Appendix D

Climate change (GHG)

Contents

D1 Greenhouse gas (GHG) methodology, assumptions and limitations

D1.1 Baseline

Operational building energy consumption

D1.1.1 To estimate the GHG emissions associated with the remaining 137 occupied homes in 2019, emission factors from the Green Book Supplementary Guidance produced by BEIS[1] have been employed and shown in Table 1. This reflects the likely decarbonisation of the UK electricity grid from the current year up to and including 2100. The likely decarbonisation of the UK electricity grid remains constant from 2050 up to and including 2100 for modelling purposes.

Table 1: UK Electricity Grid Decarbonisation

Year	Grid Average, Consumption based, Commercial/ Public sector ($kgCO_2e/kWh$)
2019	0.143
2020	0.138
2021	0.113
2022	0.105
2023	0.110
2024	0.102
2025	0.103
2026	0.097
2027	0.103
2028	0.098
2029	0.090
2030	0.081
2031	0.072
2032	0.060
2033	0.056
2034	0.048
2035	0.040
2036	0.040
2037	0.040
2038	0.040
2039	0.040
2040	0.040
2041	0.039
2042	0.038
2043	0.036
2044	0.035
2045	0.034
2046	0.032
2047	0.031

[1] Department for Business, Energy and Industrial Strategy, Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal. Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

Year	Grid Average, Consumption based, Commercial/ Public sector ($kgCO_2e/kWh$)
2048	0.030
2049	0.028
2050	0.027
…	…
2100	0.027

D1.1.2 Arup's energy specialists provided the total energy consumption per flat, shown in Table 2. The assumptions were made based on existing electricity and gas bills for the households on site.

Table 2: Total energy consumption per flat

	Energy Consumption (kWh per year)
Total per flat	2,060

D1.1.3 The Baseline GHG assessment assumes the existing partially-decanted site with 137 remaining units in 2019. The breakdown of the number of units/flats by House is presented in Table 3.

Table 3: Total number of occupied units/flats on site

House	Total Number of Units/Flats occupied
Bridge House	8
Bucknill House	22
Dalton House	1
Doneraile House	35
Edgson House	0
Hillersdon House	0
Mercer House	4
Pimlico House	4
Rye House	18
Victoria House	20
Wainwright House	2
Wellesley House	0
Westbourne House	23
Total	**137**

Operational traffic

D1.1.4 The Arup transport team employed the London National Travel Survey data[2] and 2011 Census data[3] to deliver assumptions on the total number of trips, the

[2] Department for Transport (2013; updated 2019), London National Transport Survey Data, Available at: https://www.gov.uk/government/collections/national-travel-survey-statistics
[3] Office for National Statistics (2011), 2011 Census Data, Available at: https://www.ons.gov.uk/census/2011census

purpose of the trip, the transport mode split and distance travelled to and from the site. The assumptions are outlined in Table 4 to Table 7 below.

Table 4: Total number of annual trips by trip purpose

Trip Purpose	Total Number of Trips
Residential Trips	2,023
Retail Trips	80
Community Trips	*Assumed to serve the local community and accounts for local pedestrian and cycle trips only*
Delivery and Servicing Trips	80
Total	**2,183**

Table 5: Average distance travelled by trip purpose

Trip Purpose	Average Distance Travelled (km)
Community Trips	*Assumed to serve the local community and accounts for local pedestrian and cycle trips only*
Retail Trips	3.9
Delivering and Servicing Trips	9.0

Table 6: Modal split and distances travelled for residential trip purposes

	Public Transport	Driving a Car or Van	All other methods of travel to work	All modes
Less than 10km	92%	73%	98%	92%
10km to less than 30km	6%	16%	1%	5%
30km and over	2%	11%	1%	3%

Table 7: Mode share by transport mode for residential and retail trips

Mode of Transport	Residential Census Mode Share (%)	Retail Census Mode Share (%)
Underground, metro, light rail, tram	34.5%	35%
Train	6.5%	42%
Bus, minibus or coach	24.8%	10%
Taxi	1.6%	0%
Motorcycle, scooter or moped	1.6%	1%
Driving a car or van	2.1%	0%
Passenger in a car or van	1.0%	0%
Bicycle	5.3%	5%
On foot	22.5%	5%

D1.1.5 BEIS GHG reporting conversion factors[4] (including well-to-tank factors) have been applied to estimate the GHG emissions associated with transport to and from site and are shown in Table 8.

