would be changes to access arrangements to the Toton Yard facilities to the west, with realignment of the existing network's through lines to the locations needed for the four platform faces for interchange to services on the modified existing network. It is assumed that access to existing facilities would be required at all times.
- 4.1.22 It is proposed that East Midlands Hub station be constructed in five phases, as outlined below.
- 4.1.23 Phase 1: Close the existing Toton High-Level Goods line to allow capacity enhancement works to be carried out. A temporary pair of tracks would be installed on the disused railway chord connecting the Derby and Nottingham Line to the low-level Erewash Valley Line to facilitate freight movements.
- 4.1.24 Phase 2:
- capacity enhancement works to the high-level goods line;
 - construction of part of Attenborough Grade Separated Junction, Sheet Stores Third Track and Sheet Stores Junction to High-Level Lines Chord;
 - construction of part of realigned Erewash Lines north of Derby Road; and
 - construction of station and associated trackwork on modified existing network.
- 4.1.25 All works would be completely independent of the existing Erewash Valley lines, enabling the continued operation of freight services, including access to Toton Yard and the Old/New Bank sidings
- 4.1.26 Phase 3: The permanent connections into the existing network would be made and existing traffic transferred to the newly-constructed/realigned high-level Erewash Valley Lines, vacating the low-level line corridor to enable the construction of the high speed line and station. The realigned Erewash Valley Lines would be extended through New Bank Sidings and tie into the existing Erewash Valley lines north of Derby Road.
- 4.1.27 Phase 4: Construction of the high speed part of the Interchange station would proceed. The new freight flyover connection serving Toton Yard would be constructed offline. However, the final transfer of freight services would not occur until Phase 5 to enable the existing freight lines to be realigned north of the A52, thus creating room for the high speed tracks.
- 4.1.28 Phase 5: Final connections into the Yard. Construction of high speed tracks between the new station and the crossing-point of the freight tracks north of Derby Road. The station would be commissioned and opened.



Access and site compounds

- 4.1.29 The new junction on the A52 would allow direct access to the site from the trunk road network and, if constructed early, would allow for construction traffic access. On the west side, use could be made of the existing access road to the Traction Maintenance facility and Toton Yard, provided that any necessary enabling works were carried out. To the north, use could be made of Bessell Lane, but the size and frequency of construction vehicles would be limited by road geometry and the presence of residential properties. The site could also be accessed from the east from Toton Lane.
- 4.1.30 Construction compounds could be established on the east side, using the land available here. It might also be possible to use the site of the scrap yard on Bessell Lane for the reconstruction of the A52 viaduct. Providing a sizeable compound on the west side of the rail corridor is likely to be more difficult, as this land is occupied by the Toton Yard.

Programme

- 4.1.31 It is estimated that it would take approximately four and a half years to construct East Midlands Hub station, as follows;
- Year 1 – enabling works, including site set-up, utility diversions and demolitions;
 - Year 2 to Year 3 – works in order to relocate existing network tracks and roadworks; and
 - Year 3 to Year 5 – construct high speed platforms and tracks.
- 4.1.32 The station would be ready for the installation of railway systems (e.g. track, signalling, overhead line equipment) during Year 4, with the station available for commissioning in Year 5, and available for full train operations towards the end of the year.



Sheffield Meadowhall station - location and footprint

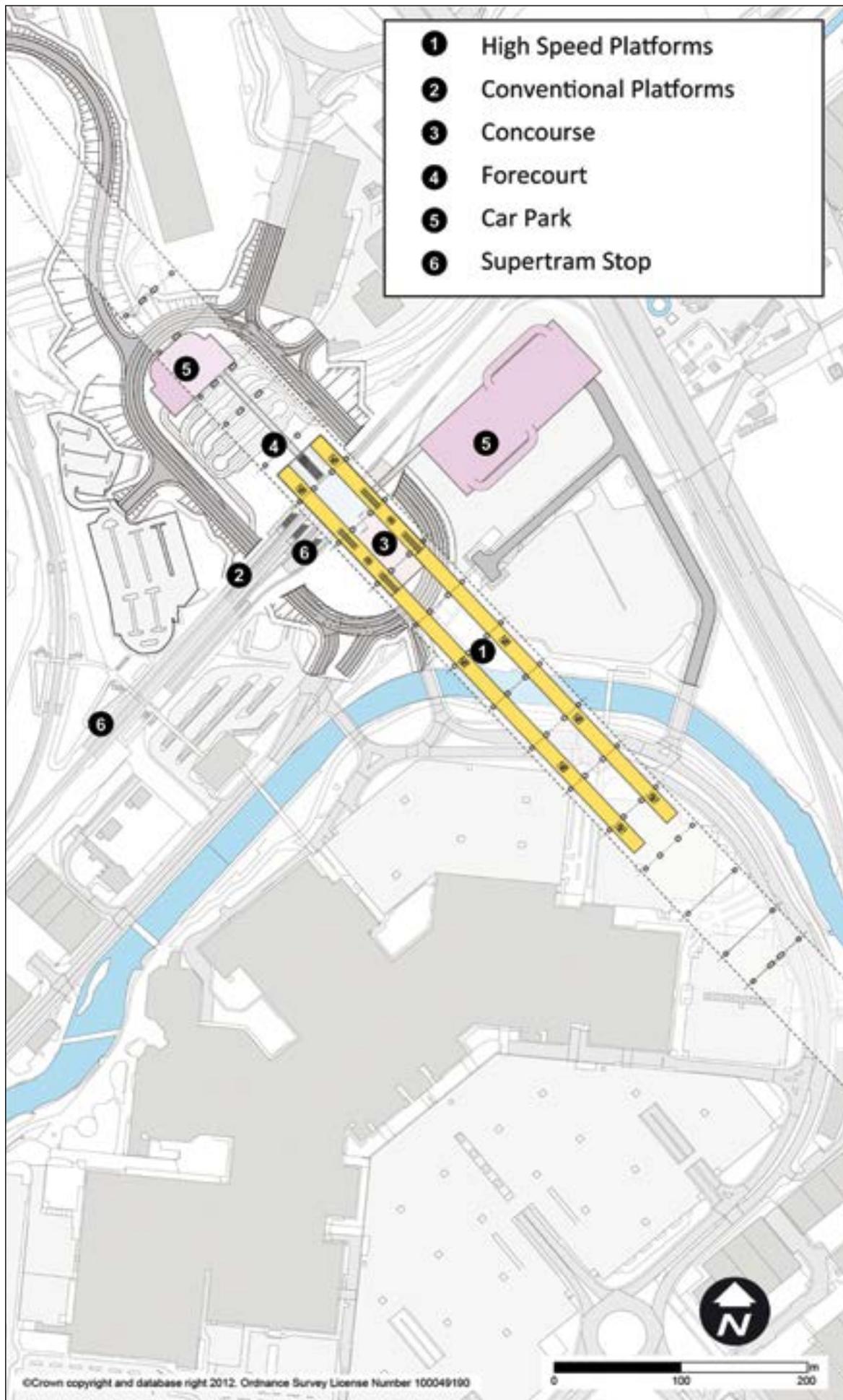
4.2 Sheffield Meadowhall station

Route overview

- 4.2.1 The route would approach the station on viaduct from Tinsley, crossing the Don Valley. The route would widen from two tracks to four, and then to six before the approach viaduct. The viaduct would be 4.0km long, up to 22m high, and at a comparable level to the M1's Tinsley Viaduct. The viaduct would run south-west of the M1, crossing the A631, the A6178, the Sheffield and Tinsley Canal, the River Don and its floodplain, the Sheffield to Rotherham railway, part of the Meadowhall Shopping Centre's car park, Meadowhall Way, Alsing Road, the South Yorkshire Supertram route and Meadowhall Road.
- 4.2.2 The station platforms would be on the viaduct. Further descriptions are given below.
- 4.2.3 North of the station, and still on the viaduct, the route would revert to four tracks, then two. The route would run along the alignment of the abandoned railway from Blackburn Junction to Wakefield and parallel to the existing Sheffield to Barnsley railway and B6082 Ecclesfield Road. For further details, see section 3.8 (HSL15).

Station location and existing site

- 4.2.4 The new Meadowhall high speed station would be orientated approximately north-south and would be located between Meadowhall shopping centre to the south-west and the Firth Rixson premises to the north-east. Meadowhall is in the Lower Don Valley, approximately 6.5km to the north-east of Sheffield and 4.5km to the south-west of Rotherham. The existing Meadowhall Interchange station lies to the west of the proposed high speed station.
- 4.2.5 The station will be primarily located on an island site formed by the remodelling of Meadowhall Road, and is split by the Sheffield to Rotherham railway line and Supertram line which run east-west through the site. The station site is partly located on a number of occupied plots, as well as land currently used as an overflow car park for the adjacent Meadowhall Shopping Centre. Some of the multi-storey car parks associated with the shopping centre would need to be reconfigured to accommodate the HS2 station.
- 4.2.6 The river Don lies along the north edge of the shopping centre and to the south of the station.



