



6. Air Quality - Appendix

Dispersion Modelling Methodology

- 6.1. Detailed dispersion modelling of NO_x, PM₁₀ and PM_{2.5} emissions from operational traffic was used to undertake assessment of human exposure at the development site and existing receptors close to the modelled road network.
- 6.2. Detailed dispersion modelling of traffic emissions has been carried out using the latest version of ADMS-Roads Extra (version 5.0.1.3), which is an internationally recognised new generation dispersion model developed by CERC. ADMS uses advanced algorithms to describe the boundary layer structure, turbulence and stability.
- 6.3. The inputs required for the modelling are outlined in the following sections

Meteorological Data

- 6.4. Hourly sequential meteorological data is required as an input to the model. Data from Manchester Airport meteorological station for 2019 has been obtained for use in this assessment. Manchester Airport is located approximately 14km to the south-west of the Proposed Development and due to its location and elevation, is considered to be the most representative meteorological station for the Proposed Development. Both the location of the Proposed Development and Manchester Airport are inland sites, without significant terrain influence.
- 6.5. Defra's LAQM.TG22 guidance recommends that meteorological data should only be used if the percentage of usable hours is greater than 75% and preferably greater than 90%. Unusable hours include missing hours and calm hours. The 2019 dataset has been checked for usability. There are 8,469 lines of usable hourly data for 2019, which equates to 96.7% of the hourly in a year. As this is well above the 75% threshold, the data is considered to be adequate for dispersion modelling, in accordance with LAQM TG22 guidance.
- 6.6. The 2019 wind rose for Manchester Airport is presented in Figure 6-7. It can be seen that the predominant wind direction is south/south-westerly.
- 6.7. Surface roughness is a component of surface texture. Air travelling over the surface is affected by the surface roughness, rough surface would result in higher roughness to smoother surfaces. Typical surface roughness values range from 1.5m (for cities, forests and industrial areas) to 0.0001m (for water or sandy deserts). The future setting of the Proposed Development has been considered in the modelling by setting the surface roughness length to 1.0m. This is the value recommended by the model developers for cities and woodlands. A surface roughness length 0.2m was used for the meteorological station, which is stated within ADMS-Roads as being suitable for 'agricultural' areas.
- 6.8. The Monin-Obukhov length is used to describe the effects of buoyancy on turbulence kinetic energy, particular in the lowest atmospheric boundary layer. This relates to the urban heat island effect, and its effects on turbulence due to surface topology and the effects from heated and shaded building surfaces. Monin-Obukhov values typically range from 2m to 10m in rural settings but can be higher in urban area where buildings and traffic results in more heat generation. In this assessment, the minimum Monin-Obukhov length scale was set to 30 m (the recommended model setting for cities and large towns). A value of 10m was used for the land around Manchester Airport meteorological station.

Traffic Data

- 6.9. Local air quality at the Proposed Development is likely to be affected during operation by local traffic flows. For each road link for each scenario, the following data has been included in the model:
 - 24-hour Annual Average Daily Traffic (AADT) flows based on historic data from DfT (2019). Additional future year traffic flows were provided by the Transport Consultant (see Figures 6-8, 6-9, 6-10). Following discussions between the Transport Consultant and Manchester City Council, no growth factors were applied, as traffic flows in the city have fallen over recent years.
 - 24-hour AADT flows for the Proposed Development, allowing for the cumulative impact of Plot 10a and 10b, which have been provided by Vectos
 - % Heavy Goods Vehicles (HGVs)
 - Estimated vehicle speeds. These were based on posted speed limits, local knowledge, evaluation of Google Traffic data and professional judgement. Speeds were reduced to 20kph at junctions within 25m of junctions, in accordance with TG22 guidance.

- Elevated road heights were included for sections of the A57 (M). Heights were calculated using data provided by Defra LIDAR survey data download.
- 6.10. The latest full year of ratified monitoring data available at the time of writing was 2020. However, during 2020, Covid-19 lockdown travel restrictions are likely to have suppressed air quality pollutant levels, i.e., conditions were atypical. To enable verification with local monitoring data, 2019 was therefore selected as a more conservative and representative dataset and modelled as the baseline year.
- 6.11. The assessment scenarios modelled are as follows:
- 2019 baseline scenario obtained from 2019 DfT traffic counts and data supplied by the Transport Consultant
 - 2027 opening year for the Proposed Development with emissions kept at 2023 (worst case scenario)
 - Do-minimum scenario (without the Proposed Development); and
 - Do-something scenario (with the Proposed Development)
 - 2027 opening year for the Proposed Development with opening year 2027 predicted emissions (best case scenario)
 - Do-minimum scenario (without the Proposed Development); and
 - Do-something scenario (with the Proposed Development)
- 6.12. A summary of the road links used within the model inputs is provided in Figure 6-11, and Table 6-21.

Table 6-21: Traffic data used in the modelling

Link	Road	Road Width (m)	AADT 2019	2027 DM	2027 DS	%HGV	Estimated Speed (kph)
1	Oxford Road	8.3	5463	5463	5463	43.6	32
2	Mancunian Way Slip	5.0	12904	12904	12904	3.3	64
3	Brook Street	9.7	8081	8081	8081	4.5	32
4	Hulme Street	18.0	654	654	706	2.4	32
4a	Hulme Street	8.0	654	654	706	2.4	32
4b	Hulme Street	8.0	654	654	706	2.4	32
5	Medlock Street	14.1	17429	17429	17649	3.3	32
6	Medlock Street N	6.2	23529	23529	23606	2.1	32
7	Roundabout 1	12.8	25808	25808	25808	3.3	20
8	Mancunian Way Slip W	6.8	25808	25808	25984	3.2	20
10	Mancunian Way	17.9	74709	74709	74921	4.3	64
11	Mancunian Way	16.2	59556	59556	59556	3.8	64
12	Albion Street	7.2	11765	11765	11803	2.1	20
14	Albion Street	6.5	11765	11765	11803	2.1	20
15	Mancunian Way	18.6	64977	64977	64977	4.1	64
16	Brook Street	7.6	4041	4041	4041	4.5	20
17	Brook Street	7.5	4041	4041	4041	4.5	20
18	Roundabout 2	10.4	25808	25808	25984	3.2	20
19	Mancunian Way	7.9	38941	38941	38941	3.5	64
20	Mancunian Way	5.3	38941	38941	38941	3.5	32
21	Mancunian Way Slip	5.0	12904	12904	12904	3.3	20
22	Mancunian Way	15.6	64977	64977	64977	4.1	64
23	Mancunian Way Slip E	7.5	25808	25808	25984	3.2	20
24	Mancunian Way Slip	5.0	12904	12904	12904	3.3	20
25	Mancunian Way	21.7	64977	64977	64977	4.1	64
26	Medlock Street	17.0	17429	17429	17649	3.3	64
27	Medlock Street	17.5	23529	23529	23606	2.1	32
31	City Road East	9.6	5645	5645	5680	2.4	64
32	River Street	20.6	1093	1093	1093	3.5	32
32a	River Street	8.6	1093	1093	1093	3.5	32

Link	Road	Road Width (m)	AADT 2019	2027 DM	2027 DS	%HGV	Estimated Speed (kph)
35	River Street	6.2	2619	2619	3075	2.0	32
36a	Wilmott Street	14.3	654	654	706	2.4	32
36b	Wilmott Street	6.5	654	654	706	2.4	32
*No growth factor applied in accordance with advice provided by Transport Consultant							

Vehicle Emission Rates

- 6.13. Vehicle emission rates for NO_x, PM₁₀ and PM_{2.5} were obtained from the latest version of Defra's Emission Factor Toolkit (EFT11.0), for the 'England (Not London)' area, with a 'Basic Split' traffic split format.
- 6.14. Vehicle emission rates are expected to decrease in the future due to increasingly stringent Euro emission standards, but there is uncertainty as to the rate of improvement for NO_x emissions from diesel vehicles, considering recent measurements of exhaust emissions and ambient air quality. Vehicle emissions for the 2019 baseline have also been used in modelling for the future year scenarios. This is a conservative assumption, as some improvements are likely by the Proposed Development opening year of 2027. Future scenarios have also been modelled using 2027 emissions, but retaining background concentrations from 2019, to provide an indication of the range of predicted results.

Receptors

- 6.15. Worst-case existing sensitive receptor locations were selected, such as those close to junctions and closest to the roads impacted by the Proposed Development, see Figure 6-12 and Table 6-22. A height of 1.5m corresponds to a ground floor property, a height of 4.5m corresponds to a first-floor property, and subsequent floors have been represented by 3.0 m increases.
- 6.16. Future proposed on-site receptors have also been modelled and also include worst case locations, such as those closest to roads and junctions. The proposed receptor locations include various facades of the proposed building at various heights, which are representative of each of the floors. The modelled proposed receptors are shown in Figure 6-13 and listed in Table 6-23.

