

M20 Junction 10a

TR010006

Appendix 10.1 Carbon Assessment Calculations

APFP Regulation 5(2)(q)

Revision A

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure)

Regulations 2009



Volume 6.3
July 2016

M20 Junction 10a

TR010006

Appendix 10.1 Carbon Assessment Calculations

Volume 6.3

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

Content

Chapter	Title	Page
1.	Introduction	8
1.2	Definitions _____	8
2.	Methodology	9
3.	Data and Key Assumptions	10
4.	Calculations and Results	11
4.2	Main Scheme _____	11
4.3	Alternative Scheme _____	14
5.	Conclusion	17

1. Introduction

- 1.1.1 This report is an appendix of the M20 Junction 10a Environmental Statement (ES). It presents the carbon calculations used within the carbon assessment presented within Chapter 10 Materials of the ES.
- 1.1.2 Materials, fuel and energy use, waste arisings and transportation during construction all produce greenhouse gas (GHG) emissions either directly, as in the case of transportation, or indirectly as embodied carbon of the materials used.
- 1.1.3 Quantification of the carbon impacts of different materials has been carried out using the Highways England Carbon Tool¹ (version release 3rd February 2016).

1.2 Definitions

- 1.2.1 Reporting for the Main and Alternative Schemes GHG impact is carried out using mass of carbon dioxide equivalent (CO₂e), which allows for the emissions of 6 key GHGs: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆); to be expressed in terms of their equivalent global warming potential in mass of CO₂.

¹ Highways England Carbon Tool available online at <https://www.gov.uk/government/publications/carbon-tool>, accessed 26/04/16
HA514442-MMGJV-GEN-SMW-RE-Z-631001
Revision A

2. Methodology

2.1.1 The methodology used is that described within the Highways England Carbon Tool Guidance (Highways England, 2015)². The collected data comprised estimates of materials that would be used for the construction of the Main and Alternative Schemes, and the waste materials that would be generated. This data is used as inputs to the Highways England Carbon Tool in order to generate an initial estimate of the carbon footprint of the Main and Alternative Schemes. The input data included:

- Material quantities, as described in Chapter 10 Materials of the ES.
- Information on the quantities of construction and demolition waste, as described in Chapter 10 Materials of the ES.

2.1.2 The Highways England Carbon Tool is split into 10 categories:

- Bulk Materials.
- Earthworks.
- Fencing, Barriers and Road Restraint Systems.
- Drainage.
- Road Pavements.
- Street Furniture and Electrical Equipment.
- Civil Structures and Retaining Walls.
- Fuels, Electricity and Water.
- Business and Employee Transport.
- Waste.

2.1.3 Energy use (fuels, electricity and water) and transport were excluded from the calculations as there was no reliable data available.

2.1.4 Each category within the Carbon Tool is further divided into item / material types e.g. fill and aggregate (within the bulk materials category). For each item type the Carbon Tool provides a unit and CO_{2e} value for that item.

² Highways England (2015) Highways England Carbon Tool Guidance available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/453177/Task_446_Guidance_Document.pdf accessed 26/04/16

3. Data and Key Assumptions

- 3.1.1 Estimated quantities of proposed material use and waste arisings were based on the latest design information available (March 2016).
- 3.1.2 A number of limitations were found when interpreting the data from the design to the Highways England Carbon Tool:
- The items / materials derived from the design information were very specific whereas the Carbon Tool items/materials were generic.
 - Assumptions had to be made when there was no direct match for the items from the design in the Carbon Tool.
 - Assumptions had to be made regarding the size of some of the items (based on the size of similar items).
 - Calculations had to be made to convert the items/materials into the units found in the Carbon Tool e.g. densities found in the Bath Inventory Version 2.0 2011 (found in the Carbon Tool). Subsequently for some items assumptions had to be made regarding the density (based on the density of similar items).
 - When assumptions and calculations were made, information found in the Carbon Tool was used.
 - Industry standards and credited sources were used for additional information if not provided in the Carbon Tool.
- 3.1.3 The main limitation of the assessment was that the Highways England Carbon Tool is designed to be used mainly for assessing the carbon impacts of maintenance activities.

4. Calculations and Results

4.1.1 Material densities (Tonnes / m³) were derived from data within the Carbon Tool and used to convert the materials in m³ from the design into Tonnes, some examples of which can be seen in Table 4.1. Where data was not available in the Tool, assumptions were made to convert the materials into compatible units for input into the Carbon Tool and were derived from industry standards and credited sources.

Table 4.1 Examples of the conversion from m³ to Tonnes using material densities

Item	Scheme	Unit	Quantity	Conversion	Carbon Tool Quantity
Type 1 unbound mixture sub-base (assuming 300mm thick).	Main	m ³	Main Scheme: 20,519.301 Alternative Scheme: 22,058.301	Used density for Quarried / Recycled Aggregate: 2.00 Tonnes / m ³	Main Scheme: 41,038.602 Tonnes. Alternative Scheme: 44,116.602 Tonnes.
Excavation.	Alternative	m ³	Main Scheme: 195,826 Alternative Scheme: 203,822	Used density for Sand: 1.85 Tonnes / m ³	Main Scheme: 362,278 Tonnes. Alternative Scheme: 377,070 Tonnes.