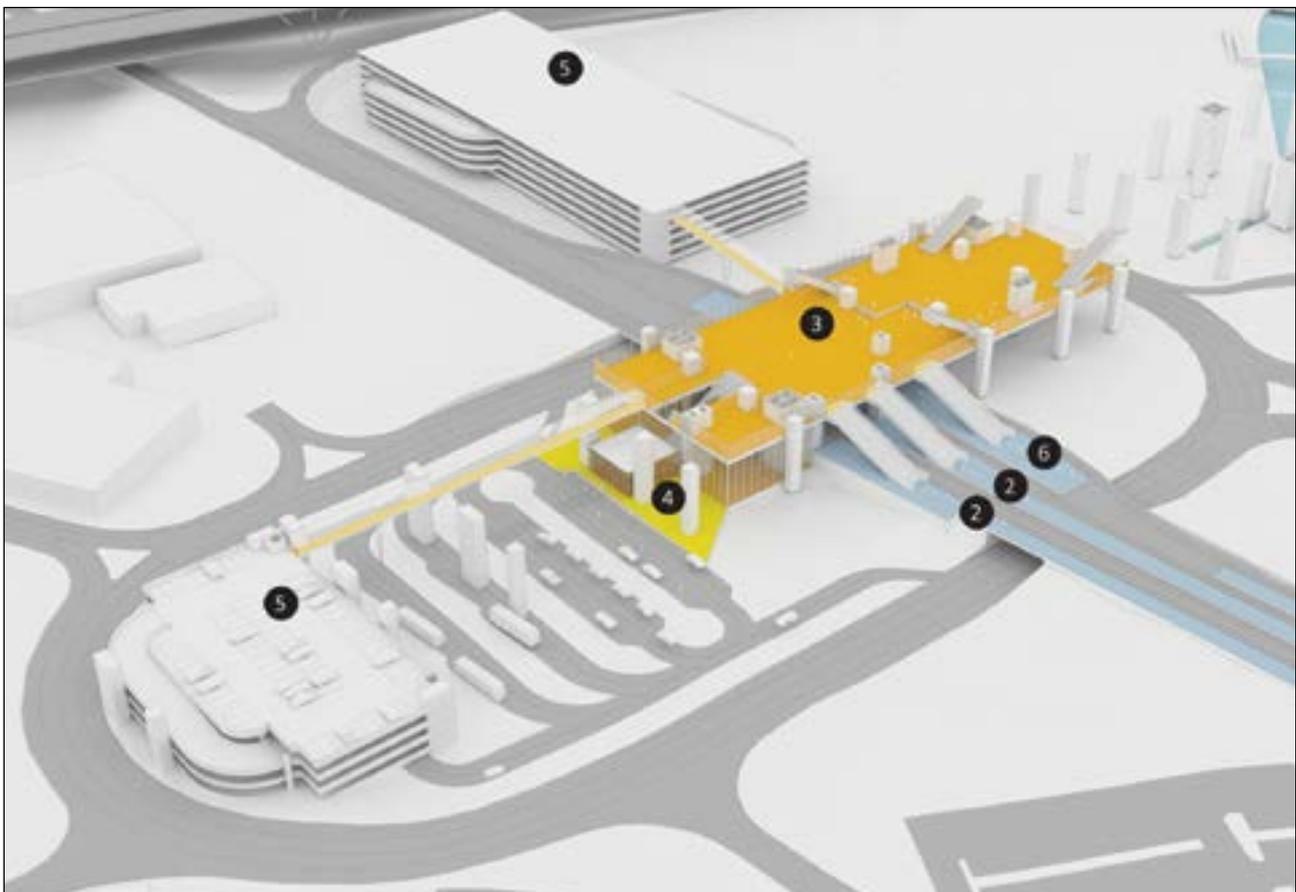
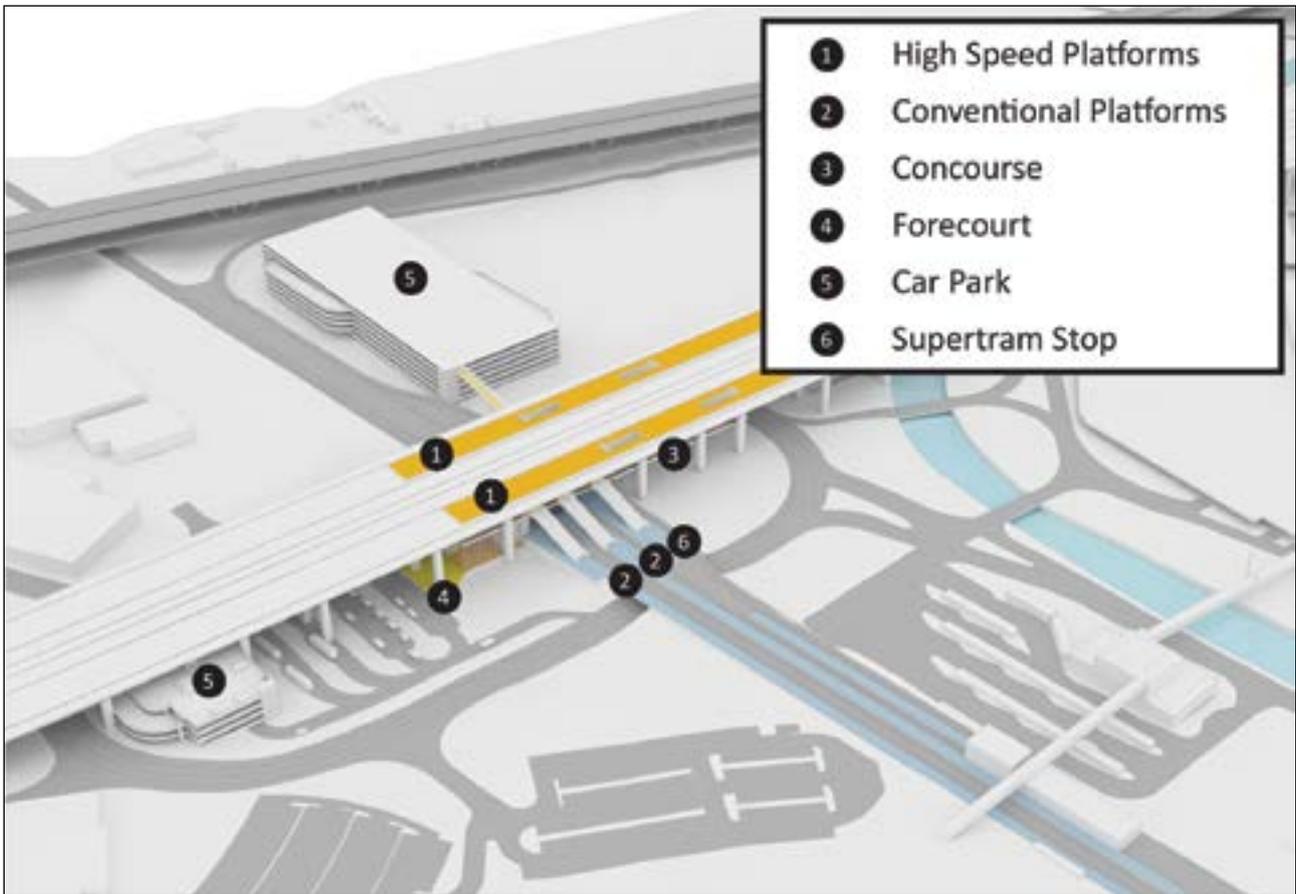
Station description – proposed station

Platforms

- 4.2.7 Meadowhall high speed station would be located on a viaduct structure running south-east to north-west across the Don Valley, approximately 22m above ground level. In the immediate area of the platforms, there would be six tracks. The two central tracks would be through lines for non-stopping trains; these would not have platform faces adjacent to them. There would be four tracks for stopping trains, based around two island platforms, one for northbound services and one for southbound services. The platforms would be 415m long and 12m wide.
- 4.2.8 At ground level, an island platform would provide dedicated connectivity between a new stop on the Supertram and the HS2 station concourse. The Sheffield to Rotherham conventional network platforms would be extended by moving them nearer to the high speed station, with a direct link to the HS2 concourse. The extended platforms would also facilitate access to Meadowhall Interchange for connections to the Sheffield to Barnsley railway and the bus station.

Concourse

- 4.2.9 The station would have multiple entrances both at ground and concourse levels, for access to and from different travel modes.
- 4.2.10 The station entrance for those arriving by road would be located at ground level, where bus stops and pick-up/drop-off areas for taxi and private cars would be provided.
- 4.2.11 From ground level, a series of escalators and lifts would provide vertical access to the platforms via an upper concourse. The upper concourse would form the main concourse and ticket hall, and would also house other station facilities. From there, further banks of escalators and lifts would lead up to the platforms. The ground level would be raised from the current ground level, beneath the station, to lift it clear of the flood plain.
- 4.2.12 From the upper concourse, there would be links down to the extended Sheffield-Rotherham platforms of the existing Meadowhall Interchange from the main concourse, and a link down to the Supertram platform directly under the HS2 station. Pedestrian bridges would give direct access to adjacent HS2 multi-storey car parks.



Sheffields Meadowhall station – layout diagrams

Forecourt and car park

- 4.2.13 The main forecourt for the station would be underneath the high speed viaduct, north of the Sheffield to Rotherham railway line, and would lead to the station entrance at ground level on the north-west facade. Drop-off and pick-up points for taxis and private cars would be provided in the forecourt, as would a taxi rank and bus stops.
- 4.2.14 Multi-storey car parks would be provided underneath the platforms to the north-west of the station concourse and to the north-east of the station across the new gyratory. Pedestrian link bridges would connect both car parks to the main concourse.