Table 6-22: Modelled Exiting Receptors

Receptor ID	Location Easting	Northing	Floors	Heights (m)
1	383793.0	397353.8	Vita Student First St	1.5
2	383854.0	397269.4	Macintosh Mills Apartments	1.5
3	383965.2	397129.2	New Medlock House - Student Halls	1.5
3a	383965.2	397129.2	New Medlock House - Student Halls	4.5
3b	383965.2	397129.2	New Medlock House - Student Halls	7.5
3c	383965.2	397129.2	New Medlock House - Student Halls	10.5
3d	383965.2	397129.2	New Medlock House - Student Halls	13.5
3e	383965.2	397129.2	New Medlock House - Student Halls	16.5
3f	383965.2	397129.2	New Medlock House - Student Halls	19.5
3g	383965.2	397129.2	New Medlock House - Student Halls	22.5
4	383886.2	397102.4	Parkway Gate - Student Halls	1.5
4a	383886.2	397102.4	Parkway Gate - Student Halls	4.5
4b	383886.2	397102.4	Parkway Gate - Student Halls	7.5
4c	383886.2	397102.4	Parkway Gate - Student Halls	10.5
4d	383886.2	397102.4	Parkway Gate - Student Halls	13.5
4e	383886.2	397102.4	Parkway Gate - Student Halls	16.5
4f	383886.2	397102.4	Parkway Gate - Student Halls	19.5
4g	383886.2	397102.4	Parkway Gate - Student Halls	22.5
4h	383886.2	397102.4	Parkway Gate - Student Halls	46.5
5	383683.1	397294.8	8 First Street	1.5
6	383740.9	397355.5	Tony Wilson Place	1.5
7	383799.7	397245.2	Plot 10b	1.5
8	383838.8	397264.8	Plot 10a	1.5
9	383699.6	397254.7	Plot9a First Street	1.5
10	383765.8	397155.5	First Street South	1.5
11	383587.1	397372.9	Flats on Medlock St	1.5
12	383556.9	397212.3	Flats on River St	1.5

Receptor ID	Location Easting	Northing	Floors	Heights (m)
13	383592.7	397264.2	Flats on Shortcroft St	1.5
14	383683.6	397191.8	Premier Inn Manchester City Centre	1.5
15	384026.5	397250.2	MSV Student Living	1.5
16	383983.8	397228.4	Cambridge Mill Flat Complex	1.5
17	384005.9	397070.1	53 Conmere Square	1.5
17a	384005.9	397070.1	53 Conmere Square	4.5
17b	384005.9	397070.1	53 Conmere Square	7.5
18	383990.2	397071.7	45 Conmere Square	1.5
18a	383990.2	397071.7	45 Conmere Square	4.5
18b	383990.2	397071.7	45 Conmere Square	7.5
19	383626.8	397333.2	One City Road	1.5

Table 6-23: Modelled Future Receptors

Receptor ID	Location Easting	Northing	Floors	Heights (m)
P1	383778.4	397324.7	Ground, 1-13	1.5, 5.5, 8.5, 11.5, 14.5, 17.5, 20.5, 23.5, 26.5, 29.5, 32.5, 35.5, 38.5, 41.5
P2	383791.3	397331.2	Ground, 1-13	1.5, 5.5, 8.5, 11.5, 14.5, 17.5, 20.5, 23.5, 26.5, 29.5, 32.5, 35.5, 38.5, 41.5
P3	383829.1	397258.2	Ground, 1-13	1.5, 5.5, 8.5, 11.5, 14.5, 17.5, 20.5, 23.5, 26.5, 29.5, 32.5, 35.5, 38.5, 41.5
P4	383817.0	397251.9	Ground, 1-13	1.5, 5.5, 8.5, 11.5, 14.5, 17.5, 20.5, 23.5, 26.5, 29.5, 32.5, 35.5, 38.5, 41.5

Model Verification

- 6.17. Model verification is the process of comparing monitored and modelled pollutant concentrations for the same year, at the same locations, and adjusting modelled concentrations wherever necessary to be consistent with monitoring data. This increases the robustness of modelling results.
- 6.18. Discrepancies between modelled and measured concentrations can arise for a number of reasons, for example:
- Traffic data uncertainties
 - Background concentration estimates
 - Meteorological data uncertainties
 - Sources not explicitly included within the model, for example car parks and bus stops
 - Overall model limitations, including treatment of roughness and meteorological data, treatment of speeds), and
 - Uncertainty in monitoring data, particularly diffusion tubes

- 6.19. Verification is the process by which uncertainties such as those described above are investigated and minimised. Disparities between modelling and monitoring results are likely to arise as result of a combination of all of these aspects.
- 6.20. Using the guidance provided in Chapter 7 of LAQM.TG (22), the modelled output has been verified against the monitoring data obtained by Manchester City Council, using the closest locations to the Proposed Development.
- 6.21. The performance of the dispersion model was assessed by comparing the modelled concentrations with measured concentrations. Meteorological data, monitored concentrations, vehicle emission rates and traffic data for 2019 were all used in the model verification process.
- 6.22. The model adjustment was undertaken using methodology which requires the determination of the ratio between the measured and modelled road contributed NO_x at each comparison site. The ratio between them, referred to as the adjustment factor, is applied to the modelled road contributed NO_x. The modelled NO₂ is then determined using the Defra NO_x/NO₂ calculator.
- 6.23. Table 6-24 presents a summary of the model performance prior to bias adjustment. The model verification is based on Defra EFT V11.0 emission factors.

Table 6-23: Model Performance Prior to Bias Adjustment

Ref	Description	Monitored NO ₂ (µg/m ³)	Modelled NO ₂ (µg/m ³)	% Difference (Modelled-Measured) / Measured
MAN77	Hewitt Street	43.7	34.2	-22.0
MAN82_84	Oxford Road	51.3	40.3	-20.3

- 6.24. These comparisons show that the model underpredicted annual mean concentrations of NO₂. Model verification was therefore carried out and an adjustment factor calculated and applied in all scenarios, in accordance with the methodology prescribed in LAQM.TG (22). A regression analysis was undertaken of modelled and measured road NO_x concentrations at these locations. The derived adjustment factor (2.926) was then applied to the modelled road NO_x concentrations to adjust for model bias. The comparison of modelled with measured values was then repeated and the results are shown in Table 6-25.

Table 6-24: Model Performance After Bias Adjustment

Ref	Description	Monitored NO ₂ (µg/m ³)	Modelled NO ₂ (µg/m ³)	% Difference (Modelled-Measured) / Measured
MAN77	Hewitt Street	43.7	41.4	-7.5
MAN82_84	Oxford Road	51.3	52.5	2.9

- 6.25. The accuracy of the adjusted model was also considered via the calculation of the Root Mean Square Error (RMSE) and fractional bias.
- 6.26. With the unadjusted model results, the RMSE was $10.0\mu\text{g}/\text{m}^3$, while with the adjusted model results this was reduced to $2.5\mu\text{g}/\text{m}^3$ so the adjustment has reduced the average error or uncertainty in the model results. LAQM.TG (22) states that ideally, an RMSE within 10% of the air quality objective would be derived, which equates to $4\mu\text{g}/\text{m}^3$ for the annual average NO_2 objective. In this respect, the model results are therefore considered robust.
- 6.27. The fractional bias was 0.23 with the unadjusted model, which shows a slight tendency to under-predict, and 0.02 with the adjusted model, which shows that the under prediction has been mostly removed.
- 6.28. The final adjusted total NO_2 concentration predicted at the diffusion tubes sites is within $\pm 25\%$ of the measured values and is therefore considered satisfactory.
- 6.29. In accordance with Defra guidance, the road contributed NO_x adjustment factor was also applied to the road contributed PM concentration. The total PM_{10} and $\text{PM}_{2.5}$ concentrations are derived by adding the adjusted road contribution value to the Defra background concentrations.

