

HIGH SPEED RAIL (LONDON - WEST MIDLANDS)

Supplementary Environmental Statement and Additional Provision 2 Environmental Statement

Volume 5 | Technical appendices

Summary of carbon calculation outputs (CL-002-000)

July 2015

SES and AP2 ES 3.5.24

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Department for Transport

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1 Introduction

- 1.1.1 This appendix provides an update to appendix CL-002-000 from the main Environmental Statement (ES) (published in November 2013) as a result of design changes and amendments assessed as part of the Supplementary Environmental Statement (SES) and the Additional Provision 2 Environmental Statement (AP2 ES). This update should be read in conjunction with Appendix CL-002-000 from the main ES.

2 Description of the scoping assessment

- 2.1.1 A process was developed to identify which of the SES design changes and AP2 amendments could be material¹ from a greenhouse gas (GHG) emissions perspective and therefore require assessing. The assessment process comprised the following steps:

1. Establish the percentage of construction elements², by type, in the main ES that are altered (i.e. a modification in design, a complete new addition or even removal of a construction element) by the SES design changes or AP2 amendments. For example, there were 148 bridges in the main ES of which five are affected by AP2, thus 3% of the total.
2. Estimate the potential for the SES design changes/AP2 amendments to influence the total construction carbon footprint reported in the main ES based on the average contribution of the relevant construction elements. Where amendments are considered to exceed 1% of the construction carbon footprint; they have been identified as potentially material. For example, of the five AP2 bridge-related amendments, three were new bridges (i.e. did not form part of the original scheme outlined in the main ES). Based on the average construction carbon footprint of a bridge, these three new bridges would increase overall construction GHG emissions by less than 0.1% and have not been identified as material;
3. Each SES design changes/AP2 amendment was also reviewed to understand each change from a qualitative perspective. For example, relocation of construction elements that were set out as part of the original scheme may have associated impacts. For example, amendment AP2-022-001 (alignment change to pass under the West Coast main line, South Staffordshire and A38, and associated amendments) relates to the lowering and realignment of the route within the original scheme, which includes the replacement of a 16m embankment with a 18m cutting. This will influence the height of retaining walls, the amount of excavated material and plant construction emissions as

¹ 'Material' in this context refers to changes in the design and construction of the HS2 scheme that are considered to be large enough to materially alter (increase or decrease) the schemes total construction GHG emissions.

² Construction elements refers to elements that make up the HS2 scheme such as bridges, viaducts, roads, tunnels, track, stations etc.

the type of construction element being proposed is changed and equipment used on site will differ.

2.1.2 Using the three-stage process listed in paragraph 2.1.1 it was determined whether an amendment was either:

- non-material: represents a situation where the presumed GHG emissions impact of the amendment is considered negligible and updating the carbon footprint for this element is not necessary (i.e. it is not necessary to update the carbon footprint of the main ES as a result of the amendment); or
- potentially material: represents a situation where, whether a single construction element (i.e. a bridge) or a combination of similar construction elements (i.e. a group of bridges), the GHG emission impact of the SES design changes/AP2 amendments is considered potentially material and that updating the carbon footprint of this construction element is necessary.

3 Scoping exercise results

3.1.1 Table 1 and Table 2 present the SES scoping exercise results, where SES design changes were compared to figures presented within Appendix CL-002-000 of the main ES. The scoping exercise results identified that the impact of the SES design changes on the overall carbon footprint presented in Volume 3 of the main ES would be negligible and therefore not require any further analysis.

3.1.2 Table 3 and Table 4 present the AP2 scoping exercise results. Nine AP2 amendments were identified as potentially material from a GHG emissions perspective, and accordingly, their carbon footprint was calculated.

4 Carbon assessment methodology

4.1.1 The total GHG emissions change was calculated from the sum of the changes for each AP2 amendment considered material. This calculation did not include contributions from the SES design changes at each site since they were considered to be negligible in the route-wide context.

4.1.2 The GHG emissions of the transport of excavated materials for the AP2 revised scheme (which includes SES changes) was then considered for the scheme as a whole taking account of the updated excavated material movement assessment for the AP2 revised scheme. This assessment considered excavated materials movements taking account of the consequence of the withdrawal of the sustainable placement area in the Wendover, Dunsmore and Halton community forum area (CFA10) (SES-010-001), the removal of the HS1-HS2 link (including SES-004-001 in the Kilburn (Brent) to Old Oak Common area (CFA4) as reported in Volume 2 of the SES and AP2 ES)³ and other SES design changes since these are relevant in determining the most appropriate

³ No further changes to the carbon footprint as reported in the main ES have been assessed in relation to the removal of the HS1-HS2 link SES design change. Updates to the carbon footprint relating to other changes in construction and operation effects as a result of the removal of the HS1-HS2 link will be fully reported in a future Environmental Statement.

overall material solution for the AP2 revised scheme since they are part of the AP2 revised scheme. The quantities of materials assumed to be removed from the scheme are consistent with those reported in the Waste and Materials chapter.

