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APPENDIX 19-A AIR QUALITY MODELLING STUDY

19-A AIR QUALITY MODELLING STUDY

This Appendix presents the technical information and data upon which the air quality assessment is based.

A.1. MODEL

In urban areas, pollutant concentrations are primarily determined by the balance between pollutant emissions that increase concentrations, and the ability of the atmosphere to reduce and remove pollutants by dispersion, advection, reaction and deposition. An atmospheric dispersion model is used as a practical way to simulate these complex processes; which requires a range of input data, which can include pollutant emissions rates, meteorological data and local topographical information.

The effect of the development on local air quality was assessed using the advanced atmospheric dispersion model ADMS-Roads, taking into account the contribution of emissions from forecast road-traffic on the local road network and from the building services plant by the completion year.

The ADMS-Roads model is a comprehensive tool for investigating air pollution in relation to road networks, and can also take into account point sources such as emissions from building services plant. On review of the site, and its surroundings, ADMS-Roads was considered appropriate for the assessment of the long and short term effects of the proposals on air quality. The model uses advanced algorithms for the height-dependence of wind speed, turbulence and stability to produce improved predictions of air pollutant concentrations. It can predict long-term and short-term concentrations, including percentile concentrations. The use of the ADMS-Roads model was agreed with the air quality Environment Health Officer at Aberdeen City Council (ACC).

ADMS-Roads model is a formally validated model, developed in the United Kingdom (UK) by CERC (Cambridge Environmental Research Consultants). This includes comparisons with data from the UK's air quality Automatic Urban and Rural Network (AURN) and specific verification exercises using standard field, laboratory and numerical data sets. CERC is also involved in European programmes on model harmonisation, and their models were compared favourably against other EU and U.S. EPA systems. Further information in relation to this is available from the CERC web site at www.cerc.co.uk.

Model Scenarios

In order to assess the effect of the development on local air quality, future ‘without development’ and ‘with development’ scenarios were assessed. The development is anticipated to be complete in 2019 and therefore this is the year in which these future scenarios were modelled. The year 2014 was modelled to establish the existing baseline situation because it is the year for which available monitoring data surrounding the site is available against which the air quality model is verified (discussed further below). Base year traffic data for 2014 and meteorological data for 2014 were also used to be consistent with the verification year.

Taking into account recent analyses by Defra[1] showing that historical NO_x and NO_2 concentrations are not declining in line with emission forecasts, a sensitivity analysis has been undertaken on the basis of no future reductions in NO_x/NO_2 concentrations (i.e. considering the potential effects of the development against the current baseline 2014 conditions by applying the 2019 road traffic data to

2014 background concentrations and road traffic emission rates). The results for this sensitivity analysis are presented further below.

A.2. TRAFFIC DATA

Traffic flow data comprising annual average daily traffic (AADT) flows, traffic composition (% HDVs – Heavy-Duty Vehicles) and vehicle speeds were used in the model as provided by Fairhurst (the project transport consultants) for the surrounding road network. Table 19A.1 presents the traffic data used within the air quality assessment.

Table 19A.1: Hourly traffic data used within assessment (based on 24 hour AADT)

Link ID	Name	Speed (kph)	Base 2014		2019			
					Without		With	
			LDV	HDV	LDV	HDV	LDV	HDV
1	Great Southern Road	48	765	84	745	79	747	80
2	Great Southern Road	48	963	104	938	97	940	98
3	Provost Watt Drive	48	400	29	400	29	400	29
4	West Tullos Road (north of Abbotswells Road)	48	762	95	743	89	745	91
5	West Tullos Road (south of Abbotswells Road)	48	523	55	501	47	503	50
6	Wellington Road (south of Wellington Circle)	48	712	79	854	89	865	101
7	Wellington Road (south of Hareness Road)	48	945	142	899	130	908	141
8	Wellington Road (north of Hareness Road)	48	702	150	626	128	626	134
9	Hareness Road	48	111	20	111	20	125	39
10	Coast Road (north of Hareness Road)	48	147	25	147	25	161	44
11	Coast Road (south of St Fittick’s Road)	48	158	23	158	23	175	23
12	Fittick’s Road	48	38	7	38	7	38	7
13	Victoria Road (north of St Fittick’s Road)	48	122	26	122	26	139	26
14	Market Street	48	1142	142	1096	128	1113	134
15	Riverside Drive	48	586	27	548	24	548	24
16	South College Street (south of Riverside Drive)	48	932	101	874	89	874	95
17	Wellington Road (north of Balnagask Road)	48	784	176	721	155	721	160

Vehicle Speeds

The traffic speeds presented in Table 19A.1 are speeds limits; to take into account the presence of slow moving traffic near junctions and at roundabouts, the speed on each road was reduced using the following criteria recommended within LAQM.TG(09)[2]:

- For a busy junction, an average of 20 kph was applied; and

- For other junctions (non-motorway) and roundabouts, where some slowing of traffic occurs, the speed was reduced by 10 kph compared to the speed limit.

Diurnal Points

The ADMS-Roads model uses an hourly traffic flow based on the daily (AADT) flows. Traffic flows follow a diurnal variation throughout the day and week. Therefore, a diurnal profile was used in the model to replicate how the average hourly traffic flow would vary throughout the day and the week. This was based on data collated by Waterman from the Department for Transport (DfT) statistics Table *TRA0307: Traffic distribution by time of day on all roads in Great Britain, 2014*[3]. Figure 19A.1 presents the diurnal variation in traffic flows that has been used within the model.

