Potato Wharf Blocks 3 and 4

Air Quality Assessment

Lendlease Residential (north west) Limited

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1. Introduction

1.1 Previous Work

In 2015 WSP Parsons Brinckerhoff undertook an air quality impact assessment ('the 2015 assessment') as part of the Planning Application for Blocks 3 and 4 at Potato Wharf, Castlefields. The application site lies within the administrative boundary of Manchester City Council (MCC) and is situated to the northeast of the Mancunian Way (A57). The development includes 191 residential units split between two eight-storey buildings, as well as the provision of 123 car parking spaces and outdoor public amenity space.

The 2015 air quality impact assessment (WSP, 2015) reported that annual mean nitrogen dioxide (chemical formulae NO_2) concentrations were at risk of being higher than the annual mean nitrogen dioxide objective value at the facades of the proposed residential apartment blocks on a number of floors. That report did not provide further clarity on which specific residential units might require air quality mitigation and recommended that the need for some form of mechanical ventilation system be considered in more detail at a later date.

This report provides a more detailed consideration of existing and future annual mean concentrations of nitrogen dioxide than the 2015 assessment based on:

- New measurement data for nitrogen dioxide at locations within the development site and from nearby land, that was not available to the 2015 assessment;
- A review and update of published measurement data
- The calibration of the ADMS Roads model against the new measurement data to optimise model performance at the development site
- The inclusion of receptors on all unit facades within the development

1.2 Scope of Work

This report considers the likely significance of predicted annual mean nitrogen dioxide concentrations at each proposed residential unit of Blocks 3 and 4 of Potato Wharf for a 2017 with development scenario, representing the anticipated opening year of the development.

As part of this detailed assessment a baseline nitrogen dioxide survey was established at Potato Wharf and the surrounding area at locations illustrated in Figure A1 (see Appendix A). The survey was undertaken over a 3 month period and the period mean concentrations scaled to equivalent annual mean values using methods from the Department of the Environment and Rural Affairs' Local Air Quality Management Technical Guidance (LAQM.TG 16) (Defra, 2016).

Where annual mean concentrations of nitrogen dioxide are predicted at facades receptors locations that are greater than the annual mean air quality objective value, appropriate mitigation is recommended.

It should be noted that the assessment undertaken by WSP Parsons Brinckerhoff in 2015 predicted that concentrations of particulate matter (PM_{10} and $PM_{2.5}$) would be well below the respective objective values. Therefore, consideration of particulate matter, both PM_{10} and $PM_{2.5}$, have not been considered further in this more detailed assessment, as the outcome of this assessment could not materially alter the conclusion of the 2015 assessment.

2. Legislation and Policy

2.1 Air Quality Legislation

The Clean Air for Europe (CAFE) programme revisited the management of Air Quality within the EU and replaced the EU Framework Directive 96/62/EC (Council of European Communities, 1996), its associated Daughter Directives 1999/30/EC (Council of European Communities, 1999), 2000/69/EC (Council of European Communities, 2000), 2002/3/EC (Council of European Communities, 2002), and the Council Decision 97/101/EC (Council of European Communities, 1997) with a single legal act, the Ambient Air Quality and Cleaner Air for Europe Directive 2008/50/EC (Council of European Communities, 2008).

Directive 2008/50/EC (Council of European Communities, 2008) is currently transcribed into UK legislation by the Air Quality Standards Regulations 2010 (H.M. Government, 2010). These limit values are binding on the UK and have been set with the aim of avoiding, preventing or reducing harmful effects on human health and on the environment as a whole.

2.2 National Air Quality Strategy

The UK National Air Quality Strategy (DOE, 1997) was initially adopted in 1997, under the requirements of the Environment Act 1995 (H.M. Government 1995). The most recent revision of the strategy (Defra, 2007) sets objective values for key pollutants as a tool to help Local Authorities manage local air quality improvements in accordance with the EU Air Quality Framework Directive. Some of these objective values have been laid out within the Air Quality (England) Regulations 2010.

The air quality objective values referred to above have been set down in regulation solely for the purposes of local air quality management. Under the local air quality management regime Manchester City Council has a duty to carry out regular assessments of air quality against the objective values and if it is unlikely that the objective values will be met in the given timescale, they must designate an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) with the aim of achieving the objective values. The boundary of an AQMA is set by the governing local authority to define the geographical area that is to be subject to the management measures to be set out in a subsequent action plan. Consequently it is not unusual for the boundary of an AQMA to include within it, relevant locations where air quality is not at risk of exceeding an air quality objective.

The UK's national air quality objective values for the pollutants of relevance to this assessment are displayed in Table 1.

Table 1: Air Quality Objective Values for England

Pollutant	*Averaging period*	*Value*	*Max Permitted Exceedances*	*Target date*
Nitrogen dioxide (NO_2)	Annual Mean	40 µg/m^3	None	31/12/05

2.3 National Planning Policy Framework

The National Planning Policy Framework (NPPF) published in March 2012 (Department for Communities and Local Government, 2012), paragraph 109 of the NPPF states that:

> *"The planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability…"*

Annex 2 of the NPPF defines 'Pollution' as:

> *"Anything that affects the quality of land, air, water or soils, which might lead to an adverse impact on human health, the natural environment or general amenity. Pollution can arise from a range of emissions, including smoke, fumes, gases, dust, steam, odour, noise and light".*

There are both national and local policies for the control of air pollution and local action plans for the management of local air quality within Manchester. The effect of the proposed development on the achievement of such policies and plans are matters that may be a material consideration by planning authorities, when making decisions for individual planning applications. Paragraph 124 of the NPPF states that:

> *"Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan."*

The Planning Practice Guidance (PPG) was updated in March 2014 (CLG, 2014), with specific reference to air quality. The PPG states that the planning system should consider the potential effect of new developments on air quality where relevant limits have been exceeded or are near the limit. Concerns also arise where the development is likely to adversely effect upon the implementation of air quality strategies and action plans and/or, in particular, lead to a breach of EU legislation (including that applicable to wildlife).