4.1.2 The quantities of materials and waste were multiplied by embodied carbon factors within the Carbon Tool to produce the calculated carbon in Tonnes of CO_{2e}.

4.2 Main Scheme

4.2.1 Table 4.2 shows that 47% of embodied emissions associated with the Main Scheme result from the use of asphalt, with 7% of the embodied footprint due to pre-cast concrete, which is used in the structures of the new bridge and footbridges. Variable Message Signs (VMS) also contribute 7% to the footprint with a similar emissions level to pre-cast concrete.

4.2.2 Overall per material category Table 4.2 shows that 51% of embodied emissions associated with the Main Scheme result from bulk materials with an 11% contribution from civil structures.

Table 4.2 Carbon embodied in materials for the Main Scheme

Category	Material	Material Description	Quantity Value and Unit	CO ₂ e/tonnes (per material)	CO ₂ e/tonnes (per material category)
Bulk materials.	Fill and aggregate.	Type 1 unbound mixture sub-base.	52,183.8 Tonnes	271.36	3,992.56
	Asphalt.	Base, Binder and Surface Course.	48,220.4 Tonnes	3,664.75	
	Ready mix concrete.	Concrete volume for MS4 and CCTV camera base.	219.8m ³	56.45	
Earthworks.	Imported topsoil.	Top soil.	29,884.9 Tonnes	263.19	717.24
Fencing, barrier and road restraint systems.	Fence.	Wooden post and 3 rail fencings (HCD H15).	5,241m	44.17	427.95
	Road restraint.	Concrete and steel barriers.	1,365m	383.79	
Drainage.	Plastic pipe.	UPVC structured wall design drain, varying diameters.	6,086.2m	235.66	302.93
	Gullies.	Plastic trapped gullies with C250 grating and frame.	196 Number	8.74	
	Precast Chamber.	Pre-cast concrete chamber Type 3 with D4000 cover and frame.	148 Number	52.18	
	Petrol Interceptor.	Oil interceptor.	5 Number	6.35	
	Headwalls.	Penstock.	3 Number	0.002	
Road pavements.	Kerb.	Kerb half and full batter, Beanie Blocks, bridge deck, kerb inlets and concrete edgings.	17,847m	257.88	349.10
	Road markings.	Number of different types of road markings.	16 Tonnes	91.23	
Street furniture and	Variable Message Signs (VMS).	Retro reflective Class R2 Traffic Signs.	128 Number	518.75	595.86

Category	Material	Material Description	Quantity Value and Unit	CO ₂ e/tonnes (per material)	CO ₂ e/tonnes (per material category)
electrical equipment.	Road lighting and columns.	LED lanterns varying number of LEDs and heights of columns.	229 Number (189 LED Light and 40 Aluminium Columns)	72.80	
	Plastic cable ducting.	Duct route.	4,275m	4.31	
Civils Structure.	Retaining walls.	Retaining wall.	1,197.9 Tonnes	99.88	863.94
	Pre-cast concrete.	Concrete for the new bridges and footbridges.	3,874.8 Tonnes	552.93	
	Bricks and blockwork.	Access to ponds.	5,4579.2 Number of bricks	35.93	
	Steelwork.	Structural steel for footbridges.	120 Tonnes	175.20	
Total					7,249.58

4.2.3 Table 4.3 shows the embodied carbon in the waste that would be generated on site through the demolition of the overbridge and footbridges for the Main Scheme.

Table 4.3 Carbon embodied in waste materials for the Main Scheme

Category	Material	Material Description	Quantity Value and Unit	CO ₂ e/tonnes	CO ₂ e/tonnes
Waste arisings.	Mixed construction.	Demolition of overbridge and footbridges.	1,998 Tonnes	569.43	569.43
Total					569.43

4.2.4 Across the Main Scheme, the estimates shown in Table 4.4 indicate that carbon embodied in materials would make up the largest proportion of the construction stage carbon footprint.

4.2.5 As shown in Table 4.4 waste makes up a very small proportion of the total project footprint.

Table 4.4 Carbon footprint summary table for the Main Scheme

Category	Tonnes CO ₂ e	% proportion
Materials	7,249.58	93%
Waste	569.430	7%
Total	7,819,01	100%

4.3 Alternative Scheme

- 4.3.1 Table 4.5 shows that 48% of embodied emissions associated with the Alternative Scheme result from asphalt. The next largest contributor to the embodied footprint is pre-cast concrete which made up 7%, and is used in the structures of the new bridge and footbridges. Variable Message Signs (VMS) also contribute to 7% footprint, with a similar contribution of pre-cast concrete.
- 4.3.2 Overall per material category Table 4.5 shows that the largest proportion of embodied emissions associated with the Alternative Scheme result from bulk materials contributing 52% with the second largest contributor from civil structures accounting for 11%.