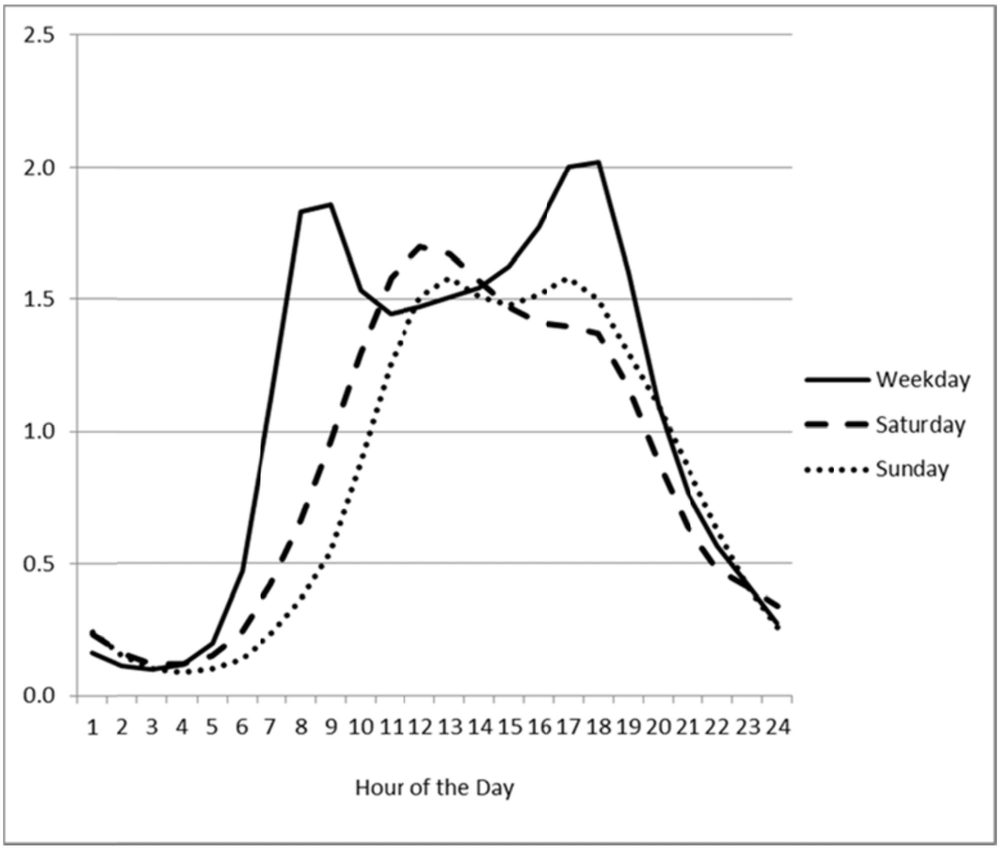

Figure 19A.1: Diurnal traffic variation

A.3. STREET CANYON EFFECT

Narrow streets with tall buildings on either side have the potential to create a confined space, which can interfere with the dispersion of traffic pollutants and may result in pollutant emissions accumulating in that area. In an air quality model these narrow streets are described as street canyons.

ADMS-Roads includes a street canyon model to take account of the additional turbulent flow patterns occurring inside a street with relatively tall buildings on both sides, known as a the ‘street canyon effect’. LAQM.TG(09)[2] identifies a street canyon *“as narrow streets where the height of buildings on both sides of the road is greater than the road width.”*

A review of the surrounding area was undertaken in relation to street canyons. The surrounding roads are relatively wide and existing buildings are not considered to be tall. Therefore, no street canyons were included within the model for the existing or with development scenarios.

A.4. EMISSION FACTORS

The latest version of the ADMS-Roads model (version 3.4.2) was used for the assessment. The model includes the latest vehicle emission factors published by Defra in the Emission Factors Toolkit (version 6.1, published in July 2014, and based on the latest COPERT database published by the European Environment Agency).

The model uses several parameters (traffic flow, percentage of HDV, speed and road type) to calculate road traffic emissions for the selected pollutants.

A.5. POLLUTANT BACKGROUND CONCENTRATIONS

The ADMS-Roads model requires background pollutant concentration data (i.e. concentrations due to the contribution of pollution sources not directly taken into account in the dispersion modelling), that correspond to the year of assessment, which is added to contributions from the modelled pollution sources.

NO_2 background monitoring is undertaken by ACC using one automatic analyser and three diffusion tubes. The automatic monitor, Errol Place, is located approximately 3.1 km to the north-west of the site. Table 19A.2 presents the NO_x, NO_2 and PM_{10} concentrations measured by the Errol Place automatic monitor, whilst Table 19A.3 presents annual mean NO_2 concentrations for the urban background diffusion tubes.

Table 19A.2: Monitored concentrations at Errol Place automatic monitor

Averaging Period	**2012**	**2013**	**2014**
Annual Mean NO_x (µg/m^3)	36	35	35
Annual Mean NO_2 (µg/m^3)$^{(a)}$	21	20	22
Number of 1-hour means > 200 µg/m$^{3\ (b)}$	0	0	0
Annual Mean PM_{10} (µg/m^3)$^{(c)}$	12	13	15
Number of 24-hour means >50µg/m$^{3\ (d)}$	1	1	0
Annual Mean $PM_{2.5}$ (µg/m^3)$^{(e)}$	9	9	10

Notes:
Source: Scottish Air Quality (www.scottishairquality.co.uk)
(a) NO_2 annual mean Air Quality Strategy objective of **40**µg/m^3
(b) NO_2 1-hour mean Air Quality Strategy objective of **200**µg/m^3 not to be exceeded more than 18 times a year
(c) PM_{10} annual mean Air Quality Strategy objective of **40**µg/m^3
(d) PM_{10} 24-hour mean Air Quality Strategy objective of **50**µg/m^3 not to be exceeded more than 7 times a year