When deciding whether air quality is relevant to a planning application the PPG states that a number of factors should be taken into consideration including if the development will:

- Expose people to existing sources of air pollutants. This could be by building new homes, workplaces or other development in places with poor air quality; and

The PPG states:

> *'The air quality assessment undertaken should be proportionate to the nature and scale of the development proposed and the level of concern about air quality. Mitigation options, where necessary, will depend on the proposed development and should be proportionate to the likely impact. It is important therefore that local planning authorities work with applicants to consider appropriate mitigation so as to ensure the new development is appropriate for its location and unacceptable risks are prevented.'*

2.4 Local Planning Policy

2.4.1 Local Development Framework

Manchester's Core Strategy was adopted in July 2012 and is the key development plan document in the Local Development Framework.

Policy EN16 relates directly to air quality and is relevant to the development.

Policy EN16: Air Quality

> *'The Council will seek to improve the air quality within Manchester, and particularly within Air Quality Management Areas, located along Manchester's principal traffic routes and at Manchester Airport. Developers will be expected to take measures to minimise and mitigate the local impact of emissions from traffic generated by the development, as well as emissions created by the use of the development itself, including from Combined Heat and Power and biomass plant.*
>
> *When assessing the appropriateness of locations for new development the Council will consider the impacts on air quality, alongside other plan objectives. This includes cumulative impacts, particularly in Air Quality Management Areas.'*

2.5 Local Air Quality Management

Manchester City Council declared the current Air Quality Management Area (AQMA) in May 2016, following the 2014 detailed assessment. The AQMA has been declared for the annual mean nitrogen dioxide objective and covers all 10 districts of Greater Manchester, including arterial routes, district centres and the airport. Under the requirements of Part IV of the Environment Act the City Council has published a draft Greater Manchester Low-Emission Strategy and Air Quality Action Plan (Manchester City Council, 2016). The action plan has been submitted for consultation, with the comments submitted currently being taken into consideration. The finalised report will be submitted later in 2016/early 2017.

3. Methodology

3.1 Air Quality Assessment Overview

There is currently no statutory guidance on the method by which an air quality impact assessment should be undertaken. Several non-statutory bodies have published their own guidance relating to air quality and development control, such as that issued by Environment Protection United Kingdom (EPUK) and the Institute of Air Quality Management (IAQM) (EPUK/IAQM, 2015) which has been referred to for the purpose of this assessment.

This section explains the methods used to determine the annual mean nitrogen dioxide concentrations in 2017, the anticipated opening year of the development, at each residential unit of Blocks 3 and 4 at Potato Wharf, Castlefields.

3.1.1 Modelling Emissions

This assessment has used the latest version of dispersion model software 'ADMS-Roads' (v4.0) to quantify pollution levels at all the residential units in Blocks 3 and 4 of Potato Wharf. ADMS-Roads is a modern dispersion model that has an extensive published track record of use in the UK for the assessment of local air quality impacts, including model validation and verification studies (CERC, 2014).

The emission factors applied to the model were derived from the UK Emission Factor Toolkit v7.0; however, a cautious approach was taken and it was assumed that there were no improvements in vehicle emissions between 2013 and 2017. Such an approach is considered to be prudent given current concern regarding 'real world' oxide of nitrogen and nitrogen dioxide emissions from road vehicles. As a result absolute concentrations predicted for the modelled 2017 scenario, are likely to be an upper estimate of future year conditions.

Details of general model conditions are provided in Table 2.

Table 2: General ADMS-Roads Model Conditions

Variables	ADMS Roads Model Input
Surface roughness at source	1.5 m
Surface roughness at meteorological station.	0.5 m
Minimum Monin-Obukhov length for stable conditions	100 m
Terrain types	Flat
Emissions	NO_x
Emission factors	UK Emission Factor Toolkit v7.0
Meteorological data	Manchester Airport, 2015

3.1.2 Road Traffic Emissions and Data

At the high temperatures and pressures found within vehicle engines, some of the nitrogen in the air and the fuel is oxidised to form oxides of nitrogen (NOx), mainly in the form of nitric oxide (NO), which is then converted to nitrogen dioxide in the atmosphere. Some nitrogen dioxide is contained in vehicle exhaust gases. Nitrogen dioxide is associated with adverse effects on human health and a health based objective has been set for this substance, but not for oxides of nitrogen or for nitric oxide. Better emission control technology and fuel specifications are expected to reduce emissions per vehicle in the long term. As discussed in Section 1.2, only nitrogen dioxide concentrations at receptor locations are considered in this report.

The traffic data applied to the assessment were taken directly from the WSP/PB air quality assessment report (WSP/PB, 2015) for 2017 with the development (Appendix B).

3.1.3 Conversion of NO to NO_2

The proportion of oxides of nitrogen in the form of nitrogen dioxide varies greatly with location and time according to a number of factors including the amount of oxidant available and the distance from the emission source. Oxides of nitrogen concentrations are expected to decline in future years due to falling emissions, therefore nitrogen dioxide concentration will not be limited as much by ozone and consequently it is likely that the NO_2/NO_x ratio will in the future increase. In addition, a trend has been noted in recent years whereby roadside nitrogen dioxide concentrations have been increasing at certain roadside monitoring sites, despite emissions of NO_x falling.

In this study modelled annual mean NO_X concentration values were converted to annual mean nitrogen dioxide concentration values using the 'NO_X to NO_2' calculator, released in June 2016 (Ricardo Energy and Environment, 2016). The year and region for which the modelling has been undertaken are specified and a local factor for the proportion of NO_X emitted as nitrogen dioxide, are used in the calculation.

3.2 Air Quality Sensitive Receptors

Air quality receptors susceptible to changes in air quality typically include residential properties, schools, care homes, hospitals and designated ecological sites. All receptors that represent exposure of the public are of equal sensitivity as any member of the public, including the very young or elderly could be present at those locations.

Impacts from road traffic emissions are quantified at selected receptor locations at the façade of each residential unit of Blocks 3 and 4 at Potato Wharf. These locations represent the building facades and not the concentration within the building.

At each location air pollutant concentrations are reported at several heights to represent the residential units on all eight floors of the apartment blocks. The location and vertical heights for each receptor location are listed in the following Tables.

