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HS2 railway, UK – route development to hybrid bill: a collaborative approach

I. C. Blight MSc, DIC, FICE, CEng
Senior Project Director, CH2M, London, UK; formerly Development Partner's Head of Delivery at HS2, Phase One (Ian.Blight@hs2.org.uk)

In January 2012 the UK government announced that powers would be sought for a London-to-West Midlands high-speed rail line based on a refined version of a 220 km route that was consulted upon in 2011. At the same time, High Speed Two (HS2) Ltd, the agency responsible for implementing the project, appointed a development partner for the London-to-West Midlands phase (phase 1) to assist HS2 and to manage and supervise the HS2 consultants. Later, 16 professional service companies were appointed to undertake the design, engineering, environmental and land referencing work necessary for the hybrid bill. Together, this joint team prepared the High Speed Rail (London–West Midlands) Bill, including an environmental statement, and deposited it into parliament in November 2013, only 22 months after route announcement. This paper describes the collaborative working practices that were employed to achieve this successful outcome.

1. Introduction

In January 2012 the UK government set out its case for high-speed rail (DfT, 2012) and announced that powers would be sought for a London-to-West Midlands high-speed line based on a refined version of a route that was consulted upon from February to July 2011 (DfT, 2011). At the same time, High Speed Two (HS2) Ltd, the agency responsible for implementing the project, appointed a development partner (DP) for the London-to-West Midlands phase (phase 1) to assist HS2 and to manage and supervise HS2's consultants. Between February and May 2012, HS2 appointed 16 professional service companies (PSCs) to undertake the design, engineering, environmental and land referencing work necessary for the hybrid bill. Together, this joint team prepared and deposited the High Speed Rail (London–West Midlands) Bill in November 2013, 22 months after the route announcement for this 220 km scheme, including a period for the preparation of a draft environ mental statement (ES) that was consulted on in mid-2013.

The 16 PSCs commissioned were either assigned to one or more of the five geographical areas (Figure 1) or were appointed to work across the whole route as follows.

- Five area 'lot 1 – civils' PSCs were responsible for developing the engineering design of the scheme.
- Two 'lot 2 – rail systems' contracts were responsible for route-wide high-speed rail systems and route-wide conventional rail interfaces, respectively.
- Four area 'lot 3 – environmental consultants' (the two lot 1 sections within the London area were combined) were responsible for environmental impact assessments (EIAs) and the definition of environmental mitigation measures, while a fifth lot 3 consultant was responsible for coordination of the overall draft and final ES and preparation of route-wide aspects of the ES.
- Finally, four 'lot 4 – land referencing consultants', geographically aligned with the lot 3 areas, were responsible for land referencing and access arrangements for environmental and other surveys.

The DP's area and route-wide delivery management teams were a mix of DP and HS2 staff, and were aligned to the PSC contracts. The DP also provided route-wide project controls, contract administration, work systems and technical services. All contracts were let under NEC3 option E (cost reimbursable) framework agreements (NEC, 2013) under which work packages (service delivery contracts) were awarded by HS2.

At the time of the secretary of state's route announcement in January 2012, the HS2 phase 1 concept design was described on 145 plan and profile drawings, a 32-page technical project specification and 17 supporting reports. Other reports and electronic data were held by the previous engineering consultant and environmental consultant who had provided services to HS2 when the strategic high-speed route options were considered (McNaughton and Banks, 2018). The period of concept design, including route optioneering, leading up to the formal route announcement had been shorter than previous comparable schemes, such as the channel tunnel rail link (CTRL) (now HS1) and Crossrail (now the Elizabeth line). The objective for HS2 in 2012 was to deposit a hybrid bill by the end of 2013, which was a shorter period of time post 'route announcement' than any of these previous comparable schemes (Figure 2).

The requisite objectives for the DP and PSCs were to deliver a consistent and uniform set of 'public-facing' hybrid bill documents, principally comprising

- a safe and affordable design suitable for the requirements of parliamentary procedures