Table 19A.3: Annual mean monitored urban background NO_2 concentrations (µg/m^3) at the nearest diffusion tubes to the site

Site	Grid Reference	Distance to Site [km]	2012	2013	2014
Northfield Swimming Pool (DT15)	390801, 808132	6.7	13	14.5	16.5
Fairview Drive (TDC10)	392239, 810163	7.0	-	14.8	13.7
Dyce Prim, Gordon Terrace (DT14)	389046, 812794	11.0	10	12.9	10.5

Note:
Source: ACC 2015 Updating and Screening Assessment
NO_2 annual mean Air Quality Strategy objective of **40**µg/m^3
Concentrations exceeding the Air Quality Strategy objectives shown in **bold**

In addition to the background monitoring, background concentrations of NO_x, NO_2, and PM_{10} are available from the Scottish Air Quality website[4] for 1 km × 1 km grid squares covering the whole of Scotland, for years 2011 to 2030. Additionally, $PM_{2.5}$ background maps have been published by Defra for the whole of the UK, available on the LAQM website[5]. Table 19A-4 presents the background concentrations for the year 2014 for the grid square the Site is located within (396500, 804500) from the Scottish Air Quality and Defra LAQM websites.

Table 19A.4: Scottish air quality and Defra Urban Background Maps in 2014 for the grid square at the location of the site

Pollutant	Concentration [µg/m^3]
NO_X	40.9
NO_2	25.2
PM_{10}	14.2
$PM_{2.5}$	8.2

Table 19A.2 to Table 19A.4 indicates that the background annual mean NO_2 concentration in 2014 is higher at the Scottish Air Quality background map (25.2µg/m^3) than the automatic monitor (22.0µg/m^3) and the three diffusion tubes at Northfield Swimming Pool (16.5µg/m^3), on Fairview Drive (13.7µg/m^3) and at Dyce Prim, Gordon Terrace (10.5µg/m^3). The background annual mean PM_{10} concentration in 2014 is slightly higher at the automatic monitor (15.0µg/m^3) than the background map (14.2µg/m^3) and the annual mean $PM_{2.5}$ concentration in 2014 is slightly higher at the automatic monitor (10.0µg/m^3) than the background map (8.2µg/m^3).

Based on the above, background concentrations used for this assessment have been obtained from the Errol Place automatic monitor. The background concentrations have been adjusted to future years using the same ratio identified within the Scottish Air Quality and the Defra LAQM websites for the same years for grid square 396500, 804500, following Technical Guidance LAQM.TG(09)[2].

Background concentrations data used within the assessment are presented in Table 19A.5.

Table 19A.5: Background concentrations (µg/m^3) used within the assessment

Pollutant	2014	2019
NO_x	35.0	30.4 (a)
NO_2	22.0	19.5 (b)
PM_{10}	15.0	14.5 (c)
$PM_{2.5}$	10.0	9.5 (d)

Notes:
(a) Projection factor of 0.869 used (derived from the Scottish Air Quality background maps)
(b) Projection factor of 0.886 used (derived from the Scottish Air Quality background maps)
(c) Projection factor of 0.967 used (derived from the Scottish Air Quality background maps)
(d) Projection factor of 0.950 used (derived from the Defra LAQM background maps)

Meteorological Data

Meteorological data provides hourly sequential data including wind direction, wind speed, temperature, precipitation and the extent of cloud cover for each hour of a given year. As a minimum ADMS-Roads requires wind speed, wind direction, and cloud cover.

Meteorological data to input into the model were obtained from the Aberdeen/Dyce International Airport Meteorological Station, which is the closest to the site and considered to be the most representative. The 2014 data were used to be consistent with the model verification year. It was also applied to the 2019 scenarios for the air quality impact assessment. Figure 19A.2 presents the wind-rose for the metrological data.

Most dispersion models do not use meteorological data if they relate to calm winds conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. ADMS-Roads treats calm wind conditions by setting the minimum wind speed to 0.75 m/s. It is recommended in Technical Guidance LAQM.TG (09)[2] that the meteorological data file be tested within a dispersion model and the relevant output log file checked, to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedences. Technical Guidance LAQM.TG (09)[2] recommends that meteorological data should only be used if the percentage of usable hours is greater than 75%, and preferably 90%. 2014 meteorological data from Aberdeen/Dyce International Airport include 8,745 lines of usable hourly data out of the total 8,784 for the year, i.e. 99.8% of usable data. This is above the 75% threshold, and is therefore adequate for the dispersion modelling.

