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Anglia Square, Norwich
Air Quality Assessment

Dated March 2022

Weston Homes

Air Quality Assessment for the proposed re-development at Anglia Square, Norwich

Report to Weston Homes Plc

ES Vol 1 Appendix 8.1

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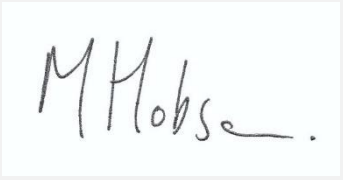
Signature	
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1 Introduction

This Air Quality Assessment (AQA) has been prepared by Aether on behalf of Weston Homes Plc (the Applicant) in support of a hybrid (part full /part outline) planning application, (the Application), submitted to Norwich City Council (NCC) for the comprehensive redevelopment of Anglia Square and various parcels of mostly open surrounding land, (the Site), as shown within a red line on Drawing '35301-ZZ-00-DR-A-01-0200'.

The Site is located in a highly accessible position within the northern part of Norwich City Centre and comprises a significant element of the Anglia Square/Magdalen Street/St Augustines Large District Centre, (the LDC). It is thus of strategic importance to the City, and accordingly has been identified for redevelopment for many years within various local planning policy documents, including the Northern City Centre Area Action Plan 2010, (NCCAAP), (now expired), the Joint Core Strategy for Broadland, Norwich and South Norfolk 2014, (JCS), and NCC's Anglia Square and Surrounding Area Policy Guidance Note 2017, (PGN). The Site forms the principal part of an allocation (GNLP 0506) in the emerging Greater Norwich Local Plan (GNLP).

This application follows a previous application on a somewhat smaller development parcel, (NCC Ref. 18/00330/F) made jointly by Weston Homes Plc as development partner and Columbia Threadneedle Investments, (CTI), the Site's owner, for a residential-led mixed use scheme consisting of up to 1,250 dwellings with decked parking, and 11,000 sqm GEA flexible ground floor retail/commercial/non-residential institution floorspace, hotel, cinema, multi-storey public car park, place of worship, and associated public realm and highway works. This was subject to a Call-in by the Secretary of State (PINS Ref. APP/G2625/V/19/3225505) who refused planning permission on 12th November 2020, (the 'Call in Scheme'). An AQA with subsequent revisions was undertaken in respect of the Call in Scheme. The Secretary of State concluded at paragraph 60 of his decision letter that he ***"agrees with the Inspector that the information before him is sufficient for air quality to be properly taken into account in this decision."*** Thus, he endorsed the methodology of that AQA, which has been followed, with updates as set out below, in respect of this AQA.

In April 2021, following new negotiations with the Site owner CTI, Weston Homes decided to explore the potential for securing planning permission for an alternative scheme via an extensive programme of public and stakeholder engagement, from the earliest concepts to a fully worked up application. The negotiations with CTI have secured a "Subject to Planning" contract to purchase the Site, (enlarged to include the southeastern part of Anglia Square fronting Magdalen Street and St Crispins Road), which has enabled a completely fresh approach to establishing a redevelopment scheme for Anglia Square. This has resulted in a different development brief for the scheme, being to create a replacement part of the larger LDC suited to the flexible needs of a wide range of retail, service, business and community uses, reflective of trends in town centre character, integrated with the introduction of homes across the Site, within a highly permeable layout, well connected to its surroundings.

The new development proposal seeks to comprehensively redevelop the Site to provide up to 1,100 dwellings and up to 8,000sqm (NIA) flexible retail, commercial and other non-residential floorspace including Community Hub, up to 450 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses), car

club spaces and associated works to the highway and public realm areas (the Proposed Development). These figures are maxima in view of the hybrid nature of the application. This proposes part of the scheme designed in full, to accommodate 367 dwellings, 5,808 sqm non-residential floorspace, and 146 car parking spaces (at least 95% spaces for residential use, and up to 5% for non-residential use), with the remaining large part of the Site for later detailed design as a "Reserved Matters" application, up to those maxima figures.

This AQA provides Norwich City Council with an assessment of the impact the Proposed Development will have on air quality of the Site and surrounding area.

The assessment utilises local monitoring data and dispersion modelling to estimate the nitrogen dioxide and particulate matter pollutant concentrations and their compliance with Air Quality Strategy objectives at relevant receptor locations in 2034. The reason for use of 2034 is set out at footnote 1 below.

The Transport Assessment establishes that the Proposed Development will not result in any increase in traffic flows on the surrounding road network in 2034, three years after the first full year of occupation, (See data in Appendix B to this report). The reason for this has been described by the Transport Consultants as follows:

The total public car parking available across the Site currently is 1,172 spaces. The Proposed Development includes 146 car parking spaces within the detailed element of the Proposed Application, and the Outline element could provide up to a further 304 car parking spaces (albeit in reality this number is likely to be lower). This equates to a total of 450 parking spaces, which is the limit set by the application's description of development. Therefore, even if the full 450 parking spaces are to be provided, which is considered unlikely, this would be a reduction of 722 spaces compared to what is at the Site currently, and also less than the total existing number of spaces in the public surface car parks currently open, ignoring the spaces within the multi storey which still benefits from its extant use as well as the existing staff parking on Site. Furthermore, it should be noted that the existing 1,172 spaces are public car parking associated with Anglia Square shopping centre and the other commercial facilities within the vicinity and will therefore have a much higher turnover than car parking associated with residential use. As such, the Proposed Development is expected to result in a net decrease in vehicular traffic on the local road network and this has been agreed with NCiC and NCoC during the scoping stage.

Accordingly, for the purposes of the AQA, it is not necessary to model "with development" or "without development" scenarios separately, and therefore only two future scenarios based on predicted traffic flows for 2034 have been modelled[1]. The first, ("without policy applied") uses a conservative approach with regards to expected improvements to air quality, in that no improvement in the pollutant background concentrations or road transport emission factors has been assumed between the base year (2019) and the future year (2034). The second future scenario ("with policy applied") utilises the projected improvements in pollutant background concentrations and road transport emission factors in 2034.

[1] It is worth noting that since the modelling has been undertaken, the year of opening has now been brought forward and is expected to be 2030, with the first full year of occupation being 2031. Therefore, the results presented in this report for 2034 as a first full year of occupation are likely to be an over-estimate for the actual opening year, as traffic levels are forecast to be approx. 2.7% higher in 2034 compared to 2031.

Thus, in total the following scenarios have been modelled:

- **2019 Baseline**: to enable model verification to be undertaken. This year has been chosen as it is the last full calendar year before the Covid-19 pandemic had any impact on activity levels.
- **2034 "with no policy applied"**: As set out in the Transport Assessment supporting the Application, no changes in traffic levels on roads surrounding the Site are expected because of the development, and therefore, taking the full occupation year of 2034, but assuming no improvement in the air pollutant emissions arising from the road traffic fleet from the baseline year, just one scenario has been necessary to model for 'without Proposed Development' which also applies to 'with Proposed Development';
- **2034 "with policy applied"**: Taking again the finding that no changes in traffic levels are expected on roads surrounding the Site because of the development, and once again taking 2034, but this time assuming the expected improvement in the air pollutant emissions arising from the application of government policy to change the road traffic fleet, it has also only been necessary to model just one scenario for 'without Proposed Development' and 'with Proposed Development'. This takes into account Defra's predicted impact (as provided in the latest version of the Emission Factor Toolkit (EFT) published in November 2021[2]) of improvements to vehicle fleet emission factors and background concentrations. Further information on this is provided in Section 2.2 (Traffic Data).

It is worth noting that a "with policy applied" scenario was provided in the AQA to support the Call in Scheme. That utilised version 9 of the EFT (the latest version at the time of undertaking the work). In response to this, Paragraph 557 of the Call in Inspector's Report states: *At the inquiry there was discussion as to whether, in principle, it is right to take account of anticipated improvements in air quality as a result of government policy. Although the Council did not take account of such improvements at the time it considered the application, it now considers that it is right to do so. I agree. The EFT User Guide 2019* [version 9]*, which is published by Defra states that: "It is a tool that allows users to calculate road vehicle pollutant emission rates for oxides of nitrogen and particulate matter for a specified year, road type, vehicle speed and vehicle fleet composition". To my mind that makes it clear that Defra is expecting anticipated changes in vehicle emissions to be factored in to assessments such as this. The Wealden Local Plan examination, where the Inspector commented that it would be unreasonable to assume no improvements over time, is an example of this approach in action.* Therefore, it is appropriate that this scenario of "with policy applied" is included in this assessment, and that it is considered to be the most applicable methodology, factoring in expected air quality improvements in the future as a result of enhancements to the emissions performance of the road traffic fleet.