Table 3: Modelled Air Quality Sensitive Receptors on the Ground Floor

Block at Potato Wharf	Receptors	Coordinates		Modelled Height (m)
		X	Y	
3	AP1a	382852	397662	2.6
	AP2a	382867	397654	
	AP3a	382871	397647	
	AP4a	382875	397639	
	AP5a	382881	397630	
	AP6a	382886	397621	
	AP7a	382892	397611	
	AP8a	382896	397595	
	AP9a	382846	397655	
	AP10a	382852	397646	
	AP11a	382858	397637	
	AP12a	382866	397623	
	AP13a	382872	397614	
	AP14a	382877	397605	
	AP15a	382884	397595	
4	AP16a	382834	397620	
	AP17a	382848	397608	
	AP18a	382853	397598	
	AP19a	382857	397590	
	AP20a	382860	397571	
	AP21a	382830	397607	
	AP22a	382833	397600	
	AP23a	382838	397592	
	AP24a	382842	397583	
	AP25a	382847	397573	

Table 4: Modelled Air Quality Sensitive Receptors on the First Floor

Block at Potato Wharf	Receptors	Coordinates		Modelled Heights (m)
		X	Y	
3	AP1b	382852	397662	5.6
	AP2b	382867	397654	
	AP3b	382871	397647	
	AP4b	382875	397639	
	AP5b	382881	397630	
	AP6b	382886	397621	
	AP7b	382892	397611	
	AP8b	382896	397595	
	AP9b	382846	397655	
	AP10b	382852	397646	
	AP11b	382858	397637	
	AP12b	382866	397623	
	AP13b	382872	397614	
	AP14b	382877	397605	
	AP15b	382884	397595	

4	AP16b	382834	397620
	AP17b	382848	397608
	AP18b	382853	397598
	AP19b	382857	397590
	AP20b	382860	397571
	AP21b	382830	397607
	AP22b	382833	397600
	AP23b	382838	397592
	AP24b	382842	397583
	AP25b	382847	397573

Table 5: Modelled Air Quality Sensitive Receptors on the Second Floor

Block at Potato Wharf	*Receptors*	*Coordinates*		*Modelled Heights (m)*
		X	*Y*	
3	AP1c	382852	397662	8.6
	AP2c	382867	397654	
	AP3c	382871	397647	
	AP4c	382875	397639	
	AP5c	382881	397630	
	AP6c	382886	397621	
	AP7c	382892	397611	
	AP8c	382896	397595	
	AP9c	382846	397655	
	AP10c	382852	397646	
	AP11c	382858	397637	
	AP12c	382866	397623	
	AP13c	382872	397614	
	AP14c	382877	397605	
	AP15c	382884	397595	
4	AP16c	382834	397620	
	AP17c	382848	397608	
	AP18c	382853	397598	
	AP19c	382857	397590	
	AP20c	382860	397571	
	AP21c	382830	397607	
	AP22c	382833	397600	
	AP23c	382838	397592	
	AP24c	382842	397583	
	AP25c	382847	397573	

Table 6: Modelled Air Quality Sensitive Receptors on the Third Floor

Block at Potato Wharf	Receptors	Coordinates		Modelled Heights (m)
		X	Y	
3	AP1d	382852	397662	11.6
	AP2d	382867	397654	
	AP3d	382871	397647	
	AP4d	382875	397639	
	AP5d	382881	397630	
	AP6d	382886	397621	
	AP7d	382892	397611	
	AP8d	382896	397595	
	AP9d	382846	397655	
	AP10d	382852	397646	
	AP11d	382858	397637	
	AP12d	382866	397623	
	AP13d	382872	397614	
	AP14d	382877	397605	
	AP15d	382884	397595	
4	AP16d	382834	397620	
	AP17d	382848	397608	
	AP18d	382853	397598	
	AP19d	382857	397590	
	AP20d	382860	397571	
	AP21d	382830	397607	
	AP22d	382833	397600	
	AP23d	382838	397592	
	AP24d	382842	397583	
	AP25d	382847	397573	

Table 7: Modelled Air Quality Sensitive Receptors on the Fourth Floor

Block at Potato Wharf	Receptors	Coordinates		Modelled Heights (m)
		X	Y	
3	AP1e	382852	397662	14.6
	AP2e	382867	397654	
	AP3e	382871	397647	
	AP4e	382875	397639	
	AP5e	382881	397630	
	AP6e	382886	397621	
	AP7e	382892	397611	
	AP8e	382896	397595	
	AP9e	382846	397655	
	AP10e	382852	397646	
	AP11e	382858	397637	
	AP12e	382866	397623	
	AP13e	382872	397614	
	AP14e	382877	397605	
	AP15e	382884	397595	

4	AP16e	382834	397620
	AP17e	382848	397608
	AP18e	382853	397598
	AP19e	382857	397590
	AP20e	382860	397571
	AP21e	382830	397607
	AP22e	382833	397600
	AP23e	382838	397592
	AP24e	382842	397583
	AP25e	382847	397573

Table 8: Modelled Air Quality Sensitive Receptors on the Fifth Floor

Block at Potato Wharf	*Receptors*	*Coordinates*		*Modelled Heights (m)*
		X	*Y*	
3	AP1f	382852	397662	17.6
	AP2f	382867	397654	
	AP3f	382871	397647	
	AP4f	382875	397639	
	AP5f	382881	397630	
	AP6f	382886	397621	
	AP7f	382892	397611	
	AP8f	382896	397595	
	AP9f	382846	397655	
	AP10f	382852	397646	
	AP11f	382858	397637	
	AP12f	382866	397623	
	AP13f	382872	397614	
	AP14f	382877	397605	
	AP15f	382884	397595	
4	AP16f	382834	397620	
	AP17f	382848	397608	
	AP18f	382853	397598	
	AP19f	382857	397590	
	AP20f	382860	397571	
	AP21f	382830	397607	
	AP22f	382833	397600	
	AP23f	382838	397592	
	AP24f	382842	397583	
	AP25f	382847	397573	

Table 9: Modelled Air Quality Sensitive Receptors on the Sixth Floor

Block at Potato Wharf	Receptors	Coordinates		Modelled Heights (m)
		X	Y	
3	AP1g	382852	397662	20.6
	AP2g	382867	397654	
	AP3g	382871	397647	
	AP4g	382875	397639	
	AP5g	382881	397630	
	AP6g	382886	397621	
	AP7g	382892	397611	
	AP8g	382896	397595	
	AP9g	382846	397655	
	AP10g	382852	397646	
	AP11g	382858	397637	
	AP12g	382866	397623	
	AP13g	382872	397614	
	AP14g	382877	397605	
	AP15g	382884	397595	
4	AP16g	382834	397620	
	AP17g	382848	397608	
	AP18g	382853	397598	
	AP19g	382857	397590	
	AP20g	382860	397571	
	AP21g	382830	397607	
	AP22g	382833	397600	
	AP23g	382838	397592	
	AP24g	382842	397583	
	AP25g	382847	397573	