Results Processing

Atmospheric Chemistry

- 6.30. NO_2 is associated with effects on human health and therefore the air quality standards for the protection of human health are based on NO_2 rather than total NO_x or NO . The model predicts NO_x concentrations which comprise nitric oxide (NO) and nitrogen dioxide (NO_2). NO_x is emitted from combustion processes primarily as NO with a small percentage (usually $<5\%$) of NO_2 . The emitted NO reacts with oxidants in the air (mainly ozone) to form secondary NO_2 . Factors affecting the rate of this oxidation occurs include the concentration of oxidants in the air, wind speed and temperature.
- 6.31. Predicted NO_x concentrations have been processed to determine annual mean nitrogen dioxide (NO_2) concentrations for comparison with the annual mean NO_2 objectives. A $\text{NO}_x:\text{NO}_2$ conversion has been applied to the modelled NO_x concentrations, in order to determine the impact of the NO_x emissions on ambient concentrations of NO_2 .
- 6.32. NO_2 concentrations were estimated from the modelled NO_x concentrations. For roads, Defra's NO_x to NO_2 calculator¹ was used with the 'All Other urban UK Traffic' mix assumed.
- 6.33. The annual mean background and modelled roads contribution from ADMS-Roads were added together to give total concentrations and enable a comparison to be made with the air quality criteria for annual mean concentrations.

Background Pollutant Concentrations

- 6.34. Adjusted Defra background concentrations were used in the NO_2 PM_{10} and $\text{PM}_{2.5}$.
- 6.35. The modelling has assumed that there will be no reduction in background NO_2 concentrations with the background value for the base year used in the opening year 2027 modelling scenarios to match that used in the model verification.

Comparison with Air Quality Standards

- 6.36. The results of dispersion modelling at sensitive residential receptors have been compared to relevant national air quality objectives for the protection of human health listed.

¹ <https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc>.

Dispersion Modelling Results

Existing Receptors

Long-Term NO₂ Concentrations- Impacts from Road Traffic Emissions at Existing Receptors

6.37. The effects of the operation phase road traffic NO₂ emissions on existing sensitive receptors close to the Proposed Development are presented in Table 6-26.

Table 6-25: NO₂ Annual Mean Concentrations at Modelled Receptors During the Operation Phase

Receptor ID	Floor	Annual Mean NO ₂ Concentrations µg/m ³							
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)				2023 background with 2027 traffic flows and 2027 Emissions (Best Case)			
		DM	DS	DS-DM	Impact	DM	DS	DS-DM	Impact
1	GF	31.9	32.1	0.2	Negligible	29.8	29.9	0.1	Negligible
2	GF	33.0	33.1	0.1	Negligible	30.5	30.6	0.1	Negligible
3	GF	58.9	59.1	0.1	Negligible	48.6	48.7	0.1	Negligible
3a	1	53.6	53.7	0.1	Negligible	44.8	44.9	0.1	Negligible
3b	2	46.5	46.6	0.1	Negligible	39.8	39.8	0.1	Negligible
3c	3	40.7	40.8	<0.1	Negligible	35.8	35.8	<0.1	Negligible
3d	4	36.4	36.4	<0.1	Negligible	32.8	32.8	<0.1	Negligible
3e	5	33.3	33.3	<0.1	Negligible	30.7	30.8	<0.1	Negligible
3f	6	31.2	31.2	<0.1	Negligible	29.3	29.3	<0.1	Negligible
3g	7	29.8	29.8	<0.1	Negligible	28.4	28.4	<0.1	Negligible
4	GF	63.6	63.8	0.2	Negligible	52.0	52.1	0.1	Negligible
4a	1	57.6	57.7	0.1	Negligible	47.7	47.8	0.1	Negligible
4b	2	50.6	50.6	0.1	Negligible	42.6	42.7	<0.1	Negligible
4c	3	43.1	43.1	<0.1	Negligible	37.4	37.4	<0.1	Negligible
4d	4	36.8	36.8	<0.1	Negligible	33.1	33.1	<0.1	Negligible
4e	5	33.1	33.1	<0.1	Negligible	30.6	30.6	<0.1	Negligible
4f	6	30.9	30.9	<0.1	Negligible	29.2	29.2	<0.1	Negligible
4g	7	29.6	29.6	<0.1	Negligible	28.3	28.3	<0.1	Negligible
4h	15	26.5	26.5	<0.1	Negligible	26.3	26.3	<0.1	Negligible
5	GF	38.4	38.7	0.3	Minor	34.1	34.4	0.2	Negligible
6	GF	31.6	31.7	0.1	Negligible	29.6	29.7	0.1	Negligible
7	GF	34.2	34.2	0.1	Negligible	31.3	31.3	<0.1	Negligible
8	GF	33.9	34.0	0.1	Negligible	31.1	31.2	0.1	Negligible
9	GF	39.0	39.1	0.1	Negligible	34.6	34.6	<0.1	Negligible
10	GF	48.1	48.1	<0.1	Negligible	40.8	40.9	<0.1	Negligible
11	GF	33.6	33.6	<0.1	Negligible	30.9	30.9	<0.1	Negligible
12	GF	34.0	34.1	<0.1	Negligible	31.2	31.2	<0.1	Negligible
13	GF	32.4	32.4	<0.1	Negligible	30.1	30.1	<0.1	Negligible
14	GF	46.5	46.5	<0.1	Negligible	39.7	39.7	<0.1	Negligible
15	GF	34.4	34.4	<0.1	Negligible	31.4	31.5	<0.1	Negligible

Receptor ID	Floor	Annual Mean NO ₂ Concentrations µg/m ³							
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)				2023 background with 2027 traffic flows and 2027 Emissions (Best Case)			
		DM	DS	DS-DM	Impact	DM	DS	DS-DM	Impact
16	GF	35.6	35.7	<0.1	Negligible	32.3	32.3	<0.1	Negligible
17	GF	42.0	42.1	0.1	Negligible	36.6	36.6	<0.1	Negligible
17a	1	39.7	39.7	0.1	Negligible	35.0	35.0	<0.1	Negligible
17b	2	36.5	36.6	<0.1	Negligible	32.9	32.9	<0.1	Negligible
18	GF	42.4	42.5	0.1	Negligible	36.8	36.9	0.1	Negligible
18a	1	40.3	40.3	0.1	Negligible	35.4	35.4	<0.1	Negligible
18b	2	37.2	37.3	<0.1	Negligible	33.3	33.4	<0.1	Negligible
19	GF	36.2	36.2	0.1	Negligible	32.7	32.7	<0.1	Negligible
Notes: Exceedances of the annual mean air quality objective are indicated in bold. Values greater than 60µg/m ³ are underlined.									

6.38. Results are presented for 2 different scenarios:

- 2023 background with 2027 traffic flows and 2023 emission factors (worst case)
- 2023 background with 2027 traffic flows and 2027 emission factors (best case)

6.39. Assuming worst case conditions, i.e., no decrease in background pollutant concentrations between 2023 and opening year, no improvement in vehicle emission factors from 2023, the worst-case impact is 'minor' at Receptor 5, where there is a predicted increase of 0.3 µg/m³. There are no new exceedances of the NO₂ annual mean air quality objective.

6.40. Assuming best case conditions in which vehicle emission factors decrease in line with predicted trends, air quality concentrations at all modelled receptor locations are reduced, including receptor 5, which is reduced to a 0.2 µg/m³ negligible increase in NO₂ in line with the other receptors.

Long Term PM₁₀ Concentrations: Impacts from Road Traffic Emissions at Existing Receptors

6.41. The effects of the operation phase road traffic PM₁₀ emissions on existing sensitive receptors close to the Proposed Development are presented in Table 6-27.

6.42. Modelled PM₁₀ concentrations in both the best- and worst-case scenarios meet the annual mean PM₁₀ objectives at all modelled receptor locations. The impact of operation traffic phase increases is negligible at all locations.

Table 6-26: PM₁₀ Annual Mean Concentrations at Modelled Receptors During the Operation Phase

Receptor ID	Floor	Annual Mean PM ₁₀ Concentrations µg/m ³ (Daily Exceedances of 50 µg/m ³ in brackets)							
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)				2023 background with 2027 traffic flows and 2027 Emissions (Best Case)			
		DM	DS	DS-DM	Impact	DM	DS	DS-DM	Impact
1	GF	20.0 (4)	20.1 (4)	0.1	Negligible	20.0 (3)	20.1 (3)	0.1	Negligible
2	GF	20.4 (4)	20.4 (4)	<0.1	Negligible	20.3 (4)	20.3 (4)	<0.1	Negligible
3	GF	28.0 (21)	28.1 (21)	<0.1	Negligible	27.9 (20)	27.9 (20)	<0.1	Negligible
3a	1	26.4 (16)	26.5 (16)	<0.1	Negligible	26.43(16)	26.4 (16)	<0.1	Negligible
3b	2	24.4 (11)	24.4 (11)	<0.1	Negligible	24.3 (11)	24.3 (11)	<0.1	Negligible
3c	3	22.7 (8)	22.7 (8)	<0.1	Negligible	22.7 (7)	22.7 (7)	<0.1	Negligible
3d	4	21.4 (5)	21.4 (5)	<0.1	Negligible	21.4 (5)	21.4 (5)	<0.1	Negligible