The Proposed Development includes 100% passive electric vehicle charging point provision for all car parking spaces. In addition, there will be no gas fired boilers, with air source heat pumps being used for hot water and electric panel heaters for heating. Therefore, the emissions arising from the Site are being minimised as much as possible.

[2] https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/

1.1 The Location of the Development

The Proposed Development is located in the northern part of Norwich City Centre, north of St Crispins Road (**Figure 1**). The location of each block referred to in the assessment is shown in **Figure 2**.

Figure 1: Location of the Site

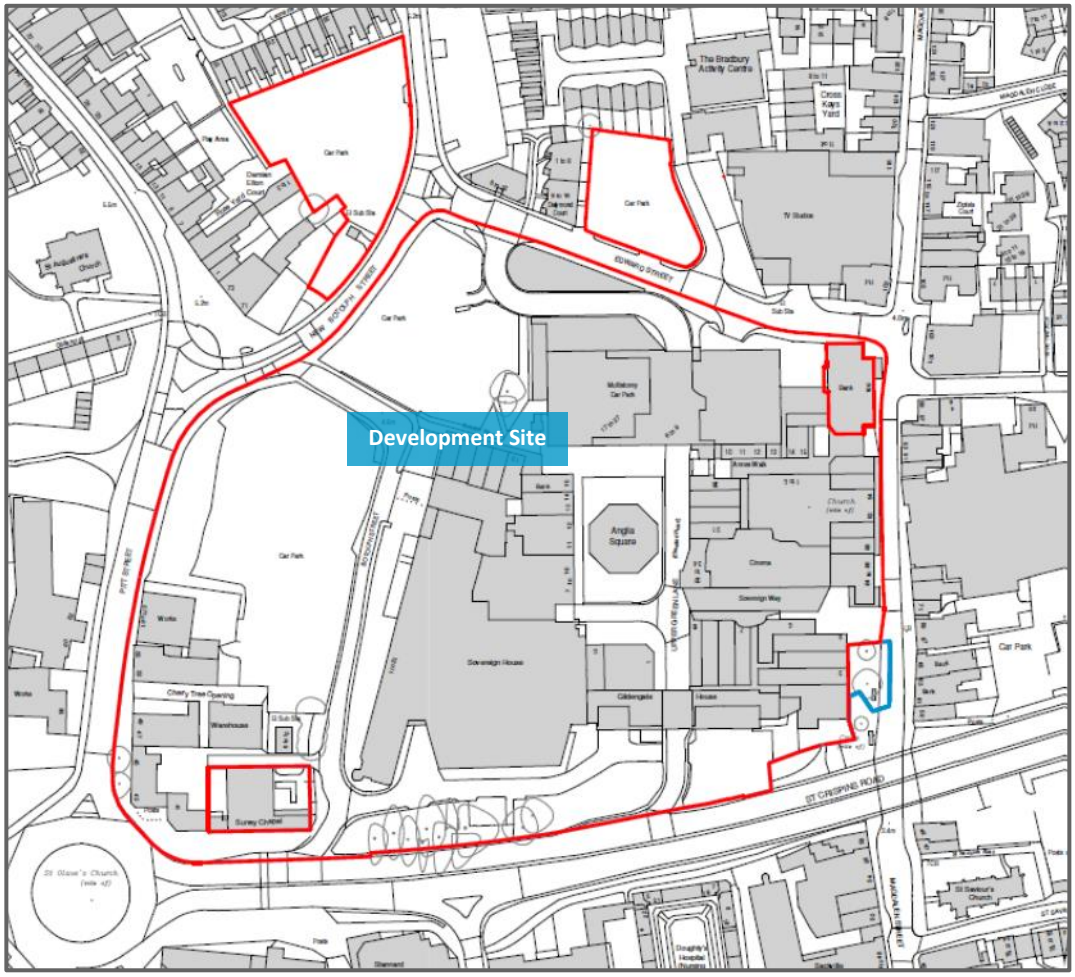
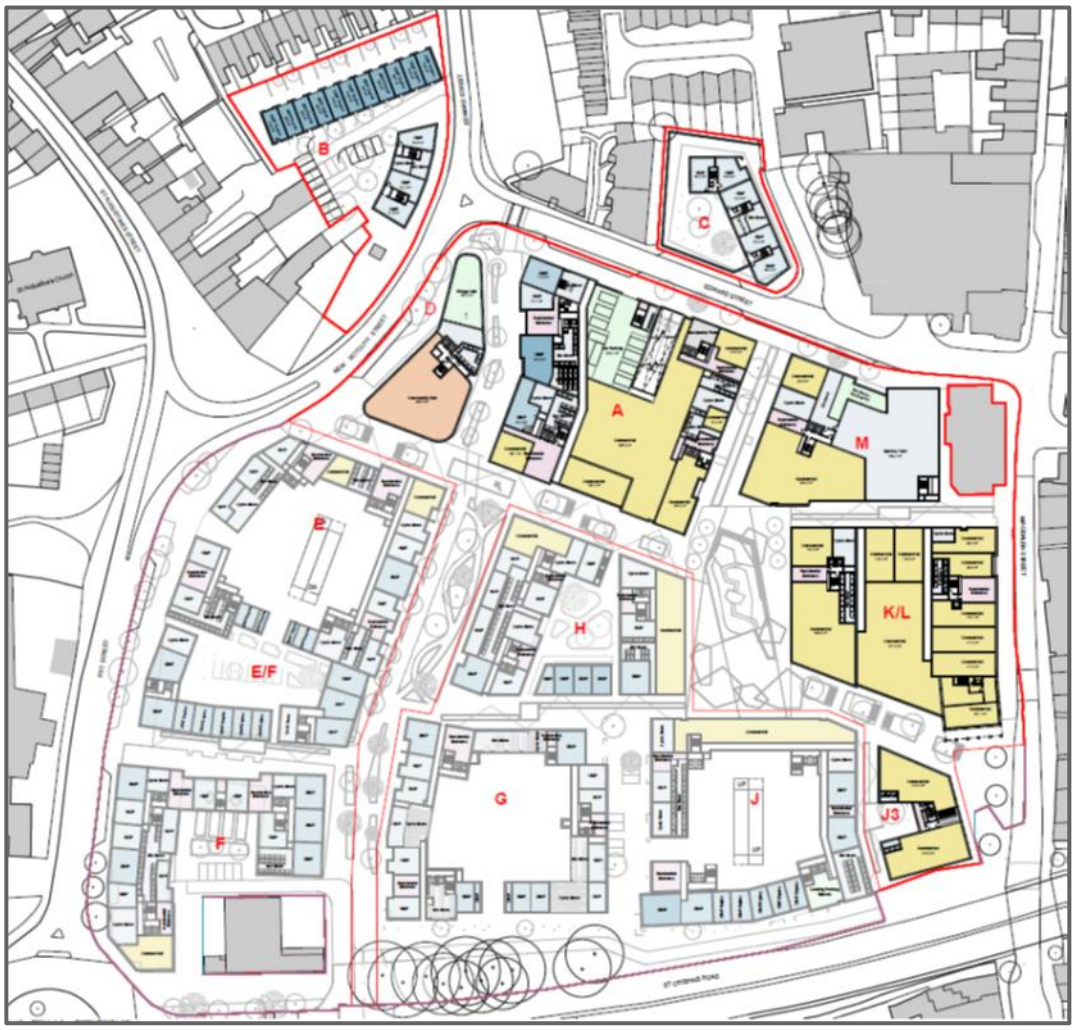


Figure 2: Block names and ground level land uses across the Proposed Development



Note: those blocks shown in a lighter shade are not part of the full application phases of the development, but rather the outline application, which does nevertheless fix building layout. Those buildings shaded in blue will be used for residential use, but note that Building M ground floor is not habitable residential accommodation.

1.2 Assessment Criteria

A summary of the air quality objectives, identifying the type of mean values used to assess the pollutant concentration, relevant to the Proposed Development, as set out in the UK Air Quality Strategy[3], is presented in **Table 1** below.

Table 1: UK Air Quality Objectives for NO_2 and PM_{10}

Pollutant	Concentration	Measured as
Nitrogen Dioxide (NO_2)	40 µg/m^3	**Annual mean**
	200 µg/m^3	**Hourly mean** not to be exceeded more than 18 times per year (99.8th percentile)

[3] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007), Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland

Particulate Matter (PM_{10})	40 µg/m^3	**Annual mean**
	50 µg/m^3	**24 hour mean** not to be exceeded more than 35 times a year (90.4th percentile)

The oxides of nitrogen (NO_X) comprise principally of nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is a reddish brown gas (at sufficiently high concentrations) and occurs as a result of the oxidation of NO, which in turn originates from the combination of atmospheric nitrogen and oxygen during combustion processes. NO_2 can also form in the atmosphere due to a chemical reaction between NO and ozone (O_3). Health based standards for NO_X generally relate to NO_2, where acute and long-term exposure may adversely affect the respiratory system.