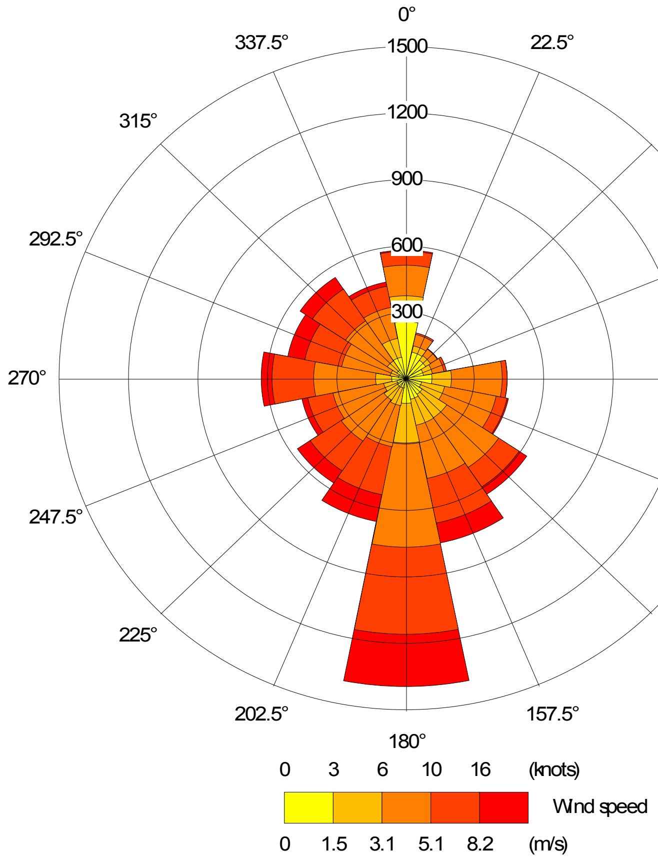

Figure 19A.2: 2014 Wind rose for the Aberdeen/Dyce International Airport meteorological site

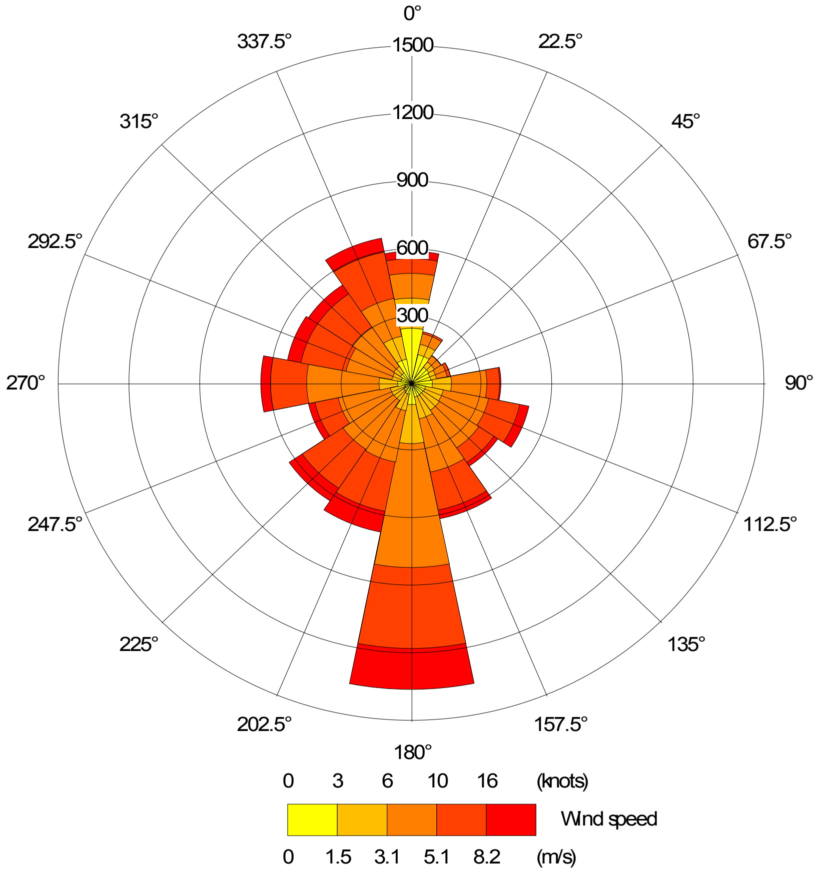

Figure 19A.3: 2013 Wind rose for the Aberdeen/Dyce International Airport meteorological site

Model Data Processing

The modelling results were processed to calculate the averaging periods required for comparison with air quality objectives.

NO_X emissions from combustion sources (including vehicle exhausts) comprise principally nitric oxide (NO) and nitrogen dioxide (NO_2). The emitted nitric oxide reacts with oxidants in the air (mainly ozone) to form more NO_2. Since only nitrogen dioxide is associated with effects on human health, the air quality standards for the protection of human health are based on NO_2 and not total NO_X or NO.

The ADMS-Roads model was run without the chemistry reaction option to allow verification (see below). Therefore, a suitable NO_X:NO_2 conversion needed to be applied to the modelled NO_X concentrations. There are a variety of different approaches to dealing with NO_X:NO_2 relationships, a number of which are widely recognised as being acceptable. However, the current approach was developed for roadside sites, and is detailed within Technical Guidance LAQM.TG (09)[2].

The LAQM Support website provides a spreadsheet calculator[6] to allow the calculation of NO_2 from NO_x concentrations, accounting for the difference between primary emissions of NO_x and background NO_x, the concentration of O_3, and the different proportions of primary NO_2 emissions, in different years. This approach is only applicable to annual mean concentrations.

Research[7] undertaken in support of LAQM.TG(09)[2] has indicated that the hourly mean limit value and objective for NO_2 is unlikely to be exceeded at a roadside location where the annual-mean NO_2 concentration is less than 60µg/m^3. The 1 hour mean objective is, therefore, not considered further within this assessment where the annual-mean NO_2 concentration is predicted to be less than 60µg/m^3.

In order to calculate the number of daily exceedances of 50µg/m^3 PM_{10} the relationship between the number of 24-hour exceedances of 50µg/m^3 and the annual mean PM_{10} concentration from LAQM.TG (09)[1] was applied as follows:

Number of Exceedances$= -18.5 + 0.00145 \times (\text{annual mean}^3) + \dfrac{206}{\text{annual mean.}}$

Other Model Parameters

There are a number of other parameters that are used within the ADMS-Roads model which are described here for completeness and transparency:

- The model requires a surface roughness value to be inputted. A value of 1 was used, which is representative of cities;
- The model requires the Monin-Obukov length (a measure of the stability of the atmosphere) to be inputted. A value of 30 m (representative of cities and large towns) was used for the modelling;
- The model requires the Road Type to be inputted. Scotland (Urban) was selected and used for the modelling.