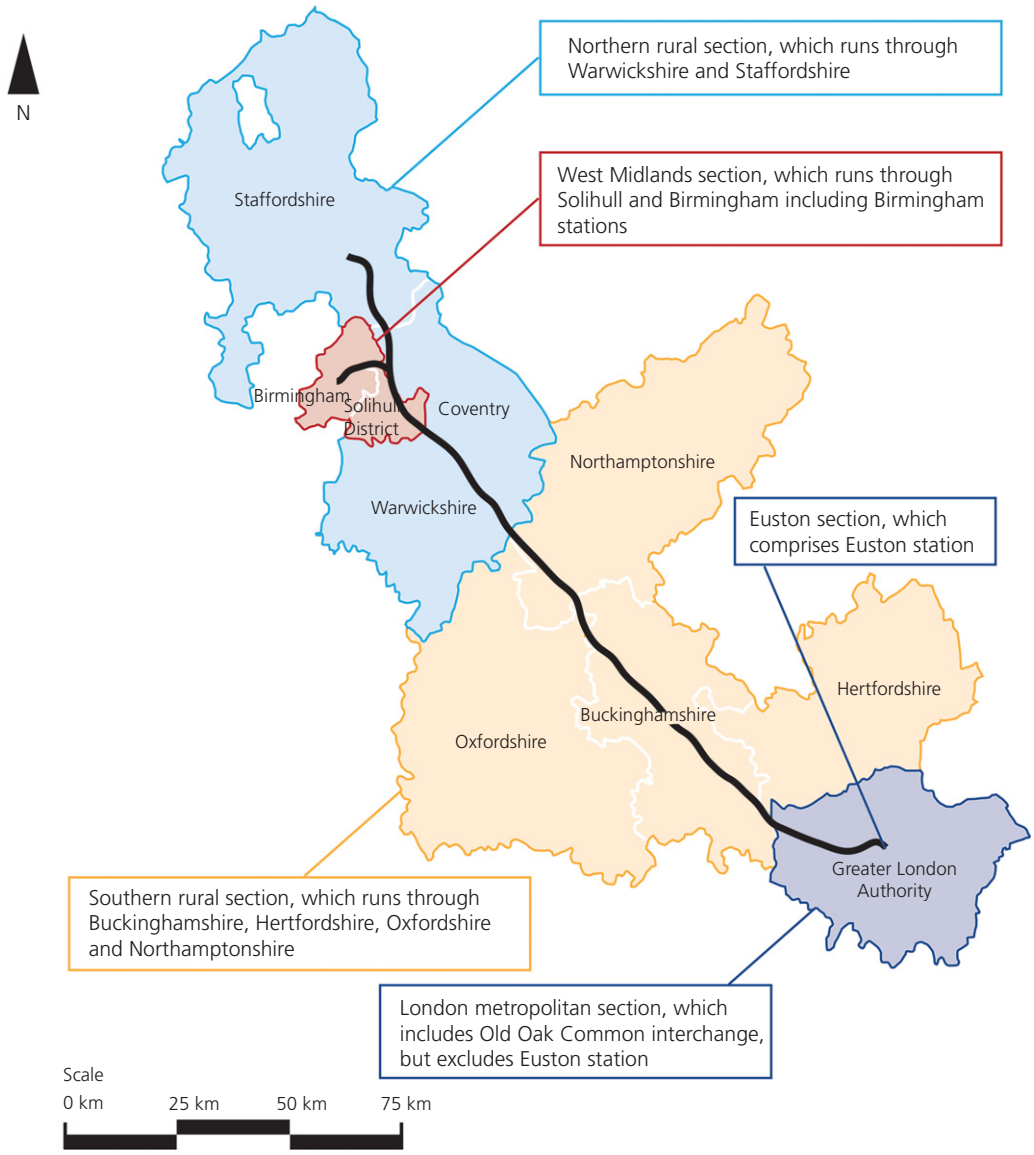

Figure 1. Geographical areas along HS2 phase 1 route

- an acceptable and proportionate ES
- a hybrid bill, including parliamentary plans and sections, a book of reference and a statement of expense.

To be successful, it was clear that the project had to establish and embed a collaborative working culture with the PSCs that motivated all the parties to contribute to the required project outcomes and the successful delivery of HS2's objectives. NEC3 requires parties to 'act in a spirit of mutual trust and co-operation' and this was reinforced in each of the package orders' issued framework agreements between HS2 and the PSCs, which stated

> The Employer intends to develop a highly professional and motivated design team which works closely with the other PSCs, the Employer and Others to deliver the Employer's objectives. The Employer wants to facilitate the exchange of expertise throughout all the teams engaged on the Programme to develop engineering solutions and standards which best meet the objectives. The Employer requires the Consultant(s) to adopt the desired collaborative culture with all elements of the Project in a way that motivates all parties to contribute to these outcomes and successful delivery.

Furthermore, the NEC3 contracts between HS2 and the PSCs included the X20 (performance targets) option that set out a number of key performance indicators, including 'collaborative working'.

2. Organisation

The organisation that was created to meet the challenge of delivering the hybrid bill is shown in summary in Figure 3.