Table 1: SES results from the quantitative element of the scoping exercise

Construction element types	Main ES - number of construction elements	Main ES - carbon contribution (%) by construction element type	Number of SES changes, by construction element	SES changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO ₂ e) per main ES construction element type	Estimated carbon emissions (tCO ₂ e) of SES changes	SES changes carbon emissions as a % of total construction emissions
Access ⁴	-	-	10	-	-	2,138	0.04%
Bridges ⁵	148	3%	-	-	-	-	-
Buildings ⁶	-	-	1	-	-	-	-
Construction compounds	41	0.1%	-	-	-	-	-
Culverts	24	1%	-	-	-	-	-
Drainage	10	1%	1	10%	6,704	6,704	0.12%
Embankments	41	0.1%	-	-	-	-	-
Land use, land use change and forestry		2%	4	-	-	-	-
Excavated materials	-	11%	-	-	-	-	-
Retaining walls	16	2%	-	-	-	-	-
Roads	118	2%	4	3%	1,019	4,076	0.07%
Stations and depots	5	12%	1	20%	5,400 per depot	5,400	0.10%

⁴ Access refers to changing, removing or issuing access 'rights' to an already existing path or road, rather than the construction or reconfiguration/ realignment of a footpath or bridleway. Occasionally access tracks to scheme construction sites were also proposed, hence the estimated construction carbon emissions of the amendments.

⁵ Excludes green bridges for mitigation purposes as this was not included in the main ES GHG assessment.

⁶ The 'Buildings' category excludes depots and stations. The one SES design changes refers to the temporary Railhead Control Towers (SES-006-002).

Construction element types	Main ES - number of construction elements	Main ES - carbon contribution (%) by construction element type	Number of SES changes, by construction element	SES changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO _{2e}) per main ES construction element type	Estimated carbon emissions (tCO _{2e}) of SES changes	SES changes carbon emissions as a % of total construction emissions
Track	-	21%	-	-	-	-	-
Tunnels, portals and divers	26	23%	-	-	-	-	-
Utilities	-	-	2	-	-	-	-
Viaducts	71	10%	-	-	-	-	-

Table 2: The SES qualitative aspect of the scoping exercise, along with justification text as to whether the amendment(s) are material, and final scoping results.

Construction element types	Justification text	Scoping results
Access	There are 10 SES access related design changes, of which only one (AP2-018-004– Burton Green area amendment, Provision of a stepped ramp to connect Footpath M184 to the Kenilworth Greenway in the vicinity of Little Beanit Farm) was a new additional construction element to the original ES design. All other amendments relate to access rights to existing paths, tracks or roads, or realignments of existing paths. The ramp is likely to be insignificant overall, as is any realignment changes off access routes. Assuming that the average construction footprint of a new road and footpath (note that bridge footprints include associated path construction emissions), this would equate to 2,138 tCO _{2e} , 0.04% of total construction GHG emissions.	Non material impact
Bridges	There are no bridge related SES design changes.	Non material impact
Buildings	In the main ES carbon footprint there were not elements classed as ‘buildings’ apart from stations, depots and the freightliner yard box. The only building related SES change, excluding stations and depots which are dealt with separately, is SES-004-005 (The temporary provision of an operational railhead control towers at Euroterminal). Being a temporary construction likely to be used again, it was assumed to not make a material difference to the overall construction GHG emissions.	Non material impact
Compounds	There are no compound related SES design changes.	Non material impact
Culverts	The main ES carbon footprint included the construction of 24 Culverts, representing 1% of total construction emissions. There are 4 culvert related SES design changes, of which all are reconfigurations rather than new additional construction elements being added.	Non material impact
Drainage	In the main ES the carbon footprint included the construction of 10 drainage elements along the route representing 1% of all construction GHG emissions. There is one SES drainage design change and this is a reconfiguration of the drainage infrastructure (i.e. no new construction). The construction of a new drainage element would result in an estimated 6,700 tCO _{2e} which is less than 0.2% of construction GHG emission.	Non material impact
Embankments	There are no embankment related SES design changes.	Non material impact
Footpaths	Footpaths were not a category which was included in original ES carbon footprint. Footpaths were part of overbridges, viaducts and green underpasses (e.g. the footprint of overbridges sometimes includes the construction of associated footpaths which cannot be separated out). There are 3 footpath SES design changes of which all are realignments rather than new additional construction.	Non material impact
Land use, land use change and forestry	Land Use, Land Use Change and Forestry (LULUCF) accounted for 2% of construction GHG emissions in the original ES. There are 4 SES land use-related design changes, of which 2 are temporary land requirements during construction, 1 is additional hedgerow planting which has a low carbon value, and the final amendment is a reduction in land uptake for mitigation purposes. This is unlikely to significantly impact the overall carbon footprint unless significant areas of land with a high carbon value (i.e. forested land, arable land or	Non material impact