Model Verification

Model verification is the process of comparing monitored and modelled pollutant concentrations for the same year.

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 (e.g. car parks and bus stops);
- Overall model limitations (e.g. treatment of roughness and meteorological data, treatment of speeds);
- Uncertainty in monitoring data, particularly diffusion tubes.

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.

Nitrogen Dioxide

The dispersion model was run to predict the annual-mean NO_2 concentration at the ACC automatic monitors on Market Street and Wellington Road and the diffusion tubes located at 86 Victoria Road; 115 Menzies Road; Wellington Road and 184 Market Street.

As highlighted above, the NO_2 concentration is a function of NO_x concentrations. Therefore, the roadside NO_x concentration predicted by the model was converted to NO_2 using the NO_x to NO_2 calculator provided by Defra on the air quality archive[3].

The modelled and equivalent measured roadside NO_2 concentrations at the ACC monitoring locations are compared in Table 19A.6.

Table 19A.6: 2014 Annual mean NO_2 modelled and monitored concentrations

Site ID	Monitored Annual Mean NO_2 ($\mu g/m^3$]	Modelled Total Annual Mean NO_2 [$\mu g/m^3$]	% Difference (modelled – monitored)
Market Street	40.3	31.7	-21.4
Wellington Road	47.7	30.6	-35.9
DT6 86 Victoria Road	35.0	24.2	-30.9
DT7 Wellington Road	45.6	31.3	-31.3
DT10 184 Market Street	53.9	30.9	-42.6
DT36 115 Menzies Road	41.0	33.3	-18.8

Table 19A.6 indicates that the model under predicts annual mean NO_2 concentrations at all six monitoring locations between 42.6 to 18.8%. Technical Guidance LAQM.TG (09)[2] suggests that where there is disparity between modelled and monitored results, particularly if this is by more than 25%, appropriate adjustment should be undertaken.

LAQM.TG (09)[2] presents a number of methods for approaching model verification and adjustment. Example 2, of Annex 3 in the LAQM.TG (09)[2] guidance document, indicates a method based on adjusting NO_2 road contribution and calculating a single adjustment factor. This method refers to modelling based on road traffic sources and can be applied to either a single diffusion tube location, or where numerous monitoring locations are sited within the modelled area. This requires the roadside NO_x contribution to be calculated. In addition, monitored NO_x concentrations are required, which have been calculated from the annual mean NO_2 concentration at the diffusion tube site using the NO_x to NO_2 spreadsheet calculator as described above. The steps involved in the adjustment process are presented in Table 19A.7.

Table 19A.7: Model verification result for adjustment NO_x emissions (µg/m^3)

Site ID	**Monitored NO_2**	**Monitored NO_x**	**Monitored Road NO_2**	**Monitored Road NO_x**	**Modelled Road NO_x**	**Ratio of Monitored Road Contribution NO_x/Modelled Road Contribution NO_x**
Market Street	40.3	56.2	18.3	21.2	19.8	1.1
Wellington Road	47.7	83.5	25.7	48.5	17.5	2.8
DT6	35.0	62.2	13.0	27.2	4.3	6.3
DT7	45.6	87.6	23.6	52.6	19.1	2.8
DT10	53.9	110.0	31.9	75.0	18.2	4.1
DT36	41.0	76.2	19.0	41.2	23.4	1.8
					Adjustment Factor	**2.41**

Figure 19A.3 shows the mathematical relationship between modelled and monitored roadside NO_x (i.e. total NO_x minus background NO_x) in a scatter graph (data taken from Table 19A.7), with a trendline passing through zero and its derived equation.

