AIR QUALITY ASSESSMENT

BARFORD VILLAGE

PREPARED BY
C4FF

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Developing the Future

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1. Introduction

The United Kingdom has some of the highest particulate and gas emissions in Europe, largely due to the mining and quarrying sector (Fugiel et al., 2017). While these sectors play a vital role in providing essential construction materials, it also has significant environmental and health consequences, including the release of harmful air pollutants like particulate matter ($PM_{2.5}$ and PM_{10}) and nitrogen dioxide (NO_2), as well as disruption to surrounding ecosystems (Fugiel et al., 2017; Sayara et al., 2016; Ekpa et al., 2022). The potential health impacts of these pollutants are of particular concern for nearby communities, especially those with vulnerable populations like children attending schools.

Smiths Concrete Ltd (Smiths) has submitted a planning application for a sand and gravel quarry near Wasperton, Warwickshire (the proposed development). While Smiths has conducted simulations to assess potential impacts, these assessments may not accurately capture the real-world effects on the air quality and the surrounding environments (Drahler and Fishbain, 2018). This is especially concerning given the proximity of the proposed quarry to residential areas, with a pre-school and primary school located just 700 metres away.

In response to the air quality assessment conducted by DustScanAQ (DS) on behalf of the applicant, C4FF has undertaken its own measurements in Barford and at another active quarry. These measurements were carried out by Nottingham Trent University (NTU) on our behalf.). This report will present these findings, directly countering the claims made by DS and providing a more accurate assessment of the proposed development's potential consequences. It will highlight the inadequacy of relying solely on simulations and emphasize the importance of real-world data in assessing the true environmental and health risks associated with the proposed quarry.

Heavy Goods Vehicles (HGVs), which includes trucks, buses, and lorries, play a crucial role in the UK's transportation and logistics sectors. However, their operations have significant side effects on air quality, public health, and the environment. This underscores the necessity for accurate air quality assessments and the use of real-life measurements in evaluating these impacts.

The proposed development scheme involves significant changes to traffic flow on the A429, potentially impacting air quality in the surrounding area. The DS report utilised the ADMS-Roads Dispersion Modelling software to predict these impacts, but it lacked real-life measurements on how HGVs could really impact the air quality.

Unlike theassessment conducted by DS, which relied heavily on dispersion models, this report emphasizes the importance of using real-life measurements. Accurate air quality assessments are crucial for ensuring public health and environmental protection, and this report aims to present a more precise analysis based on actual readings.

1.1. Objectives

- **Critically Evaluate Air Quality Assessments:** Analyse and compare the air quality assessments conducted by DustScanAQ (DS) and Nottingham Trent University (NTU) to determine the validity of their findings and the potential impact of the proposed quarry on air quality in the surrounding area, particularly
- **Assess Compliance with Air Quality Regulations:** Evaluate whether the proposed quarry, based on the data collected by NTU, would likely comply with relevant air quality regulations and standards, considering the proximity to sensitive receptors like schools and residential areas.
- **Assess Potential Health Risks:** Evaluate the potential health risks associated with the predicted air quality impacts of the proposed quarry, as suggested by the NTU data, particularly for vulnerable populations such as children and those with pre-existing respiratory conditions.
- **Assess the impact of increased HGV traffic on air quality:** Determine the current traffic flow and estimate how much it will be increased by the proposed development. Combine this information with real life air quality measurements from HGVs.

1.2. Proposed Site Location and Development

The proposed development will occupy an 89-hectare (220 acre) area of land currently used for agriculture. Located immediately east of the A429, the site is framed by Wasperton Lane to the north and open fields to the east and south. Several farmhouses, including Wasperton Farm and Holloway Farm, lie in the vicinity, with the nearest villages being Wasperton (200m west) and Barford (330m north). As shown in figure 1, even though the development will not affect any designated ecological sites within a 3km radius, there are a nursery, a pre-school, and a primary school located within 690m radius.