Particulate matter, (PM), is a term used to describe all suspended solid matter, sometimes referred to as Total Suspended Particulate matter (TSP). Sources of particles in the air include road transport, power stations, quarrying, mining and agriculture. Chemical processes in the atmosphere can also lead to the formation of particles. Particulate matter with an aerodynamic diameter of less than 10 µm is the subject of health concerns because of its ability to penetrate deep within the lungs and is known in its abbreviated form as PM_{10}.

A growing body of research has also pointed towards the smaller particles as a metric more closely associated with adverse health impacts, in particular, particulate matter with an aerodynamic diameter of less than 2.5 micrometres, known as $PM_{2.5}$. Local Authorities in England have a flexible role[4] in working towards reducing emissions and concentrations of $PM_{2.5}$ as there is no specific objective for them, since the pollutant is often transboundary in nature and therefore beyond a Local Authority's control. However, there is a UK (excluding Scotland) annual mean objective of 25 µg/m^3. In addition, there is a World Health Organisation recommended guideline annual average level of 10µg/m^3 and the government is currently considering whether this is appropriate and how it could be met[5]. The UK's Committee on the Medical Effects of Air Pollutants (COMEAP) has agreed that reducing concentrations below the World Health Organization's Air Quality Guideline (10 µg/m^3) would benefit public health and therefore it is expected that this will be incorporated as a UK standard at some point.

Further information on the health effects of air pollution can be found in the reports produced by COMEAP[6].

As defined by the regulations, the air quality objectives for the protection of human health are applicable:

- Outside of buildings or other natural or man-made structures above or below ground
- Where members of the public are regularly present.

Using these definitions, the **annual mean** objectives will apply at locations where members of the public might be regularly exposed, such as building façades of residential properties, schools and hospitals and will not apply at the building façades of offices or other places of work, where members of the public do not have regular

[4] LAQM TG16 – paragraph 1.09
[5] https://www.who.int/publications/i/item/9789240034228 It is worth noting that the 2021 WHO air quality guidelines now recommend an annual average $PM_{2.5}$ concentration of 5µg/m^3. However, this has not been considered by the UK government at the current time.
[6] https://www.gov.uk/government/collections/comeap-reports

access. The **24 hour objective** will apply at all locations where the annual mean objective would apply. Therefore, in this assessment, different objectives will apply at different locations on different floor levels around the Proposed Development. Please see **Figure 2** for scheme block labelling and ground level land uses.

Ground floor residential accommodation will be provided in Blocks A, B, C, E, E/F, F, G, H, & J and therefore the annual mean and 24 hour mean objectives will apply at these locations

On the first floor and above, the annual mean and 24 hour mean objectives will also apply at blocks D, J3, K/L and M.

The hourly objective will apply at all locations where members of the public could reasonably be expected to spend that amount of time. Therefore, in this assessment the hourly objective will apply at all levels and across the Proposed Development site.

1.3 Local Air Quality Management

Local authorities are required to periodically review and assess the current and future quality of air in their areas. Where it is determined that an air quality objective is not likely to be met, the authority must designate an Air Quality Management Area (AQMA) and produce an Air Quality Action Plan (AQAP).

Norwich City Council (NCC) has declared one AQMA[7] covering the centre of the city, broadly covering an area within the inner link road. This AQMA was declared in 2012 due to exceedances of the annual mean NO_2 objective. The latest AQAP[8] was published in 2021. The Proposed Development site is located within this AQMA.

The Council have developed mitigation actions that can be considered under ten broad topics:

- Introduction of Low Emission Zone
- Reducing vehicle idling through engine switch-off legislation
- Promoting low emission transport
- Promoting travel alternatives
- Alternatives to private vehicle use
- Transport planning and infrastructure
- Freight and delivery management
- Traffic management
- Policy guidance and development control
- Public information
- Vehicle fleet efficiency
- Environmental permits

The main priorities are to reduce emissions from public transport (Buses, Private Hire Vehicles and Taxis) and promote alternative modes of travel. To achieve this, Norwich City Council in conjunction with Norfolk County Council are proposing the following measures to be carried out over the next 5 years:

- Expansion of the Low Emission Zone (LEZ)

[7] https://www.norwich.gov.uk/info/20212/pollution/1491/air_pollution
[8] https://www.norwich.gov.uk/download/downloads/id/7493/2021_air_quality_action_plan.pdf

- Restricting traffic in the LEZ to a much tougher Euro emission standard by end of 2023 following discussions with transport operators
- Extending engine switch off powers to accommodate extended LEZ
- Promote low emission public transport through the use of external grant schemes and private investment
- Reviewing traffic light junctions to reduce congestion and improve traffic flow – this could include updating traffic lights to smarter technology
- Make road junctions safer and easier for cycles & pedestrians
- Expand the cycle networks (Pedalways) and create safe more connected corridors for pedestrians and cyclists
- Build upon School Travel Plans and introduce School Streets. Encourage schools to participate in air quality initiatives such as Clean Air Day
- Introduce Mobility Hubs at key transport interchanges
- Engage the public through a behaviour change programme, including the use of social media, to be more aware of taking personal responsibility for reducing air pollution, such as engine switch off, walking/cycling/car share/car club, using an open fire responsibly.

2 Methodology

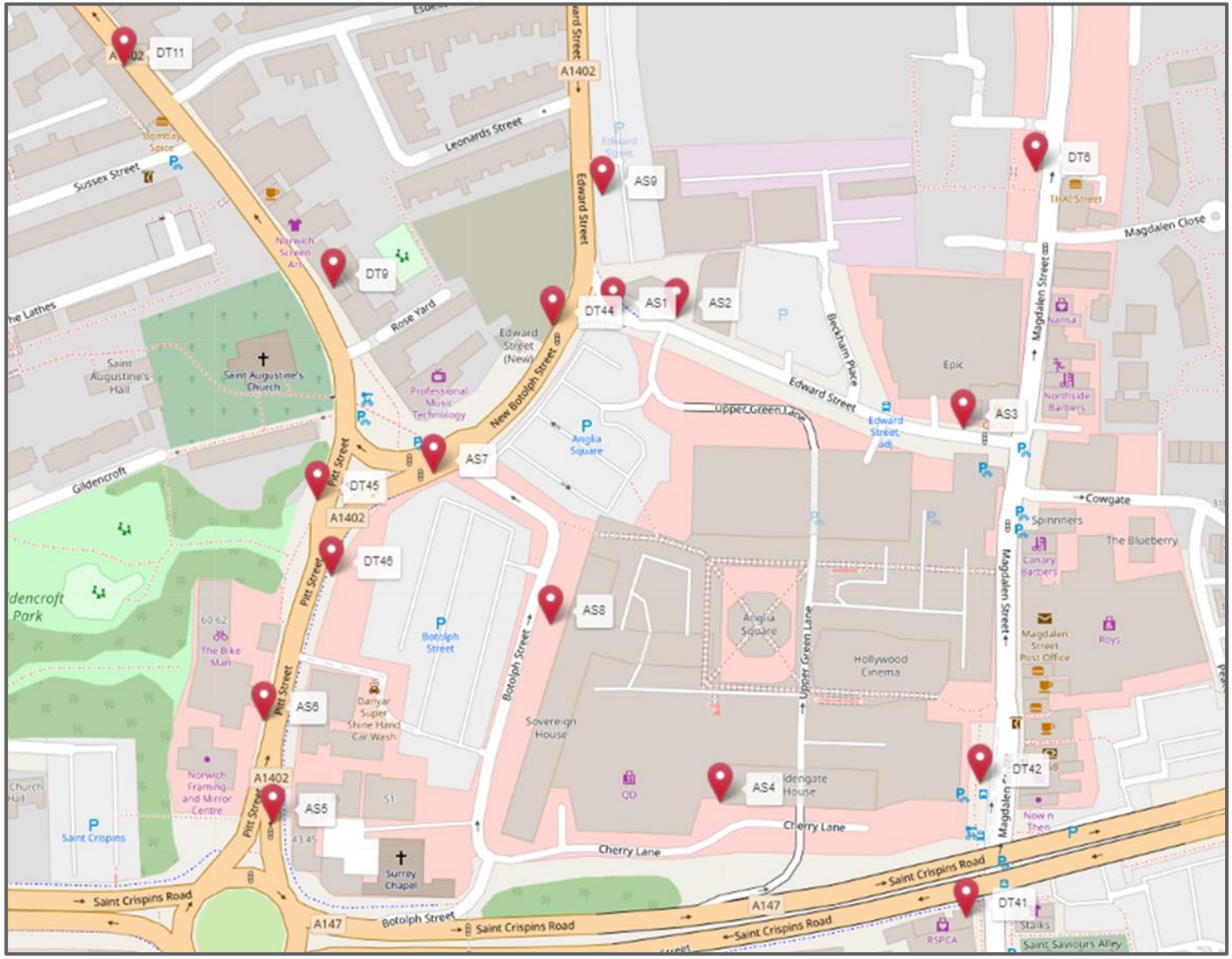
2.1 Local Pollutant Concentrations

It is good practice to include up-to-date local background pollutant concentrations in the assessment model, and also to verify modelled outputs against local monitoring data where available. This section provides an overview of the local data available for use in the assessment.