Table 8: Transport GHG emissions factors

Vehicle Type	GHG Emissions factor ($kgCO_2e/km$)
Underground, metro, light rail, tram	0.035
Train	0.049
Bus, minibus or coach	0.102
Taxi	0.186
Motorcycle, scooter or moped	0.146
Driving a car or van	0.215
Passenger in a car or van	0.215

D1.2 Proposed Development: Construction

Construction Materials - Buildings

D1.2.1 The Atkins Carbon Critical Masterplanning (ACCM) Tool[5] has been used to estimate the GHG emissions associated with the manufacture and production of construction materials for buildings. The ACCM Tool reports embodied GHG emissions for a number of building typologies. For the purposes of this assessment, factors were adopted for the medium rise apartment/condo (6-10 storey); and the mixed-use city block was employed for residential building with an allocation for commercial and community space. This is outlined in Table 9 below.

Table 9. Construction material GHG emissions factor by building type

Proposed Block	Building Type	GHG Emissions factor ($kgCO_2e/m^2$)
Block B1	Medium Rise Apartment/Condo (6-10 storey)	860
Block B2	Medium Rise Apartment/Condo (6-10 storey)	860
Block B3	Medium Rise Apartment/Condo (6-10 storey)	860
Block B4	Medium Rise Apartment/Condo (6-10 storey)	860
Block B5	Mixed use city block (ground floor, commercial, residential above	720
Block B6	Mixed use city block (ground floor, commercial, residential above	720
Block B7	Mixed use city block (ground floor, commercial, residential above	720
Block B8	Mixed use city block (ground floor, commercial, residential above	720

[4] Department for Business, Energy and Industrial Strategy, Greenhouse gas reporting: conversion factors 2019. Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019
[5] Atkins, 2018. Atkins Carbon Tools. Available at: https://www.atkinsglobal.com/en-gb/corporatesustainability/an-environment-with-a-future/a-low-carbon-economy/lower-carbon/carbon-tools

Proposed Block	Building Type	GHG Emissions factor ($kgCO_2e/m^2$)
Block B9	Mixed use city block (ground floor, commercial, residential above	720

D1.2.2 Total gross external area (GEA) for each of the proposed blocks on site was provided in the Schedule of Area (Revision P) and is summarised in Table 10.

Table 10. Total Gross External Area (GEA) by Proposed Block

Proposed Block	Gross External Area (m^2)
Block B1	4,840
Block B2	5,836
Block B3	5,836
Block B4	4,840
Block B5	10,140
Block B6	13,123
Block B7	14,476
Block B8	12,291
Block B9	16,668

Construction Materials - Roads and Pathways

D1.2.3 To calculate the GHG emissions associated with the manufacture and production of roads and pathways, the Arup design team provided assumptions relating to the length, width and depth of the roads and pathways for the Proposed Development. The assumptions are presented in Table 11.

Table 11. Construction material breakdown

Construction Material			Depth (m)	Width (m)	Length (m)
Road	Surface course	Asphalt	0.04	3	430
	Binder & Base course	Asphalt	0.21	3	430
	Sub-base course	Aggregate	0.15	3	430
Pathway	Surface course	Asphalt	0.04	2	120
	Binder & Base course	Asphalt	0.21	2	120
	Sub-base course	Aggregate	0.15	2	120

D1.2.4 The ICE Database v3.0[6] was used to provide assumptions relating the GHG emissions factors associated with each material choice, as outlined in Table 12.

Table 12. Construction material GHG emissions factors

Construction material	GHG Emissions factor ($kgCO_2e/kg$)
Asphalt	0.0521
Aggregate	0.0052

Transport of Construction Materials

[6] ICE Database v3.0, November 2019. Available at: https://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html#.Xm-nsKj7SUk

D1.2.5 Arup's construction planning team used the draft CMP (Ref EBR-14) to provide assumptions relating to the transport mode and estimated number of trips per day for each construction phase. This is outlined within Table 13.

Table 13: Number of construction vehicle trips per day during the construction period

Construction Phase	Transport mode	No. of trips per day
Phase 1	Small vehicles (vans, cars)	20
	Large axle vehicles (delivery)	60
	Large articulated wagons	4
Phase 2	Small vehicles (vans, cars)	20
	Large axle vehicles (delivery)	80
	Large articulated wagons	8
Phase 3	Small vehicles (vans, cars)	20
	Large axle vehicles (delivery)	80
	Large articulated wagons	8

D1.2.6 Arup's construction planning team also employed the findings from the draft CMP to outline the number of days (the duration) within each Construction Phase. This is outlined within Table 14.