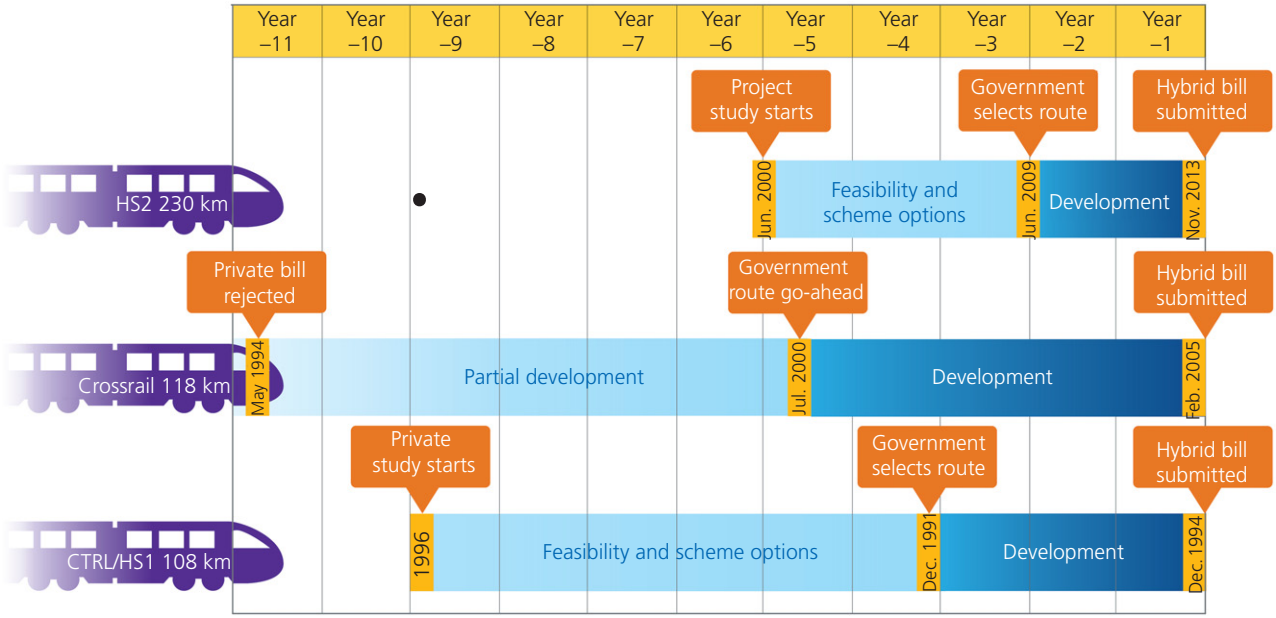

Figure 2. HS2: development timeline comparison

Reporting to the HS2 phase 1 board, the delivery team lay at the heart of the organisation, and comprised five area delivery teams that aligned to the geographical areas shown in Figure 1 and that incorporated the associated PSCs in lots 1, 2, 3 and 4. The teams were led by an area manager who coordinated the work in that area. Each area team included the lead DP or HS2 personnel responsible for civil design, environmental design and assessment, and liaison with affected parties within that area. Route-wide managers were aligned to the route-wide environmental, rail systems and land referencing contracts and coordinated the work across the areas. The delivery teams were supported by contract administration and project controls staff allocated to each area and contract, but which reported functionally to the board. A dedicated technical stakeholder interface team liaised with the major technical stakeholders, including local authorities, non-governmental organisations, utility companies, Network Rail, Transport for London and London Underground. Hybrid bill preparation was coordinated by a single route-wide team, while HS2's technical directorate coordinated and led both the development of project requirements and specifications and technical assurance of the engineering and environmental deliverables. In total, and at peak just before bill submission, the 'client-side' team comprised approximately 200 people, while about 5700 PSC staff and over 100 sub-consultants were approved to work across all the PSC contracts.

3. Programme

The principal key dates set out in the PSC contracts are shown in Figure 4. The programme was described in early 2012 as comprising the following stages.

- Stage 0: mobilisation.
- Stage 1: definition and scope, comprising the development of the 'draft initial preliminary design' and the ES scope and methodology.
- Stage 2: refinement and iteration, comprising the development of a more environmentally mitigated 'final initial preliminary design' that formed the basis of a draft ES that was published for public consultation.
- Stage 3: assessment and reporting, comprising the development of an environmentally mitigated 'interim preliminary design' and associated preparation of the final ES that formed the basis of the High Speed Rail (London–West Midlands) Bill that was deposited into parliament in November 2013.

In practice, these stages overlapped each other across the key dates.

4. Stage 0: mobilisation

At the outset of the contracts in early 2012, considerable effort was made to transfer knowledge of the scheme from the incumbent PSCs and client staff to the new teams. This involved design briefings, route tours, reviews of documentation and audits of existing data. Over the first 2–3 months the area teams became familiar with the work that had been carried out to date, the challenges 'on the ground' and the required programme of deliverables. It was also over this period that a sense of commitment to achieve the hybrid bill deposit date was created. Beyond the need to comply with the key dates in the contract programme (Figure 4), meet HS2's objectives and submit a legally compliant hybrid bill