Construction element types	Justification text	Scoping results
	peat for example) is lost permanently.	
Excavated materials	The transport of excavated material represents 11% of construction GHG emissions in the main ES. The scoping assessment identified 3 SES design changes (SES-010-001, SES-015-001 and SES-016-001) that would have a minor impact on the transport and volume of excavated material generated, and thus considered non material. SES-010-001 is the removal of the sustainable placement area for depositing excavated material permanently at Hunt's Green Farm. Although the volume is approximately 1 million cubic metres (1% of total excavated material), the proposed amount disposed of does not change, just the disposal location. Transport emissions are not believed to change significantly, as the average logistics trip distance for excavated material decreased from 41.7km in the main ES, to 40.6km when considering AP2 design changes. As a result excavated material amendments were regarded as non-material.	Non material impact
Retaining walls	There are no retaining walls related SES design changes	Non material impact
Roads	There were 118 different road elements across the route in the original ES, whose construction accounted for 2% of total GHG construction emissions. That is an average construction figure of 1,010 tCO ₂ e per road. There are 4 SES road-related design changes, of which 3 are temporary elements providing turning heads, and 1 is a review of construction material for two roads (Harvil Road and Swakeleys Road). These changes are not considered material as the work at these two roads is likely to represent less than 0.1% of construction GHG emissions.	Non material impact
Stations and depots	The original ES accounted for 2 stations and 3 depots, representing 12% of total construction GHG emissions. The SES design change SES-004-002 (North Pole Depot) proposes the use of the North Pole East Site for the new HEx depot, which is no longer an option and no new construction it taking place at this location.	Non material impact
Track	There are no SES changes applicable to track works with the exception of the HS ₁ -HS ₂ link removal (SES-004-001). As explained in Section 4 of this Annex, any changes to carbon footprint resulting from this change, with the exception of changes to construction waste arisings, will be fully reported in a future Environmental Statement.	Non material impact
Tunnels, portals and divers	SES-004-001 relates to the deletion of the HS ₁ -HS ₂ Link, which is approximately 6.3 km long. The potential construction impact of this amendment will be dealt with in a future Environmental Statement.	Non material impact
Viaducts	There are no viaduct related SES design changes.	Non material impact

Table 3: AP2 results from the quantitative element of the scoping exercise.

Construction element types	Main ES - number of construction elements	Main ES - carbon contribution (%) by construction element type	Number of AP2 amendments, by construction element	AP2 changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO ₂ e) per main ES construction element type	Estimated carbon emissions (tCO ₂ e) of AP2 amendments	AP2 amendments carbon emissions as a % of total construction emissions
Access ⁷	-	-	21	-	-	2,138	0.04%
Bridges ⁸	148	3%	5	3%	1,119	3,356	0.06%
Buildings ⁹	-	-	2	-	-	-	-
Construction compounds	41	0.1%	3	7%	-	-	-
Culverts	24	1%	1	4%	1,711	1,711	0.03%

⁷ Access refers to changing, removing or issuing access 'rights' to an already existing path or road, rather than the construction or reconfiguration/ realignment of a footpath or bridleway. Occasionally access tracks to scheme construction sites were also proposed, hence the estimated construction carbon emissions of the amendments.

⁸ Excludes green bridges for mitigation purposes as this was not included in the main ES GHG assessment.

⁹ There were only AP2 amendments relating to buildings (excluding depots and stations) had to do with the relocation of a village hall (SES-018-001), and the provision of a multi-story car park for the West Midlands Fire & Rescue Service (AP2-026-007).