Receptor ID	Floor	Annual Mean PM ₁₀ Concentrations µg/m ³ (Daily Exceedances of 50 µg/m ³ in brackets)							
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)				2023 background with 2027 traffic flows and 2027 Emissions (Best Case)			
		DM	DS	DS-DM	Impact	DM	DS	DS-DM	Impact
3e	5	20.5 (4)	20.5 (4)	<0.1	Negligible	20.5 (4)	20.5 (4)	<0.1	Negligible
3f	6	19.9 (3)	19.9 (3)	<0.1	Negligible	19.9 (3)	19.9 (3)	<0.1	Negligible
3g	7	19.5 (3)	19.5 (3)	<0.1	Negligible	19.5 (3)	19.5 (3)	<0.1	Negligible
4	GF	29.4 (25)	29.4 (25)	0.1	Negligible	29.2 (25)	29.3 (25)	0.1	Negligible
4a	1	27.9 (20)	27.9 (20)	<0.1	Negligible	27.7 (20)	27.8 (20)	<0.1	Negligible
4b	2	26.1 (15)	26.1 (15)	<0.1	Negligible	26.0 (15)	26.0 (15)	<0.1	Negligible
4c	3	23.7 (9)	23.7 (9)	<0.1	Negligible	23.6 (9)	23.6 (9)	<0.1	Negligible
4d	4	21.6 (6)	21.6 (6)	<0.1	Negligible	21.6 (6)	21.6 (6)	<0.1	Negligible
4e	5	20.5 (4)	20.5 (4)	<0.1	Negligible	20.4 (4)	20.4 (4)	<0.1	Negligible
4f	6	19.8 (3)	19.8 (3)	<0.1	Negligible	19.8 (3)	19.8 (3)	<0.1	Negligible
4g	7	19.4 (3)	19.4 (3)	<0.1	Negligible	19.4 (3)	19.4 (3)	<0.1	Negligible
4h	15	18.6 (2)	18.6 (2)	<0.1	Negligible	18.6 (2)	18.6 (2)	<0.1	Negligible
5	GF	21.9 (6)	22.0 (6)	0.1	Negligible	21.8 (6)	21.9 (6)	0.1	Negligible
6	GF	20.0 (3)	20.0 (3)	<0.1	Negligible	19.9 (3)	20.0 (3)	<0.1	Negligible
7	GF	20.7 (4)	20.7 (4)	<0.1	Negligible	20.6 (4)	20.6 (4)	<0.1	Negligible
8	GF	20.6 (4)	20.6 (4)	<0.1	Negligible	20.5 (4)	20.6 (4)	<0.1	Negligible
9	GF	21.9 (6)	21.9 (6)	<0.1	Negligible	21.9 (6)	21.9 (6)	<0.1	Negligible
10	GF	24.6 (11)	24.6 (11)	<0.1	Negligible	24.5 (11)	24.5 (11)	<0.1	Negligible
11	GF	20.8 (4)	20.8 (4)	<0.1	Negligible	20.7 (4)	20.7 (4)	<0.1	Negligible
12	GF	20.9 (5)	20.9 (5)	<0.1	Negligible	20.9 (5)	20.9 (5)	<0.1	Negligible
13	GF	20.3 (4)	20.3 (4)	<0.1	Negligible	20.3 (4)	20.3 (4)	<0.1	Negligible
14	GF	24 (10)	24 (10)	<0.1	Negligible	23.9 (10)	23.9 (10)	<0.1	Negligible
15	GF	20.8 (4)	20.8 (4)	<0.1	Negligible	20.7 (4)	20.8 (4)	<0.1	Negligible
16	GF	21.1 (5)	21.1 (5)	<0.1	Negligible	21.0 (5)	21.0 (5)	<0.1	Negligible
17	GF	22.8 (8)	22.8 (8)	<0.1	Negligible	22.7 (8)	22.7 (8)	<0.1	Negligible
17a	1	22.2 (7)	22.2 (7)	<0.1	Negligible	22.1 (6)	22.1 (6)	<0.1	Negligible
17b	2	21.3 (5)	21.3 (5)	<0.1	Negligible	21.3 (5)	21.3 (5)	<0.1	Negligible
18	GF	22.9 (8)	22.9 (8)	<0.1	Negligible	22.8 (8)	22.8 (8)	<0.1	Negligible
18a	1	22.4 (7)	22.4 (7)	<0.1	Negligible	22.3 (7)	22.3 (7)	<0.1	Negligible
18b	2	21.5 (6)	21.5 (6)	<0.1	Negligible	21.5 (5)	21.5 (5)	<0.1	Negligible
19	GF	21.3 (5)	21.3 (5)	<0.1	Negligible	21.3 (5)	21.3 (5)	<0.1	Negligible

Long Term PM_{2.5} Concentrations: Impacts from Road Traffic Emissions at Existing Receptors

6.43. The effects of the operation phase road traffic PM_{2.5} emissions on existing sensitive receptors close to the Proposed Development are presented in Table 6-28.

6.44. Modelled PM_{2.5} concentrations in both the best- and worst-case scenarios meet the annual mean PM_{2.5} objectives at all modelled receptor locations. The impact of operation traffic phase increases is negligible at all locations.

Table 6-27: PM_{2.5} Annual Mean Concentrations at Modelled Receptors During the Operation Phase

Receptor ID	Floor	Annual Mean PM _{2.5} Concentrations µg/m ³							
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)				2023 background with 2027 traffic flows and 2027 Emissions (Best Case)			
		DM	DS	DS-DM	Impact	DM	DS	DS-DM	Impact
1	GF	11.5	11.6	<0.1	Negligible	11.5	11.5	<0.1	Negligible
2	GF	11.7	11.7	<0.1	Negligible	11.7	11.7	<0.1	Negligible
3	GF	16.1	16.1	<0.1	Negligible	15.9	15.9	<0.1	Negligible
3a	1	15.2	15.2	<0.1	Negligible	15.0	15.0	<0.1	Negligible
3b	2	14.0	14.0	<0.1	Negligible	13.9	13.9	<0.1	Negligible
3c	3	13.0	13.0	<0.1	Negligible	13.0	13.0	<0.1	Negligible
3d	4	12.3	12.3	<0.1	Negligible	12.3	12.3	<0.1	Negligible
3e	5	11.8	11.8	<0.1	Negligible	11.8	11.8	<0.1	Negligible
3f	6	11.4	11.4	<0.1	Negligible	11.4	11.4	<0.1	Negligible
3g	7	11.2	11.2	<0.1	Negligible	11.2	11.2	<0.1	Negligible
4	GF	16.8	16.9	<0.1	Negligible	16.7	16.7	<0.1	Negligible
4a	1	16.0	16.0	<0.1	Negligible	15.8	15.8	<0.1	Negligible
4b	2	14.9	14.9	<0.1	Negligible	14.8	14.8	<0.1	Negligible
4c	3	13.6	13.6	<0.1	Negligible	13.5	13.5	<0.1	Negligible
4d	4	12.4	12.4	<0.1	Negligible	12.4	12.4	<0.1	Negligible
4e	5	11.8	11.8	<0.1	Negligible	11.7	11.7	<0.1	Negligible
4f	6	11.4	11.4	<0.1	Negligible	11.4	11.4	<0.1	Negligible
4g	7	11.2	11.2	<0.1	Negligible	11.2	11.2	<0.1	Negligible
4h	15	10.7	10.7	<0.1	Negligible	10.7	10.7	<0.1	Negligible
5	GF	12.6	12.6	0.1	Negligible	12.5	12.6	0.1	Negligible
6	GF	11.5	11.5	<0.1	Negligible	11.5	11.5	<0.1	Negligible
7	GF	11.9	11.9	<0.1	Negligible	11.8	11.8	<0.1	Negligible
8	GF	11.8	11.9	<0.1	Negligible	11.8	11.8	<0.1	Negligible
9	GF	12.6	12.6	<0.1	Negligible	12.5	12.5	<0.1	Negligible
10	GF	14.1	14.1	<0.1	Negligible	14.0	14.0	<0.1	Negligible
11	GF	11.9	11.9	<0.1	Negligible	11.9	11.9	<0.1	Negligible
12	GF	12.0	12.0	<0.1	Negligible	12.0	12.0	<0.1	Negligible
13	GF	11.7	11.7	<0.1	Negligible	11.6	11.6	<0.1	Negligible
14	GF	13.8	13.8	<0.1	Negligible	13.7	13.7	<0.1	Negligible
15	GF	12.0	12.0	<0.1	Negligible	11.9	11.9	<0.1	Negligible
16	GF	12.1	12.1	<0.1	Negligible	12.1	12.1	<0.1	Negligible