2.1.1 Local monitoring data

Norwich City Council has two automatic monitoring sites which measure nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$); however neither of these are located within close proximity of the Site and are therefore not discussed further for NO_2 as they are unlikely to be representative. The results are however presented for PM as this provides the only source of information in Norwich and therefore provides indicative levels for the whole city area. NO_2 concentrations are also measured passively at diffusion tube sites across the Borough. Details of those in the roads surrounding the Site are provided in **Table 2.** In addition, the Applicant has instigated via Aether a diffusion tube monitoring survey which is being undertaken at nine locations across the Site, agreed with NCC, from November 2021 to April 2022 inclusive, and details of these are provided in **Table 3**. It is worth noting that the on-Site survey results are provided as indicative only, as it is understood that due to the Covid-19 pandemic, air pollutant concentrations may currently be artificially low and therefore not representative of future years. The location of the monitoring sites listed in **Tables 2 and 3** are provided in **Figure 3**.

Figure 2: The location of the Diffusion Tube (DT) monitoring sites.



Note: NCCs long term diffusion tube locations are prefaced with "DT" and those that are part of the Applicant's short-term survey are prefaced with "AS". Map source: Open Street Map

Table 2: NCC's diffusion tube sites around Anglia Square

Site Name	Site Type	Grid Reference	Distance to Kerb (m)
CM1 (Castle Meadow) *	K	623202,308615	1.0
CM2 (Lakenfields) *	UB	623637,306940	N/A
DT 6: 130 Magdalen St	R	623161,309550	4.0
DT 9: 13 St Augustines St	K	622906,309496	1.5
DT 11: 52 St Augustines St	K	622826,309573	1.0
DT16: Zipfel House	R	623186,309650	3.0
DT 41: Magdalen Street (RSPCA)	R	623148,309277	3.5
DT 42: Magdalen St (bus stop)	R	623151,309326	2.5
DT 44: Botolph Street / Edward St jcn	R	622987,309486	2.0
DT 45: Pitt Street W	R	622904,309418	2.2
DT 46: Pitt Street E	R	622910,309391	2.1

*Note: R = roadside, K = kerbside, UB = urban background. *= automatic monitor, N/A = not applicable*

Table 3: The Applicant's Short term diffusion tube sites around Anglia Square

Site Name	Site Type	Grid Reference	Distance to Kerb (m)
AS1: South side of Edward Street	R	623009,309490	1.6
AS2: Dalymond Court, Edward Street	R	623032,309491	1.9
AS3: Epic Studios, Edward Street	R	623139,309455	4.4
AS4: St Crispins Road (Cherry Lane)	UB	623056,309315	N/A
AS5: St Crispins / Pitt Street	R	622893,309300	6
AS6: South end of Pitt Street	R	622888,309337	1
AS7: New Botolph Street	R	622946,309430	3
AS8: St George's Street	UB	622991,309377	N/A
AS9: Edward Street - north of AS	R	623003,309534	2.5

Note: R = roadside, UB = urban background

Both sets of diffusion tubes have been supplied and analysed by Gradko International Ltd using the 50% TEA in acetone method. Grakdo participate in the Proficiency scheme[9]. Whilst diffusion tubes provide an indicative estimate of pollutant concentrations, they tend to under or over read. The data is therefore corrected using a bias adjustment factor. There are two types of bias adjustment factor – local and national. The local factor is derived from co-locating diffusion tubes (usually in triplicate) with automatic monitors, whereas the national factor is obtained from the average bias from all local authorities using the same laboratory. NCC has applied a local bias adjustment factor (0.88) to their 2020 diffusion tube results. In 2019 (the base year used in the assessment) the Council used a national adjustment factor (0.89). The short-term diffusion tube survey results have not been bias corrected and are therefore likely to be an over-estimate of actual concentrations during the monitoring period, which is

[9] This is a national QA/QC scheme.

therefore a robust approach. Whilst three diffusion tubes each month have been placed at the Council's automatic monitoring site in Lakenfields and to date (covering the results for Nov, Dec and Jan) a bias adjustment factor of 0.74 has been calculated, it was decided that as this was a relatively short period of time, as a robust, worst case approach a bias adjustment factor would not be applied.

Results have been taken from the Council's latest Annual Status Report (ASR)[10] and supplemented with more recent data for 2021 that is yet to be published. The methodology for the Anglia Square diffusion tube survey is provided in the Monitoring Survey Report.

Monitoring results are presented in **Tables 4, 5 and 6**. The data shows that the annual mean NO_2 objective was exceeded at the DT11 (52 St Augustines St) monitoring location in 2019 and 2021, with the result being very close in 2020. In addition, the DT9 (13 St Augustines St recorded an exceedance in 2019 and a value close to the objective in 2021. However, at the other sites, the objective was met in all years shown.

The Anglia Square monitoring survey results have so far only recorded values over 40µg/m^3 at the AS5 (St Crispins / Pitt Street) site, with many of the sites recording values substantially below the objective.

Diffusion tubes do not provide information on hourly exceedances, but research[11] identified a relationship between the annual and 1 hour mean objective, such that exceedances of the latter were considered unlikely where the annual mean was below 60 µg/m^3. Therefore, no exceedances of the 1 hour mean objective are expected.

Table 4: Monitoring results for NCC tubes, 2019 - 2021

Objective	Site Name	2019	2020	2021*
Annual mean NO_2 (µg/m^3)	DT6 130 Magdalen St	29.8	21.7	26.3
	DT9 13 St Augustines St	**40.1**	33.0	39.5
	DT11 52 St Augustines St	**46.0**	39.4	**48.4**
	DT16 Zipfel House	36.1	30.5	N/A
	DT 41: Magdalen Street (RSPCA)	34.2	27.4	35.4
	DT 42: Magdalen St (bus stop)	33.0	21.4	33.0
	DT 44: Botolph Street / Edward St jcn	N/A	22.5	25.7
	DT 45: Pitt Street W	N/A	25.4	27.3
	DT 46: Pitt Street E	N/A	25.4	28.8

*Note: Values exceeding the 40 µg/m^3 annual mean objective are shown in bold. *2021 data has not been bias corrected and is therefore likely to be an over-estimate. N/A= not available*

[10]https://www.norwich.gov.uk/downloads/download/1917/air_quality_monitoring_reports_and_assessments

[11] As described in Box 5.2 of LAQM Technical Guidance (TG16).

Table 5: Monitoring results from the Anglia Square survey (Nov 2021 to April 2022 inclusive)

Objective	Site Name	Nov	Dec	Jan	Feb	Mar	Apr
Annual mean NO_2 ($\mu g/m^3$)	AS1: South side of Edward St	28.7	28.9	33.2	19.6		
	AS2: Dalymond Court	28.6	24.3	27.1	19.3		
	AS3: Epic Studios, Edward St	32.9	31.7	32.0	26.0		
	AS4: St Crispins Road (Cherry Ln)	23.4	21.1	22.4	17.4		
	AS5: St Crispins / Pitt St	**42.3**	38.3	**45.0**	33.8		
	AS6: South end of Pitt St	35.6	32.1	37.8	31.6		
	AS7: New Botolph St	32.9	28.0	35.5	22.6		
	AS8: St George's St	27.5	26.2	27.4	17.4		
	AS9: Edward Street - north of Anglia Square	33.3	28.8	37.7	23.5		

Note: Values exceeding the 40 $\mu g/m^3$ annual mean objective are shown in bold. All data has not been bias corrected and is therefore likely to be an over-estimate.