Table 4.5 Carbon embodied in materials for the Alternative Scheme

Category	Material	Material Description	Quantity Value and Unit	CO ₂ e/tonnes (per material)	CO ₂ e/tonnes (per material category)
Bulk materials.	Fill and aggregate.	Type 1 unbound mixture sub-base.	55,470.9 Tonnes	288.45	4,227.98
	Asphalt.	Base, binder and surface course.	51,693.2 Tonnes	3,883.08	
	Ready mix concrete.	Concrete volume for MS4 and CCTV camera base.	219.8m ³	56.45	
Earthworks.	Imported topsoil.	Top soil.	31,816.3Tonnes	763.59	763.59
Fencing, barrier and road restraint systems.	Fence.	Wooden post and 3 rail fencings (HCD H15).	5,241m	44.17	427.95
	Road restraint.	Concrete and steel barriers.	1,365m	383.79	
Drainage.	Plastic pipe.	UPVC Structured wall design drain, varying diameters.	6,301m	240.20	310.74

Category	Material	Material Description	Quantity Value and Unit	CO ₂ e/tonnes (per material)	CO ₂ e/tonnes (per material category)
	Gullies.	Plastic trapped gullies with C250 grating and frame.	214 Number	9.54	
	Precast chamber.	Pre-cast concrete chamber Type 3 with D4000 cover and frame.	155 Number	54.64	
	Petrol interceptor.	Oil interceptor.	5 Number	6.35	
	Headwalls.	Penstock.	3 Number	0.002	
Road pavements.	Kerb.	Kerb half and full batter, Beanie Blocks, bridge deck, kerb inlets and concrete edgings.	13,413.4m	187.89	278.50
	Road markings.	Number of different types of road markings.	15.9 Tonnes	90.61	
Street furniture and electrical equipment.	Variable Message Signs (VMS).	Retro reflective Class R2 Traffic Signs.	133 Number	539.02	625.58
	Road lighting and columns.	LED lanterns varying number of LEDs and heights of columns.	250 Number (204 LED Light and 46 Aluminium Columns)	82.26	
	Plastic cable ducting.	Duct route.	4,275m	4.31	
Civils Structure.	Retaining walls.	Retaining wall.	1,197.9 Tonnes	99.88	863.94
	Pre-cast concrete.	Concrete for the new bridges and footbridges.	3,874.8 Tonnes	552.93	
	Bricks and blockwork.	Access to ponds.	54,579.2 Number of bricks	35.93	
	Steelwork.	Structural steel for footbridges.	120 Tonnes	175.20	

Category	Material	Material Description	Quantity Value and Unit	CO ₂ e/tonnes (per material)	CO ₂ e/tonnes (per material category)
Total					7,498.29

4.3.3 Table 4.6 shows the embodied carbon in the waste that would be generated on site through the demolition of the overbridge and footbridges for the Alternative Scheme.

Table 4.6 Carbon embodied in waste materials for the Alternative Scheme

Category	Material	Material Description	Quantity Value and Unit	CO ₂ e/tonnes	CO ₂ e/tonnes
Waste arisings.	Mixed construction.	Demolition of overbridge and footbridges.	1,998 Tonnes	569.43	569.43
Total					596.43

4.3.4 Across the Alternative Scheme, the estimates shown in Table 4.7 indicate that carbon embodied in materials would make up the largest proportion (93%) of the construction stage carbon footprint.

4.3.5 As shown in Table 4.7 waste makes up a very small proportion of the total project footprint.

Table 4.7 Carbon footprint summary table for the Alternative Scheme

Category	Tonnes CO ₂ e	% proportion
Materials	7498.29	93%
Waste	596.43	7%
Total	8,067.72	100%

5. Conclusion

- 5.1.1 A carbon assessment has been carried out using Highways England's Carbon Tool which estimated that approximately 7,819 tonnes CO₂e would result from material use and waste arisings associated with the construction of the Main Scheme and 8,068 tonnes CO₂e for the Alternative Scheme. The magnitude of this impact has been assessed as Minor which is not considered to be significant.
- 5.1.2 The calculation did not take into account energy usage on site, fuel usage, or the transportation of materials and waste. However, based on previous similar schemes this normally accounts for 20% to 30% of the total carbon footprint, therefore the worst case scenario would be 10,165 tonnes CO₂e associated with the construction of the Main Scheme and 10,488 tonnes CO₂e for the Alternative Scheme. Based on Highways England data for the last 3 years carbon intensity figures a £91.9 M scheme would be expected to cause emissions in the range of 16,232 to 16,972 tonnes CO₂e, averaging circa 16,564 tonnes CO₂e³, this is still less than expected for a scheme of this size.
- 5.1.3 These lower than expected figures can in part be attributed to the fact that opportunities have been sought to enhance the sustainability of the design early on in the process, which has allowed sustainability criteria to inform the decision making process throughout the scheme. This has led to tangible changes in the design which have improved the overall sustainability of the scheme in line with Highway England's sustainability objectives. The principles of Design for Resource Efficiency (DfRE) have been used so that design decisions have aimed to reduce the generation of waste and use of resources. In addition, carbon calculations of design options have been undertaken to inform the design process and facilitate low carbon design.

³ Dean-Kerwick-Chrisp, Highways England, private communication, May 2016
HA514442-MMGJV-GEN-SMW-RE-Z-631001
Revision A