Receptor ID	Floor	Annual Mean PM _{2.5} Concentrations µg/m ³							
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)				2023 background with 2027 traffic flows and 2027 Emissions (Best Case)			
		DM	DS	DS-DM	Impact	DM	DS	DS-DM	Impact
17	GF	13.1	13.1	<0.1	Negligible	13.0	13.0	<0.1	Negligible
17a	1	12.7	12.7	<0.1	Negligible	12.6	12.7	<0.1	Negligible
17b	2	12.2	12.3	<0.1	Negligible	12.2	12.2	<0.1	Negligible
18	GF	13.2	13.2	<0.1	Negligible	13.1	13.1	<0.1	Negligible
18a	1	12.8	12.8	<0.1	Negligible	12.8	12.8	<0.1	Negligible
18b	2	12.4	12.4	<0.1	Negligible	12.3	12.3	<0.1	Negligible
19	GF	12.2	12.3	<0.1	Negligible	12.2	12.2	<0.1	Negligible

New Receptors

Long-Term NO₂ Concentrations- Emissions from Road Traffic

6.45. The effects of the operation phase road traffic NO₂ emissions are presented in Table 6-29 for 2 different scenarios:

- 2019 Back2023 background with 2027 traffic flows and 20222023 emission factors (worst case)
- 2019 Back2023 background with 2027 traffic flows and 2027 emission factors (best case)

Table 6-28: NO₂ Annual Mean Concentrations at Modelled Receptors During the Operation Phase

Receptor ID	Floor	Annual Mean NO ₂ Concentration µg/m ³	
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)	2023 background with 2027 traffic flows and 2027 Emissions (Best Case)
P1a	GF	32.4	30.1
P1b	1	31.8	29.7
P1c	2	31.3	29.4
P1d	3	30.8	29.1
P1e	4	30.3	28.7
P1f	5	29.8	28.4
P1g	6	29.4	28.1
P1h	7	29.0	27.9
P1i	8	28.5	27.6
P1j	9	28.2	27.4
P1k	10	27.8	27.1
P1l	11	27.6	26.9
P1m	12	27.3	26.8
P1n	13	27.1	26.6
P2a	GF	32.1	29.9
P2b	1	31.5	29.6
P2c	2	31.0	29.2
P2d	3	30.6	28.9
P2e	4	30.2	28.6
P2f	5	29.7	28.4

Receptor ID	Floor	Annual Mean NO ₂ Concentration µg/m ³	
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)	2023 background with 2027 traffic flows and 2027 Emissions (Best Case)
P2g	6	29.3	28.1
P2h	7	28.9	27.8
P2i	8	28.5	27.6
P2j	9	28.2	27.3
P2k	10	27.8	27.1
P2l	11	27.6	26.9
P2m	12	27.3	26.8
P2n	13	27.1	26.7
P3a	GF	33.5	30.8
P3b	1	32.9	30.5
P3c	2	32.4	30.1
P3d	3	31.9	29.8
P3e	4	31.3	29.4
P3f	5	30.7	29.0
P3g	6	30.1	28.6
P3h	7	29.5	28.2
P3i	8	28.9	27.8
P3j	9	28.4	27.5
P3k	10	28.0	27.3
P3l	11	27.7	27.0
P3m	12	27.4	26.8
P3n	13	27.1	26.7
P4a	GF	33.8	31.0
P4b	1	33.2	30.7
P4c	2	32.7	30.3
P4d	3	32.1	29.9
P4e	4	31.5	29.5
P4f	5	30.8	29.1
P4g	6	30.2	28.6
P4h	7	29.5	28.2
P4i	8	29.0	27.9
P4j	9	28.5	27.5
P4k	10	28.0	27.3
P4l	11	27.7	27.0
P4m	12	27.4	26.8
P4n	13	27.1	26.7

6.46. Following interpretation of modelled results, no exceedances of the annual mean objective were recorded throughout the Proposed Development:

Long Term PM₁₀ Concentrations: Operation Phase Road Traffic Emissions

6.47. The effects of the operation phase road traffic PM₁₀ emissions are presented in Table 6-30.

6.48. Modelled PM₁₀ concentrations in all scenarios meet the annual mean PM₁₀ objectives at all receptor locations.

Table 6-9: PM₁₀ Annual Mean Concentrations at Modelled Receptors During the Operation Phase

Receptor ID	Floor	Annual Mean PM ₁₀ Concentration µg/m ³ (Daily Exceedances of 50 µg/m ³ in brackets)	
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)	2023 background with 2027 traffic flows and 2027 Emissions (Best Case)
P1a	GF	20.2 (4)	20.1 (4)
P1b	1	20.0 (3)	20.0 (3)
P1c	2	19.9 (3)	19.8 (3)
P1d	3	19.7 (3)	19.7 (3)
P1e	4	19.6 (3)	19.6 (3)
P1f	5	19.5 (3)	19.5 (3)
P1g	6	19.4 (3)	19.3 (3)
P1h	7	19.2 (3)	19.2 (3)
P1i	8	19.1 (2)	19.1 (2)
P1j	9	19.0 (2)	19.0 (2)
P1k	10	18.9 (2)	18.9 (2)
P1l	11	18.8 (2)	18.8 (2)
P1m	12	18.8 (2)	18.8 (2)
P1n	13	18.7 (2)	18.7 (2)
P2a	GF	20.1 (4)	20.1 (3)
P2b	1	19.9 (3)	19.9 (3)
P2c	2	19.8 (3)	19.8 (3)
P2d	3	19.7 (3)	19.7 (3)
P2e	4	19.6 (3)	19.5 (3)
P2f	5	19.4 (3)	19.4 (3)
P2g	6	19.3 (3)	19.3 (3)
P2h	7	19.2 (3)	19.2 (2)
P2i	8	19.1 (2)	19.1 (2)
P2j	9	19.0 (2)	19.0 (2)
P2k	10	18.9 (2)	18.9 (2)
P2l	11	18.8 (2)	18.8 (2)
P2m	12	18.8 (2)	18.8 (2)
P2n	13	18.7 (2)	18.7 (2)
P3a	GF	20.5 (4)	20.4 (4)
P3b	1	20.3 (4)	20.3 (4)
P3c	2	20.2 (4)	20.1 (4)
P3d	3	20.0 (3)	20.0 (3)
P3e	4	19.9 (3)	19.8 (3)

Receptor ID	Floor	Annual Mean PM ₁₀ Concentration µg/m ³ (Daily Exceedances of 50 µg/m ³ in brackets)	
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)	2023 background with 2027 traffic flows and 2027 Emissions (Best Case)
P3f	5	19.7 (3)	19.7 (3)
P3g	6	19.5 (3)	19.5 (3)
P3h	7	19.4 (3)	19.4 (3)
P3i	8	19.2 (3)	19.2 (3)
P3j	9	19.1 (2)	19.1 (2)
P3k	10	19.0 (2)	19.0 (2)
P3l	11	18.9 (2)	18.9 (2)
P3m	12	18.8 (2)	18.8 (2)
P3n	13	18.7 (2)	18.7 (2)
P4a	GF	20.6 (4)	20.5 (4)
P4b	1	20.4 (4)	20.4 (4)
P4c	2	20.3 (4)	20.2 (4)
P4d	3	20.1 (4)	20.1 (3)
P4e	4	19.9 (3)	19.9 (3)
P4f	5	19.7 (3)	19.7 (3)
P4g	6	19.6 (3)	19.5 (3)
P4h	7	19.4 (3)	19.4 (3)
P4i	8	19.2 (3)	19.2 (3)
P4j	9	19.1 (2)	19.1 (2)
P4k	10	19.0 (2)	19.0 (2)
P4l	11	18.9 (2)	18.9 (2)
P4m	12	18.8 (2)	18.8 (2)
P4n	13	18.7 (2)	18.7 (2)

Long Term PM_{2.5} Concentrations: Operation Phase Road Traffic Emissions

6.49. The effects of the operation phase road traffic PM_{2.5} emissions are presented in Table 6-31.

6.50. Modelled PM_{2.5} concentrations in all scenarios meet the annual mean PM_{2.5} objectives at all receptor locations.