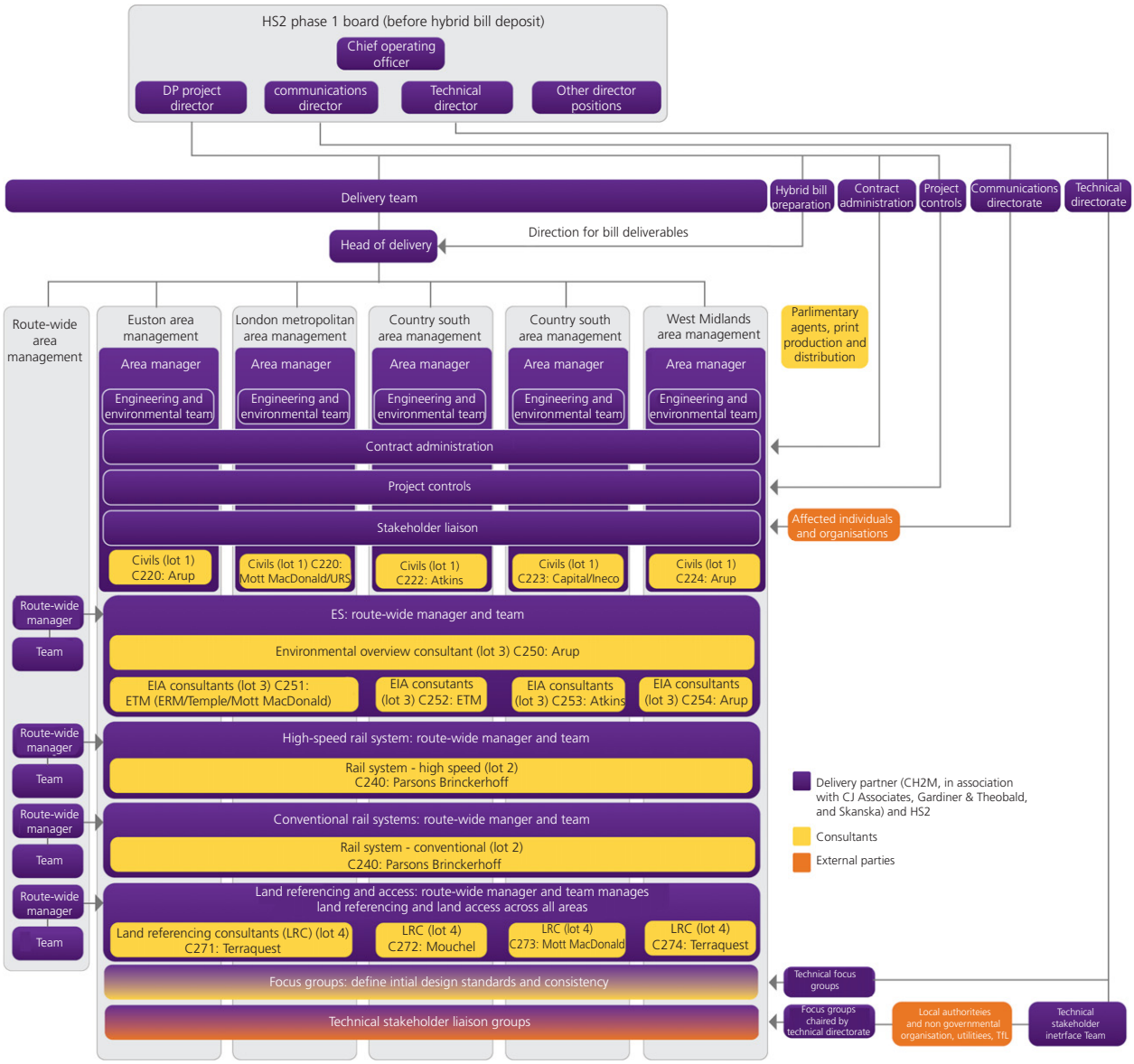

Figure 3. HS2 phase 1 DP: integrated organisation structure

and ES at the end of 2013, there was little contract definition about the exact deliverables, their format, the technical and programme interfaces between the contracts, or the methodologies associated with either the design or environmental assessment processes. To be successful, it was clear that the organisation would need to harness individual and collective skills across the whole supply chain to address these matters. With government policy anticipating HS2 phase 1 to open in 2026 (DfT, 2012), it felt as though the reputation of many of the UK's engineering and environmental consultant companies was at stake.

With the number of teams and people being rapidly mobilised, a set pattern of team and stakeholder interaction was quickly established. In general, Mondays comprised individual team progress meetings at all team levels, both within the HS2/DP organisation and in the PSCs. Multi-discipline/contract progress meetings within each area or route-wide contract were held on Tuesdays, generally at the lot 1 (civils) consultants' offices where desks were also provided for staff from both HS2/DP and the other lots. Wednesdays and Thursdays were for meetings with affected persons, communities, stakeholders and other third parties. Thursdays were also used for 'single engineering discipline' meetings across the areas in order to ensure a consistency of design or environmental assessment approach. No regular meetings were generally planned for Fridays. Every calendar month, formal contract 'dashboard' meetings were held between HS2/DP and each PSC contract