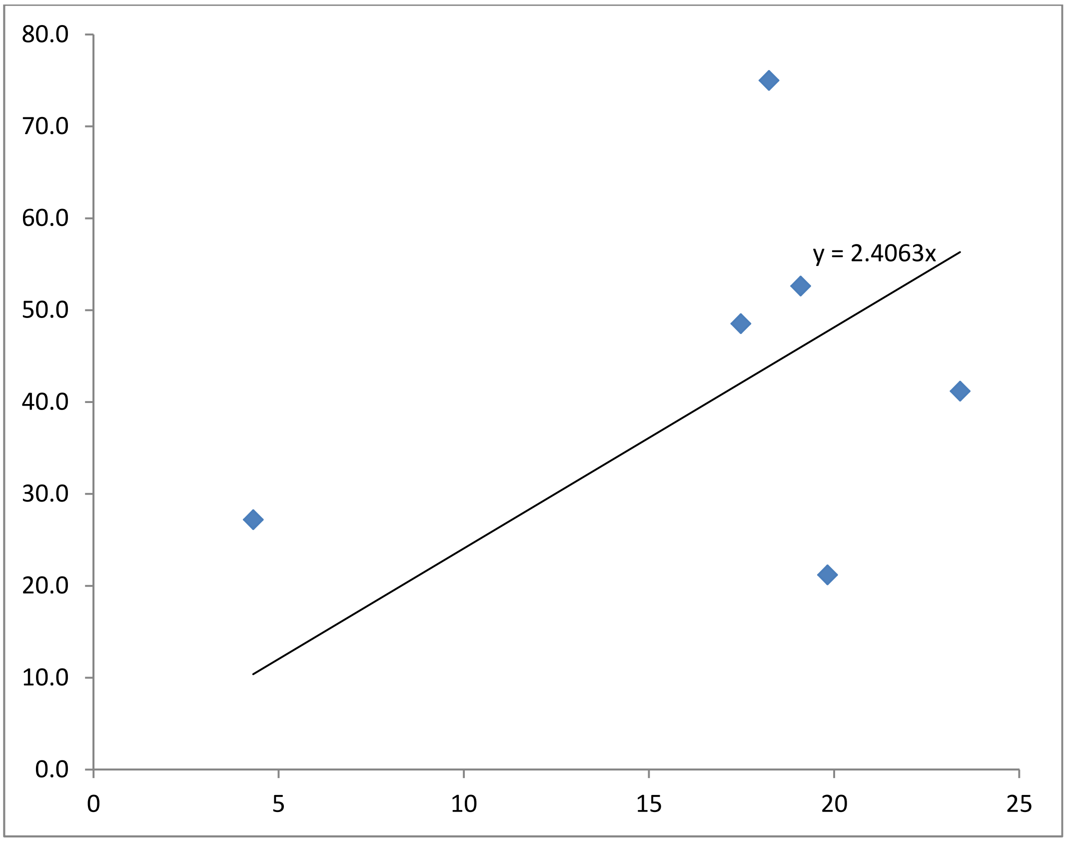

Figure 19A.3: Unadjusted modelled versus monitored annual mean roadside NO_x at the monitoring sites ($\mu g/m^3$)

Consequently in Table 19A.8 the adjustment factor (2.4063) obtained from Figure 19A.3 is applied to the modelled NO_x Roadside concentrations to obtain improved agreement between monitored and modelled annual mean NO_x. This has been converted to annual mean NO_2 using the NO_x:NO_2 spreadsheet calculator.

Table 19A.8: Final adjusted annual average NO_2 concentrations compared to monitored annual mean NO_2 concentrations ($\mu g/m^3$)

Site ID	Adjusted Modelled Road NO_x	Adjusted Modelled Total NO_x	Modelled Total NO_2	Monitored Total NO_2	% Difference
Market Street	51.0	86.0	45.0	40.3	11.6
Wellington Road	45.0	80.0	42.6	47.7	-10.8
DT6	11.1	46.1	27.5	35.0	-21.3
DT7	49.1	84.1	44.2	45.6	-3.0
DT10	46.9	81.9	43.4	53.9	-19.6
DT36	60.2	95.2	48.5	41.0	18.3

The data in Table 19A.8 indicates an improved agreement between monitored and modelled annual mean NO_2 results compared to the unadjusted/unverified model.

The NO_x adjustment process was subsequently applied to all of roadside NO_x modelling for 2014 and 2019 ‘without’ and ‘with’ the development in place, at the specific receptors locations assessed, before heating plant concentrations were added and before the predicted concentrations were converted to NO_2.

Particulate Matter (PM_{10} and $PM_{2.5}$)

Roadside PM_{10} monitoring is also undertaken at the automatic monitoring sites at the Market Street and Wellington Road, and therefore, a similar process to that above has been applied to PM_{10}. The steps involved in the adjustment process are presented in Table 19A.9.

Table 19A.9: Model verification result for annual mean PM_{10} in 2014

Site ID	Monitored PM_{10}	Background PM_{10}	Monitored Road PM_{10}	Modelled Road PM_{10}	Ratio of Monitored Road Contribution PM_{10}/Modelled Road Contribution PM_{10}
Market Street	26.0	15.0	11.0	1.4	8.2
Wellington Road	21.0	15.0	6.0	1.1	5.6
Adjustment Factor					**6.87**

The adjustment factor (6.8738) obtained in Table 19A.9 is applied to the modelled PM_{10} Roadside concentrations, prior to the addition of the background concentrations and before the number of daily PM_{10} exceedences was calculated, to obtain improved agreement between monitored and modelled annual mean PM_{10}.

Table 19A.10: Adjusted annual average PM_{10} concentration compared to measured annual mean PM_{10} concentration ($\mu g/m^3$)

Site ID	Modelled Road PM_{10}	Adjusted Modelled Road PM_{10}	Modelled Total PM_{10}	Monitored PM_{10}	% Difference
Market Street	1.35	9.24	22.24	26.0	-6.8
Wellington Road	1.08	7.40	22.40	21.0	6.7

The data in Table 19A.10 indicates an improved agreement between monitored and modelled annual mean PM_{10} results compared to the unadjusted/unverified model. This process of verification improves confidence in the modelling results and further reduces uncertainty, with the agreement between monitored and modelled annual mean PM_{10} results improved compared to the unadjusted/unverified model, shown in Table 19A.9.

The adjustment process was then applied to all of the roadside PM_{10} modelling results at receptors for 2014 and 2019 without and with the development in place, at the specific receptors locations assessed and before daily mean PM_{10} concentrations were calculated.

$PM_{2.5}$ monitoring data is not available for the Site area. Therefore, the roadside modelled PM_{10} adjustment factor of 6.8738 was subsequently applied to all the roadside $PM_{2.5}$ modelling results, before adding on the background concentrations, for the study area for 2014 and each of the 2019 scenarios, at the specific receptors locations assessed.

Verification Summary

Any atmospheric dispersion model study will always have a degree of inaccuracy due to a variety of factors. These include uncertainties in traffic emissions data, in the differences between available meteorological data and the specific microclimate at each receptor location, simplifications made in the model algorithms that describe the atmospheric dispersion and chemical processes. There will also be uncertainty in the comparison of predicted concentrations with monitored data, given the potential for errors and uncertainty in sampling methodology (technique, location, handling, and analysis) as well as processing of any monitoring data.