Accessibility

- 4.2.15 The station would be located between Sheffield and Rotherham and would have direct highway connections to both. The nearby M1 Junction 34 would give direct access to the wider South Yorkshire region. Road access to the station would be provided by means of an enhanced gyratory roundabout on Meadowhall Road. The supporting piers for the HS2 viaduct would be configured so as to minimise disruption to the local road network. The proposed Tinsley Link would provide access for traffic from the east, avoiding Junction 34.
- 4.2.16 There are concerns about the capacity of the road network around Meadowhall and congestion of the M1 junction 34. Further enhancements to address the capacity concerns at Junction 34 could range from widening and reconfiguration of the roundabouts to new roads and links onto and from the M1. The level of provision of capacity enhancements would need to be determined by further work in conjunction with the Highways Agency and local transport authorities, and would include detailed traffic modelling.
- 4.2.17 The station would also be accessible by Supertram and conventional rail from the Sheffield to Rotherham railway, immediately underneath the high speed platforms, and by train and bus at the adjacent Meadowhall Interchange via the extended Sheffield to Rotherham railway platforms.



Sheffield Meadowhall station – intermodal options

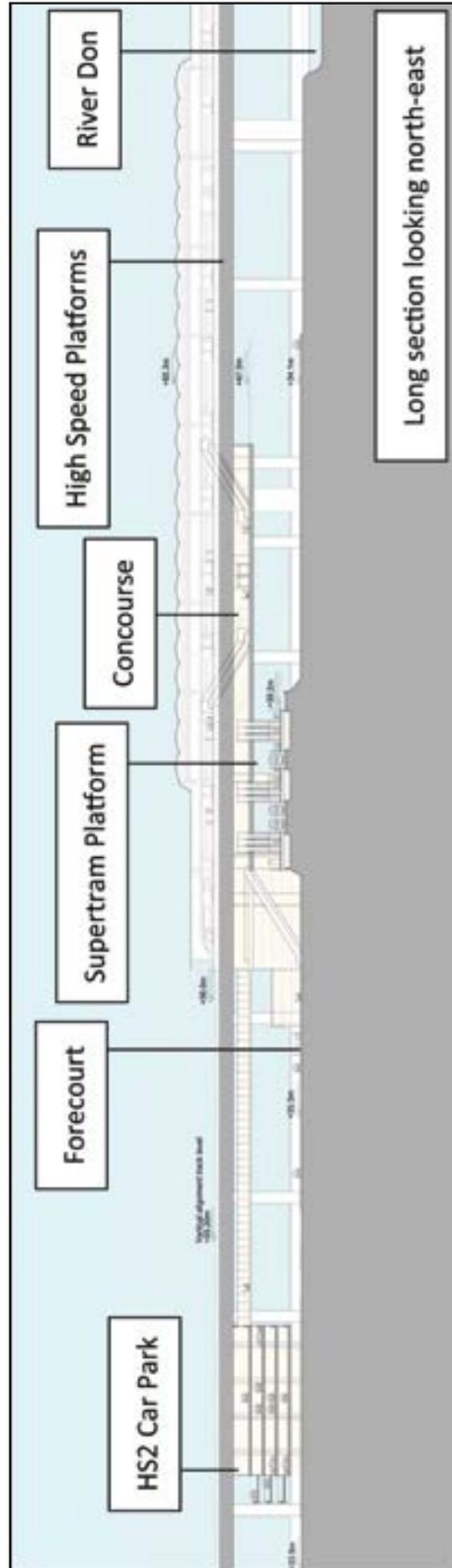
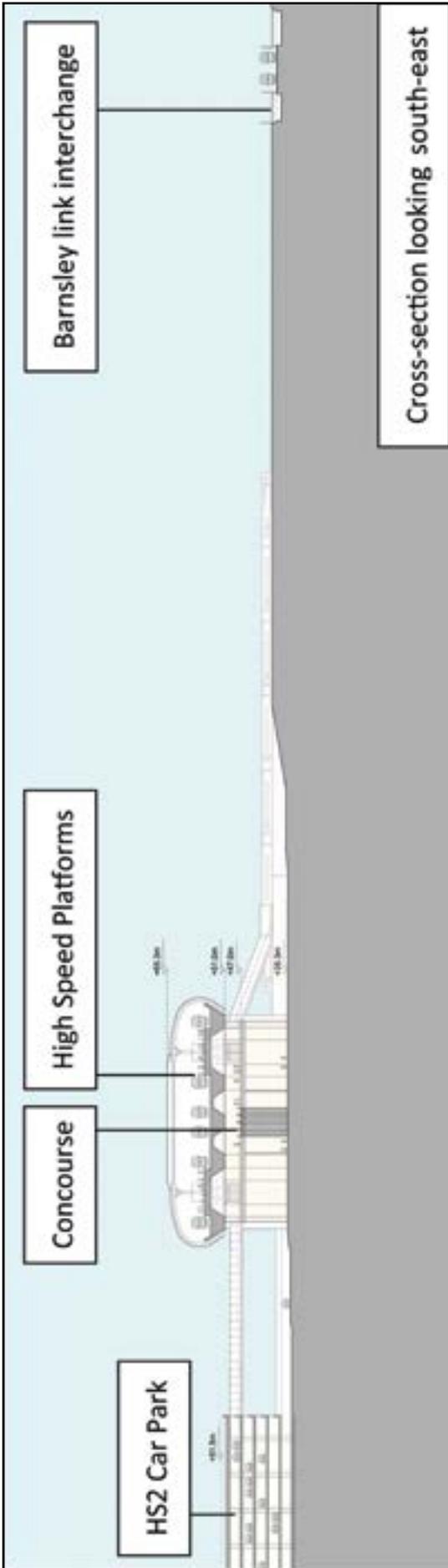
Intermodal interchange

- 4.2.18 As the new Meadowhall station would be outside the main Sheffield, Rotherham and Barnsley urban areas, it would be essential to link it to other modes of transport so that passengers could complete their journeys to Sheffield city centre and the surrounding areas. As a result, access to the station has been designed with a view to optimising interchange with other public and private transport modes, and particularly to creating good pedestrian links between the high speed station, the existing rail network and the tram.
- 4.2.19 Meadowhall station would provide interchanges between rail, tram and bus, as well as major road access and car parking provision.
- 4.2.20 The high speed station would be located approximately 200m to the east of the existing Meadowhall Interchange, which is served by trains, buses and trams, as well as providing park-and-ride facilities. This would provide a minimum interchange time of four minutes.
- 4.2.21 The existing Meadowhall Interchange station on the conventional network has two sets of platforms. One set is on the Sheffield to Barnsley line, with curved platforms to the west of the main interchange. The other platforms, on the Sheffield to Rotherham line, are on the same axis as the tram line, and pass directly underneath the high speed route, alongside the proposed location of the high speed station.

- 4.2.22 The current minimum travel time between the existing Meadowhall Interchange station and Sheffield Midland station is five minutes. The current peak-hour service to Sheffield Midland is nine trains an hour, on average one every seven minutes, as follows:
- five trains an hour via Platform 1 (an additional two trains pass the platform but do not stop); and
 - four trains an hour from Platform 3.
- 4.2.23 The interchange between the high speed platforms and the existing Meadowhall Interchange station would be facilitated by the provision of a direct pedestrian link between the main concourse of the high speed station and the existing Meadowhall Interchange station.
- 4.2.24 In order to provide a direct interchange with the Supertram, a new tram stop is proposed below the high speed station, accessed directly from the main concourse.
- 4.2.25 Bus provision would incorporate the existing bus station at Meadowhall Interchange and new bus bays on the high speed station forecourt. Future design would investigate the desirability of merging these facilities.
- 4.2.26 The South Yorkshire Passenger Transport Executive (SYPTTE), with Rotherham Metropolitan Borough Council and Sheffield City Council, has proposed the introduction of a Bus Rapid Transit system of fast bus services between Rotherham and Sheffield. One of the proposed routes, the Northern Route, would pass close to the high speed station and could create a fast bus route from the station to Sheffield and Rotherham, augmenting the other transport modes discussed above.
- 4.2.27 SYPTTE, in association with Network Rail, Northern Rail and Stagecoach Supertram, is introducing tram-trains to run on local tram routes and Network Rail lines between Sheffield, Meadowhall and Rotherham. This is initially a two-year pilot scheme. If it is successful and is retained, it will provide an additional interchange facility with the high speed station.

Site constraints

- 4.2.28 Constraints at Meadowhall would include:
- the height of the land on either side of the Don Valley;
 - the M1 and congestion at Junction 34;
 - Sheffield to Rotherham railway and associated embankment and underpasses;
 - the existence of the floodplain on the station site;
 - the Firth Rixson premises;
 - Meadowhall Interchange station park-and-ride car parks; and
 - Meadowhall shopping centre.