Table 10: Modelled Air Quality Sensitive Receptors on the Seventh Floor

Block at Potato Wharf	Receptors	Coordinates		Modelled Heights (m)
		X	Y	
3	AP1h	382852	397662	23.6
	AP2h	382867	397654	
	AP3h	382871	397647	
	AP4h	382875	397639	
	AP5h	382881	397630	
	AP6h	382886	397621	
	AP7h	382892	397611	
	AP8h	382896	397595	
	AP9h	382846	397655	
	AP10h	382852	397646	
	AP11h	382858	397637	
	AP12h	382866	397623	
	AP13h	382872	397614	
	AP14h	382877	397605	
	AP15h	382884	397595	

AP16h	382834	397620
AP17h	382848	397608
AP18h	382853	397598
AP19h	382857	397590
AP20h	382860	397571
AP21h	382830	397607
AP22h	382833	397600
AP23h	382838	397592
AP24h	382842	397583
AP25h	382847	397573

4

3.3 Meteorological Data

The meteorological dataset used in the assessment was recorded at the meteorological station at Manchester Airport in 2015, located approximately 12 km to the south of the site. The meteorological site is considered to be representative of regional meteorological conditions and sufficient to satisfy the requirements of this assessment.

The wind rose for this site and further details are provided in Appendix C.

3.4 Background Concentrations

A large number of sources of air pollutants exist which individually may not be significant, but collectively, over a large area, need to be considered. The concentrations calculated by the model due to vehicle emissions can then be added to these background concentrations to give the total concentration.

Modelled estimations of background air quality concentrations are provided by Defra (Defra, 2013) for each 1 km square in the UK for each year between 2010 and 2030. Modelled road sources were discounted from the total background pollutant concentrations, to give 'adjusted' values. The estimated background concentrations for the Ordnance Survey grid square where the development is located and was considered to be representative of nitrogen dioxide background concentrations at the site are provided in Table 11 for 2013. These data were downloaded in October 2016.

Table 11: Annual Mean Nitrogen Dioxide Background Concentration

Grid Reference	Annual Mean Concentration ($\mu g/m^3$)
382500, 397500	31.6

3.5 Bias Adjustment of Road Contribution to NO_x Concentrations

Model verification was performed using the results of the new nitrogen dioxide diffusion tube monitoring survey undertaken in 2016, using values annualised to equivalent annual mean values for for the calendar year 2015. Further details regarding the diffusion tube survey are provided in Section 4.2. All diffusion tubes included in the survey were used for model verification, with the results for the tubes shown in Table 12 below.

The verification (calibration) process has been undertaken following the methodology described in LAQM TG(16) (Defra, 2016). Modelled predictions were made for annual mean nitrogen dioxide concentrations at the location of the diffusion tubes listed in Table 12. A comparison of the unadjusted predictions and the measured concentrations at these locations is illustrated in Figure 1, by the red dots and trend line (The dashed lines either side of the centre line indicate y = x +/- 10 %, +/- 20 % and +/- 50 %).

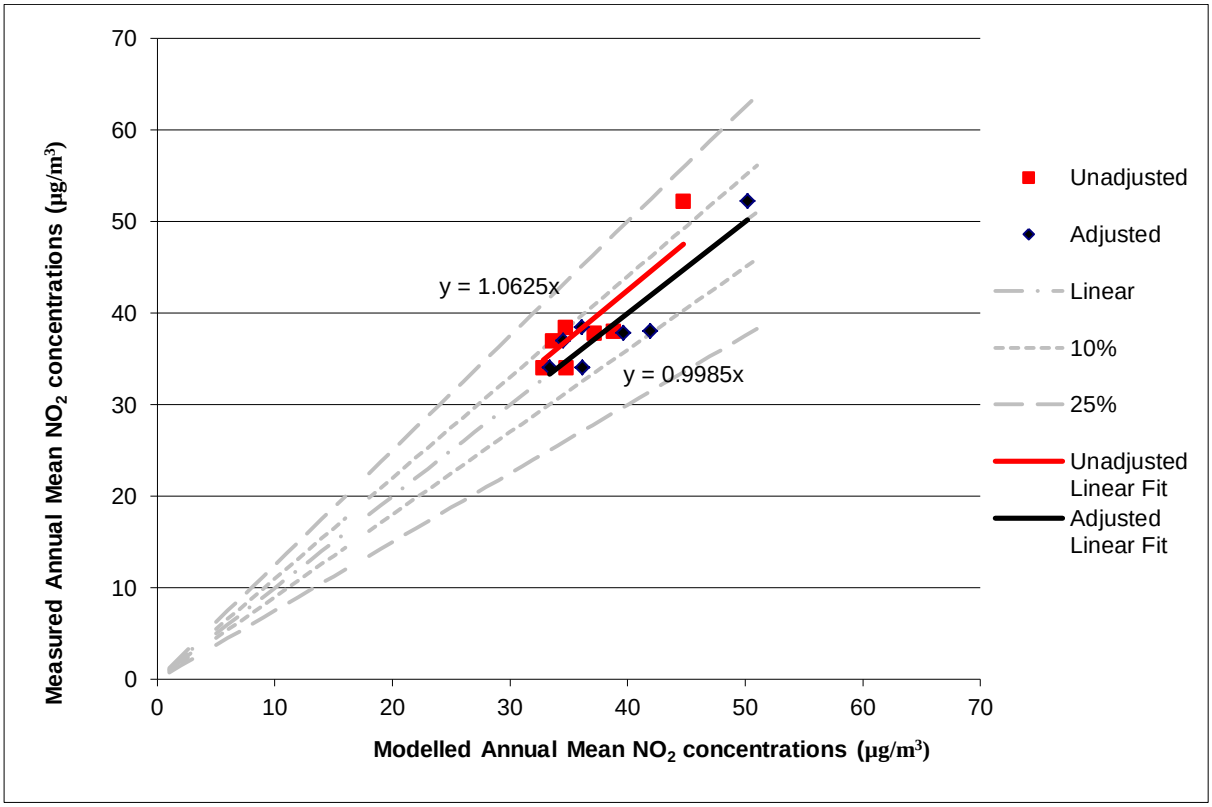
In general, the model performed well in predicting the annual mean concentrations of nitrogen dioxide. The accuracy of the unadjusted model was considered via the calculation of the Root Mean

Square Error (RMSE). LAQM TG(16) states that the RMSE of modelled predictions should ideally be within 10% of the air quality objective value for nitrogen dioxide (4 µg/m^3), and should be within 25% (10 µg/m^3) . In this instance, an adjustment factor of 1.47 was applied to the monitored concentrations which resulted in an RMSE value of 2.4 µg/m^3. The data therefore meets the 'ideal' identified by Defra and the output from the dispersion model provides a robust basis for decision making.