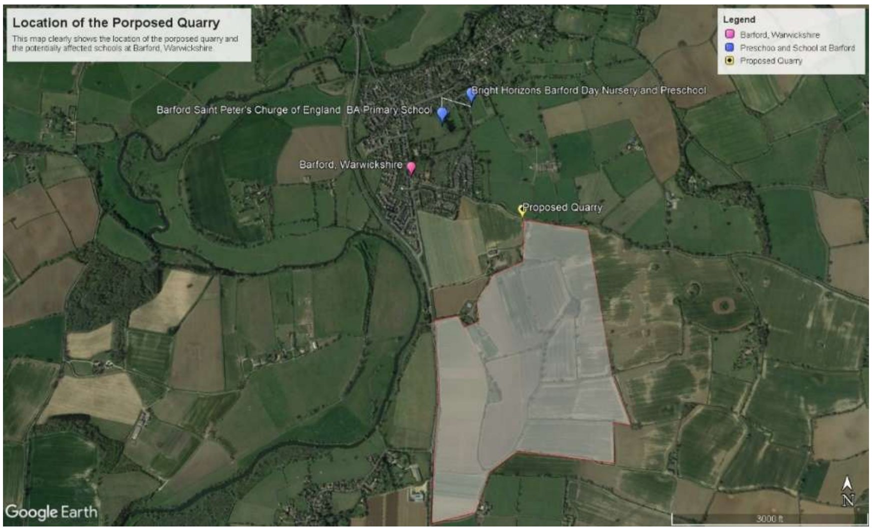

Figure 1: Proposed site location and the surrounding areas

This development aims to extract approximately 1.8 million tonnes of sand and gravel from a 89-hectare site. The anticipated extraction rate is up to 200,000 tonnes annually, with a projected operation of 10 to 15 years. The proposed working hours will be 0700 to 1900 on weekdays and 0700 to 1300 on Saturdays. Furthermore, upon completion of the project, the site will primarily be restored to agricultural use. Additionally, small water bodies and marshland areas will be established near the centre of the development area.

Extracted and processed minerals will be transported via Heavy Goods Vehicles (HGV) for use at the Smiths' concrete batching sites, primarily Bubbenhall Quarry south of Coventry. In documentation circulated to local residents Smiths anticipated that the proposed development would generate up to 216 HGV movements per weekday.

2. Methodology

This section outlines the methodology employed for the air quality assessments conducted by C4FF to evaluate the potential impacts of the proposed quarry development and operation on the local environment. The assessment focused on key pollutants associated with both road traffic movement and quarrying activities, specifically NO_2, NO_x, PM_{10}, and $PM_{2.5}$.

2.1. Particulates

2.1.1. Data Sources

- **NTU Study:** NTU conducted real-time air quality monitoring at various locations in Barford, including the primary school, a house on Barford Road, the main road itself and an existing sand & gravel quarry. This study provides valuable data on existing air quality within an existing quarry and the community area most likely to be affected by the quarry at Barford.
- **DS Study:** DS, on behalf of Smiths Concrete Ltd, conducted air quality monitoring near the proposed development side in Wasperton and at Wolston Fields Quarry. However, their study relied on a distant meteorological station for wind data and focused on average pollutant concentrations, potentially underestimating the impact on surrounding areas.

2.1.2. Monitoring Equipment

- In his study, Professor Amin utilized Aeroqual devices, which included a logger and monitoring head, as referenced in this report. A total of four devices were employed, with two specifically dedicated to monitoring particulate matter. These particulate matter heads were designed to measure both PM10 and PM2.5 levels. The other two heads were used to measure NOx and SOx levels, as illustrated in Figure 2. To ensure comprehensive data collection, the loggers were programmed to record readings at 2-minute intervals. This setup enabled the continuous collection of data over several days, providing a robust dataset for thorough analysis.

- To assess the potential impact of heavy goods vehicles (HGVs) on air quality, a proxy methodology was employed due to the limited availability of direct HGV emissions data. Air quality measurement equipment was attached to a car following a bus to measure its nitric oxide (NO) emissions during stop-and-start patterns similar to those expected of HGVs used in quarry operations. The Chemi Luminescence Detection (CLD) measurement principle, which is the industry-standard method for measuring engine exhaust NO concentration, was utilized in this experiment. The CLD500, manufactured by Cambustion, was employed in this experiment, offering a more advanced 2-millisecond response time compared to conventional CLDs, which have response times of 1-2 seconds and are typically used to measure bag emissions where the concentration changes very slowly. The collected NO emissions data were then converted to nitrogen dioxide (NO2) using conversion factors provided by DEFRA and compared to UK government air quality standards to assess potential exceedances.

2.1.3. Monitoring Duration

- **NTU:** Monitoring periods ranged from two hours to four days, depending on the location
- **DS:** The assessment at the proposed quarry site spanned 134 days.

2.1.4. Wind Data

It is important to note that the wind rose diagram (figure 1) provided by DS shows the dry hours in 2017-2021 for church Lawford. It is claimed by DS to be the nearest appropriate Met Office land surface observation station, approximately 23km to the northeast of the site. Considering the distance of the observation station to the proposed quarry, it is difficult to use this data in any assessment of the potential effect of the quarry on the surrounding areas.