Table 6: PM Monitoring results for NCC (2019 to 2020)

Objective	Site Name	2019	2020	2021
Annual mean PM_{10} ($\mu g/m^3$)	CM1 (Castle Meadow) *	19	19	19
	CM2 (Lakenfields) *	14	13	N/A
Number of PM_{10} daily means >50 $\mu g/m^3$	CM1 (Castle Meadow) *	5	0	0
	CM2 (Lakenfields) *	4	0	N/A
Annual mean $PM_{2.5}$ ($\mu g/m^3$)	CM1 (Castle Meadow) *	10	10	9
	CM2 (Lakenfields) *	10	8	N/A

The PM_{10} monitoring shows that even at the busy Castle Meadows site, which is effectively a bus interchange / terminus, concentrations were substantially below the objectives. In addition, $PM_{2.5}$ concentrations met the WHO annual mean standard of 10 $\mu g/m^3$ at both automatic monitoring locations.

NCC's Annual Status Report[10] provides information to show that there were very significant decreases in NO_2 levels at the Castle Meadow site due to the Covid lockdown but that there was an insignificant impact on particulate matter levels. The report also provides information to show that in Norwich $PM_{2.5}$ is primarily a transboundary pollutant and that the Lakenfields site, which is outside the urban area, is just as likely to have elevated levels of $PM_{2.5}$ as the urban kerbside site, thus indicating traffic pollution is not the primary source of $PM_{2.5}$.

2.1.2 Background mapped data

Background pollutant concentration maps are available from the Defra LAQM website[12] and data has been extracted for the local vicinity of the Proposed Development for this assessment. These 2018 baseline, 1 kilometre grid resolution maps are derived from a complex modelling exercise that takes into account emissions inventories and measurements of ambient air pollution from both automated and non-automated sites. The projections in the 2018 LAQM background maps are based on assumptions which were current before the Covid-19 outbreak in the UK. In consequence these maps do not reflect short or longer term impacts on emissions in 2020 and beyond, resulting from behavioural change during the national or local lockdowns.

The estimated mapped background NO_x, NO_2 and PM_{10} concentrations around the Site are 23.2 µg/m³, 16.6 µg/m³ and 16.2 µg/m³ respectively in 2019. For 2030 (the latest year for which projected mapped background concentrations are available), the concentrations obtained for the same pollutants are 17.0 µg/m³, 12.5 µg/m³ and 14.9 µg/m³ respectively.

Due to the lack of a nearby urban background monitoring site, the 2019 mapped background concentrations have been used for the 'with no policy applied' scenarios in this assessment. This provides a worst-case scenario as it does not take into account predicted improvements to the road traffic fleet which should reduce background pollutant concentrations. These predicted improvements that reduce background concentrations have been factored in for the 'with policy applied' scenarios by using the 2030 projected values. This could potentially be an over-estimate as pollutant concentrations would be expected to decrease further for 2034, the year modelled as the previously expected first full year of occupation.

2.2 Traffic data

Information on traffic flows both 'without Proposed Development' and 'with Proposed Development' is provided in the Transport Assessment. The values are shown in Appendix B. These demonstrate that the Proposed Development does not increase traffic flows on roads surrounding the Site. However, general anticipated increases in traffic between 2019 and 2034 are taken into account in the assessment.

Average speeds for the major roads have been supplied in the Transport Assessment. In the absence of any other data being available, average speeds on local minor roads have been assumed based on the speed limit.

2.2.1 Queuing Traffic

Special consideration has been given to junctions modelled in this assessment. Junctions on the following roads qualified for traffic queue modelling as based on expert judgment: Edward Street Magdalen Street, St Augustines Street and on the intersection between Magpie Road and Bull Close Road. CERC Note 60[13] has been used for estimating emissions from queuing traffic. This defines a representative AADT for queuing traffic to be 30,000 at 5 kph, assuming an average vehicle length of 4 m. These figures, along with the traffic composition of the corresponding roads were inputted into the Emission

[12] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html
[13] Cambridge Environmental Research Consultants Ltd, Modelling Queuing Traffic – Note 60, 20th August 2004

Factor Toolkit (EFT)[14] to calculate emission rates. The emission rates were used within the dispersion model as separate road sources of pre-defined length, representing each queue with time-varying emission profiles applied to represent busy periods.

2.2.2 Emission rates

The latest version of Defra's Emission Factor Toolkit (EFT) (Version 11, published in November 2021) has been used to derive vehicle emission rates. The toolkit provides emission rates for 2018 through to 2050 for England. The EFT takes into consideration the following information from the National Atmospheric Emissions Inventory:

- Fleet composition data for motorway, urban and rural roads in the UK
- Fleet composition based on European Emission standards from pre Euro I to Euro6 / VI
- Scaling factors reflecting improvements in the quality of fuel and some degree of retrofitting; and
- Technology conversions in the national fleet.

The EFT guidance document[15] states that *it is published by Defra and the Devolved Administrations to assist Local Authorities in carrying out Review and Assessment of local air quality as part of their duties under the 1995 Environment Act. It is of particular interest for use in the assessment of measures implemented as part of LAQM Air Quality Action Plans (AQAPs) and policy interventions on road traffic emissions, such as Clean Air Zones and other measures that form part of the UK national plan on compliance with Air Quality Standards*.

2.3 Model input data

Hourly meteorological data from Norwich for 2019 has been used in the model. The wind-rose diagram, (**Figure 4**), presents this below.

[14] Latest version 9.0, http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html
[15] https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/

Figure 4: Wind-rose diagram for Norwich meteorological data, 2019

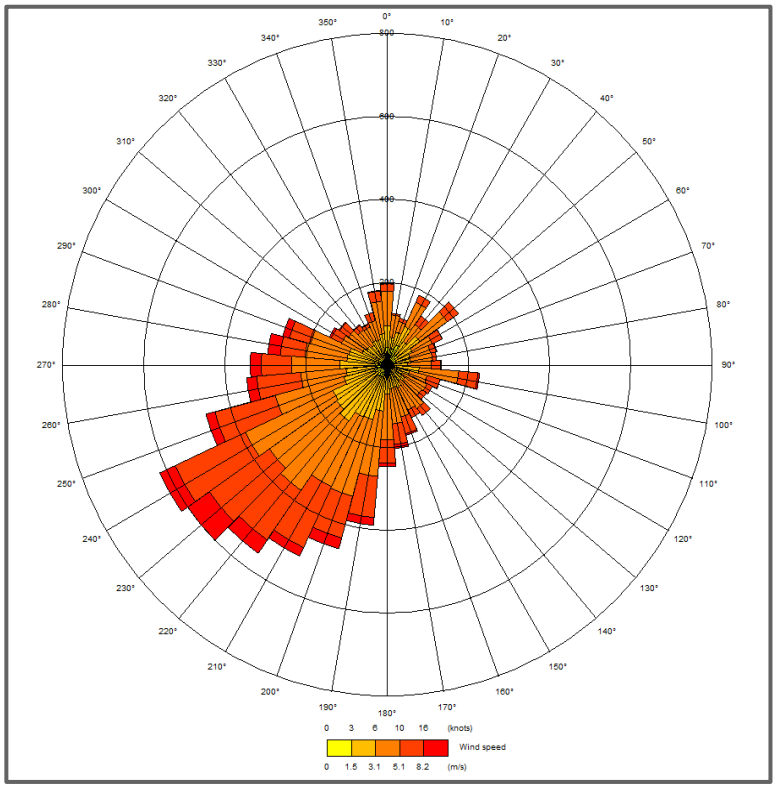
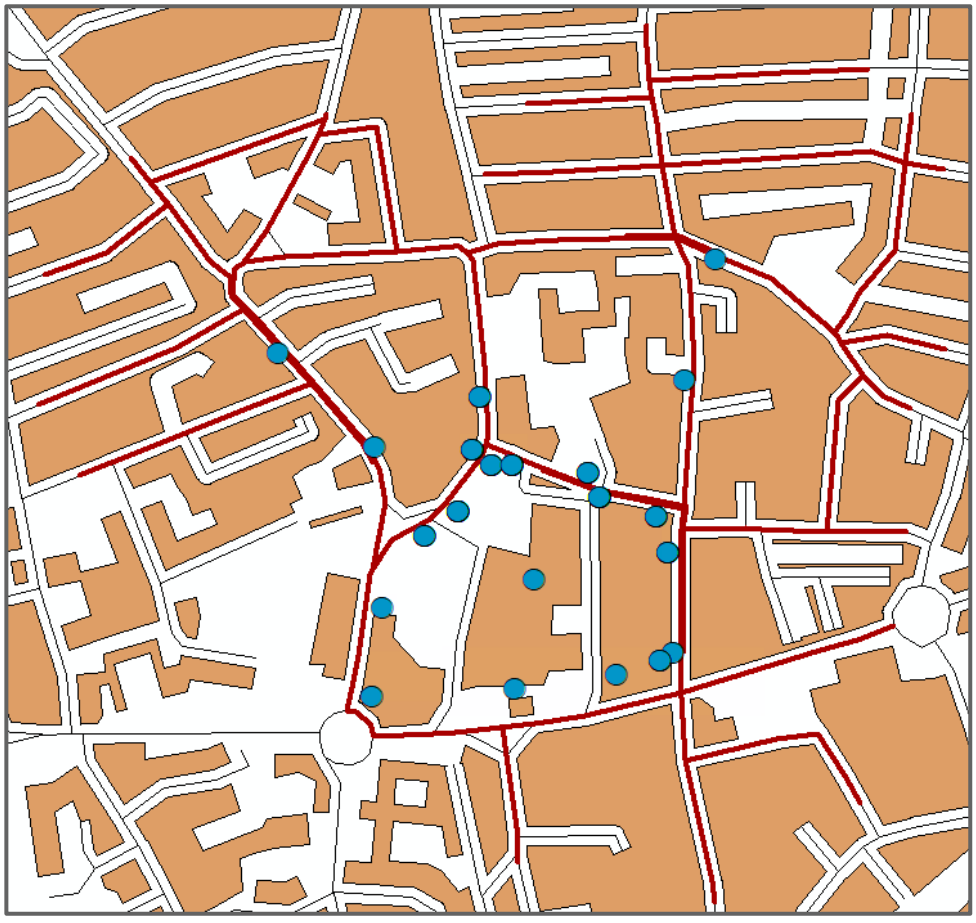