Table 12: Nitrogen dioxide concentration measurement data

Diffusion Tube	OS Grid Reference		Measured Total NO_2 ($\mu g/m^3$)	Modelled Total NO_2 ($\mu g/m^3$)	Predicted Total NO_2 ($\mu g/m^3$)
	East	North			
DT1	382912	397638	34.1	32.8	33.4
DT2	382868	397653	34.1	34.7	36.2
DT3	383086	397820	38.4	34.7	36.1
DT4	382812	397603	52.2	44.7	50.2
DT5	382821	397635	38.1	38.8	41.9
DT6	382921	397680	37.8	37.2	39.7
DT7	382795	397567	37.0	33.6	34.5

Figure 1 Comparison of measured and modelled nitrogen dioxide concentrations



4. Baseline Conditions

4.1 Manchester City Council Monitoring Data

Manchester City Council (MCC) operates an extensive nitrogen dioxide monitoring network using both continuous and passive techniques. However, only one passive monitoring site is located within the study area. Monitoring is undertaken on Liverpool Street, approximately 500 m to the east of the Block 3 at Potato Wharf (illustrated on Figure A1). Annual mean nitrogen dioxide concentrations at this site, recorded between 2010 and 2014, are provided in Table 13. Although nitrogen dioxide concentrations have decreased since 2010, exceedances of the objective have been recorded in all years.

Table 13: Local Authority Measurements of Nitrogen Dioxide Concentrations

Location		Type	Annual Mean Nitrogen Dioxide ($\mu g/m^3$)				
			2010	2011	2012	2013	2014
MA70	Liverpool Street	Roadside	52	45	46	41	40

* The last reported data on the council website was 2014.

4.2 AECOM Monitoring Data

In 2016 AECOM undertook diffusion tube monitoring at seven locations within the study area. Monitoring was undertaken between 1st September and 22nd November 2016. A three month period of sample collection is identified by Defra (Defra, 2016), as the shortest period local authorities should use to gather data as part of their own local air quality management duties. The diffusion tubes were changed every month.

The period mean concentration of nitrogen dioxide measured at each measurement location, was annualised to give an equivalent annual mean value for the calendar year 2015, using the method described in LAQM.TG 16 (Defra, 2016). Full details of the calculations are presented in Appendix D of this report.

The measured nitrogen dioxide concentrations used in this assessment are provided in Table 14.

Table 14: Biased Adjusted Annual Mean nitrogen dioxide Concentrations

ID	2015 Biased Adjusted Annual Mean nitrogen dioxide Concentration ($\mu g/m^3$)
DT1	34.1
DT2	34.1
DT3	38.4
DT4	**52.2**
DT5	38.1
DT6	37.8
DT7	37.0

Concentrations that are greater than the annual mean objective value are highlighted in bold

According to Table 14, annual mean nitrogen dioxide concentrations were below the objective at all measurement sites in 2015, except DT4. Sampling location DT4 is located in close proximity to the A57. At DT4, the reported annual mean nitrogen dioxide concentration of 52.2 $\mu g/m^3$ was due to the proximity of the site to the A57 and the limited opportunity for air containing vehicle exhaust emissions to become diluted before reaching the sampling location.

4.3 Significance Criteria

Impacts on air quality, whether beneficial or adverse, will have an effect on human health that can be judged as 'significant' or 'not significant'. For air quality impacts arising from surrounding sources on new occupants of a development then the impacts are best described in relation to whether or not an

air quality objective will be met or is at risk of not being met. According to the EPUK/IAQM Guidance (2015) the effect on the residents or occupants on any new development where the air quality objective at the building façade is not met should be judged as significant, unless provision is made to reduce their exposure.

In addition, the potential for the development to contribute to or interfere with the successful implementation of policies and strategies for the management of local air quality are considered if relevant. However, the principal focus when determining whether or not the development is significant in terms of air quality is the likelihood of achieving the air quality objective value for the annual mean nitrogen dioxide (NO_2) concentration of 40 µg/m^3.

5. Predicted Concentrations

Detailed dispersion modelling using ADMS-Roads software has been undertaken to predict annual mean nitrogen dioxide concentrations at the façade of each proposed residential unit in Blocks 3 and 4 of Potato Wharf in 2017, the assumed opening year of the development.

The predicted range of annual mean nitrogen dioxide (NO_2) concentrations at the façade of each floor of Blocks 3 and 4 are provided in Table 15. The modelled concentrations at the façade of each residential unit are provided in Appendix E.

Table 15: Modelled Annual Mean Concentrations

Block	Facade	Annual Mean Concentration Range (μg/m^3)
3	Ground Floor	35.5 to 36.5
	First Floor	35.4 to 36.3
	Second Floor	35.2 to 36.0
	Third Floor	34.9 to 35.5
	Fourth Floor	34.6 to 35.0
	Fifth Floor	34.2 to 34.6
	Sixth Floor	33.9 to 34.1
	Seventh Floor	33.6 to 33.7
4	Ground Floor	37.3 to 38.9
	First Floor	37.0 to 38.4
	Second Floor	36.6 to 37.6
	Third Floor	36.0 to 36.7
	Fourth Floor	35.3 to 35.8
	Fifth Floor	34.7 to 35.0
	Sixth Floor	34.2 to 34.3
	Seventh Floor	33.7 at all receptors

Overall higher concentrations were predicted at Block 4 than Block 3 due to the proximity of the building to the A57 and therefore vehicle exhaust emissions. For both Blocks, annual mean nitrogen dioxide concentrations decreased with increasing height of the façade.