Table 6-10: PM_{2.5} Annual Mean Concentrations at Modelled Receptors During the Operation Phase

Receptor ID	Floor	Annual Mean PM _{2.5} Concentration µg/m ³	
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)	2023 background with 2027 traffic flows and 2027 Emissions (Best Case)
P1a	GF	11.6	11.6
P1b	1	11.5	11.5
P1c	2	11.4	11.4
P1d	3	11.4	11.3
P1e	4	11.3	11.3
P1f	5	11.2	11.2

Receptor ID	Floor	Annual Mean PM _{2.5} Concentration µg/m³	
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)	2023 background with 2027 traffic flows and 2027 Emissions (Best Case)
P1g	6	11.1	11.1
P1h	7	11.1	11.1
P1i	8	11.0	11.0
P1j	9	11.0	10.9
P1k	10	10.9	10.9
P1l	11	10.9	10.8
P1m	12	10.8	10.8
P1n	13	10.8	10.8
P2a	GF	11.6	11.5
P2b	1	11.5	11.4
P2c	2	11.4	11.4
P2d	3	11.3	11.3
P2e	4	11.3	11.2
P2f	5	11.2	11.2
P2g	6	11.1	11.1
P2h	7	11.1	11.0
P2i	8	11.0	11.0
P2j	9	10.9	10.9
P2k	10	10.9	10.9
P2l	11	10.9	10.8
P2m	12	10.8	10.8
P2n	13	10.8	10.8
P3a	GF	11.8	11.7
P3b	1	11.7	11.6
P3c	2	11.6	11.6
P3d	3	11.5	11.5
P3e	4	11.4	11.4
P3f	5	11.3	11.3
P3g	6	11.2	11.2
P3h	7	11.2	11.1
P3i	8	11.1	11.1
P3j	9	11.0	11.0
P3k	10	10.9	10.9
P3l	11	10.9	10.9
P3m	12	10.8	10.8
P3n	13	10.8	10.8
P4a	GF	11.8	11.8
P4b	1	11.7	11.7
P4c	2	11.7	11.6

Receptor ID	Floor	Annual Mean PM _{2.5} Concentration µg/m ³	
		2023 background with 2027 traffic flows and 2023 Emissions (Worst Case)	2023 background with 2027 traffic flows and 2027 Emissions (Best Case)
P4d	3	11.6	11.5
P4e	4	11.5	11.4
P4f	5	11.4	11.3
P4g	6	11.3	11.2
P4h	7	11.2	11.1
P4i	8	11.1	11.1
P4j	9	11.0	11.0
P4k	10	10.9	10.9
P4l	11	10.9	10.9
P4m	12	10.8	10.8
P4n	13	10.8	10.8

Proposed Mitigation Measures: Operation Phase Road Traffic Emissions

- 6.51. Measures to encourage cycling and walking, including provision of 88 secure cycle parking places (15%) plus 10 x Sheffield Stands in the public realm that offers cycle parking for 20 cycles;
- 6.52. There is no car parking provided. As above, users will be able to access the First Street multi-storey car park and the on-street parking bays on River Street.
- 6.53. Implementation of Travel Plan via an action plan managed by travel plan coordinator- to include public transport initiatives, e.g., financial concessions
- 6.54. Implementation of Student Traffic Management Plan for student arrivals and departures at the start and end of term

Construction Dust Assessment Methodology

- 6.55. The construction dust assessment follows the methodology outlined in the IAQM guidance, which is outlined as follows.

Screening (Step 1)

- 6.56. As 'human receptors' were identified within 50 m of the boundary of the site; and within 50 m of the route(s) to be used by construction vehicles on the public highway, up to 500 m from the site entrance, a detailed risk assessment was undertaken.

Dust Emission (Step 2A)

- 6.57. The potential dust emission magnitude for different activities have been defined based on the criteria listed in Table 6-32.

Table 6-32: Potential Dust Emission Magnitude Criteria

Stage	Description	Large	Medium	Small
Demolition	Definitions for demolition are:	- Total building volume >50,000 m³ - Potentially dusty construction material (e.g., concrete) - On-site crushing and screening	- Total building volume 20,000 m³ – 50,000 m³ - Potentially dusty construction material (e.g., concrete)	- Total building volume <20,000 m³ - Construction material with low potential for dust release (e.g., metal cladding or timber)

Stage	Description	Large	Medium	Small
		Demolition activities >20 m above ground level	Demolition activities 10 – 20 m above ground level	Demolition activities <10 m above ground, demolition during wetter months
Earthworks	Earthworks will primarily involve excavating material, haulage, tipping, and stockpiling. This may also involve levelling the site and landscaping.	- Total site area >10,000 m² - Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size) >10 heavy earth moving vehicles active at any one-time formation of bunds >8 m in height - Total material moved >100,000 tonnes	- Total site area 2,500 m² – 10,000 m² - Moderately dusty soil type (e.g. silt) 5-10 heavy earth moving vehicles active at any one-time formation of bunds 4 m – 8 m in height - Total material moved 20,000 tonnes – 100,000 tonnes	- Total site area <2,500 m² - Soil type with large grain size (e.g. sand) <5 heavy earth moving vehicles active at any one-time formation of bunds <4 m in height - Total material moved <20,000 tonnes, earthworks during wetter months
Construction	The key issues when determining the potential dust emission magnitude during the construction phase include the size of the building(s) / infrastructure, method of construction, construction materials, and duration of build.	- Total building volume >100,000 m³ - On-site concrete batching and sandblasting	- Total building volume 25,000 m³ – 100,000 m³ - Potentially dusty construction material (e.g. concrete) - On-site concrete batching	- Total building volume <25,000 m³ - Construction material with low potential for dust release (e.g. metal cladding or timber)
Trackout	Factors which determine the dust emission magnitude are vehicle size, vehicle speed, vehicle numbers, geology, and duration. Only receptors within 50 m of the routes used by vehicles on the public highway and up to 500 m from the site entrances are considered to be at risk from the effects of dust.	>50 HDV (>3.5 tonnes) outward movements in any one day - Potentially dusty surface material (e.g. high clay content) - Unpaved road length >100 m	10-50 HDV (>3.5 tonnes) outward movements in any one day - Moderately dusty surface material (e.g. high clay content) - Unpaved road length 50 m – 100 m	<10 HDV (3.5 tonnes) outward movements in any one day - Surface material with low potential for dust release - Unpaved road length <50 m

Sensitivity of the Area (Step 2B)

6.58. The sensitivity of the area takes account of several factors:

- The specific sensitivities of receptors in the area.
- The proximity and number of those receptors.
- In the case of PM₁₀, the local background concentration; and
- Site-specific factors, such as whether there are natural shelters, such as trees, to reduce the risk of wind-blown dust.

6.59. Table 6-33 provides guidance on the sensitivity of different types of receptors.

Table 6-33: Sensitivities of People to Dust Soiling Effects, Health Effects of PM₁₀, and Sensitivities of Receptors to Ecological Effects

Description	High Sensitivity Receptor	Medium Sensitivity Receptor	Low Sensitivity Receptor
Sensitivities of People to Dust Soiling Effects	▪ Users can reasonably expect enjoyment of a high level of amenity ▪ The appearance, aesthetics, or value of their property would be diminished by soiling ▪ The people or property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land ▪ Indicative examples include dwellings, museums, and other culturally important collections, medium, and long-term car parks, and car showrooms	▪ Users would expect a to enjoy a reasonable level of amenity, but would not reasonably expect a to enjoy the same level of amenity as in their home ▪ The appearance, aesthetics, or value of their property could be diminished by soiling ▪ The people or property wouldn't reasonably be expected a to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land ▪ Indicative examples include parks and places of work	▪ The enjoyment of amenity would not reasonably be expected; or ▪ Property would not reasonably be expected a to be diminished in appearance, aesthetics, or value by soiling ▪ There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land ▪ Indicative examples include playing fields, farmland (unless commercially sensitive horticultural), footpaths, short-term car parks, and roads
Sensitivities of People to the Health Effects of PM ₁₀	▪ Locations where members of the public are exposed over a time period relevant to the air quality objective for PM₁₀ (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day) ▪ Indicative examples include residential properties. Hospitals, schools and residential care homes should also be considered as having equal sensitivity to residential areas for the	▪ Locations where the people exposed are workers d, and exposure is over a time period relevant to the air quality objective for PM₁₀ (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). ▪ Indicative examples include office and shop workers but will generally not include workers occupationally exposed to PM₁₀, as protection is	▪ Locations where human exposure is transient. ▪ Indicative examples include public footpaths, playing fields, parks, and shopping streets

Description	High Sensitivity Receptor	Medium Sensitivity Receptor	Low Sensitivity Receptor
	purposes of this assessment	covered by Health and Safety at Work legislation	
Sensitivities of Receptors to Ecological Effects	- Locations with an international or National designation and the designated features may be affected by dust soiling - Locations where there is a community of a particular dust sensitive species such as vascular species included in the Red Data List for Great Britain - Indicative examples include a Special Area of Conservation designated for acid heathlands or a local site designated for lichens adjacent to the demolition of a large site containing concrete (alkali) buildings	- Locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown - Locations with a National designation where the features may be affected by dust deposition - Indicative example is a Site of Special Scientific Interest with dust sensitive features	- Locations with a local designation where the features may be affected by dust deposition. - Indicative example is a local Nature Reserve with dust sensitive features

6.60. Full details of the sensitivities of receptors are provided in the IAQM Guidance document.

6.61. Table 6-34, Table 6-35, and Table 6-36 show how the sensitivity of the area has been determined for dust soiling, human-health, and ecosystem impacts respectively.