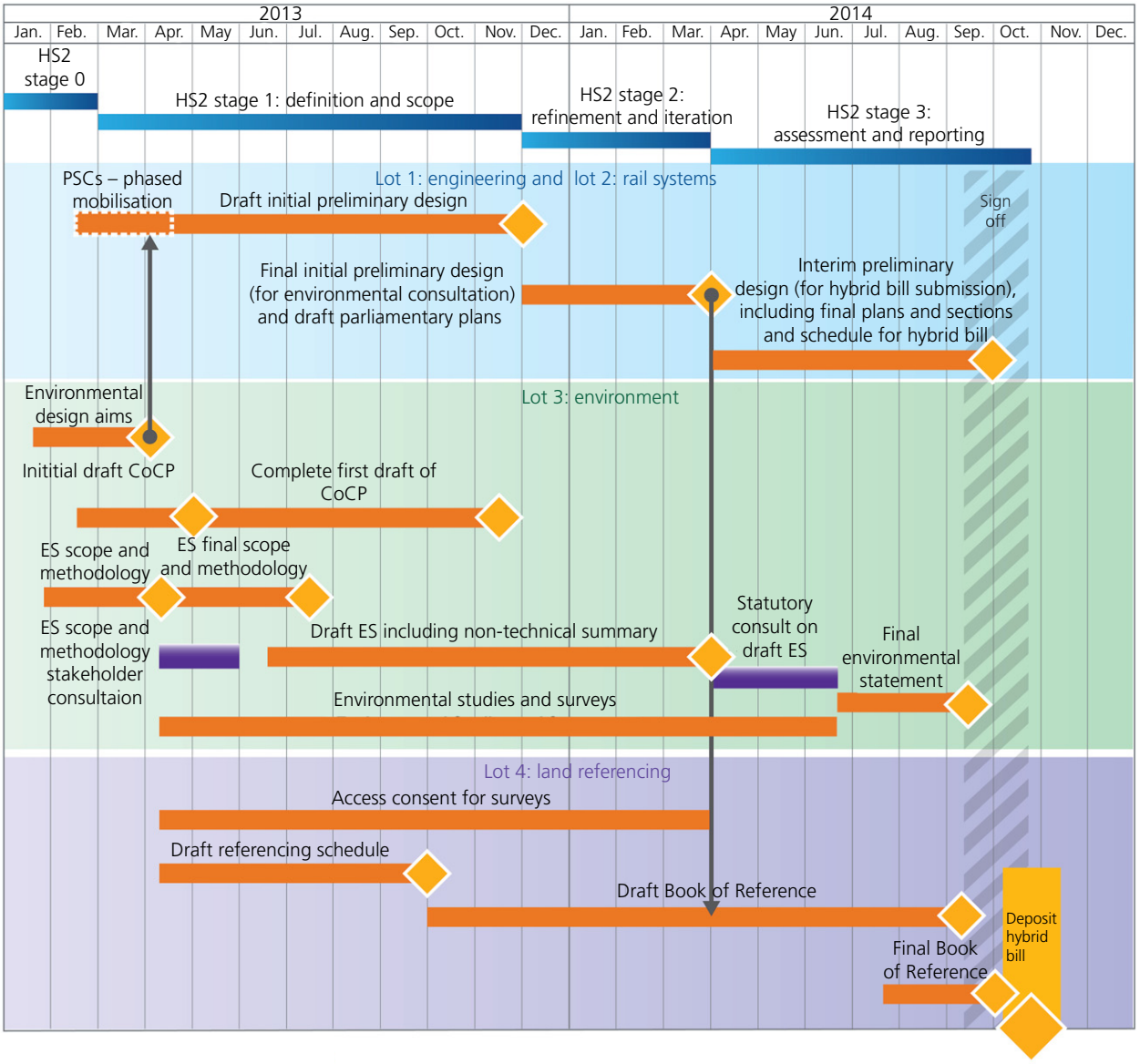

Figure 4. Summary of principal key dates

using the progress-reporting dashboards submitted by the PSCs as the basis for the agenda, and these were immediately followed by a meeting of PSC framework directors with the DP's head of delivery at which common issues of either good practice or challenge were discussed. Every 3 months, the DP's project director chaired a meeting for PSC chief executive officers (CEOs) with HS2 board members.

Adopting standard processes and tools is a recognised collaborative approach that improves project delivery (Paton, 2002). It was essential that a consistent approach was taken across all the deliverables because, ultimately, the teams were producing a single set of public-facing documents for phase 1 of HS2. At the core of the work systems, the DP established a ProjectWise drawing management system, hosted by the DP and then by HS2, which was structured to comply with BS 1192:2007 (BSI, 2007), and within which all PSCs would work. Baseline light detection and ranging (Lidar) surveys were procured centrally and the data were held on ProjectWise. Geographic information system (GIS) data sets held by third parties were obtained under contracts with HS2, rather than through individual PSCs, and provided on a centrally hosted GIS system from which data could be copied to the PSCs as required. However, to obtain all available GIS sets in the shortest time, a central GIS team was formed comprising practitioners from across the lot 1 and lot 3 PSCs who, together, sought and

procured data from third parties. Engineering documentation that did not comprise drawings was required to be held, submitted and reviewed on eB Web, which could be accessed by all the PSCs, subject to appropriate permissions. A SharePoint system was also established, which the environmental teams used to prepare the early scope and methodology reports and the later draft and final ESs. Ensuring that all DP and PSC staff had immediate access to these systems proved an early challenge, and a separate information technology administrative team was mobilised to deal with authorisations and accesses. At the time of the hybrid bill submission, about 20 months after the end of mobilisation, the quantum of data and usage associated with these work systems was as follows.

- ProjectWise: 11 900 drawings, 8700 models, 1485 users, 36 million records in the audit trail, 1·2 TB of storage.
- eB Web: 134 700 documents, 242 organisations, 2654 users, 332 GB of storage.
- GIS: 32 670 data sets, 6000 maps, 13 TB of storage.
- SharePoint: 17 300 documents, 2709 users, 279 GB of storage.

Consistent contract administration under the NEC3 contract was also addressed during mobilisation. In addition to setting a project reporting calendar, a suite of over 35 standard contract documentation pro formas in eB Web were produced, including proposals for staff and sub-consultants, instructions and quotations, early warnings and progress-reporting dashboards. At the outset and throughout the period of the services, PSCs were encouraged to submit early warnings under the contract, especially about any matter that could either delay meeting a key date or affect the work of either HS2 or another PSC. These early warnings, and their solutions, were considered an essential means of improving the whole team's overall performance and efficiency. Early consideration was also given to the PSCs' progress dashboard reporting, which, in addition to reporting key activities and milestone progress, required commentary associated with contract-specific, project-wide and interface risks, and also required metrics of hours worked by both 'all staff' and 'key staff' compared with the mobilisation plans.

All the PSCs' project delivery schedules were required to be prepared on Primavera P6 and submitted to the DP for integration. Later, and when the software was developed further, the PSCs were required to work in a common P6 data environment (in the same way as drawing production in ProjectWise) so that there was greater immediate recognition of interfaces and programme dependencies by the project controls team. The integrated Primavera P6 program was then used to produce a single-sheet high-level visual programme, in a similar format to Figure 4, which showed key activities, dates and interfaces in order to provide the wider team with an appreciation of the overall approximately 2-year hybrid bill deposit delivery programme.

5. Stage 1: definition and scope

This period of the programme, from early 2012 to November 2012 and which overlapped the mobilisation stage, was characterised by the need to establish consistent standards/requirements, design processes and EIA approaches.

In early 2012, the governing requirements for design were set out in a project specification (HS2, 2012a) comprising the key technical, operational and environmental requirements that needed to be defined and subsequently met by HS2. This project specification was intentionally not comprehensive in all areas as it only set out those requirements that were pertinent to the project deliverables defined in the exchange of letters between Sir David Rowlands and Lord Adonis in 2009 (DfT, 2009; HS2, 2009) and the selection of a preferred route. These design-relevant deliverables primarily comprised a proposed specification (e.g. gauge, line speed, capability) and proposed locations for maintenance facilities. Clearly, further design requirements and standards needed to be developed and the collaborative approach adopted was to form technical focus groups whose members were the relevant discipline experts from the PSCs, but chaired by discipline heads within the HS2 technical directorate. Each focus group developed deliverable approach statements that outlined both the requirements and the approach to be adopted route-wide for the design of about 60 relevant technical design topics. The statements recognised that the level of design needed to be appropriate for identifying the land required to construct and operate HS2, and enabled a 'reasonably worst case' for environmental assessment (Smart and Irwin, 2018). Subsequently, all the PSCs were instructed to comply with the developed deliverable approach statements and the PSCs were required to certify that the interim preliminary designs, submitted as part of the deliverables for the submitted hybrid bill, complied with these and other developing requirements. With requirements in place, the preliminary design followed the simplified generic design process shown in Figure 5.