Construction element types	Main ES - number of construction elements	Main ES - carbon contribution (%) by construction element type	Number of AP2 amendments, by construction element	AP2 changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO ₂ e) per main ES construction element type	Estimated carbon emissions (tCO ₂ e) of AP2 amendments	AP2 amendments carbon emissions as a % of total construction emissions
Drainage	10	1%	1	10%	6,704	6,704	0.12%
Embankments	41	0.1%	2	5%	-	-	-
Footpaths	-	-	12	-	-	1,119	0.02%
Land use, land use change and forestry		2%	27	-	-	-	-
Excavated materials	-	11%	-	-	-	-	-
Retaining walls	16	2%	1	6%	7,216	7,216	0.13%
Roads	118	2%	23	19%	1,019	10,191	0.18%

Construction element types	Main ES - number of construction elements	Main ES - carbon contribution (%) by construction element type	Number of AP2 amendments, by construction element	AP2 changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO ₂ e) per main ES construction element type	Estimated carbon emissions (tCO ₂ e) of AP2 amendments	AP2 amendments carbon emissions as a % of total construction emissions
Stations and depots	5	12%	2	40%	5,400 per depot	10,800	0.19%
Track	-	21%	1	-	3,477 per km	1,043	0.02%
Tunnels, portals and dive-unders	26	23%	3	12%	48,639	145,619	2.16%
Utilities	-	-	1		-	-	-
Viaducts	71	10%	8	11%	63,676	63,676	1.14%

Table 4: The AP2 qualitative aspect of the scoping exercise, along with justification text as to whether the amendment(s) are material, and final scoping results.

Construction element types	Justification text	Scoping results
Access	There are 20 AP2 access related amendments, of which seven are about granting access rights, and eight are realignments or alternative routes being proposed. Four new tracks and a new access road are added which are likely to be insignificant. Assuming that the average construction carbon footprint of a new road and footpath (note that bridge footprints include associated path construction emissions), this would equate to 2,138 tCO _{2e} , 0.04% of total construction GHG emissions.	Non material impact
Bridges	The main ES carbon footprint included the construction of 148 bridges. There are 5 AP2 amendments, of which 3 are new bridges being added to the scheme (of which one is temporary), one is relocated from the location outlined in the original scheme and another is upgraded to accommodate larger vehicles. The average construction GHG emissions of a bridge were calculated at 1,119 tCO _{2e} . The construction of the 3 new bridges represent 0.06% of total construction GHG emissions.	Non material impact
Buildings	In the main ES carbon footprint there were no elements classed as 'buildings' apart from stations, depots and the freightliner yard box. The AP2 amendments relate to the reprovision of a village hall, and the provision of a new multi-story car park. These two buildings are unlikely to materially influence the overall construction GHG emissions, due to the size of the buildings.	Non material impact
Compounds	The main ES carbon footprint included emissions from the provision of 41 construction compounds, accounting for 7% of total construction GHG emissions. There are three AP2 construction compound amendments, all of which are either reconfigurations or relocations of the compounds proposed as part of the original scheme. No new construction compound is being proposed.	Non material impact
Culverts	The main ES carbon footprint included the construction of 24 culverts, representing 1% of total construction GHG emissions. There is one culvert related amendment, which is a reconfiguration of a culvert in the original scheme rather than a new one. Even if it were a new construction, its GHG emissions would represent less than 0.05% of total construction GHG emissions.	Non material impact
Drainage	In the main ES the carbon footprint included the construction of 10 drainage elements along the route representing 1% of all construction GHG emissions. There is one AP2 drainage amendment, a reconfiguration of the drainage infrastructure proposed as part of the original scheme (i.e. no new construction). The average drainage element construction emits an estimated 6,700 tCO _{2e} of construction GHG emissions, less than 0.2% of the total.	Non material impact
Embankments	There are 41 embankment elements in the main ES. Under AP2 only two embankment amendments are included, of which one was believed to materially impact construction GHG emissions. AP2-022-001 (alignment change and associated amendments in the Lichfield area) involves the removal of a 16m high embankment, which in itself would have a small impact to the overall construction GHG emissions considering embankments account for less than 1% of construction emissions. But, this embankment is replaced by an 18m deep cutting over a 3km distance. This is likely to have implications to the volume of excavated material being transported, as well as construction implications since cuttings account for 2% of construction GHG emissions.	Potential material impact
Footpaths	Footpaths were not a category which was assessed as part of the carbon footprint in the main ES. Footpaths were part of overbridges, viaducts and green underpasses (e.g. the footprint of overbridges sometimes includes the construction of associated footpaths which	Non material impact