6.62. These tables take account of several factors which may influence the sensitivity of the area. The highest level of sensitivity from each table has been recorded.

Table 6-14: Sensitivity of the Area to Dust Soiling Effects on People and Property

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table 6-35: Sensitivity of the Area to Human-Health Impacts

Receptor Sensitivity	Annual Mean PM ₁₀ Concentration (µg/m ³)	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low

Receptor Sensitivity	Annual Mean PM ₁₀ Concentration (µg/m ³)	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
	24-28	1-10	High	Medium	Low	Low	Low
		>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
	<24	1-10	Medium	Low	Low	Low	Low
		>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<28	>10	Low	Low	Low	Low	Low
Low	-	≥1	Low	Low	Low	Low	Low

Table 6-36: Sensitivity of the Area to Ecological Impact

Receptor Sensitivity	Distance from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

- 6.63. The highest level of sensitivity from each table has been recorded. Professional judgement has been used to determine alternative sensitivity categories with consideration of additional factors, such as any pre-existing screening between the source and the receptors, the season during which the works will take place, and duration of the potential impact.

Risk of Impact Definition

- 6.64. The dust emission magnitude (Step 2A) was combined with the sensitivity of the area (Step 2B) to determine the risk of impact with no mitigation applied. Table 6-37 to Table 6-40 provide the method of assigning the level of risk of each activity and used to determine the level of site-specific mitigation.

Table 6-37: Risk of Impact - Demolition

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High risk	Medium risk	Medium risk
Medium	High risk	Low risk	Low risk
Low	Low risk	Low risk	Negligible

Table 6-38: Risk of Impact - Earthworks

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High risk	Medium risk	Medium risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible

Table 6-39: Risk of Impact - Construction

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High risk	Medium risk	Medium risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible

Table 6-40: Risk of Impact - Trackout

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High risk	Medium risk	Medium risk
Medium	Medium risk	Low risk	Low risk
Low	Low risk	Low risk	Negligible

Construction Phase Impacts

Need for a Detailed Assessment

6.65. An assessment was undertaken as there are 'human receptors' within 350m of the boundary of the site; and 50m of the route used by construction vehicles on the public highway, up to 500m from the site entrance.

Risk of Dust Impact Assessment

Dust Emission Magnitude Analysis

6.66. The dust emission magnitude is based on the scale of the anticipated work and classified as Table 6-50 below. Assumptions listed are based on indicative design information provided by Jon Matthews Architects.

Table 6-2: Determination of the potential dust emission magnitude

Stage	Relevant Definition	Highest Potential Dust Emission Magnitude
Demolition	No proposed demolition activities	N/A
Earthworks	- Site area is 2,500 m² – 10,000 m² (3,000m²) - Potentially loamy dusty soil type	Medium
Construction	- Estimated total building volume is >100,000 m³ - Potentially dust construction material (concrete piles)	Large
Track out	Estimated to be between 10-50 HDV (>3.5 tonnes) outward movements in any one day	Medium

6.67. The highest dust emission magnitude is likely to be **Large**.

Sensitivity of the Area

- 6.68. The surrounding area has a significant density of sensitive receptors, which have wide range of sensitivities to dust soiling and health effects. The numbers of these receptors likely to be affected by earthworks and construction activities during the construction phase has been assessed. The analysis involved counting receptors, identified via the current Address Base Plus geographical data set, within each of the distance bands from the Site boundary. Buffers illustrating the assessment distances of 20, 50, 100, 200 and 350 metres from the Site boundary are illustrated in Figure 6-14. The analysis of sensitive receptors within each distance band is presented in Table 6-51.
- 6.69. Defra MAGIC mapping has been reviewed to determine the presence of any sensitive ecological sites. There are no designated ecological receptors sensitive to dust within 500m of the site boundary and therefore the sensitivity of the area to ecological receptors is negligible.

Table 6-3: Number of Receptors in Each Distance Band

Distance (metres)	Receptor Type Residential / Development (High)	Non-Residential Development (High)	Commercial / Retail / Office (Medium)	Commercial / Leisure / Transport (Low)	Ecological	Totals
20	102	2	1	3	0	108
50	279	5	1	2	0	287
100	385	14	5	5	0	409
200	1840	52	41	14	0	1947
350	6473	247	215	84	0	7019

- 6.70. In summary, the evaluation shows that:
- >100 high risk receptors are located within 20m of the Proposed Development boundary
 - >100 high risk receptors are located within 50m of the Proposed Development boundary
- 6.71. The sensitivity of the area to dust soiling effects on people and property from earthworks and construction activities is therefore **High**.
- 6.72. The Defra PM₁₀ background concentration in the area of the Proposed Development is <14.0µg/m³ and the urban background monitoring sites PM₁₀ concentration in the area of the Proposed Development is <20µg/m³. There are >100 high sensitivity receptors within 20m and 50m of the Proposed Development boundary. The sensitivity of the area to human health impacts for earthworks and construction activities is therefore **Medium**.
- 6.73. Sensitive receptors are also susceptible to dust soiling and health effects resulting from construction vehicle trackout. The IAQM guidance states that trackout may occur from roads up to 500m from large sites and 200m from medium sites. As the highest dust emission magnitude is large, a 500m distance band has been applied accounting for sensitive receptors 50m from the potential construction routes (Figure 6-15). It is assumed the construction traffic will travel west from the site to join Medlock Street and onwards to the south to the A57 (M).
- 6.74. An evaluation of numbers of sensitive receptors lying within 20m and 50m of the edge of the carriageway of those links identified in Step 2A has been carried (See Figure 6-12) and the number of these receptors likely to be affected by trackout on roads used by construction vehicles is summarised in Table 6-52.

Table 6-4: Number of Receptors Identified in Distance Bands from the Edge of Carriageways Potentially Included in Construction Traffic Routes

Distance (metres)	Receptor Type Residential / Development (High)	Non-Residential Development (High)	Commercial / Retail / Office (Medium)	Commercial / Leisure / Transport (Low)	Ecological	Totals
20	68	2	0	0	0	70
50	2031	307	7	0	0	2345

6.75. In summary, the evaluation shows that:

- 10-100 high risk residential receptors are located within 20m of the of the potential construction traffic routes

6.76. The sensitivity of the area to dust soiling effects on people and property from trackout activities is therefore **High**.

6.77. The Defra PM₁₀ background concentration in the area of the Proposed Development is <14.0µg/m³ and the urban background monitoring sites PM₁₀ concentration in the area of the Proposed Development is <20µg/m³. There are 10-100 high sensitivity receptors within 20 m and >100 within 50m of the construction phase boundary of roads used by construction traffic within 250 m of the Site exits. The sensitivity of the area to human health impacts for trackout activities is therefore **Low**.

6.78. Using the IAQM guidance, the sensitivity of the surrounding area has been determined for dust soiling effects and human health effects, based on the receptor type and density, as well as low annual mean PM₁₀ concentrations. The determined sensitivities for each phase of construction are summarised in Table 6-1.

6.79. There are no ecological sensitive receptors within 50 m of the boundary of the site; and within 50 m of the route used by construction vehicles on the public highway, up to 500 m from the site entrance. Therefore, no further consideration of dust impact on ecological receptors has been undertaken.

Sensitivity of the Area Analysis

6.80. The sensitivity of the receptors and area has been defined for both dust soiling and human-health impact as shown in Table 6-53.

Table 6-5: Determination of the sensitivity of the surrounding area

Receptor Sensitivity	Relevant Definition	Sensitivity of the Receptors	Relevant Definition	Sensitivity of the Area
Dust Soiling for Earthworks and Construction	Dwellings	High	>100 receptors within 50 m of site.	High
Dust Soiling for Trackout	Dwellings	High	>100 receptors within 20 m of route used by construction traffic.	High
Human-Health Effects of PM ₁₀ for Earthworks and Construction	Dwellings	High	<24 µg/m ³ annual mean PM ₁₀ concentration. >100 receptors within 20 m of site.	Medium
Human-Health Effects of PM ₁₀ for Trackout	Dwellings	High	<24 µg/m ³ annual mean PM ₁₀ concentration. >100 receptors within 20 m of route used by construction traffic	Medium

Risk of Impact

6.81. The risk of dust impact to both dust soiling and human-health effects for each construction activities are summarised in Table 6-54.