In parallel with the development of the design standards, the environmental overview consultant, with DP/HS2, developed a scope and methodology report for the ES (HS2, 2013a) and a first draft of the code of construction practice (CoCP), building on similar CoCPs developed for the Crossrail and HS1 (previously the CTRL) projects. As the former had to be published in draft for public consultation very early in the programme, experts from across the supply chain, under the direction of the lot 3 environmental overview consultant, were used to develop documents that were best practice (Bonard and Richards, 2018).

At the commencement of this period of design, access to land to carry out environmental surveys was a priority because the results from these underpinned, and formed the baseline for, the subsequent environmental assessments (Bonard and Richards, 2018). However, in order to gain access to any land

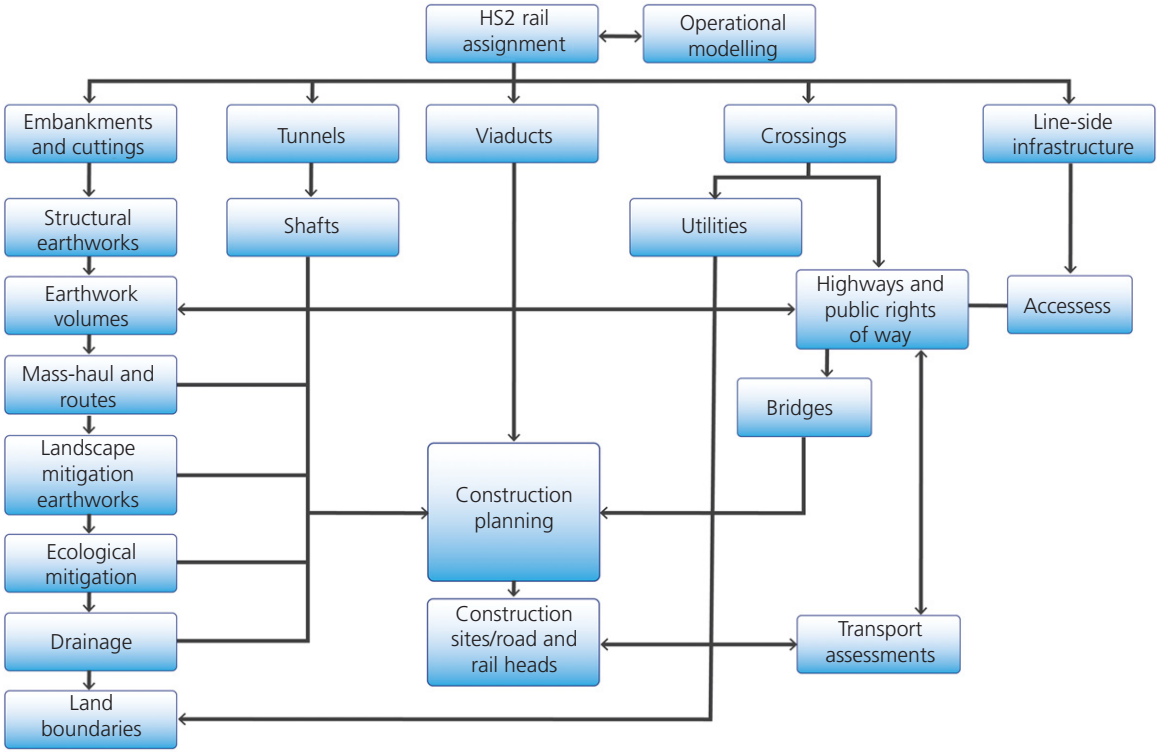

Figure 5. Generic design sequence

or property, both the landowner and occupier (where relevant) had to be identified and an access agreement put in place. Unfortunately, many stakeholders did not co-operate and permission for access was not obtained. Subsequent environmental assessments therefore had to rely on existing published or known information, or information that could be viewed from aerial photographs.

As one of the first steps in the design process, the consulted route was the subject of more detailed train operational modelling than had been carried out to date. Further details are described by Smart and Irwin (2018), but areas that proved particularly significant comprised

- the arrangements for an infrastructure maintenance depot in Calvert, Buckinghamshire
- the rail infrastructure depot in Bromford, Birmingham
- the rail construction depot in the Staffordshire area
- the 'delta' junction where both the Birmingham rail spur and the proposed connection to Leeds would join the main north/south rail route
- the need for rail cross-overs and loops to accommodate periods of train service perturbation.

Other aspects of operational modelling concerned power supply, tunnel ventilation and transient pressures, and the location of vent shafts. These considerations all assessed the need either to develop further the proposed infrastructure or add additional infrastructure.