Whilst systematic under or over prediction can be taken in to account through the model verification/adjustment process, random errors will inevitably occur and a level of uncertainty will still exist in corrected/adjusted data.

Model uncertainties arise because of limited scientific knowledge, limited ability to assess the uncertainty of model inputs, for example, emissions from vehicles, poor understanding of the interaction between model and/or emissions inventory parameters, sampling and measurement error associated with monitoring sites and whether the model itself completely describes all the necessary atmospheric processes.

Overall, it is concluded that with the adjustment factors applied to the ADMS-Roads model is performing well and is considered to be suitable for use within the impact assessment.

NO_2 Sensitivity Test

Whilst this air quality assessment was based on current guidance, i.e., with reduced emission rates and background concentration for the completion year of 2019, to take into account the trend that NO_x and NO_2 concentrations are not declining as expected[1], a sensitivity test has been carried out, on the basis of no future reductions in road traffic emission rates and background concentrations (i.e. considering the potential effect of the Development against the current baseline, 2014, conditions). Modelled results of this additional scenario are presented in Table 19A.11.

Table 19A.11: Results of the ADMS-roads modelling at sensitive receptors, assuming no improvement in NO_x and NO_2

	NO_2 Annual Mean [µg/m^3]
Receptor 1: 119 Menzies Road	
2019 Without Development	42.1
2019 With Development	42.5
2019 Change	0.4
Receptor 2: 1 Polwarth Road	
2019 Without Development	43.8
2019 With Development	44.2
2019 Change	0.4

Note:
For accuracy, the changes arising from the Development have been calculated using the exact output from the dispersion model (i.e. numbers to at least 10 decimal places) rather than the rounded numbers in **Table 19A.11**.

Table 19A.11: Results of the ADMS-roads modelling at sensitive receptors, assuming no improvement in NO_x and NO_2 continued

	NO_2 Annual Mean [$\mu g/m^3$]
Receptor 3: 57 Wellington Road	
2019 Without Development	40.1
2019 With Development	40.4
2019 Change	0.4
Receptor 4: 133 Wellington Road	
2019 Without Development	31.4
2019 With Development	31.7
2019 Change	0.3
Receptor 5: Smiddy Cottage, Wellington Road	
2019 Without Development	37.1
2019 With Development	37.9
2019 Change	0.8
Receptor 6: 138 Abbotswell Crescent	
2019 Without Development	26.4
2019 With Development	26.6
2019 Change	0.2
Receptor 7: 100 Abbotswell Crescent	
2019 Without Development	27.3
2019 With Development	27.5
2019 Change	0.2
Receptor 8: 119 Great Southern Road	
2019 Without Development	33.8
2019 With Development	33.9
2019 Change	0.1
Receptor 9: 2 Flat South	
2019 Without Development	27.5
2019 With Development	27.7
2019 Change	0.2
Receptor 10: 153 Victoria Road	
2019 Without Development	27.6
2019 With Development	27.9
2019 Change	0.3
Receptor 11: 346 Victoria Road	
2019 Without Development	25.5
2019 With Development	25.7
2019 Change	0.2
Receptor 12: 94 St Fitticks Road	
2019 Without Development	23.3
2019 With Development	23.3
2019 Change	0.0
Note: For accuracy, the changes arising from the Development have been calculated using the exact output from the dispersion model (i.e. numbers to at least 10 decimal places) rather than the rounded numbers in **Table 19A.11**.	

Construction Phase Dust Assessment

Table 19A.12 provides examples of the potential dust emissions classes for each of the construction activities, as provided in the IAQM guidance on the assessment of construction dust. It should be noted that not all the criteria need to be met for a particular class. Once the class has been determined the risk category can be determined from the matrices presented in Tables 19.5 to 19.8 in Chapter 19: Air Quality.

Table 19A.12: Criteria for the potential dust emissions class

Activity	Class	Example Criteria
Demolition	Large	Total Building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on site crushing and screening, demolition activities >20 m above ground level.
	Medium	Total Building volume 20,000-50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level.
	Small	Total Building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10 m above ground, demolition during wetter months.
Earthworks	Large	Total site area >10,000 m^2, 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.
	Medium	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 <10,000 tonnes, earthworks during wetter months.
	Small	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 <10,000 tonnes, earthworks during wetter months.

Table 19A.12: Criteria for the potential dust emissions class continued

Activity	Class	Example Criteria
Construction	Large	Total Building volume >100,000m^3, piling, on site concrete batching, sand blasting.
	Medium	Total building volume 25,000 m^3 - 100,000 m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching.
	Small	Total building volume <25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber).
Trackout	Large	>100 HDV (>3.5t) trips in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m.
	Medium	25-100 HDV (>3.5t) trips in any one day, moderately dusty surface material, unpaved road length 50-100 m.
	Small	<25 HDV (>3.5t) trips in any one day, surface material low potential for dust release, unpaved road length <50 m.

Once the risk category has been defined, the significance of the likely dust impacts can be determined, taking into account the factors that define the sensitivity of the surrounding area. Examples of the factors defining the sensitivity of the area as set out in the IAQM guidance are presented in Table 19A.13.