According to Table 15, annual mean nitrogen dioxide concentrations were predicted to be within the objective at all façades of both Blocks 3 and 4 at Potato Wharf. The highest concentration of 38.9 μg/m^3 was predicted at unit ap21a, located on the ground floor of Block 4. Unit ap21a is located on the west side of the building, with residential use proposed.

As discussed in Section 4.3, the significance of the air quality effects was determined based on whether or not the annual mean nitrogen dioxide objective will be met or is at risk of not being met at the facades of the residential units.

Annual mean nitrogen dioxide concentrations on all facades of Block 3 and on floors 2 to 7 of Block 4 were predicted to achieve the objective in 2017, the assumed opening year of the development. Concentrations will continue to improve in future years at these units as background concentrations decrease, as has been observed at council monitoring sites. Therefore the air quality effects were considered to be not significant and no mitigation is required at these units.

On the ground and first floors of Block 4, 11 units were predicted to experience annual mean nitrogen dioxide concentrations at risk of exceeding the objective in 2017. Residential use is proposed for all 11 units. Annual mean nitrogen dioxide concentrations between 38.1 and 38.9 μg/m^3 were predicted at these units.

These 11 units were predicted to achieve the objective in 2017; however, by a smaller margin that the remainder of units in Block 4. Background concentrations are decreasing in Manchester as observed at the council monitoring sites and therefore by the time these units are occupied, the nitrogen dioxide

objective is likely to be achieved by a larger margin at these units. Taking this into consideration, the air quality effects were considered to be not significant and therefore no mitigation is required at these units.

6. Conclusions

In 2015 WSP Parsons Brinckerhoff undertook an air quality impact assessment as part of the Planning Application for Blocks 3 and 4 at Potato Wharf, Castlefields, Manchester. The development includes 191 residential units split between two eight-storey buildings, as well as the provision of 123 car parking spaces and outdoor public amenity space.

The 2015 air quality impact assessment (WSP, 2015) reported that annual mean nitrogen dioxide (chemical formulae NO_2) concentrations were at risk of being higher than the annual mean nitrogen dioxide objective value at the facades of the proposed residential apartment blocks on a number of floors. That report did not provide further clarity on which specific residential units might require air quality mitigation and recommended that the need for some form of mechanical ventilation system be considered in more detail at a later date.

This report provided a more detailed consideration of existing and future annual mean concentrations of nitrogen dioxide than the 2015 assessment. New measurement data for nitrogen dioxide at locations within the development site and from nearby land, that was not available to the 2015 assessment, was obtained and a review of the updated published measurement data was undertaken. The ADMS-Roads model was calibrated against the new measurement data to optimise model performance at the development site to predict the annual mean nitrogen dioxide concentrations at the facades of all units in Blocks 3 and 4.

The assessment concluded the following:

- Annual mean nitrogen dioxide concentrations on all facades of Block 3 were predicted to achieve the objective in 2017, the assumed opening year of the development. Concentrations will continue to improve in future years at these units as background concentrations decrease, as has been observed at council monitoring sites and therefore no mitigation is required.
- Annual mean nitrogen dioxide concentrations on the facades of floors 2 to 7 of Block 4 were predicted to achieve the objective in 2017. Concentrations will continue to improve in future years at these units as background concentrations decrease, as has been observed at council monitoring sites and therefore no mitigation is required.
- On the ground and first floors of Block 4, 11 units were predicted to experience annual mean nitrogen dioxide concentrations at risk of exceeding the objective in 2017. Residential use is proposed for all 11 units. Annual mean nitrogen dioxide concentrations between 38.1 and 38.9$\mu g/m^3$ were predicted at these units.
- These 11 units were predicted to achieve the objective in 2017; however, by a smaller margin that the remainder of units in Block 4. Background concentrations are decreasing in Manchester as observed at the council monitoring sites and therefore by the time these units are occupied, the nitrogen dioxide objective is likely to be achieved by a larger margin at these units than predicted in 2017. Taking this into consideration, no mitigation is required at these units.

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Appendix A Figures



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Drawing Title: LOCATION OF MONITORING SITES

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- Receptors
- Location of Diffusion Tube Sites
- Indicative Building Outline

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POTATO WHARF BLOCKS 3 AND 4 AIR QUALITY ASSESSMENT

Drawing Title
RECEPTOR LOCATIONS

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Appendix B Traffic Data

Table 16: 2017, with development traffic data

	AADT	%HDVs	Speed (kph)
Water Street South	6569	3.5	38
Water Street South JXN A6042	6569	3.5	24
Water Street South JXN Liverpool Road	6569	3.5	24
Water Street North	6569	3.5	38
Water Street North JXN Liverpool Road	6569	3.5	24
Liverpool Road	4723	4.7	48
Liverpool Road JXN Water Street	4723	4.7	24
Liverpool Road JXN Deansgate	4723	4.7	24
A57 Mancunian Way	65,180	2.8	64
A57 Mancunian Way JXN Regent Road	65,180	2.8	32
A57 Mancunian Way Fast	65,180	2.8	80
A57 Regent Road East	42,420	3.6	64
A57 Regent Road East JXN Mancunian Way	42,420	3.6	32
A57 Regent Road East JXN Ordsall Lane	42,420	3.6	32
A57 Regent Road West	42,420	3.6	64
A57 Regent Road West JXN Ordsall Lane	42,420	3.6	32
A57 Regent Road West JXN A5066	42,420	3.6	32
A6042	22,353	2.4	48
A6042 JXN A57	22,353	2.4	24
A6042 JXN Water Street Top	22,353	2.4	24