As the design was developed, the effects of and requirements for utility infrastructure were also considered. In the first instance, and during the mobilisation period, the PSCs liaised with utility companies to obtain data on their existing infrastructure. Meanwhile, the DP's central utilities interface team worked with the utility companies to agree working arrangements and entered into formal agreements that enabled their design teams to be paid for the work they carried out. During this stage, design responsibility for utility works lay with the PSCs, while the utility companies were requested to review the designs to the extent they defined the hybrid bill powers sought, and the environmental effects they created, particularly temporary construction effects. The works identified generally fell into

- the need for utility diversions where the route (rail or road) either 'cut' the utility or tunnelled beneath the utility
- the need for new supplies, particularly new temporary power supplies for tunnel boring machines and new permanent supplies for train traction power, tunnel ventilation and stations.

The need to divert power lines proved to be particularly significant as re-stringing routes and the associated need to access

pylons meant that the proposed construction arrangements often extended many hundreds of metres from the rail route, affecting people who had previously thought they would be largely unaffected.

At the end of stage 1, in November 2012, the PSCs submitted drawings to HS2 that showed a draft interim design, a revised cost estimate, a draft construction schedule and a risk and opportunity register. Although these products had gone through a series of discipline and multi-disciplinary reviews, they were generally not optimised with respect to either environmental effects or cost. The purpose of stage 2 was therefore to deal with both these aspects of design development.

6. Stage 2: refinement and iteration

Stage 2 included the further design of mitigation measures to address the environmental effects of the developing scheme. In general, the preferred mitigation measures comprised earth bunds to mitigate both the operational noise from trains and visual impacts, compensation areas for ecology and floods to mitigate the loss of habitats, woodlands and flood plains, the use of rail rather than road to transport construction materials and the use of a route trace for construction traffic to mitigate the traffic effects on public roads. However, some of the mitigation measures created new or different environmental impacts, or increased cost, and consequently their design was very much an iterative process. For instance, visual and noise impacts can be effectively dealt with by 'submerging' routes into the landscape using cuttings or tunnels. However, tunnels are generally 2·5 to 3 times the cost of cuttings per kilometre, while deep cuttings require more land to be compulsory-purchased than either a surface or shallow section of route, and hence a 'balanced' design needed to be developed.

The iterative approach also included the presentation of 'sift' information and technical evidence that compared the options under development with each other. Factors considered and included in the sift information comprised environmental impact, cost, programme and discussion with, and the views of, stakeholders. None of the changes described in the following were approved without governance oversight by the HS2 board (Figure 3) and also by the Department for Transport (DfT) for major changes to route alignment. High expectations were demanded of the technical evidence, not least because many of the decisions had to be described in the ES and also relied upon when the DfT promoted the bill through parliament. HS2 board meetings were generally held monthly, but specially convened meetings were also held when particularly significant changes were proposed.

The announced HS2 rail alignment (HS2, 2012b) included defined surface route sections (embankments and cuttings), tunnels or viaducts. While stage 1 of the design developed the announced route, stage 2 tested and refined the proposed engineering form of the route sections as the engineering and environmental constraints became better understood. Most notable of these refinements were the changes from a surface route to a tunnel for the sections from Old Oak Common to Northolt, in London, and in Bromford, Birmingham. Between Old Oak Common and Northolt, the consulted surface route ran along the existing Chiltern line route corridor and passed beneath 20 existing road bridges. As the design development proceeded it became clear that construction works along this section would significantly impact both the existing rail corridor and the road bridges and would create significant traffic congestion, noise and disruption to residents. Changing to twin-bored tunnels, incorporating three vent shafts, would significantly mitigate these effects. In Bromford, the proposed surface section of the route beneath the M6 Bromford viaduct lay within a congested corridor comprising the viaduct, an existing rail line, a river and an electricity pylon route. The change to twin tunnels for this section of route would lead to less disruption to both traffic and property and would also avoid changes to the river, electricity pylons and the existing railway. Both these design refinements, together with a number of others, were the subject of further public consultation in mid-2013, which was reported on in October of that year (DfT, 2013).

The draft initial preliminary design reported at the end of stage 1 was the basis of extensive discussions with affected third parties, led by the stakeholder team (see Figure 3) and supported by the engineering and environmental teams. Their views on the design options developed to date had to be tested against local knowledge and whether reasonably practicable improvements could be made to reduce their environmental effects. The following design features particularly benefited from these discussions with stakeholders.

- The locations and arrangements of construction sites at key structures (theoretically, a construction site could be placed in any one of the four quadrants defined by a rail/road intersection).
- Revised access arrangements to properties and farmland.
- The routes of diverted footpaths and bridleways.
- The locations of ecological mitigation areas either to compensate ecological loss or to be used for the translocation of protected species.
- The location and form of embankments/bunds to mitigate visual and/or noise effects. For example, in some circumstances, there was a choice between either a relatively steeply sided mitigation embankment/bund that minimised the land required to be taken for construction or an embankment/bund with relatively shallow side slopes that maximised the land that could be returned to agricultural use after construction.
- Temporary construction routes.

In the absence of stakeholder input, decisions were made on best engineering and environmental judgement.

The cost estimates from the lot 1 PSCs were the subject of considerable review in order to ensure consistency of methodologies and rates and also to identify cost-saving measures that could either be implemented immediately (such as changes from a viaduct to an embankment over certain sections of the route) or opportunities that could be implemented later once the existing ground conditions were better understood (such as steepening cutting slopes). Once again, the concept of establishing focus groups to lever the very best expertise from all the PSCs was employed: a contractor panel was set up to review the key construction challenges arising either from the identification of risks within the cost estimate or areas of high cost, such as tunnelling. All the lot 1 PSCs had partnered with tier 1 contractors, just as the DP included Skanska, and it was this collective expertise that was mobilised in early 2013 under Skanska's direction. A similar focus group was established under the direction of Gardner & Theobald, also as a member of the DP, to agree both the estimate methodology and cost rates used.