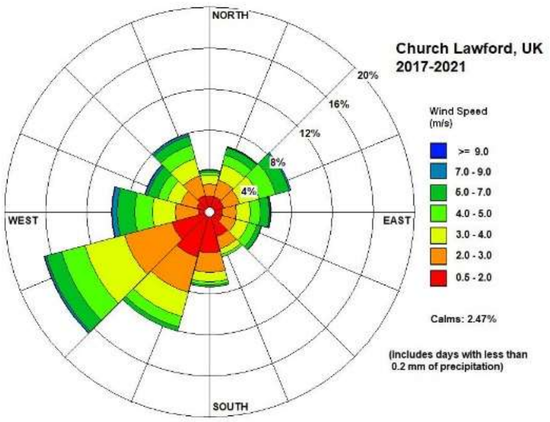

Figure 2: Wind rose diagram (Source: DustScanAQ Dust assessment report, August 2022)

In Figure 3 of this report, C4FF presents a new wind rose diagram illustrating the average wind patterns during dry hours. The data is sourced from Wellesbourne Airfield, located about 6 kilometres from the proposed quarry, and spans the past eight years, from 2015 to 2023. While the Wellesbourne data broadly agrees that the prevailing winds are from the West and Southwest it also shows a much higher prevalence of winds from South and Southeast towards Barford village and from East towards Wasperton.

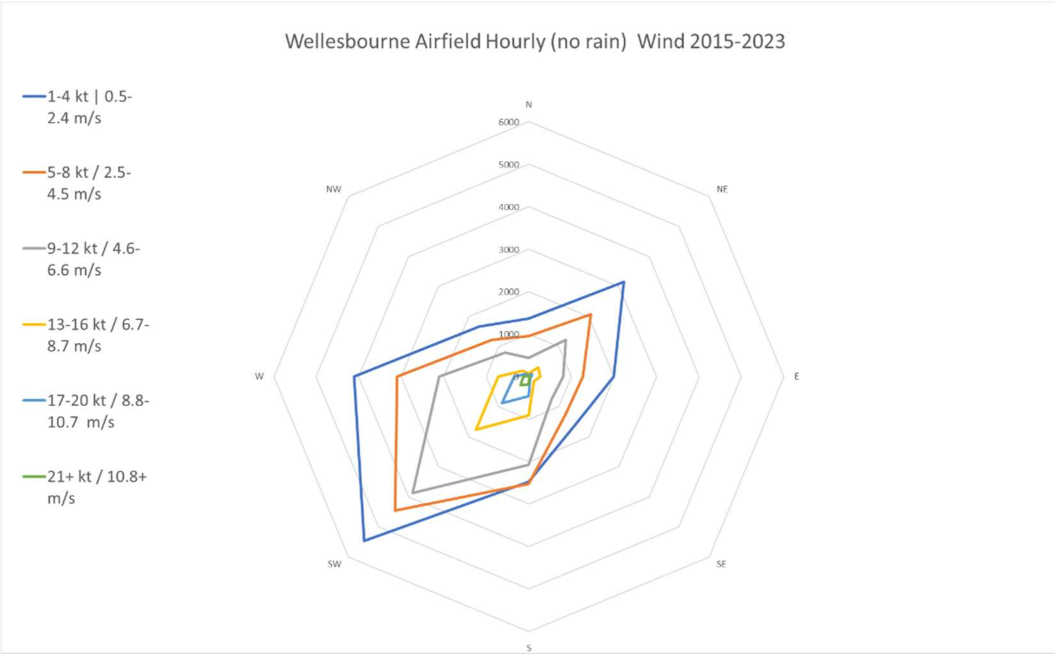

Figure 3:Wellesbourne airfield hourly (No rain) 2015 – 2023 wind road Diagram

2.2. HGV Emissions

This section outlines the methodology used in assessing the traffic impact and air quality implications of the proposed development in Warwickshire. The assessment incorporates annual traffic data by vehicle type, an analysis of the operational logistics of the development, and real-life measurements of nitrogen oxide (NO) emissions from HDVs.

2.2.1. Data Collection

Numerous limitations have been identified in the DS air quality assessments. The accuracy of dispersion models such as ADMS-Roads depends on the quality and precision of the input data. Any inaccuracies or assumptions made in the input data can lead to errors. The study uses historical meteorological data (2017-2019) form a station 23 km away. Local weather conditions might vary, and this could affect the accuracy of the dispersion modelling. Also, Traffic data is based on counts from specific locations and projected using growth factors. These projections might not accurately reflect future traffic conditions, especially given potential changes in traffic patterns, local developments, or transportation policies. Figure 10 seems to depict roads that aren't the main route used by lorries. In reality, lorries likely travel from the quarry near Wasperton Village, passing along A429 adjacent to Barford Village on their journeys.

Figure 410: Modelled road network, model verification scenario only (Source: DS Report)

Data from Department for Transport (DfT) has been utilized on the number of vehicles that travel past the count point (in both directions) on an average day of the year. The specific dataset is accessible from the local authorities' section for Warwickshire on the DfT's Road Traffic Statistics website[1]. The dataset includes comprehensive details on vehicle counts, including cars, taxis, buses, light goods vehicles (LGVs), and various categories of heavy vehicles (HGVs).