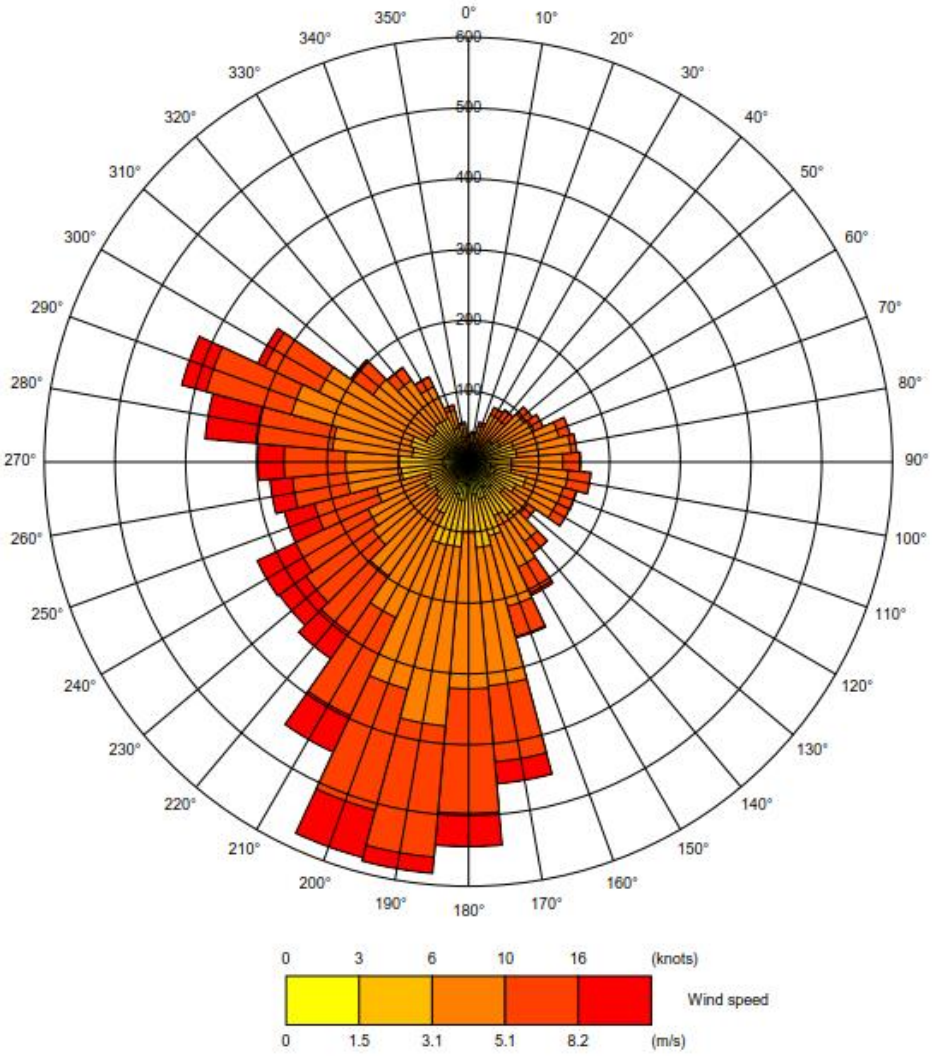
Source: WSP| PB (2015)

Appendix C Meteorological Data

The meteorological dataset used in the assessment was recorded at the meteorological station at Manchester Airport in 2015, located approximately 12 km to the south of Potato Wharf. This site is considered to be representative of regional meteorological conditions and sufficient to satisfy the requirements of this assessment.

The meteorological data were used to produce a wind/stability rose (Figure 2). This illustrates the wind direction and wind speed as a function of the proportion of the year.

Figure 2: Meteorological Data, 2015



Appendix D Seasonal and Biased Adjustment Procedure for Monitoring Data

Seasonal Adjustment

The monitoring study was undertaken between 1st September and 22nd November 2016, with the diffusion tubes changed every 4 weeks. According to Defra guidance (Defra, 2016), monitoring surveys should ideally be undertaken for 12 months as concentrations vary throughout the year; however, if this is not possible then the monitored concentrations need to seasonally adjusted in accordance with the methodology described in the guidance.

As monitoring was not undertaken for a full 12 months, the monitored concentration at each diffusion tube site was seasonal adjustment by comparison with five regional automatic monitoring station operated as part of the AURN. All the automatic monitoring sites were located within 30 km of Potato Wharf. The seasonal biased adjustment procedure was undertaken in line with the methodology described in Defra Guidance (Defra, 2016).

Table 17: Summary of 2013 Regional AURN Nitrogen Dioxide Data

Site	Site Type	Annual Mean (AM)	Period Mean (PM)	Ratio (AM/PM)
Manchester Piccadilly	Urban Background	39.4	40.1	1.0
Glazebury	Rural Background	15.5	13.7	1.1
Salford Eccles	Urban Background	27.0	30.7	0.9
Wigan Centre	Urban Background	19.4	22.1	0.9
Manchester South	Suburban Background	19.6	23.2	0.8
			Average	0.9

A ratio was then determined of the annual mean to the period mean for each site, which were then averaged to determine the annualisation factor of 0.9 (Table 17). This factor was applied to the monitored concentrations (Table 18).

Table 18: Seasonal Adjustment of Nitrogen Dioxide Diffusion Tubes

Site	Monitored Concentration (1st September to 22nd November 2016)	Seasonally Adjusted Mean
DT1	42.5	40.1
DT2	42.5	40.1
DT3	48.0	45.2
DT4	65.2	61.4
DT5	47.5	44.8
DT6	47.2	44.5
DT7	46.2	43.6

Biased Adjustment

Once annualised, the concentrations were adjusted for biased. Although diffusion tubes are a useful low cost method for indicative monitoring of ambient nitrogen dioxide concentrations, they are affected by several sources of interference which can cause them to under or over estimate compared to the

chemiluminescent analyser which is considered to be the reference method. To overcome this, an appropriate biased adjustment factor was applied to the annualised concentrations.

The biased adjustment factor was derived from the National biased adjustment spreadsheet. This spreadsheet has been complied based on the results of many co-location studies (using the same laboratory and tube preparation method). For the purpose of this survey the diffusion tubes were analysed by Staffordshire Scientific Services laboratory using 20% TEA in water. The derived biased adjustment factor was 0.85.

The monitored seasonally and biased adjusted concentrations are provided in Table 19.