Constructability

- 4.2.29 The construction would involve building a reinforced concrete viaduct over 4km long and up to 20m high. This viaduct would need to support both the high speed tracks and the station platforms. The construction of this structure could be challenging in view of the industrial history of the area, with the previously worked coal seams potentially needing a significant drilling and grouting programme.
- 4.2.30 The station entrance and concourse levels would be immediately below the viaduct. The entrance level would provide access to the elevated concourse above, which would span over and link to the adjacent Sheffield to Rotherham line on the conventional rail network. These structures would be formed in reinforced concrete, supported by secondary steel framing within the primary viaduct structural zone.
- 4.2.31 Highway works would be required to the surrounding road network with temporary restrictions on capacity. The multi-storey car parks to the north-east of the shopping centre would be demolished and replaced.
- 4.2.32 Construction would be carried out in four broad phases. These would comprise an enabling works phase; Phase One, which would be the construction of the viaduct and station sub-structures and include the first stage of the new gyratory; Phase Two, which would be the construction of the viaduct and station superstructure, including the final road layout; and Phase Three, which would be the completion of the station and the associated buildings and railway works. These are described below:

Enabling works phase

- Demolish existing buildings and clear the site, including parts of the shopping centre car park. Demolition of the car parks will need to be phased, with possible temporary provision, in order to minimise the impact on parking capacity at the shopping centre.
- Divert utilities.
- Carry out ground remediation.
- Carry out grouting operations.
- Set up plant for precast concrete viaduct units.

4.2.33 Phase One:

- Construct the permanent road system near the M1 Junction 34 south.
- Construct and install the eastern thrust bore box under the Sheffield to Rotherham railway line.
- Construct the foundations and piers for the approach viaducts and station.
- Construct the viaduct and concourse superstructure over the Sheffield to Rotherham railway line.
- Modify the existing Meadowhall Interchange station simultaneously with the main works, taking advantage of any possessions required for the viaduct construction.
- Construct the eastern side and southern arc of gyratory from the new Newman Road to Meadowhall Road, divert traffic and operate as a two-directional road.

4.2.34 Phase Two:

- Construct the approach viaduct and platform superstructure, including crossing over the Barnsley Line.
- Construct the frame of the main station building and associated facade.
- Construct and install the western thrust bore box under the Sheffield to Rotherham railway line.
- Complete gyratory and open to one-way, four-lane traffic.
- Construct new road network amendments to Meadowhall Road/Meadowhall Way.

4.2.35 Phase Three:

- Complete car park construction (both under deck and independent).
- Complete drop-off points, access roads and passenger access to Network Rail and Sheffield Tram stations.
- Construct station platforms and roof.
- Fit out station.
- Install railway systems – lay track, install OHLE and signalling, etc.
- Commission and open station.

Access and site compounds

- 4.2.36 Primary construction access would be via Meadowhall Way and Meadowhall Road and thence through the site area. Access to the southern portion of the viaduct would be more complicated due to the proximity of a railway, a canal, the river and the M1 viaduct.
- 4.2.37 There is sufficient space near the station building and the viaduct for a construction compound, precast concreting yard and laydown areas.

Programme

- 4.2.38 It is estimated that it would take approximately five and a half years to construct Meadowhall station. This period would be divided as follows:
- Year 1 – enabling works, including site set-up, utility diversions, road diversions, decontamination activities, ground stabilisation and demolitions;
 - end of Year 1 to end of Year 4 – viaduct and road construction;
 - Year 3 to Year 5 – construct and fit out station; and
 - up to mid-Year 6 – installation of railway systems and commissioning.
- 4.2.39 The station would be ready for installation of railway systems (track, signalling, OHLE etc.) during Year 5, with the station available for full commissioning in Year 6, and available for full train operations towards the end of Year 6.



Leeds New Lane station - location and footprint

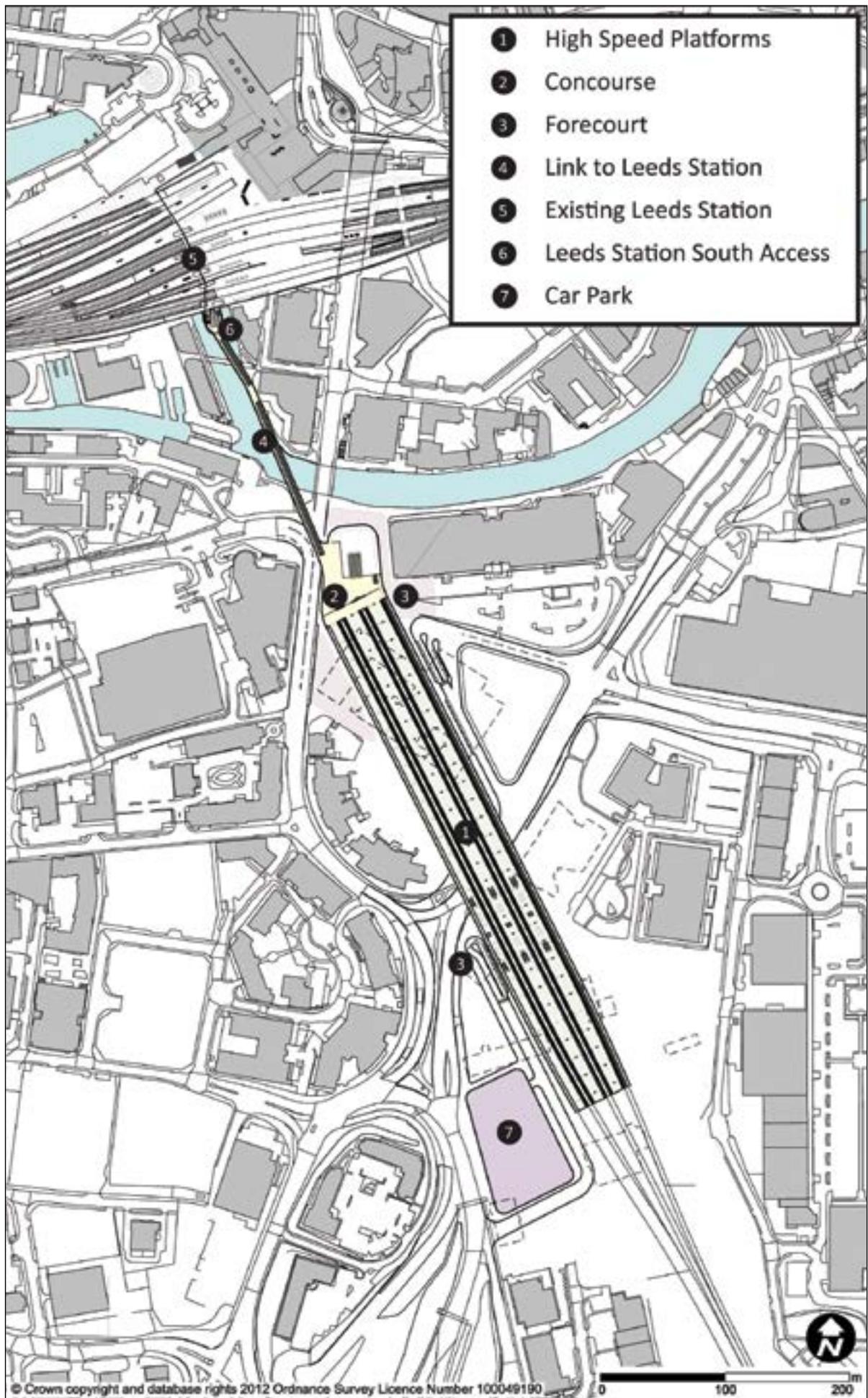
4.3 Leeds New Lane station

Route overview

- 4.3.1 The route would widen sequentially from a twin-track railway to three, four and five tracks, to allow access to and from all the proposed five platform faces, rising from below ground level onto a retained structure. The station approach layout would then pass from retained embankment onto the elevated structure on which the station would be situated. For further details, see section 3.12 (HSL22).

Station location and existing site

- 4.3.2 Leeds New Lane station would be a new station, located approximately 300m south of the existing Leeds station, immediately to the south of the River Aire, and would be aligned approximately north-south. This would provide a minimum interchange time of five minutes.
- 4.3.3 The site would be to the west of the Asda headquarters building and along the east boundary of Victoria Road, just south of Victoria Bridge and across from Bridgewater Place. The station would be built on the sites of the existing commercial premises on either side of New Lane. To the south, it would pass to the west side of the Leeds City Office Park and, further south, to the east of Dewsbury Road. Across the river and to the north of the station, Neville Street leads under the existing Leeds station to the city centre. A new pedestrian entrance proposed by Network Rail could provide passengers with a southern access to the existing Leeds station; however, there are concerns over the capacity of this entrance to support the additional passenger numbers generated by HS2.
- 4.3.4 The station would be positioned so as to end directly on the south side of the River Aire, with a small pedestrian plaza to the north (in between the station and the river) and a forecourt for vehicular access to the east. The station would be elevated above Meadow Lane and Great Wilson Street to offer public facilities at ground-floor level and minimise east-west severance of adjacent transport routes, communities and facilities.