Construction element types	Justification text	Scoping results
	cannot be separated out). There are 12 footpath AP2 amendments, of which 10 are realignments, one is a conversion of a footpath to a bridleway, and one is an upgrade of an underpass. There is no new construction as such and thus unlikely to influence construction GHG emissions significantly.	
Land use, land use change and forestry	Land use, land use change and forestry (LULUCF) accounts for 2% of construction GHG emissions in the main ES. There are 27 AP2 land use related amendments, of which 21 are additional permanent land requirements, five are temporary land requirements and 2 are adjustments to land areas. Considering how small of an impact land use change has on the overall carbon footprint, it is unlikely to materially influence the overall construction carbon footprint.	Non material impact
Excavated materials	The transport of excavated material represents 11% of construction GHG emissions in the main ES. There are 16 AP2 amendments that influence material excavation and transport. The combination of these amendments are likely to influence overall construction GHG emissions. Some of these amendments appear material: i.e. the Handsacre Connection and the removal of four viaducts (AP2-022-001), the realignment of the track replacing an embankment with a cutting (AP2-022-001), or Burton Green and Kenilworth Greenway alignment changes (AP2-018-004), as well as the reduction of the North Wood embankment (AP2-020-005). The qualitative descriptions of the amendments would suggest changes in the volume of excavated material enough to trigger a GHG assessment update. For example, AP2-022-001 involves replacing a 16m embankment with an 18m cutting over a 3km distance, which on its own appears material.	Potential material impact
Retaining walls	There were 16 retaining walls within the main ES, responsible for 2% of construction GHG emissions. Under AP2 there is only one retaining wall amendment, which consists of revision works from those set out as part of the original scheme (i.e. not a new construction). The average retaining wall construction carbon footprint is 7,200 tCO ₂ e which represents less than 0.3% of total construction GHG emissions.	Non material impact
Roads	There were 118 different road elements across the HS2 route in the main ES. The construction of these accounted for 2% of total construction GHG emissions. That equates to an average of 1,010 tCO ₂ e per road. There are 26 AP2 road related amendments, of which 10 are new roads being constructed. These 10 new roads are likely to increase construction GHG emissions by less than 0.2%, whilst the remaining amendments vary between turning heads (turnings points) and realignments which will generate less construction GHG emissions than a new road construction.	Non material impact
Stations and depots	The main ES included two stations and three depots, representing 12% of total construction GHG emissions. The AP2 amendments here relate to the reconfiguration of the freightliner yard box, and the construction of the Heathrow Express (HEX) Depot at Langley (off-route). Although stations' construction GHG emissions are significantly larger than that of depots, the size of Langley at this stage is unknown. Washwood Heath depot's construction emissions were estimated at 5,400 tCO ₂ e (less than 0.1% of construction emissions). On this basis the HEX Depot is unlikely to materially impact total construction GHG emissions.	Non material impact
Track	Track construction in the main ES accounted for 21% of all construction GHG emissions. Only one AP2 amendment was considered to be potentially material – the additional infrastructure to allow a future connection between the West Coast Main Line (WCML) and the Great Western Main Line (GWML) at Old Oak Common. It was estimated that around 300m of additional track would be required. Track	Non material impact

Construction element types	Justification text	Scoping results
	construction emissions are 3,477 tCO ₂ e per km (including, rails, sleepers, concrete and reinforcement). The additional 300m of track could add less than 0.5% to track construction GHG emissions, and less than 0.05% to overall construction GHG emissions and this is considered non material.	
Tunnels, portals and dive-unders	Tunnels, portals and dive-unders account for 23% of all construction GHG emissions in the main ES. There were 26 elements (e.g. tunnels, tunnel portals and dive-unders) along the HS2 route, the construction of which, on average would emit 50,000 tCO ₂ e. Under AP2, three tunnelling/portal amendments were identified: the revised Burton Green tunnel (AP2-018-004), the extension of the Chiltern tunnel portal by 200m (AP2-009-001), and the Temporary Tunnel Adit (AP2-004-005 in London Met) to help remove spoil. On this basis it was assumed that these amendments could be material in terms of construction GHG emissions.	Potential material impact
Viaducts	In the main ES the construction of 71 viaducts were included in the carbon footprint, accounting for 10% of all construction emissions. Four separate AP2 amendments were identified that directly influenced viaducts. AP2-022-001 (Horizontal and vertical realignment near the Trent and Mersey Canal) removing 4 viaducts as a result, AP2-021-001 (Replace Drayton Basset Viaduct with embankment and culverts), AP2-020-007 (Lowering of HS2 alignment from Middleton northwards) which results in a reduction in the length of a viaduct, and AP2-023-004 (Extension to River Blythe viaduct). With the average viaduct construction emitting 7,959 tCO ₂ e of construction emissions, it was estimated that these AP2 amendments could alter total construction GHG emissions by 1%.	Potential material impact

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