Figure 5: Road sources and receptors



Contains Ordnance Survey data © Crown copyright and database right [2022]

ArcMap software has been used to model the road source locations (red lines) that are within 200 metres of the receptor locations (blue circles). This data can then be automatically uploaded to ADMS-Roads. This generates an accurate representation of the surrounding area to be assessed in the model in terms of the length of roads and distances between sources and receptors. This is shown in **Figure 5** above. It is assumed that the contribution of other sources to NO_2 and PM_{10} is included in the background concentrations.

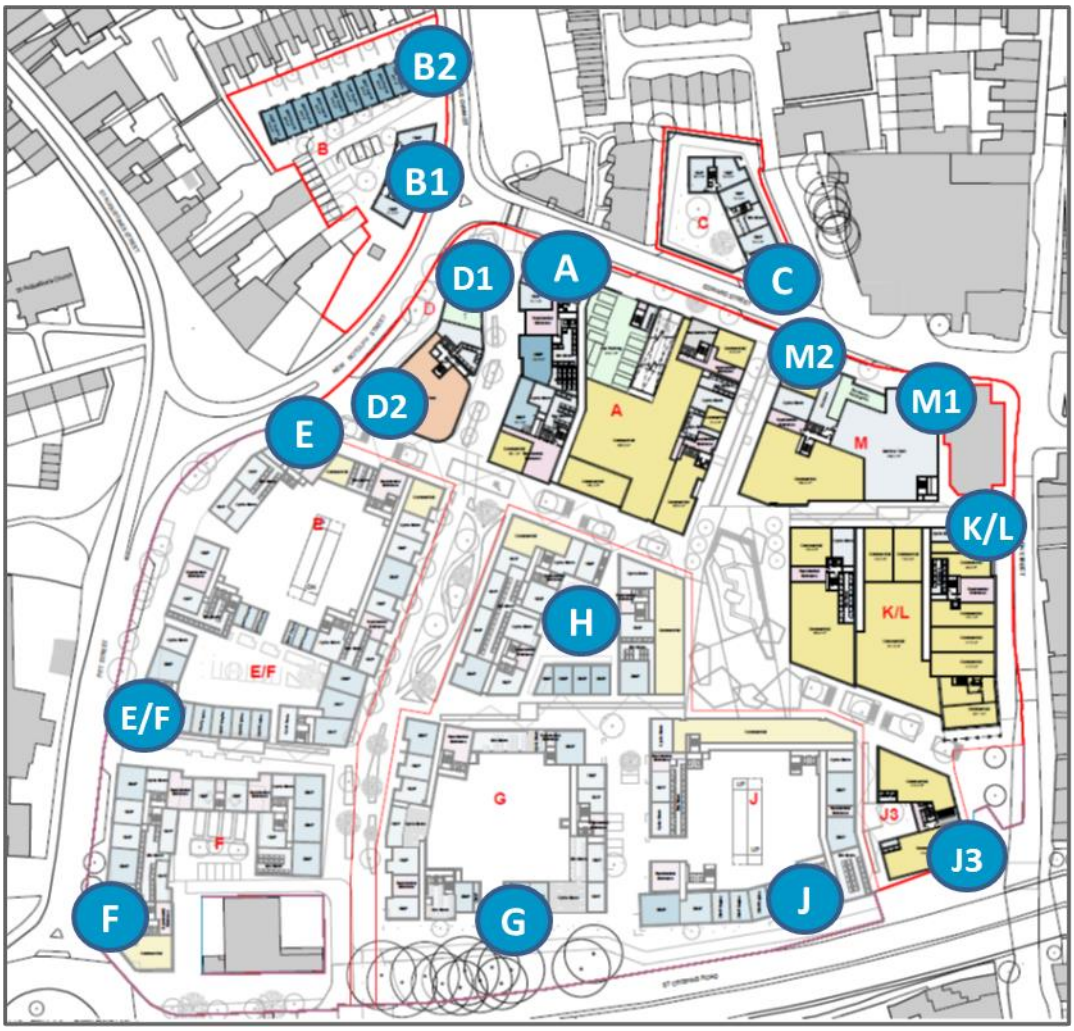
Sixteen sensitive receptor locations have been selected for the assessment:

- A:northwest corner of block A
- B1: east façade of block B
- B2: northeast corner of block B
- C: south façade of block C
- D1: north façade of block D
- D2: southwest corner of block D
- E: northwest corner of block E
- E/F: western façade of block E/F
- F: southwest corner of block F
- G: southern façade of block G
- H: centre of block H, representing the drop off in concentrations with distance from the road
- J: southern façade of block J
- J3: southeast corner of block J3, located closest to Magdalen Street at the St Crispins Road flyover
- K/L: northeast corner of block K/L
- M1:northeast corner of block M
- M2: northwest corner of block M

These receptor sites have been chosen to reflect the façades of buildings within the Proposed Development and their proximity to road traffic sources. The layout plan (**Figure 6**) shows the Proposed Development in more detail with receptor locations highlighted (blue circles). An assessment is made for the receptors at varying heights to assess likely concentrations across floor levels. It has been assumed that background concentrations remain constant at all heights of the Proposed Development based on the 2017 City Air Quality at Height report[16]. Exposure has been assumed to be represented at the mid-point of each floor. The heights of the floors have been taken from architectural drawings provided.

[16] http://www.wsp-pb.com/PageFilesn/80156/WSPPB%20City%20Air%20Quality%20at%20Height.pdf

Figure 6: The location of the receptors around the Proposed Development used in the modelling



Note: those locations shaded in dark and light blue are proposed for residential use, but this does not include the light grey area in Block M, which is a service yard

2.4 Conversion of NO_X to NO_2

Evidence shows that the proportion of primary NO_2 in vehicle exhaust has increased[17]. This means that the relationship between NO_X and NO_2 at the roadside has changed from that currently used in the ADMS model. A NO_X to NO_2 calculator (Published in August 2020)[18] has therefore been developed and has been used in conjunction with the ADMS model to obtain a more accurate picture of NO_2 concentrations.

2.5 Model Verification

Model verification refers to checks that are carried out on model performance at a local level. This involves the comparison of predicted versus measured concentrations. Where there is a disparity, the first step is to check the input data and the model parameters in

[17] http://uk-air.defra.gov.uk/assets/documents/reports/aqeg/primary-no-trends.pdf
[18] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOXNO2calc

order to minimise the errors. If required, the second step will be to determine an appropriate adjustment factor that can be applied.

In the case of NO_2, the model should be verified for NO_X as the initial step and should be carried out separately for the background contribution and the source (i.e. road traffic)[19]. Once the NO_X has been verified and adjusted as necessary, a final check should be made against the measured NO_2 concentration.

For this project, modelled annual mean road-NO_X estimates in 2019 have been verified against the concentrations measured at the three most appropriate local diffusion tube sites: DT9, DT16 and DT42. For further detail on the methodology see **Appendix A**.

The adjustment factor determined for annual mean NO_X concentrations was also applied to the modelled annual mean PM_{10} concentrations. This was done as no PM_{10} monitoring data that is representative of the Site is available from NCC, and this approach was considered more appropriate than not applying any adjustment[20].