Table 14. Total construction phase days during the construction period

Construction Phase	Duration (days)
Phase 1	773
Phase 2	773
Phase 3	900
Total	**2,446**

D1.2.7 Assumptions relating to the distance travelled by construction vehicles has been informed by RICS Whole life carbon assessment for the built environment (2017)[7], shown in Table 15.

Table 15. Distance travelled by construction vehicles to and from the site

Distance travelled for transport of materials to and from site (km)	
Nationally manufactured materials	**300**

D1.2.8 To estimate the GHG emissions associated with the transport of construction materials to and from site, the distance travelled has been multiplied by the relevant factor from BEIS GHG reporting conversion factors[4], as shown in Table 16. The BEIS factors account for the direct emissions from each vehicle as well as the well-to-tank factors.

Table 16. Construction Material Transport GHG Emissions factor

Transport mode	GHG Emissions factor ($kgCO_2e/km$)
Artic HGV >33t 100% laden	1.095
WTT: Artic HGV >33t 100% laden	0.263
	1.358

[7] RICS (2017), RICS Professional standards and Guidance UK: Whole-life carbon assessment for the built environment, 1st edition Available at: https://www.rics.org/globalassets/rics-website/media/upholdingprofessional-standards/sector-standards/building-surveying/whole-life-carbon-assessment-for-the-builtenvironment-1st-edition-rics.pdf

Transport mode	GHG Emissions factor ($kgCO_2e/km$)
Van: Diesel: Class III (1.74 to 3.5 tonnes)	0.278
WTT: Van: Diesel: Class III (1.74 to 3.5 tonnes)	0.067
	0.344

Construction worker transport

D1.2.9 Arup's construction planning team employed the findings from the draft CMP to outline the number of days (the duration) within each Construction Phase. This is outlined within Table 17.

Table 17. Total construction phase days during the construction period

Construction Phase	Duration (days)
Phase 1	773
Phase 2	773
Phase 3	900
Total	**2,446**

D1.2.10 Arup's construction planning team used the draft CMP to provide assumptions relating to the construction worker transport mode, average distance travelled for a return trip, and the total number of workers per day throughout the construction phase. This is outlined within Table 18.

Table 18. Construction worker transport distance and number

Transport mode	Distance travelled (km) (2-way journey)	Total no. of workers per day
Train / National Rail	60	100
London Underground	10	145
Coach	60	10
Local London Bus	10	145

D1.2.11 To estimate the GHG emissions associated with the transport of construction workers to and from site, the distance travelled has been multiplied by the relevant factor from BEIS GHG reporting conversion factors[4]. The BEIS factors account for the direct emissions from each vehicle in addition to the well-to-tank factors. See Table 19 below.

Table 19. Construction worker transport carbon factors

Transport Mode	GHG Emissions factor ($kgCO_2e/pass.km$)
London Underground	0.031
WTT: London Underground	0.004
	0.035
Coach	0.028
WTT: Coach	0.007
	0.034
Local London bus	0.082
WTT: Local London bus	0.020
	0.102

Transport Mode	GHG Emissions factor ($kgCO_2e$/pass.km)
National rail	0.041
WTT: National rail	0.008
	0.049

Construction site works: Construction and Demolition Plant Activities

D1.2.12 To inform the calculations for construction plant activities, Arup's construction planning team also employed the findings from the draft l Construction Management Plan (Ref EBR-14) to outline the number of days (the duration) within each Construction Phase. This is outlined within Table 20 below.

Table 20. Total construction phase days during the construction period

Construction Phase	Duration (days)
Phase 1	773
Phase 2	773
Phase 3	900
Total	**2,446**

To inform the calculations for the GHG emissions associated with construction plant activities, the draft CMP was employed to outline working hours as shown in Table 21.

Table 21. Construction phase working hours

Construction Activity	Hours of work per day
Weekdays (8am to 6pm)	10
Saturday (8am to 1pm)	5
Sunday & Bank Holiday	0

D1.2.13 Arup's construction planning team developed assumptions for the on-time and number of construction plant and equipment required for the Proposed Development. To do so, the team developed a specific Carbon Dioxide Assumptions document for this assessment. The assumptions are outlined in Table 22 below.