Table 19A.13: Examples of factors defining sensitivity of the area

Type of Effect	Sensitivity of Receptor	Examples
Sensitivities of People to Dust Soiling Effects	High	Users can reasonably expect a enjoyment of a high level of amenity; or The appearance, aesthetics or value of their property would be diminished by soiling; and the people or property would reasonably be expected[1] 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[2] and car showrooms.
	Medium	Users would expect[1] to enjoy a reasonable level of amenity, but would not reasonably expect[1] to enjoy the same level of amenity as in their home; or The appearance, aesthetics or value of their property could be diminished by soiling; or The people or property wouldn't reasonably be expected[1] 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.
	Low	The enjoyment of amenity would not reasonably be expected[1]; or property would not reasonably be expected[1] to be diminished in appearance, aesthetics or value by soiling; or 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[2] and roads.
Sensitivities of People to Health Effects of PM_{10}	High	Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, relevant location would be one where individuals may be exposed for eight hours or more in a day).[3] Indicative examples include residential properties. Hospitals, schools and residential care homes should also be considered as having equal sensitivity to residential areas for the purposes of this assessment.
	Medium	Locations where the people exposed are workers[4], and exposure is over a time period relevant to the air quality objective for PM_{10} (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 PM_{10}, as protection is covered by Health and Safety at Work legislation.
	Low	Locations where human exposure is transient.[5] Indicative examples include public footpaths, playing fields, parks and shopping streets.

Notes:

1 People's expectations will vary depending on the existing dust deposition in the area.

2 Car parks can have a range of sensitivities depending on the duration and frequency that people would be expected to park their cars there, and the level of amenity they could reasonably expect whilst doing so. Car parks associated with work place or residential parking might have a high level of sensitivity compared to car parks used less frequently and for shorter durations, such as those associated with shopping. Cases should be examined on their own merits.

3 This follows Defra guidance as set out in LAQM.TG (09)[2].

4 Notwithstanding the fact that the air quality objectives and limit values do not apply to people in the workplace, such people can be affected to exposure of PM10. However, they are considered to be less sensitive than the general public as a whole because those most sensitive to the effects of air pollution, such as young children are not normally workers. For this reason workers have been included in the medium sensitivity category.

5 There are no standards that apply to short-term exposure, e.g. one or two hours, but there is still a risk of health impacts, albeit less certain.

6 Cheffing C. M. and Farrell L. (Editors) (2005), The Vascular Plant. Red Data List for Great Britain, Joint Nature Conservation Committee.

Table 19A.13: Examples of factors defining sensitivity of the area continued

Type of Effect	Sensitivity of Receptor	Examples
Sensitivities of Receptors to Ecological Effects	High	Locations with an international or national designation and the designated features may be affected by dust soiling; or Locations where there is a community of a particularly dust sensitive species such as vascular species included in the Red Data List For Great Britain[6] Indicative examples include a Special Area of Conservation (SAC) designated for acid heathlands or a local site designated for lichens adjacent to the demolition of a large site containing concrete (alkali) buildings.
	Medium	Locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown; or Locations with a national designation where the features may be affected by dust deposition. Indicative example is a Site of Special Scientific Interest (SSSI) with dust sensitive features.
	Low	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.

Notes:

1 People's expectations will vary depending on the existing dust deposition in the area.

2 Car parks can have a range of sensitivities depending on the duration and frequency that people would be expected to park their cars there, and the level of amenity they could reasonably expect whilst doing so. Car parks associated with work place or residential parking might have a high level of sensitivity compared to car parks used less frequently and for shorter durations, such as those associated with shopping. Cases should be examined on their own merits.

3 This follows Defra guidance as set out in LAQM.TG (09)[2].

4 Notwithstanding the fact that the air quality objectives and limit values do not apply to people in the workplace, such people can be affected to exposure of PM10. However, they are considered to be less sensitive than the general public as a whole because those most sensitive to the effects of air pollution, such as young children are not normally workers. For this reason workers have been included in the medium sensitivity category.

5 There are no standards that apply to short-term exposure, e.g. one or two hours, but there is still a risk of health impacts, albeit less certain.

6 Cheffing C. M. and Farrell L. (Editors) (2005), The Vascular Plant. Red Data List for Great Britain, Joint Nature Conservation Committee.

Table 19A.14, Table 19A.15 and Table 19A.16 show how the sensitivity of the area may be determined for effects related to dust soiling (nuisance), human health and ecosystem respectively. When using these tables it should be noted that distances are to the dust source and so a different area may be affected by the on-site works than by trackout (i.e. along the routes used to access the site). The IAQM guidance advises that the highest level of sensitivity from each table should be recorded.

Table 19A.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 19A.15: Sensitivity of the area to human health impacts

Receptor Sensitivity	Annual Mean PM10 Concentration	Number of Receptors	Distance from the Source [m]				
			<20	<50	<100	<200	<350
High	>32µg/m^3	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32µg/m^3	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28µg/m^3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24µg/m^3	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low	Low
	-	1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table 19A.16: Sensitivity of the area to ecological impacts

Receptor Sensitivity	Distance from the Source [m]	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Assessor Experience

Name: Christopher Brownlie

Years of Experience: 8

Qualifications:

- BSc (Hons);
- MSc;
- AIEMA (Associate Member of the Institute of Environmental Management and Assessment);
- MIAQM (Member of the Institute of Air Quality Management).

Chris has over eight years of experience in the assessment of air quality and odour for a variety of environmental impact assessment projects. Chris has knowledge and extensive experience of designing and undertaking ambient air quality monitoring programmes using real time equipment and passive diffusion tubes. This includes devising monitoring programs for dust deposition, typically to monitor levels of dust generated during construction activities in populated areas where there is the potential for nuisance to be caused.

Chris has been responsible for the technical delivery of a wide range of air quality projects for a variety of clients in both the public and private sector. These projects include consideration of emissions from both transportation and industrial sources, through both monitoring and modelling, and therefore he has an in depth understanding of the regulatory requirements for these sources and the published technical guidance for their assessment.

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