Station description

Platforms

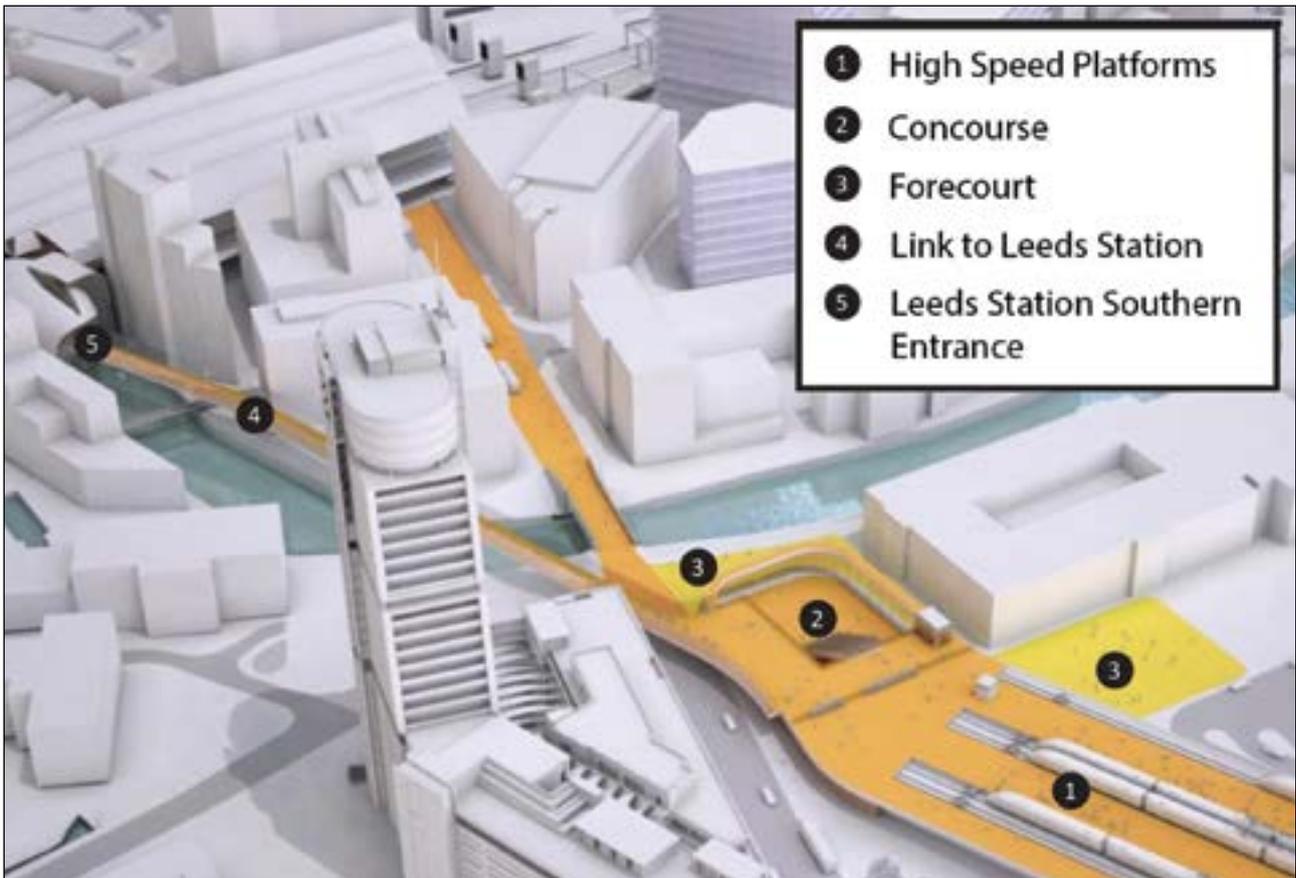
- 4.3.5 The station would comprise five platform faces, arranged as two island platforms (440m long, including buffer zone, and 12m wide) providing four platform faces and a single 7.5m wide side platform. The island platforms would be tapered to accommodate the station throat and approach alignment. The side platform would be curved to follow the taper of the island platforms, but would not itself be tapered.
- 4.3.6 The platforms would be elevated above Meadow Lane in order to accommodate the existing road and avoid negative impacts on permeability. Access would be from the north and south ends of the platforms.

Concourse

- 4.3.7 The station would have two concourses. The north concourse would be accessed via the forecourt on the south side of the river for pedestrians for the city centre, bus, and rail interchange. The south concourse, to the southern end of the station, would provide access for passengers from suburban locations, arriving or departing by car via the M621, for drop-off or pick-up and for long-term parking. There would be a dedicated first-floor link between the south concourse and the north concourse, and passengers would be able to access the platforms from both station entrances.
- 4.3.8 A direct link crossing the River Aire could be provided for passenger interchange with Leeds station. This would be a pedestrian bridge leading from the high speed station platform level to the existing platform footbridge via the currently proposed new southern entrance at Leeds station.

Forecourt and car park

- 4.3.9 The north vehicular forecourt and entrances for passengers arriving and departing by taxi and private car would be on the east side of the station, just south of the river. Bus stops and a station entrance would be provided on Victoria Road, on the west side of the station concourse, in addition to the existing provision on Meadow Lane. To accommodate this arrangement, the western end of Great Wilson Street would be occupied by the station and vehicular forecourt, with changes required to the local road network. East-west permeability would be provided through opening up pedestrian routes at ground level, under the station platforms.
- 4.3.10 A long-term car park would be located next to the southern end of the station, adjacent to Dewsbury Road. The close proximity of this car park to the M621, the Inner Ring Road and the wider motorway network would provide convenient access for passengers from the Leeds suburbs and the wider West Yorkshire region.
- 4.3.11 In addition to the separate long-term car park, some short-term car parking would be provided in the station undercroft. A smaller forecourt would be located towards the southern end of the station, providing access to the south concourse.



Leeds New Lane station – layout diagram



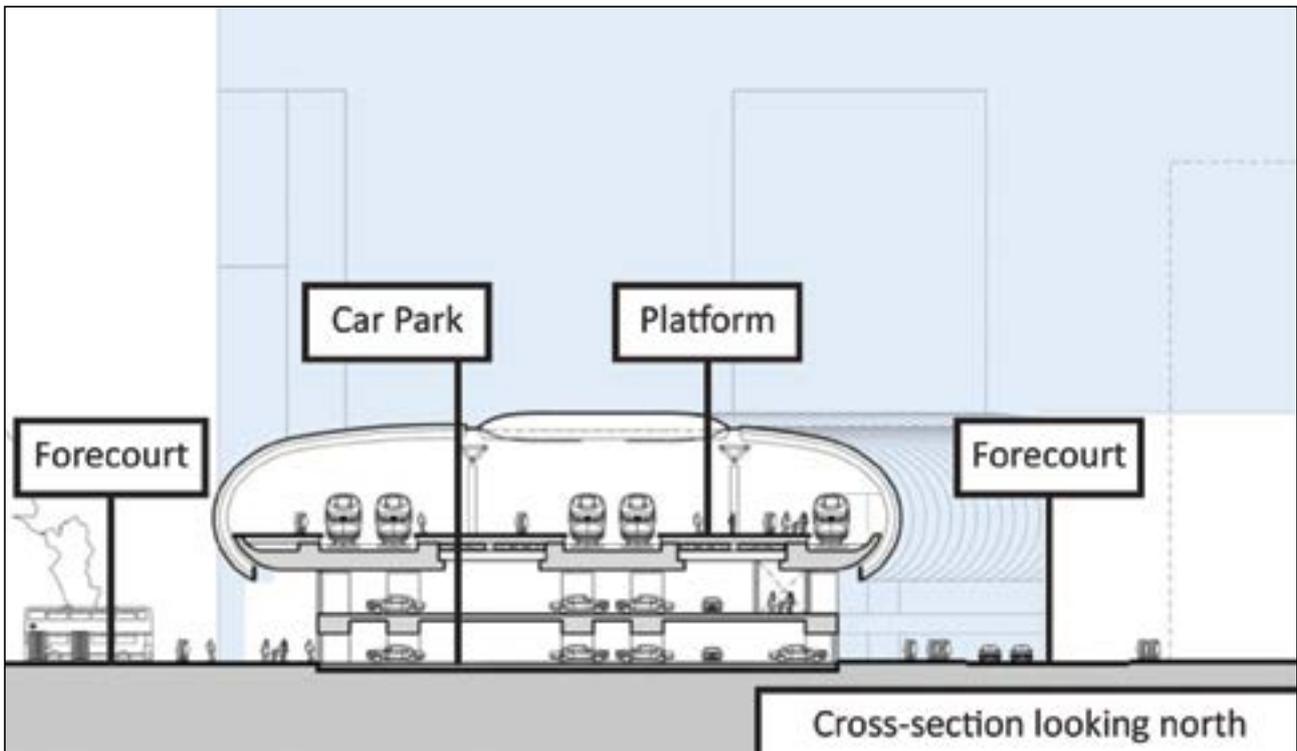
Leeds New Lane station – intermodal options

Accessibility

- 4.3.12 Pedestrian access to the north concourse would primarily be from the north of the river via Neville Street and the Victoria Bridge. Neville Street would be remodelled as an improved pedestrian route with access restricted to public transport only, to improve links to the city centre and the existing Leeds station.
- 4.3.13 The station would also be well placed for easy access from other destinations on the south of the river, such as the Holbeck Urban Village and other developments in the vicinity of the station.
- 4.3.14 Access to the north vehicular forecourt would be off Great Wilson Street. This would require local highway modifications, including the closure of the western end of Great Wilson Street as already described.
- 4.3.15 The south station entrance would provide good access for passengers and car parking to the south of the station from the A653 gyratory (Meadow Road and Dewsbury Road), which would need to be remodelled, and from the M621 and the Inner Ring Road, leading to the suburbs and the motorway network, for destinations in the West Yorkshire region.

Intermodal interchange

- 4.3.16 Direct interchange with the existing Leeds station could be via a covered bridge link from the high speed station, crossing the River Aire in a sheltered environment with minimum level changes to the new south entrance of the existing station, and leading to the high-level footbridge in the existing station. Alternatively, passengers could access the station by walking along Neville Street.
- 4.3.17 Bus, taxi and vehicle access to the north concourse would be from the forecourt sited on the east side of the station, with further bus stops on the west side of the station.
- 4.3.18 Access to the north entrance by bus would be from Victoria Road as well as from Meadow Lane.
- 4.3.19 Taxi ranks would be located along the east side of the station and fed from Meadow Lane, with a second drop-off point at the south station entrance, for passengers arriving from the suburbs.