[19] In accordance with Box 7.16, page 7-132 of LAQM TG16
[20] Paragraph 7.529 of LAQM TG(16)

3 Results

3.1 Results of the Dispersion Modelling

Table 7 below provides the estimated annual mean NO_2 concentrations in:

- The base year (2019)
- The development year plus three, (2034), in a "with no policy applied" and a "with policy applied" scenario[21].

Table 8 provides the estimated annual mean PM_{10} concentrations for the same respective scenarios.

[21] For this assessment, as traffic levels are not predicted to increase as a result of the development, so the "without" and "with" development scenario will be the same.

Table 7: Estimated NO_2 concentrations ($\mu g/m^3$)

Annual mean NO_2 concentration ($\mu g/m^3$)					
Floor level	**Receptor**	**2019 Baseline**	**2034 Without Policy Applied**	**2034 With Policy Applied**	**Difference in 2034 without and with Policy Applied**
Ground	A	26.5	27.1	17.1	10.0
	B1	25.8	26.8	16.3	10.6
	B2	26.1	27.2	16.3	11.0
	C	**52.5**	**52.8**	34.6	18.3
	D1	25.9	26.8	16.5	10.3
	D2	24.1	24.8	15.5	9.3
	E	24.5	25.5	15.6	10.0
	E/F	24.7	26.0	15.6	10.5
	F	24.7	26.1	15.5	10.6
	G	21.6	22.2	14.5	7.8
	H	21.3	21.5	14.8	6.7
	J	22.0	22.5	14.9	7.6
	J3	25.2	25.7	16.8	8.9
	K/L	39.7	**40.0**	26.0	14.0
	M1	**46.3**	**46.6**	30.5	16.1
	M2	**56.2**	**56.4**	37.2	19.2
First	A	23.0	23.2	15.5	7.7
	B1	22.5	23.0	15.1	8.0
	B2	22.2	22.6	14.9	7.7
	C	30.5	30.7	20.6	10.1
	D1	22.6	23.0	15.2	7.8
	D2	21.7	22.1	14.7	7.4
	E	21.5	22.0	14.5	7.5
	E/F	20.8	21.4	14.2	7.2
	F	20.3	20.9	14.0	6.9
	G	20.3	20.8	14.0	6.7
	H	20.7	20.9	14.5	6.4
	J	21.5	21.9	14.6	7.2
	J3	22.9	23.3	15.5	7.8
	K/L	26.4	26.6	18.0	8.6
	M1	22.6	22.8	15.8	7.0
	M2	27.4	27.4	18.6	8.8
Second	A	20.4	20.5	14.3	6.2
	B1	20.5	20.8	14.3	6.5
	B2	20.3	20.5	14.2	6.3
	C	21.4	21.5	15.0	6.5
	D1	20.3	20.5	14.2	6.3

	D2	20.0	20.2	14.0	6.2
	E	19.7	20.0	13.8	6.1
	E/F	19.0	19.2	13.5	5.7
	F	18.4	18.6	13.3	5.3
	G	19.2	19.4	13.6	5.8
	H	19.9	20.0	14.1	6.0
	J	20.2	20.5	14.1	6.4
	J3	20.6	20.9	14.4	6.6
	K/L	20.6	20.7	14.6	6.1
	M1	21.4	21.5	15.1	6.5
	M2	20.8	20.8	14.6	6.2
Third	A	18.9	19.0	13.6	5.4
	B1	19.3	19.4	13.8	5.7
	C	19.1	19.1	13.7	5.5
	D1	19.0	19.1	13.6	5.5
	D2	18.8	19.0	13.5	5.4
	K/L	18.5	18.6	13.4	5.2
	M2	18.8	18.9	13.6	5.3
Fourth	A	18.1	18.2	13.2	5.0
	D2	18.1	18.2	13.2	5.0
	M2	18.0	18.0	13.1	4.9
Firth	A	17.6	17.6	13.0	4.6
	D2	17.6	17.7	13.0	4.7

Note 1: Exceedances of the annual mean objective are highlighted.

Table 8: Estimated PM_{10} concentrations ($\mu g/m^3$)

Annual mean PM_{10} concentration ($\mu g/m^3$)					
Floor level	**Receptor**	**2019 Baseline**	**2034 Without Policy Applied**	**2034 With Policy Applied**	**Difference in 2034 without and with Policy Applied**
Ground	A	17.2	17.5	17.2	0.4
	B1	17.4	17.9	17.5	0.4
	B2	17.5	18.2	17.7	0.5
	C	18.3	18.6	18.1	0.5
	D1	17.3	17.8	17.4	0.4
	D2	17.2	17.5	17.2	0.3
	E	17.4	17.7	17.4	0.3
	E/F	17.5	17.8	17.6	0.2
	F	17.5	17.8	17.6	0.2
	G	17.0	17.2	17.1	0.2
	H	16.6	16.8	16.6	0.2
	J	16.9	17.1	16.9	0.2
	J3	17.0	17.2	17.0	0.2

	K/L	17.5	17.7	17.4	0.3
	M1	17.8	18.1	17.7	0.4
	M2	18.4	18.6	18.2	0.5
First	A	16.8	17.1	16.8	0.3
	B1	16.9	17.3	16.9	0.3
	B2	16.9	17.4	16.9	0.5
	C	17.0	17.3	17.0	0.3
	D1	16.9	17.2	16.9	0.3
	D2	16.8	17.1	16.8	0.2
	E	16.8	17.1	16.9	0.2
	E/F	16.8	17.0	16.9	0.2
	F	16.8	16.9	16.8	0.1
	G	16.8	16.9	16.8	0.1
	H	16.6	16.7	16.6	0.2
	J	16.8	17.0	16.9	0.1
	J3	16.9	17.1	16.9	0.2
	K/L	16.8	17.0	16.8	0.2
	M1	16.6	16.8	16.6	0.2
	M2	16.9	17.1	16.8	0.2
Second	A	16.6	16.8	16.6	0.2
	B1	16.6	16.9	16.6	0.3
	B2	16.6	17.0	16.6	0.4
	C	16.6	16.8	16.6	0.2
	D1	16.6	16.8	16.6	0.2
	D2	16.6	16.8	16.6	0.2
	E	16.6	16.8	16.6	0.2
	E/F	16.5	16.7	16.5	0.1
	F	16.4	16.5	16.4	0.1
	G	16.5	16.7	16.6	0.1
	H	16.5	16.7	16.5	0.1
	J	16.6	16.8	16.7	0.1
	J3	16.7	16.8	16.7	0.1
	K/L	16.5	16.6	16.5	0.1
	M1	16.6	16.7	16.5	0.2
	M2	16.5	16.7	16.5	0.2
Third	A	16.4	16.6	16.4	0.2
	B1	16.5	16.7	16.5	0.2
	C	16.4	16.6	16.4	0.2
	D1	16.4	16.6	16.4	0.2
	D2	16.4	16.6	16.4	0.2
	K/L	16.4	16.5	16.4	0.1

	M2	16.4	16.6	16.4	0.1
Fourth	A	16.3	16.5	16.4	0.2
	D2	16.3	16.5	16.4	0.1
	M2	16.3	16.5	16.3	0.1
Firth	A	16.3	16.4	16.3	0.1
	D2	16.3	16.4	16.3	0.1
	M2	16.3	16.4	16.3	0.1

3.1.1 Without Policy Applied scenarios

In the scenarios modelled without the predicted impact of UK air quality and climate change policy, the model predicts annual mean NO_2 concentrations to be below the annual mean NO_2 objective at all modelled receptor locations on the first floor and higher floors. At ground floor level, NO_2 concentrations are estimated to exceed the annual mean NO_2 objective at modelled locations towards the east of the site at receptors K/L, M1, M2 and C. The ground floor receptor K/L is proposed for commercial use and therefore the annual mean NO_2 objective does not apply at this location. In addition, where receptors M1 and M2 will be located will be a commercial unit with a service yard, and bin / cycle store respectively, and therefore the annual mean objective will also not apply at this location. Receptor C will however be used for residential use and therefore the annual mean objective will apply at this location.

Research[22] suggests that the 1-hour mean NO_2 objective is likely to be exceeded where annual NO_2 concentrations exceed 60 µg/m^3. At all receptors, modelled concentrations are below 60 µg/m^3 and therefore exceedance of the hourly objective is not an issue.

With regards to PM_{10}, concentrations at all receptors on all floors were modelled to be below the annual mean objective. Indicative results also show that there are no estimated exceedances of the daily mean PM_{10} objective.