Another particularly complex and iterative aspect of design that became particularly important during stage 2, and which was also of particular interest to affected third parties, was the assessment of traffic effects during construction, comprising both the traffic routes proposed and the predicted peak numbers of vehicles on those routes. In addition to general construction traffic to and from construction sites, the movement of excavated material most influenced the assessment. At the heart of the traffic assessment for the movement of excavated material was the calculation of volumes of both proposed ground excavations (i.e. tunnels and cuttings) and proposed fill (road and railway embankments and mitigation embankments/bunds) and the 'earthworks balance' between them, taking account of the ground characteristics. Geotechnical assumptions, such as avoiding the use of high-plasticity clay to construct rail/road embankments and determining cutting slope gradients, were made based on the extensive existing geotechnical information available in the UK through conventional desk studies and using best practice. In parallel, the construction programme was developed to take account of the rate of excavation and embankment placement and the period over which the work would take place; simply put, cuttings that would supply material to embankments had to be constructed first, but deciding which cutting would supply each embankment proved to be complex, especially as one aim was to minimise overall haul distances along the total 220 km of the route. Having established this overall 'mass-haul' strategy, lorry routes were identified that maximised use of the proposed construction corridor but took account of intermediate construction route 'blockers' such as tunnels, major road crossings or viaduct construction sites. This information allowed traffic assessments to be carried out, which then led to the identification of the effects that required mitigation and, often, reassessment of all the design steps described above and as shown in Figure 5. In the urban areas of London and Birmingham, mainly involving tunnel excavations, little or no reuse of excavated materials on the project could be practically identified, so mitigation comprised the use of rail to transport excess materials to either an assumed tip or to reuse on other future projects. To deal with this complexity, a focus group comprising discipline leads from each of the PSCs was formed to establish common methodologies, assumptions, reporting pro formas and a programme of activity, with regular reviews of the emerging results. Even then, this assessment activity and its subsequent input into the assessment and reporting of noise, air quality and cumulative environmental effects within the ES proved to be a critical path for completion of the ES.

Stage 2 was completed with the preparation, and publication for public consultation, of a draft ES based upon a design that had been effectively 'frozen' in about early 2013 for the purposes of the draft ES. The document comprised thousands of pages and was prepared by co-located staff from across the PSCs in a dedicated HS2 office of about 80 desks. In retrospect, it was agreed, by all staff involved, that the draft ES could only have been prepared within the required timescale by co-locating the staff responsible for its preparation from across the geographical areas, environmental disciplines and supporting functions involved (i.e. editing, GIS, computer-aided design, printing). Further information on the preparation of the draft environmental assessment is provided by Bonard and Richards (2018).

Publication of the draft ES was celebrated at an event for all members of HS2, the DP and the PSCs who had helped to prepare either the designs or the environmental assessments. As well as being a significant and important milestone, this event was a celebration of the creation of the 'one team' culture over the preceding year obtained through regular social events, both within the areas and HS2, technical focus groups and the regular area, package director and CEO meetings.

7. Stage 3: assessment and reporting

Stage 3 commenced with a period of formal consultation on both the draft ES (HS2 , 2013b) and route refinement proposals (DfT, 2013). Responses from the consultation were immediately fed back into the design process, although many of the issues raised were already known about and were in the process of being addressed because they had been raised by stakeholders in the period after the effective design freeze for the draft ES earlier in 2013. Many other more general comments on route-wide effects, assessment methodologies and route-wide mitigation measures had been raised during consultations with national organisations (Miller, 2018). Long-lead-time activities, such as the finalisation of traffic effects and their mitigation, were also completed during stage 3.

With the design development, for the purposes of preparing a hybrid bill, effectively reaching a conclusion, the draft parliamentary plans, schedules and identification of 'scheduled' work were scrutinised in further detail in order for the

parliamentary agents to be satisfied that full compliance with parliamentary standing orders was achieved (Podkolinski, 2018). This was carried out through workshops chaired by the DP and attended by all the PSCs responsible for developing the design in the geographical area being considered, the lot 4 land referencing PSCs and the parliamentary agents. Areas of challenge in these workshops typically included justification for each and every parcel of land proposed to be within the powers of the bill and that the areas taken coincided with both convenient land parcels (such as field boundaries) and land ownership boundaries wherever possible. All plans had to match both Ordnance Survey plans and Land Registry plans. It is the consensus of all those involved in the preparation of the bill drawings and schedules that the collaborative workshops used to review and check the prepared documentation were essential to the preparation and publication of a compliant bill.

Stage 3 concluded in November 2013 with publication of the High Speed Rail (London–West Midlands) Bill (Podkolinski, 2018) together with the ES (Bonard and Richards, 2018). The PSCs also produced interim preliminary design documentation that underpinned and supported the bill and the ES, and which totalled around 50 000 pages. All this information was then used to promote the bill successfully through parliament (Knight and Lagerweij, 2018).

8. Conclusions

This paper described the approach taken to prepare and publish a hybrid bill and ES for HS2 in a timescale that was shorter than any recent comparable major infrastructure scheme in the UK. This outcome was achieved using a collaborative approach that levered the expertise and experience of most of the UK's engineering, environmental and land referencing consultants in order to meet the objectives of HS2.

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Thanks are extended to Roy Hill who, as the DP's project director for this period of the project, provided the essential overall leadership and direction that enabled the whole team to be successful. The author also acknowledges the significant contribution and leadership of the area managers that led the area teams within the delivery directorate.

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