Site constraints

- 4.3.20 The range of constraints for this station option would include:
- maintaining east-west permeability and a suitable local road network;
 - minimising impacts to the River Aire, the listed Victoria Bridge and other developments;
 - creating a link to the existing Leeds station while minimising impacts to the canal wharf conservation area; and
 - devising workable vehicle and pedestrian forecourt arrangements on a tight site on the south side of the river.

Constructability

- 4.3.21 This option would comprise both the new high speed station and a pedestrian bridge connection between the new station and the new southern entrance to the existing station.
- 4.3.22 The site would be split into several parcels of land. As access would be available to all parcels, this would be not a major issue. Traffic management will be required where the construction work crosses over streets.
- 4.3.23 Constructing the footbridge link to Leeds station with its long spans over the river would be challenging, particularly given the restricted access to sites north of the river and the complexity of connecting to the operational station.
- 4.3.24 The construction of New Lane station would be carried out in two broad phases. Phase One would cover the construction of the station sub-structure. Phase Two would cover the construction of the station superstructure and the erection of the platforms.

4.3.25 Phase 1:

- Clear the site and divert utilities.
- Carry out ground remediation – the extent of required ground remediation is unknown at this time, but the site history suggests that provision should be made.
- Construct the foundations and piers for the approach viaduct.
- Install piles and sub-structure for platforms and car park.

4.3.26 Phase 2:

- Install the deck of the approach viaduct.
- Construct the superstructure for platforms.
- Install the platform deck structures and station enclosure.
- Construct the station building and forecourts – the station building would be constructed in parallel to the platform construction works, and pedestrian link to existing station.
- Install railway systems – lay track, install OHLE and signalling, etc.
- Commission and open the station.

Access and site compounds

4.3.27 There are two main access routes that could be used for the construction of the New Lane station; both connect to Junction 3 of the M621. One is via Meadow Lane and New Lane – this route would provide access to the north end of the station. The other is a new access from Dewsbury Road near Holmes Street – this route would use the southern station access road to access the southern section of the site.

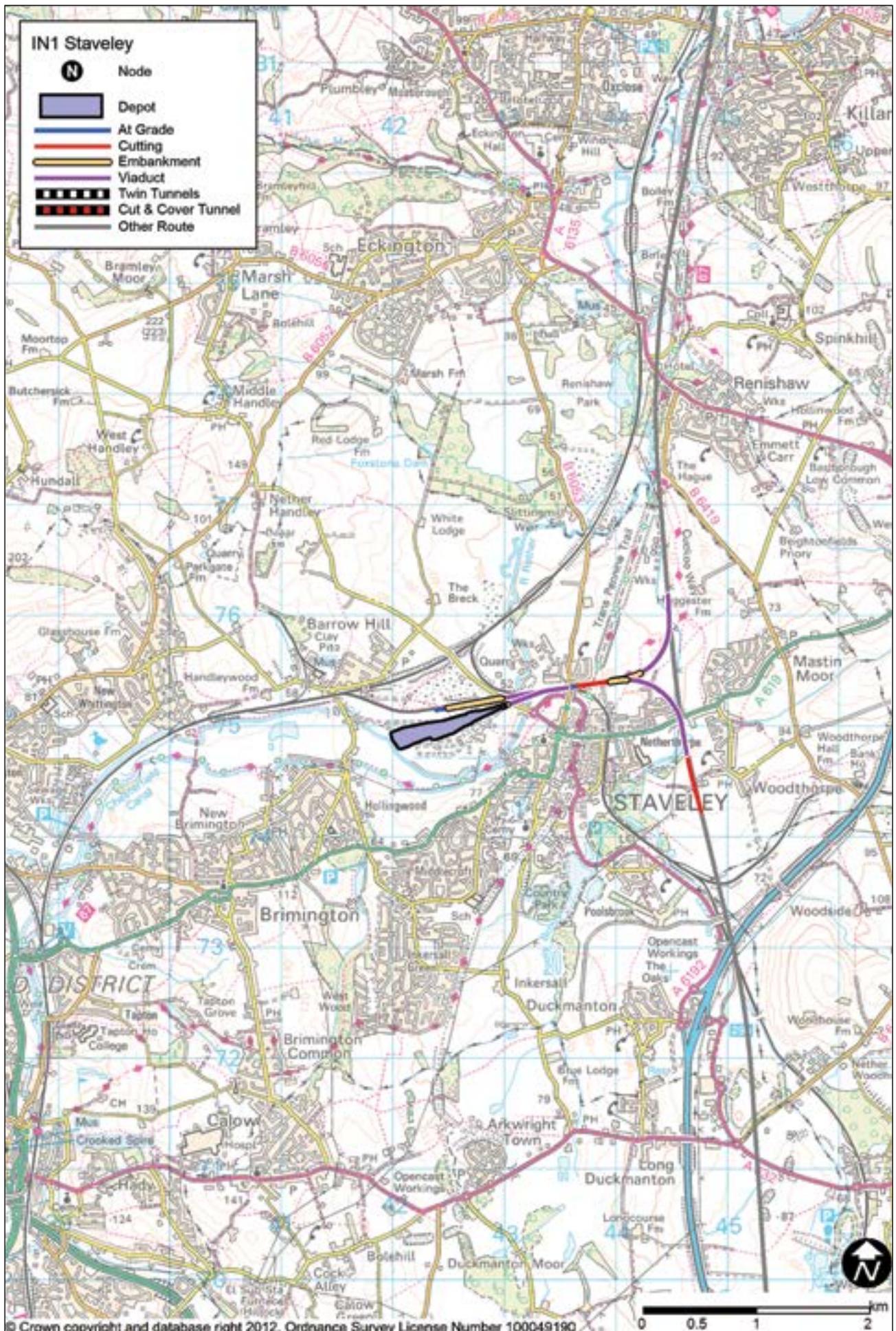
4.3.28 The construction of Leeds New Lane would require demolitions near the site. As not all of this land would be occupied by the permanent works, it is anticipated that sufficient space would be available in the immediate vicinity of the station for contractors' compounds and laydown areas.

Programme

4.3.29 It is estimated that it would take approximately four and a half years to construct the New Lane station. This period is made up of:

- Year 1 – enabling works, including site set-up, utility diversions, decontamination activities and demolitions;
- Years 2 and 3 – construction of the station structure and the pedestrian link to existing station; and
- Years 4 and 5 – fit-out and commissioning of the station.

4.3.30 The station would be ready for installation of railway systems (track, signalling, OHLE, etc.) at the end of Year 3, with the station available for full commissioning in Year 5 and available for full train operations towards the end of Year 5.



5 Depots

5.1 Introduction

5.1.1 Two depots would be required for the operation of the Birmingham to Leeds section of HS2. One would be an infrastructure maintenance depot (IMD) as a base from which to carry out engineering activities to maintain and renew the track and other elements of fixed infrastructure, such as electrification systems. The other would be a Rolling Stock Depot (RSD) as a base where the trains for the route would be stabled overnight, for cleaning and maintenance.

5.2 Infrastructure maintenance depot

5.2.1 Staveley IMD would be located south of the existing Chesterfield to Rotherham railway which passes the site. This line forms the principal freight route between the Midlands and the North of England and has a junction with an out-of-use branch to Seymour Junction.