3.1.2 With Policy Applied scenarios

This assessment has also considered the UK's commitment to improving air quality as a result of improving transport fleet emission factors through the promotion of electric vehicles (EVs) (primarily driven by climate change concerns and the commitment for all new cars and vans to be effectively zero emission by 2040[23]) and the increasingly stringent Euro standards that vehicles need to meet. The predicted improvements to air quality have been incorporated into the model through improvements to the fleet emission factors (projected in the latest version of Defra's EFT) and background concentrations (projected in Defra's background concentration maps). It is worth noting that these are potentially under estimates of improvements as projections are only available up to 2030, and improvements are expected to continue post this year.

[22] As described in Box 5.2 of LAQM Technical Guidance (TG16).
[23] Set out in 'The Road to Zero', Department for Transport, published July 2018, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf

In the scenarios modelled with the predicted impact of UK air quality and climate change policy, the model predicts annual mean NO_2 concentrations to be below the annual mean NO_2 objective at all modelled receptor locations including ground floor.

The 'With Policy Applied' scenario results indicate that annual mean NO_2 concentrations would be substantially lower compared to the 'Without Policy Applied' scenario.

It is worth noting that the ADMS results using 2019 as the base year are substantially higher than the 2021 – 2022 short term diffusion tube survey results, giving confidence that air quality will not an issue across the Site.

There are no concerns related to PM_{10} concentrations in the 'With Policy Applied' scenario.

For estimating $PM_{2.5}$ concentrations, where no appropriate sites measuring both PM_{10} and $PM_{2.5}$ are available, then a nationally derived correction ratio of 0.7 can be used. If this factor is used, then all locations in the modelling meet the EU Directive annual mean $PM_{2.5}$ limit value of 25 µg/m^3 by a substantial amount. This is likely to be an over-estimate of the values, given the $PM_{2.5}$ concentrations recorded at the two continuous monitoring sites in Norwich.

3.2 Mitigation Measures

Based on the ADMS results for the 'With Policy Applied' scenario, no mitigation is required to reduce residents or employees' exposure to air pollution as the air quality strategy objectives are estimated to be met by at least 10% at relevant receptor locations. This scenario is the most likely outcome and was endorsed by the planning inspector in the previous Call in Scheme application (see Section 1, page 3).

As identified previously, the Proposed Development will not give rise to an increase in traffic levels and there will be no air pollutant emitting on-site energy generation. Therefore, the emissions arising from the Site are being minimised as much as possible.

4 Summary and Conclusions

An air quality assessment has been undertaken in support of a hybrid (part full /part outline) planning application, submitted to Norwich City Council for the comprehensive redevelopment of Anglia Square and various parcels of mostly open surrounding land (the Site). The Proposed Development comprises the redevelopment of the Site as it currently exists to provide up to 8,000 sq m Net Internal Area, flexible commercial and other non-residential floorspace and up to 1,100 new residential dwellings with up to 450 parking spaces, of which at least 95% would be for residents of the scheme. All parking spaces would have EV charging capability and there would be no gas boilers within the Proposed Development.

The Transport Assessment establishes that the Proposed Development will not result in any increase in traffic flows on the surrounding road network in 2034, which is 3 years after the first full year of occupation. Accordingly, for the purposes of the air quality assessment, it is not necessary to model "with development" or "without development" scenarios separately, and therefore only two future scenarios based on predicted traffic flows for 2034 have been modelled. The first ("without policy applied") uses a conservative approach with regards to expected improvements to air quality in that no improvement in the pollutant background concentrations or road transport emission factors has been assumed between the base year (2019) and the future year (2034). The second more likely future scenario ("with policy applied") utilises the projected improvements in pollutant background concentrations and road transport emission factors in 2034.

The ADMS-Roads dispersion model has been used to determine the impact of emissions from road traffic on sensitive receptors under two scenarios – without and with policy. Predicted concentrations have been compared with the air quality objectives. The results of the assessment indicate that annual mean nitrogen dioxide (NO_2) concentrations are above the objective in 2034 (in the "without policy applied" scenario) at Block C at ground floor level. However, in the "with policy applied" scenario, the annual mean objective is met by more than 10%, giving confidence that air quality will not be an issue across the Site. These results are also in accordance with the 2021 – 2022 short term diffusion tube survey results, which to date has not highlighted any concerns around block C.

Concentrations of particulate matter (PM_{10} and $PM_{2.5}$) are predicted to be below the annual and daily mean objectives. at all sensitive receptors, and therefore these results do not indicate any need for mitigation measures .

Appendix A – Model Verification

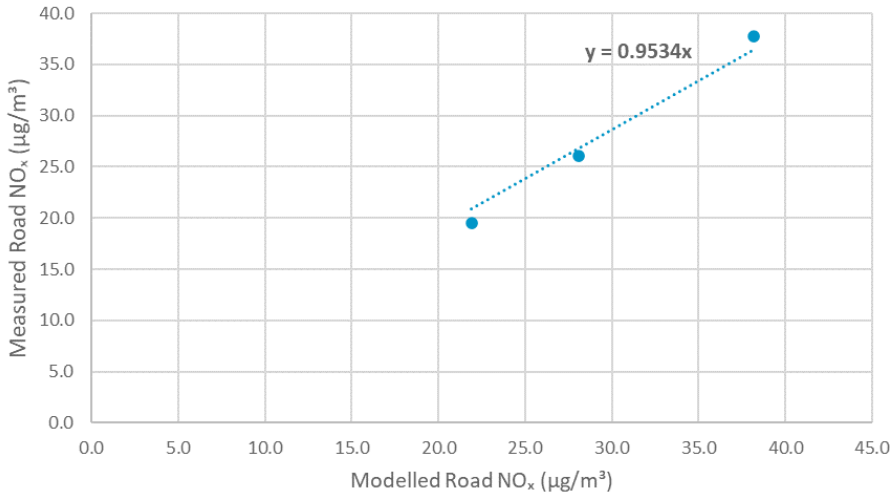
In order to verify modelled pollutant concentrations generated in the assessment, the model has been run to predict the annual mean road-NO_X concentration during 2019 at the DT9, DT16, and DT42 diffusion tube sites described in **Table 2**.

The model output of road-NO_X has been compared with the 'measured' road-NO_X. Measured NO_X for the monitoring sites was calculated using the NO_X to NO_2 calculator[18].

A primary adjustment factor was determined to convert between the 'measured' road contribution and the model derived road contribution (**Figure A.1**). This factor was then applied to the modelled road-NO_X concentration for each receptor to provide adjusted modelled road-NO_X concentrations. Total NO_2 concentrations were then determined by combining the adjusted modelled road-NO_X concentrations with the background NO_2 concentration.

The results imply that the model was very accurate at predicting the road-NO_X contribution. In addition, the same adjustment factor was applied to the modelled road-PM_{10} concentrations.

Figure A.1: Comparison of Measured road-NO_X to unadjusted modelled road-NO_X concentrations



RMSE

The root mean square error (RMSE) is used to define the average error or uncertainty of the model. The following RMSE value has been calculated:

NO_2: 0.86

If the RMSE values are higher than ±25 % of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. Ideally an RMSE within 10 % of the objective would be derived. In this case the model is being assessed against the annual mean objective, which is 40 µg/m^3 for NO_2. An RMSE value of less than 10 % of the objective (less than 4 µg/m^3) is obtained and therefore the model behaviour is acceptable.

Appendix B – Traffic Data

Table B.1: Traffic data for 2019 (and prediction for 2034 with and without development

Road links	Annual Average Daily Traffic (AADT) 2019	Annual Average Daily Traffic (AADT) 2034 without Development	Annual Average Daily Traffic (AADT) 2034 with Development	% Heavy Duty Vehicles (HDV)	Speed (kph)
Pitt Street	20,255	24,437	24,437	4.1	29.3
Edward Street (South)	3,004	3,624	3,624	27.9	33.0
Magdalen Street North	3,993	4,817	4,817	13.6	30.2
Magdalen Street South	1,580	1,906	1,906	19.7	30.1
Edwards Street North	12,374	14,929	14,929	8.4	36.3
New Botolph Street	11,377	13,726	13,726	4.1	32.8
Magpie Road	11,486	13,858	13,858	7.1	39.4
St Augustines Street	14,733	17,775	17,775	6.4	28.1
St Crispins Road	24,624	29,708	29,708	7.3	53.1
Duke Street	9,556	11,529	11,529	4.6	30.8
Bull Close Lane	9,873	11,912	11,912	5.2	35.2
Minor Roads	1,500	1,810	1,810	2.0	48.3

Note 1: % HDV assumed to remain constant in all scenarios. Note 2: the Proposed Development is not expected to cause an increase in traffic. The increase shown between 2019 and 2034 in the table above is due to predicted general local traffic increases.

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