Table 19: 2015 Annual Mean Nitrogen Dioxide Concentrations

Site	2015 Annual Mean Nitrogen Dioxide concentration
DT1	34.1
DT2	34.1
DT3	38.4
DT4	52.2
DT5	38.1
DT6	37.8
DT7	37.0

Appendix E Receptor Results

Table 20: Annual Mean Nitrogen Dioxide concentrations at residential units on the ground floor

Block Number	Receptor	Modelled Annual mean Nitrogen Dioxide concentration
3	AP1a	36.2
	AP2a	35.8
	AP3a	35.7
	AP4a	35.7
	AP5a	35.6
	AP6a	35.6
	AP7a	35.5
	AP8a	35.6
	AP9a	36.5
	AP10a	36.4
	AP11a	36.4
	AP12a	36.2
	AP13a	36.2
	AP14a	36.1
	AP15a	36.0
4	AP16a	38.1
	AP17a	37.4
	AP18a	37.4
	AP19a	37.3
	AP20a	37.6
	AP21a	38.9
	AP22a	38.8
	AP23a	38.7
	AP24a	38.6
	AP25a	38.5

Table 21: Annual Mean Nitrogen Dioxide concentrations at residential units on the first floor

Block Number	Receptor	Modelled Annual mean Nitrogen Dioxide concentration
3	AP1b	36.0
	AP2b	35.6
	AP3b	35.6
	AP4b	35.5
	AP5b	35.5
	AP6b	35.4
	AP7b	35.4
	AP8b	35.5
	AP9b	36.3
	AP10b	36.2
	AP11b	36.2
	AP12b	36.1
	AP13b	36.0
	AP14b	35.9
	AP15b	35.8

4	AP16b	37.7
	AP17b	37.1
	AP18b	37.1
	AP19b	37.0
	AP20b	37.3
	AP21b	38.4
	AP22b	38.3
	AP23b	38.2
	AP24b	38.2
	AP25b	38.1

Table 22: Annual Mean Nitrogen Dioxide concentrations at residential units on the second floor

Block Number	Receptor	Modelled Annual mean Nitrogen Dioxide concentration
3	AP1c	35.7
	AP2c	35.4
	AP3c	35.3
	AP4c	35.3
	AP5c	35.3
	AP6c	35.2
	AP7c	35.2
	AP8c	35.3
	AP9c	36.0
	AP10c	35.9
	AP11c	35.8
	AP12c	35.8
	AP13c	35.7
	AP14c	35.6
	AP15c	35.6
4	AP16c	37.1
	AP17c	36.6
	AP18c	36.6
	AP19c	36.6
	AP20c	36.7
	AP21c	37.6
	AP22c	37.6
	AP23c	37.5
	AP24c	37.4
	AP25c	37.4

Table 23: Annual Mean Nitrogen Dioxide concentrations at residential units on the third floor

Block Number	Receptor	Modelled Annual mean Nitrogen Dioxide concentration
3	AP1d	35.3
	AP2d	35.1
	AP3d	35.0
	AP4d	35.0
	AP5d	35.0
	AP6d	34.9
	AP7d	34.9

	AP8d	35.0
	AP9d	35.5
	AP10d	35.5
	AP11d	35.4
	AP12d	35.4
	AP13d	35.3
	AP14d	35.3
	AP15d	35.2
4	AP16d	36.4
	AP17d	36.0
	AP18d	36.0
	AP19d	36.0
	AP20d	36.1
	AP21d	36.7
	AP22d	36.7
	AP23d	36.6
	AP24d	36.6
	AP25d	36.5

Table 24: Annual Mean Nitrogen Dioxide concentrations at residential units on the fourth floor

Block Number	Receptor	Modelled Annual mean Nitrogen Dioxide concentration
3	AP1e	34.9
	AP2e	34.7
	AP3e	34.7
	AP4e	34.7
	AP5e	34.6
	AP6e	34.6
	AP7e	34.6
	AP8e	34.6
	AP9e	35.0
	AP10e	35.0
	AP11e	35.0
	AP12e	34.9
	AP13e	34.9
	AP14e	34.9
	AP15e	34.8
4	AP16e	35.6
	AP17e	35.4
	AP18e	35.4
	AP19e	35.3
	AP20e	35.4
	AP21e	35.8
	AP22e	35.8
	AP23e	35.8
	AP24e	35.7
	AP25e	35.7

Table 25: Annual Mean Nitrogen Dioxide concentrations at residential units on the fifth floor

Block Number	Receptor	Modelled Annual mean Nitrogen Dioxide concentration
3	AP1f	34.5
	AP2f	34.3
	AP3f	34.3
	AP4f	34.3
	AP5f	34.3
	AP6f	34.3
	AP7f	34.2
	AP8f	34.3
	AP9f	34.6
	AP10f	34.5
	AP11f	34.5
	AP12f	34.5
	AP13f	34.5
	AP14f	34.4
	AP15f	34.4
4	AP16f	34.9
	AP17f	34.8
	AP18f	34.7
	AP19f	34.7
	AP20f	34.7
	AP21f	35.0
	AP22f	35.0
	AP23f	34.9
	AP24f	34.9
	AP25f	34.9

Table 26: Annual Mean Nitrogen Dioxide concentrations at residential units on the sixth floor

Block Number	Receptor	Modelled Annual mean Nitrogen Dioxide concentration
3	AP1g	34.0
	AP2g	34.0
	AP3g	33.9
	AP4g	33.9
	AP5g	33.9
	AP6g	33.9
	AP7g	33.9
	AP8g	33.9
	AP9g	34.1
	AP10g	34.1
	AP11g	34.1
	AP12g	34.1
	AP13g	34.0
	AP14g	34.0
	AP15g	34.0

4	AP16g	34.3
	AP17g	34.2
	AP18g	34.2
	AP19g	34.2
	AP20g	34.2
	AP21g	34.3
	AP22g	34.3
	AP23g	34.2
	AP24g	34.2
	AP25g	34.2

Table 27: Annual Mean Nitrogen Dioxide concentrations at residential units on the seventh floor

Block Number	Receptor	Modelled Annual mean Nitrogen Dioxide concentration
3	AP1h	33.7
	AP2h	33.6
	AP3h	33.6
	AP4h	33.6
	AP5h	33.6
	AP6h	33.6
	AP7h	33.6
	AP8h	33.6
	AP9h	33.7
	AP10h	33.7
	AP11h	33.7
	AP12h	33.7
	AP13h	33.6
	AP14h	33.6
	AP15h	33.6
4	AP16h	33.7
	AP17h	33.7
	AP18h	33.7
	AP19h	33.7
	AP20h	33.7
	AP21h	33.7
	AP22h	33.7
	AP23h	33.7
	AP24h	33.7
	AP25h	33.7