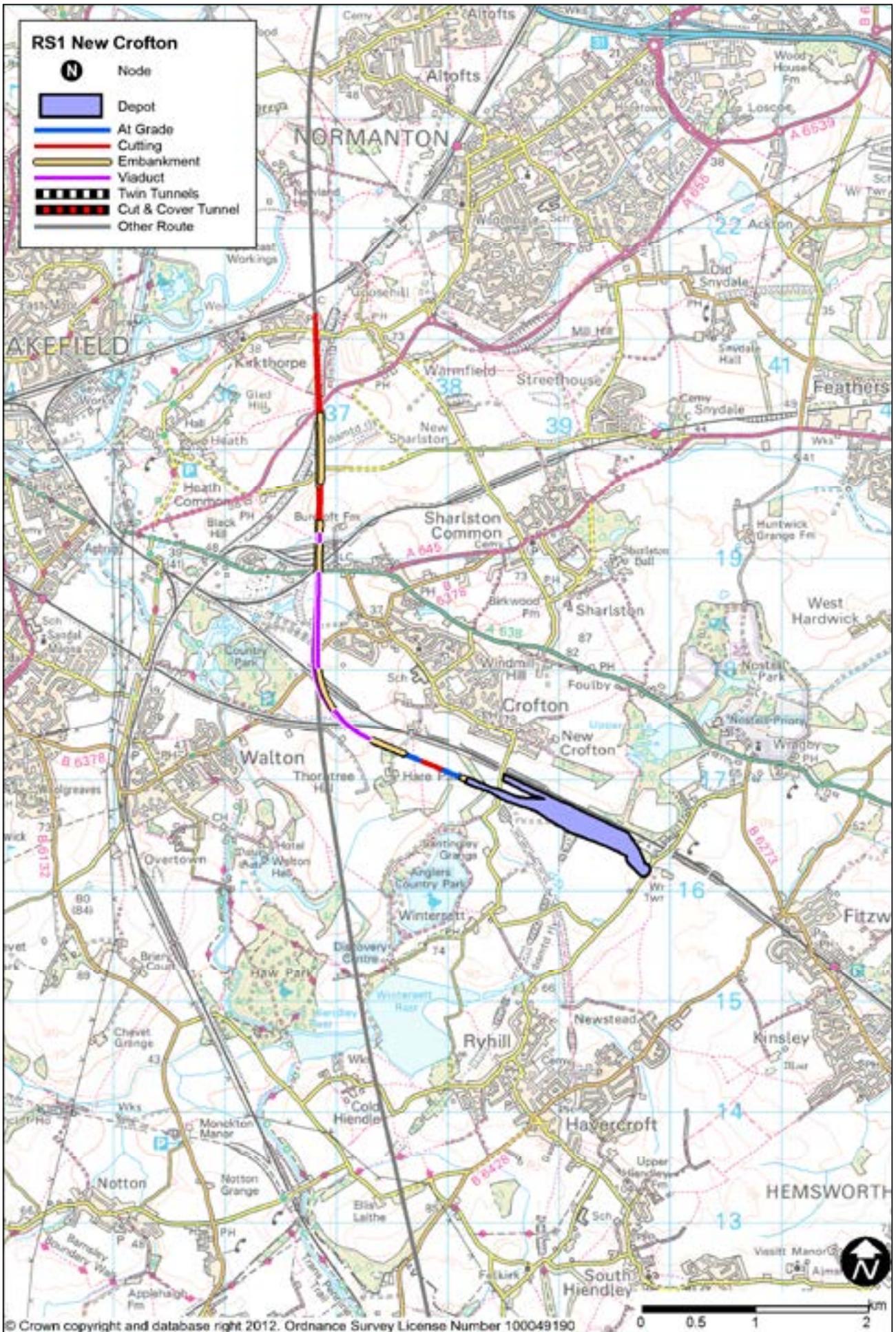
5.2.2 The depot would occupy 11 hectares of the southern part of the brownfield site, where an ironworks formerly stood. This site has a long history of industrial activity and is also located within a flood plain.

5.2.3 High speed rail access would be via flat junctions off the mainline (HSL13) onto curves leading toward the depots. These curves would merge and run into the eastern end of the depot. Access from the existing rail network would be near the existing sidings at Barrow Hill, using Seymour Junction for access into the depot. Road access to the site would be off Works Road, which already serves heavy goods vehicles; therefore, road upgrades are unlikely to be required.

5.2.4 The depot would be single-ended, facing the high speed route, and it would be laid out in accordance with HS2 Ltd's *Options for Phase Two of the high speed rail network: Approach to design*.

5.2.5 The IMD would be used to stable and service/maintain a variety of On Track Plant and Engineering Supply Train equipment. It would also provide strategic engineering material stores. There would be no intention for ballast or rail to be stored at the IMD, and all ballast and spoil wagons would need to be able to run on and off the existing rail network, bringing supplies.

5.2.6 The brownfield site may include contaminated land, which would need to be dealt with as part of the proposals. A river diversion would be required and flood plain compensation may also be required. Due to the size of the site, it is envisaged that sufficient space would be available for this within the site boundary. Other than these contaminated land and flood issues, construction of the depot would use standard methods.



5.3 Rolling stock depot

- 5.3.1 A rolling stock depot would be required for the operation of the West Midlands to Leeds section of HS2 as a base at which the trains for the route would be stabled overnight, for cleaning and maintenance.
- 5.3.2 New Crofton RSD would be located approximately 22km south of Leeds and 6.0km south-east of the centre of Wakefield. The site would be on a disused coal disposal plant adjacent to the existing Doncaster to Leeds line. The village of New Crofton lies approximately 200m north of the proposed site on the opposite side of the Network Rail line.
- 5.3.3 This site would offer good rail connections with direct access onto the existing electrified rail network. The site's location, south of the Leeds delta junction, would also provide access to both Leeds and to the spur to the ECML.
- 5.3.4 The depot would be laid out as a single-ended depot in accordance with HS2 Ltd's *Options for Phase Two of the high speed rail network: Approach to design*.
- 5.3.5 High speed rail access to the depot from the main route would be via a south-facing grade-separated junction in the vicinity of Kirkthorpe, immediately south of the Leeds delta junctions. This would enable direct connections from and to Leeds and the ECML. These connections would also serve as turnbacks for trains to and from the south. A number of crossovers would be provided on both the arrival and departure connections to enable trains to stand and allow other trains to enter or leave the depot without adversely affecting train operations.
- 5.3.6 The site would require the refurbishment of a Network Rail siding connection and the associated changes to the signalling.
- 5.3.7 Road access to the site would be proposed off Swine Lane, which connects to the main A638 Doncaster Road.

6 Ancillary design works

6.1 Tunnel portals

6.1.1 Tunnel portals are required to fulfil a number of purposes. These include:

- providing a structure to sustain the surrounding local topography at the tunnel entrance.
- providing emergency intervention access to the tunnels from the surface.
- providing emergency passenger evacuation where evacuation through the portal is part of the emergency strategy; and
- reducing noise and air pressure effects as trains enter or exit the tunnel.

6.1.2 Tunnel portals would incorporate some or all of the following features:

- portal hoods (tapered, perforated, reinforced concrete structures, up to 100m long);
- building housing services such as power, telecommunications, water supply, fire safety, drainage and ventilation equipment to service the tunnel, in what is generally known as a 'headhouse'; and
- parking for service vehicles.

6.1.3 Tunnel portals would take different forms, depending on ground conditions, local topography and train speeds. In rural locations, portals would typically be constructed in open excavation, with soil and rock slopes benched (i.e. cut in steps) and reinforced as necessary, and reinforced concrete headwalls and wing walls around the tunnel entrances. In urban locations and where space is restricted portals would use earth retaining structures.

6.1.4 Where excavation is relatively shallow, tunnel portals would be constructed by open cut. For deeper excavations, diaphragm wall or contiguous bored pile techniques would be used, requiring support by propping beams or a cover slab for the deepest excavations.

6.1.5 A minimum 'rescue' area of 550m² for emergency services would be provided at both portals for tunnels longer than 1.0km and at one portal for those shorter than 1.0km.

6.1.6 The function of the headhouse is to accommodate ventilation fans, lift winding gear and other plant, together with emergency access doors. The headhouse structure would generally be a single-storey building of 4m-5m in height, depending on whether air intakes to fans are required.

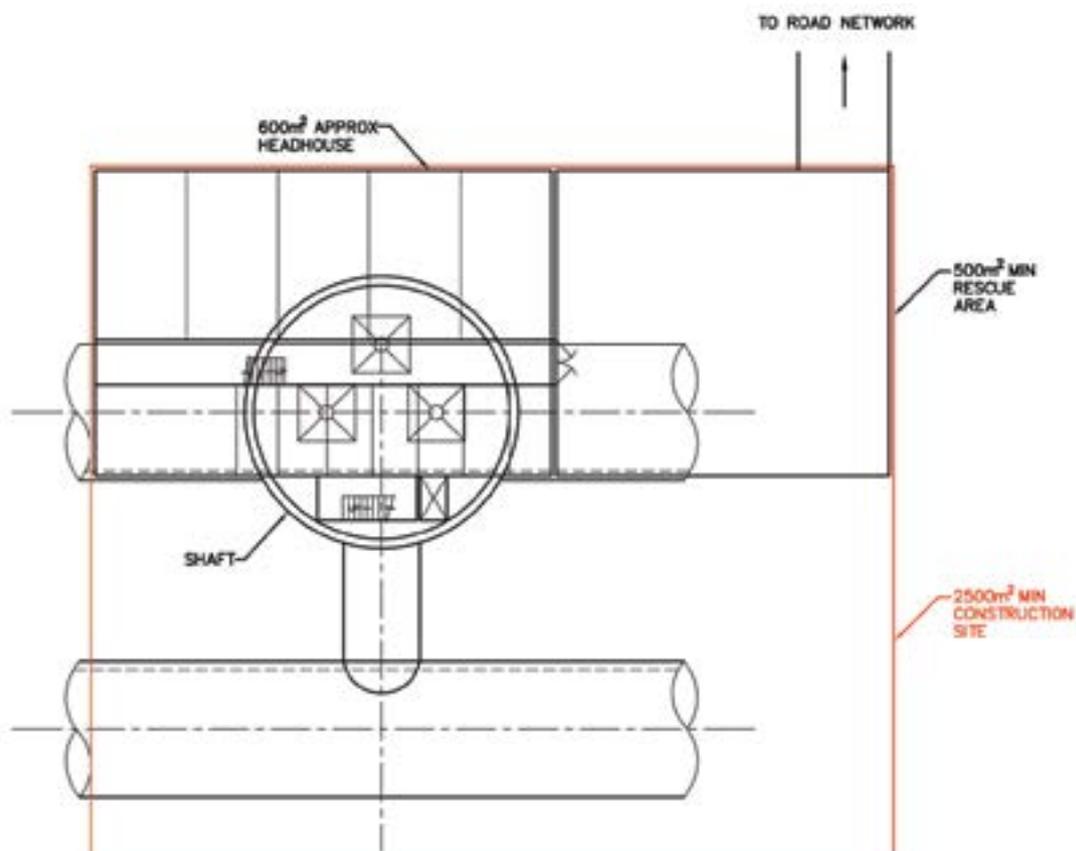
6.2 Ventilation shafts

6.2.1 Typically, tunnels will have shafts for ventilation maintenance, pressure relief and emergency intervention located at 2.0km-3.0km intervals, as follows:

- The vent shafts would require mechanical ventilation for smoke extraction purposes in the event of fire, air temperature and air quality inside the tunnel;
- Vent shafts would incorporate both lifts and stairs, terminating at ground level in 'headhouses' where ventilation fans, lift winding gear and other plant for servicing the tunnel and the shaft would be located;
- A minimum 'rescue' area of 550m² for emergency services would be provided adjacent to each intervention point.