Table 22. Number and % on time of construction plant & equipment

Construction Plant & Equipment	No. of Plant & Equipment	% on time per day
Excavators / with hydraulic cutting shears	3	70%
Mini piling rigs	2	50%
Excavators	3	70%
Compressors	2	100%
Muck away lorries	60	30%
Goods hoist	9	70%
Tower crane	9	70%
Mobile concrete pump	9	50%
Power tools	100	70%
Forklifts	6	50%

D1.2.14 Arup's construction planning team provided data from the Demolition and Environmental Management Plan (See CMP (Ref EBR-14)) to outline the number of working days (the duration) within each Demolition Phase – enabling works, utilities, soft strip, and demolition. In total, twelve buildings are to be demolished on site between 2019 and 2024. The demolition phase for each is outlined below.

Table 23: Total demolition phase days by building

Building	Enabling Works Duration (days)	Utilities Duration (days)	Soft Strip Duration (days)	Demolition Duration (days)	Total
Dalton House	32	5	27	32	**96**
Hillerston House	38	5	37	38	**117**
Wainwright House	10	5	6	11	**31**
Wellesey House	16	5	16	31	**68**
Mercer House	20	3	14	31	**68**
Pimlico House	20	3	14	31	**68**
Bridge House	14	3	14	33	**64**
Doneraile House	44	9	52	71	**175**
Westborne House	22	3	28	45	**97**
Victoria House	21	5	27	45	**97**
Rye House	27	5	27	56	**114**
Bucknill House	38	5	38	45	**125**

D1.2.15 Arup's construction planning team developed assumptions for the on-time and number of demolition plant and equipment required for the Proposed Development. To do so, the team developed a specific Carbon Dioxide Assumptions document for this assessment. The assumptions are outlined in Table 24.

Table 24: Number and % on time of demolition plant and equipment

Demolition Plant & Equipment	Enabling Works		Utilities		Soft Strip		Demolition	
	No. Plant & Equipment	% on time per day	No. Plant & Equipment	% on time per day	No. Plant & Equipment	% on time per day	No. Plant & Equipment	% on time per day
Rear Dump Trucks	1	5%	2	0%	0	0%	15	75%
Small Dumpers	2	27%	2	8%	10	136%	2	30%
Crane	1	40%	0	10%	1	40%	1	40%
Generator	1	80%	1	27%	1	80%	1	80%
Excavators	2	100%	2	100%	2	100%	4	66%
Hand Tools (Power tools)	10	200%	10	40%	10	200%	10	200%
Access Platform	0	-	0	-	2	100%	2	100%
Crane	0	-	0	-	0	-	1	20%
Concrete Mixer	0	-	0	-	0	-	1	5%
Dust Buster (Power tools)	0	-	0	-	0	-	4	320%

D1.2.16 Diesel consumption factors for the construction and demolition plant and equipment have been derived from The Reference Manual for Construction Plant by the Institute Civil Engineering Surveyors (1998)[8]. Electricity consumption factors have been derived from the British Standard: Code of practice for noise and vibration control on construction and open sites[9] which provides power ratings for various plant and equipment.

[8] The Institute Civil Engineering Surveyors (1998), The Reference Manual for Construction Plant.
[9] BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Noise. Available at: https://shop.bsigroup.com/ProductDetail?pid=000000000030258086

Table 25. Plant & equipment electricity and diesel consumption rates

Plant & Equipment	Electricity consumption (kWh/hour)	Diesel consumption (litres/hour)
Excavators / with hydraulic cutting shears	23.18	-
Mini piling rigs	-	110
Excavators	23.18	-
Compressors	14.84	-
Small Dumper	-	4.89
Rear Dump Trucks	39.125	-
Goods hoist	-	184
Tower crane	-	184
Mobile concrete pump	3.05	-
Power tools	-	26
Forklifts	8.77	-
Access Platform	-	8.21
Generator	-	18.46
Concrete Mixer	-	3.05

D1.2.17 To calculate the GHG emissions associated with both general diesel-powered and electricity-powered construction and demolition plant and equipment, the BEIS GHG conversion reporting factors[4] were employed. This includes well-to-tank factors and is outlined in Table 26.