Table 6-6: Risk of Impacts

Potential Impact (Sensitivity of the Area)	Dust Risk (Dust Emission Category)	Demolition (N/A)	Earthworks (Medium)	Construction (Large)	Trackout (Medium)	Overall Risk
Dust Soiling (High for Earthworks, Construction and Trackout)	N/A		Medium	High	Medium	High
Human-health	N/A		Medium	Medium	Low	Medium

Potential Impact (Sensitivity of the Area)	Dust Risk (Dust Emission Category)				Overall Risk
	Demolition (N/A)	Earthworks (Medium)	Construction (Large)	Trackout (Medium)	
(Medium for Earthworks and Construction and Low for Trackout)					
Overall Risk	N/A	Medium	High	Medium	High

- 6.82. The dust impact assessment has demonstrated that the risk of dust soiling without any mitigation is **High** for construction, and **Medium** for earthworks and trackout.
- 6.83. The risk of adverse human-health effects of PM₁₀ without any mitigation is **Medium** for earthworks, construction and trackout.
- 6.84. The overall risk of unmitigated impacts is **High** for construction and **Medium** for earthworks and trackout.

Construction Mitigation Measures

- 6.85. Primary measures are those that will be implemented at all times; Secondary measures will be implemented as necessary (in agreement with the local authority), while n/a measures are not required for a given level of risk.

Table 6-7: Construction Mitigation Measures- Site Management

Site Management	Low Risk	Medium Risk	High Risk
1. Display the name and contact details of person(s) accountable for air quality pollutant emissions and dust issues on the site boundary.	Primary		
2. Display the head or regional office contact information.	Primary		
3. Record and respond to all dust and air quality pollutant emissions complaints.	Primary		
4. Make a complaint log available to the local authority.	Primary		
5. Carry out regular site inspections to monitor compliance with air quality and dust control procedures, record inspection results, and make an inspection log available to the local authority.	Primary		
6. Increase the frequency of site inspections by those accountable for dust and air quality pollutant emissions issues when activities with a high potential to produce dust and emissions and dust are being carried out, and during prolonged dry, or windy conditions.	Primary		
7. Record any exceptional incidents that cause dust and air quality pollutant emissions, either on or off the site, and the action taken to resolve the situation is recorded in the log book.	Primary		
8. Develop and implement a stakeholder communications plan that includes community engagement before work commences on-site.	n/a	Primary	
9. Develop a dust management plan .	n/a	Primary	
10. Hold regular liaison meetings with other high-risk construction sites within 500 m of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised.	n/a		Primary

Table 6-8: Construction Mitigation Measures- Preparing and Maintaining the Site

Preparing and Maintaining the Site	Low Risk	Medium Risk	High Risk
11. Plan site layout: machinery and dust causing activities will be located away from receptors.	Primary		

12.	Erect solid screens or barriers around dust activities or the site boundary that are, at least, as high as any stockpiles on-site.	Primary	
13.	Avoid site runoff of water or mud.	Primary	
14.	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	Secondary	Primary
15.	Keep site fencing, barriers, and scaffolding clean using wet methods.	Secondary	Primary
16.	Remove materials from site as soon as possible.	Secondary	Primary
17.	Cover, seed, or fence stockpiles to prevent wind whipping.	Secondary	Primary
18.	Agree monitoring locations with the local authority.	n/a	Primary
19.	Where possible, commence baseline monitoring at least three months before phase begins.	n/a	Primary
20.	Put in place real-time dust and air quality pollutant monitors across the site and ensure they are checked regularly.	n/a	Primary
21.	Carry out regular dust soiling checks of buildings within 100 m of site boundary and, if necessary, cleaning to be provided.	n/a	Secondary Primary
22.	Consider, if practical, installation of green walls, screens, or other green infrastructure to minimise the impact of dust and pollution.	n/a	Secondary

Table 6-9: Construction Mitigation Measures- Operating Vehicle/Machinery and Sustainable Travel

Operating Vehicle/Machinery and Sustainable Travel	Low Risk	Medium Risk	High Risk
23. Ensure all non-road mobile machinery (NRMM) complies with relevant local standards.	Primary		
24. Ensure all vehicles switch off engines when stationary – no idling vehicles.	Primary		
25. Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment.	Primary		
26. Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).	n/a	Secondary	Primary
27. Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	n/a	Primary	
28. Impose and signpost a maximum-speed-limit of 10 mph on surfaced haul routes and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority).	Secondary		Primary

Table 6-10: Construction Mitigation Measures- Operations

Operations	Low Risk	Medium Risk	High Risk
29. Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g., suitable local exhaust ventilation systems.	Primary		
30. Ensure an adequate water supply on the site for effective dust/particulate matter mitigation (using recycled water).	Primary		
31. Use enclosed chutes, conveyors, and covered skips.	Primary		
32. Minimise drop heights from conveyors, loading shovels, hoppers, and other loading, or handling equipment, and use fine water sprays on such equipment.	Primary		
33. Ensure equipment is readily available on-site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	n/a	Primary	

Table 6-11: Construction Mitigation Measures- Waste Management Activities

Waste Management	Low Risk	Medium Risk	High Risk
34. Reuse and recycle waste to reduce dust from waste materials	Primary		
35. Avoid bonfires and burning of waste materials.	Primary		

Table 6-12: Construction Mitigation Measures- Demolition Activities

Measurement Specific to Demolition	Low Risk	Medium Risk	High Risk
36. Ensure water suppression is used during demolition operations.	Primary		
37. Avoid explosive blasting, using appropriate manual, or mechanical alternatives.	Primary		
38. Bag and remove any biological debris or damp down such material before demolition.	Primary		
39. Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	Secondary		Primary

Table 6-13: Construction Mitigation Measures- Earthworks Activities

Measurement Specific to Earthworks	Low Risk	Medium Risk	High Risk
40. Consider re-vegetating earthworks and exposed areas/soil stockpiles to stabilise surfaces.	n/a	Secondary	Primary
41. Consider the use of hessian, mulches, or trackifiers where it is not possible to re-vegetate or cover with topsoil.	n/a	Secondary	Primary
42. Only remove secure covers in small areas during work and not all at once.	n/a	Secondary	Primary

Table 6-14: Construction Mitigation Measures- Construction Activities

Measurement Specific to Construction	Low Risk	Medium Risk	High Risk
43. Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.	Secondary	Primary	
44. Avoid scabbling (roughening of concrete surfaces) if possible	Secondary		Primary
45. Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	n/a	Secondary	Primary
46. For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust.	n/a	Secondary	

Table 6-15: Construction Mitigation Measures- Trackout Activities

Measures Specific To Trackout	Low Risk	Medium Risk	High Risk
47. Regularly use a water-assisted dust sweeper on the access and local roads, as necessary, to remove any material tracked out of the site.	Secondary	Primary	
48. Avoid dry sweeping of large areas.	Secondary	Primary	
49. Ensure vehicles entering and leaving sites are securely covered to prevent escape of materials during transport.	Secondary	Primary	
50. Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site).	Secondary	Primary	
51. Record all inspections of haul routes and any subsequent action in a site log book.	Secondary	Primary	
52. Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems and regularly cleaned.	n/a	Primary	

Measures Specific To Trackout	Low Risk	Medium Risk	High Risk
53. Inspect haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable;	n/a	Primary	
54. Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size, and layout permits.	n/a	Primary	
55. Access gates to be located at least 10 m from receptors where possible.	n/a	Primary	
56. Apply dust suppressants to locations where a large volume of vehicles enter and exit the construction site.	n/a	Secondary	Primary

Reference List

This ES chapter has been prepared by reference to the following:

- Defra (2022) Local Air Quality Management Technical Guidance TG(22) August 2022. <https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf>
- Department of Transport (DfT) Traffic Count Data. See: <https://roadtraffic.dft.gov.uk/local-authorities/85>.
- LIDAR Defra Surveys Data Download. See: <https://environment.data.gov.uk/DefraDataDownload/?Mode=survey>.
- <https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/>.
- <https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc>.
- <https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html>.
- Institute of Air Quality Management (IAQM) (2016) Guidance on the Assessment of Dust from Demolition and Construction (Version 1.1) <https://iaqm.co.uk/text/guidance/construction-dust-2014.pdf>
- Department for Environment, Food and Rural Affairs (Defra) (2019). MAGIC <https://magic.defra.gov.uk/MagicMap.asp>



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