6.2.2 Tunnel shafts would be constructed by various techniques, depending on the location and ground/groundwater conditions.

6.2.3 An indicative layout and footprint of the ventilation shaft is shown below. Ideally, a site of 2,500m² would be required to facilitate the overall construction of the shaft.



Ventilation shafts – indicative layout

- 6.2.4 The indicative vent shaft locations can be found on plan and profile maps.
- 6.2.5 The proposed scheme includes a total of three tunnels on the eastern leg to Leeds. Only the proposed tunnel under East Midlands Airport, being 3.0km in length, would be likely to require a vent shaft, located immediately north of the airport boundary. This is summarised in the table below:

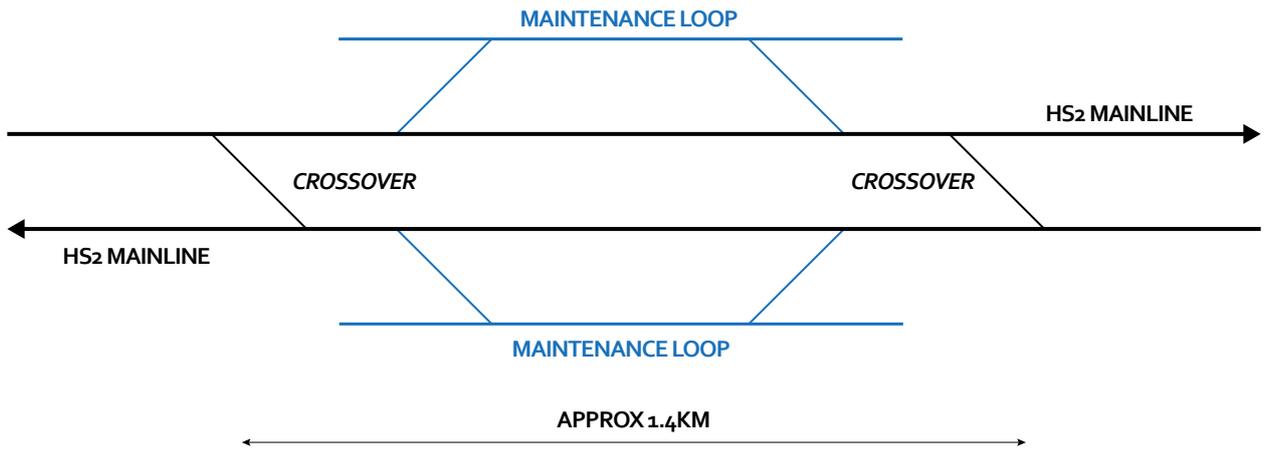
Tunnel	Length	No. of shafts
EMA Airport	2,965m	1
Red Hill	200m	0
Strelley	770m	0
Hoyland	2,175m	0
Ardsley	1,205m	0

Table 1: Number of shafts required – Leeds Leg

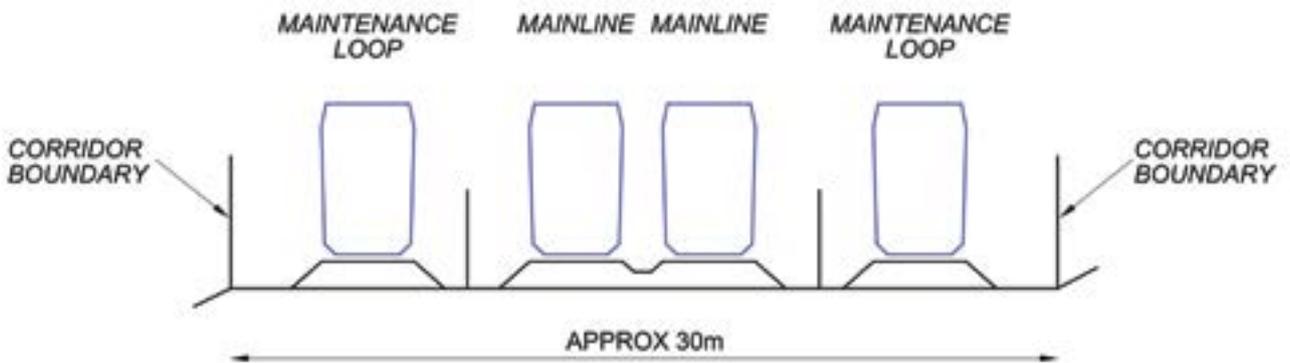
- 6.2.6 Tunnels of 2.2km and 1.2km would also be required to take the route under Hoyland and then Ardsley on the eastern edge of Barnsley, but would not require vent shafts. In addition to these three twin bored tunnels, there would be two cut and cover tunnels at Red Hill, near the East Midlands and at Strelley, respectively 200m and 770m in length.

6.3 Maintenance loops

- 6.3.1 Maintenance loops are a series of sidings used to provide stabling for maintenance trains required for operational maintenance work, and failed trains which that cannot readily be pushed through to the next station, so allowing the line to be cleared with limited delay. Depots can be used for this purpose, but, due to the nature of the lengths between depots and stations on the proposed high speed network, it is necessary to provide loops between these locations to allow quick start-up of work when the limited engineering hours commence. Assessment of requirements in this respect indicate that such berthing facilities should be supplied on the network, be they stations depots or loops, at no more than approximately 60km along the route.
- 6.3.2 Ideally, the layout of maintenance loops will comprise two loops or sidings, one either side of the mainline. Each of these loops will be approximately 1.4km long. Crossovers will also be provided at either end of the maintenance loops to allow for operational movements.
- 6.3.3 Road access and parking will be provided to these maintenance loops on one side as a minimum. A road rail access point will also be incorporated into the spur siding adjacent to the car park.
- 6.3.4 Maintenance sidings are available on the Phase One route at Washwood Heath RSD. Based on these, loops will be located at Toton, incorporated into the East Midlands Hub station layout. Both of the loops will be located on the west side of the station due to the station access and car park on the east side.



Maintenance loops – typical layout



Typical cross-section configuration

7 Glossary of terms

At-grade – at ground level.

Classic compatible trains – a European high speed standard train which can also run on existing UK rail lines, also known as the ‘classic network’.

Conservation area – designated areas of special architectural and historic interest.

Cut and cover tunnel – a method of tunnel construction involving excavation of ground, installation of a structure and backfill over the top

East Coast Main Line (ECML) – Intercity railway route in the UK connecting London, Leeds, York, Newcastle and Edinburgh.

Engineering hours – the hours during the night when passenger services are not running and engineering work can be carried out on the tracks.

Floodplain – area of land surrounding a watercourse which will be subject to flooding.

GC gauge – ‘gauge’ is the shape beyond which a vehicle is not to be built, or within which a structure is not to intrude. GC gauge is an intermediate shape between a vehicle gauge and a structure gauge, defining limits to which a vehicle should conform in a limited range of operating conditions.

Grade-separated junction – a junction where one or more routes cross other routes at a different levels by being raised above or below them. This could apply to either to railways or highways.

Grade I listed building – a listed building of exceptional interest, sometimes considered to be internationally important.

Grade II listed building – nationally important buildings that are of special interest.

Grade II* listed building – a listed building of particular importance, of more than special interest.

High Speed Two Limited (HS2 Ltd) – a company wholly owned by the Department for Transport, responsible for developing and promoting HS2 London to West Midlands and preparing proposals for HS2 to Leeds, Manchester and Heathrow.

Intermodal interchange – interchange between different forms of transport (e.g. between rail and tram or bus).

Infrastructure maintenance depot – base for maintenance of infrastructure associated with the proposed high speed rail line, including track, signalling equipment, overhead line equipment, cuttings and embankments.

Listed buildings - a building of special architectural and historic interest brought under the consideration of the planning system by English Heritage.

Maintenance loop – sidings to allow the berthing of engineering or failed trains alongside the mainline.

Network Rail – owner and operator that runs, maintains and develops Britain’s rail tracks, signalling, bridges, tunnels, level crossings, viaducts and selected rail stations. Network Rail owns and manages Birmingham New Street station and Leeds station.

Overhead line equipment (OHLE) – method of transmitting electrical energy to the trains.

Rolling stock depot – Depot used to stable, service and maintain trains operating on the proposed route.

Sprayed concrete lining (SCL) – a method for the construction of tunnels; it involves spraying concrete immediately on the exposed ground to retain it.

Spur – a railway line which branches off the main through route.

Switch and crossing (S&C) – mechanical trackwork allowing movement of a train from one line to another.

TBM – tunnel boring machine, used to construct tunnels.

Tunnel portal – the entrance to a tunnel.

Twin tunnel (twin bore) – two tunnels constructed side by side, spaced slightly apart, one of which will take the northbound track and one the southbound track.