Table 26. Plant & equipment GHG emissions factors

Construction Plant & Equipment	GHG emissions factor	Unit
Diesel powered Plant & Equipment (including Well-to-Tank)	3.39	$kgCO_2e$/litres
Electricity powered Plant & Equipment (including Well-to-Tank)	0.28	$kgCO_2e$/kWh

D1.3 Proposed Development: Operational

Operational traffic

D1.3.1 To calculate the GHG emissions associated with the operational traffic of the Proposed Development, the Arup transport team employed the London National Travel Survey data[2] and 2011 Census data[3] to deliver assumptions on the total number of trips, the purpose of the trip, the transport mode split and distance travelled to and from the site. The assumptions are outlined in Table 27 to Table 31 below.

Table 27: Total number of daily trips by trip purpose

Trip Purpose	Total Number of Trips
Residential Trips	4,564
Retail Trips	123
Office Trips (Daily Staff and Daily Visitors)	44
Gym Trips	10
Nursery Trips	15
Delivery and Servicing Trips	158
Total	**4,914**

Table 28: Average distance travelled by trip purpose

Trip Purpose	Average Distance Travelled (km)
Community Trips	*Assumed to serve the local community and accounts for local pedestrian and cycle trips only*
Retail Trips	3.9
Delivering and Servicing Trips	9.0
Sport/Entertainment Trips	8.3
Commuting (Office Trips)	12.5

Table 29: Modal split and distances travelled for residential trip purposes

	Public Transport	Driving a Car or Van	All other methods of travel to work	All modes
Less than 10km	92%	73%	98%	92%
10km to less than 30km	6%	16%	1%	5%
30km and over	2%	11%	1%	3%

Table 30: Mode share by transport mode for both residential and retail trips

Transport mode	Residential Trips - Mode Share	Retail Trips - Mode Share
Underground, metro, light rail, tram	32.57%	35%
Train	6.16%	42%
Bus, minibus or coach	23.43%	10%
Taxi	1.61%	0%
Motorcycle, scooter or moped	1.58%	1%
Driving a car or van	5.80%	0%
Passenger in a car or van	1.01%	0%
Bicycle	5.31%	5%
On foot	22.54%	5%

Table 31: Mode share by transport mode for office, gym, and nursery trips

Mode of Transport	Office, Gym and Nursey Trips - Mode Share
Underground, metro, light rail, tram	35%
Train	42%
Bus, minibus or coach	10%
Taxi	0%
Motorcycle, scooter or moped	1%
Driving a car or van	0%
Passenger in a car or van	0%
Bicycle	5%
On foot	5%

D1.3.2 BEIS GHG reporting conversion factors[10] have been applied to estimate the GHG emissions associated with the transport to and from site for the Proposed Development, shown in Table 32.

Table 32: Transport GHG emissions factor

Transport mode	GHG Emissions factor ($kgCO_2e/km$)
Underground, metro, light rail, tram	0.035
Train	0.049
Bus, minibus or coach	0.102
Taxi	0.186
Motorcycle, scooter or moped	0.146
Driving a car or van	0.215
Passenger in a car or van	0.215

Operational energy

D1.3.3 Arup's energy specialists presented the total electricity demand and PV generation for the Proposed Development. This is outlined in Table 33 below.

Table 33: Total energy demand and PV generation

	Electricity Generation (MWh)
Total electricity demand	1,843
Total PV generation	115

D1.3.4 To estimate the GHG emissions associated with the remaining 137 occupied homes in 2019, emission factors from the Green Book Supplementary Guidance produced by BEIS[11] have been employed and shown in Table 34. This reflects

[10] Department for Business, Energy and Industrial Strategy, Greenhouse gas reporting: conversion factors 2019. Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019
[11] Department for Business, Energy and Industrial Strategy, Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal. Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

the likely decarbonisation of the UK electricity grid from the current year up to and including 2100. The likely decarbonisation of the UK electricity grid remains constant from 2050 up to and including 2100 for modelling purposes.

Table 34: UK Electricity Grid Decarbonisation

Year	Grid Average, Consumption based, Commercial/ Public sector ($kgCO_2e/kWh$)
2019	0.143
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2029	0.090
2030	0.081
2031	0.072
2032	0.060
2033	0.056
2034	0.048
2035	0.040
2036	0.040
2037	0.040
2038	0.040
2039	0.040
2040	0.040
2041	0.039
2042	0.038
2043	0.036
2044	0.035
2045	0.034
2046	0.032
2047	0.031
2048	0.030
2049	0.028
2050	0.027
…	…
2100	0.027