Sample data has been taken to provide an overview of traffic on a specific major road A429 in Warwickshire providing a representative snapshot of traffic conditions in the area. The A429 passes close to Barford and Wasperton Villages and it will be the main route used by lorries to transport the extracted minerals and imported inert fill.

[1] https://roadtraffic.dft.gov.uk/manualcountpoints/57084

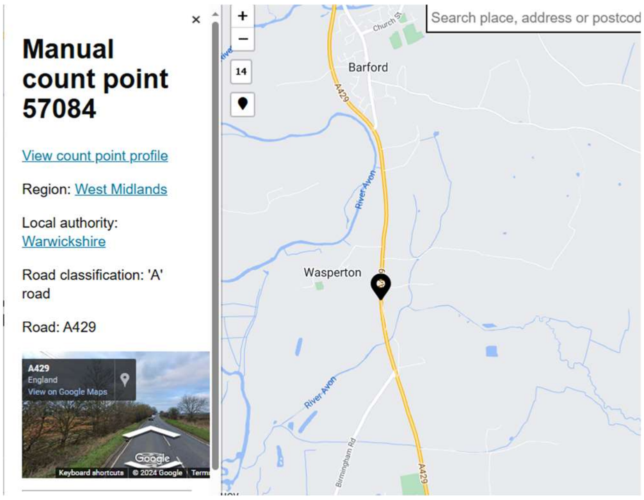

Figure 5~~11~~: Location of Road A429 (Source: Road Traffic Statistics[2])

2.2.2. Calculation of Lorry Requirements for the Development

To understand the logistical impact of the proposed development, the number of lorry trips required to transport the annual production output. The site is expected to produce 200,000 tonnes of material per annum. In their planning application Smiths have stated that a mixture of 25t and 18t vehicles would be used. If it is assumed that only the larger 25t vehicles are used the calculation is as follows:

- Annual Trips: $\frac{200{,}000\ tonnes}{25\ tonnes\ per\ lorry} = 8{,}000\ trips$
- Daily trips: $\frac{8{,}000\ trips}{300\ days} \approx 27\ trips\ pers\ day$

This equates to an average of 27 trips per day (54 vehicle movements including the return journey) over 12 hours of operation, across 300 working days per year (Monday to Saturday). However, water abstraction restrictions—such as those limiting operations when the flow of the River Avon falls below a certain threshold—might reduce the number of operational days if water needs to be pumped from the excavation pits. If smaller vehicles are being used, it would be necessary to complete up to 200 trips per day to fulfil the project's objectives.

An alternative calculation, using Smiths headline statement is that 1.8 million tonnes are to be extracted over 15 years, equating to 120,000 tonnes per year. Assuming a maximum of 300 working days, 400 tonnes per day need to be transported. This number is doubled for infill importation[3], resulting in 800 tonnes per day. If 25-tonne lorries are utilized, 32 trips per day (64 trips including the return journey) will be required. If some smaller18-tonne lorries are used, then even more daily trips will be necessary.

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[2] https://roadtraffic.dft.gov.uk/#14/52.2234/-1.6114/basemap-countpoints

[3] Restoration of the first 3 phases of the quarry is planned to commence when Phase 4 is opened for extraction. This will be approximately 3 to 4 after extraction commences with Phase 1.

2.2.3. Real-Life Measurements of Nitrogen Oxide (NO) Emissions

To provide a realistic assessment of air quality impacts, real-life measurements of NO emissions. These measurements were obtained from street-level monitors that record NO concentrations when lorries pass by. This approach allows for a more realistic representation of the air quality impact than relying solely on modelled data.

3. Key Pollutants and Health Impacts

Indicators for air pollutant emissions within quarrying sector encompass a range of substances. These, depending on the type of quarry, include emissions of sulphur oxide (SO_x), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), ammonia (NH_3), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), and fine particulate matter ($PM_{2.5}$ and PM_{10}) (Fugiel et al, 2017).

- **PM_{10}:** Those with a diameter of 10 micrometres or less, are small enough to be inhaled and cause health problems. These particles are generated by quarries through several processes. Blasting, essential for breaking up rock, creates a significant amount of dust that includes larger PM_{10} particles. Crushing and screening the extracted rock into different sizes also produces lots of dust within the PM_{10} range. The movement of trucks and heavy equipment across the quarry stirs up dust, especially on unpaved surfaces, with larger particles often being in the PM_{10} size. Exposed soil and stockpiles are also sources of PM_{10}, particularly in windy conditions. In the UK, air quality targets for PM_{10} are set to protect public health. As shown in table 1, these targets are based on World Health Organisation air quality guidelines.

- **$PM_{2.5}$:** These particles are extremely fine with a diameter of 2.5 microns or less, primarily originate from the combustion processes within diesel engines. These engines power heavy equipment, trucks, generators used at quarries. Additionally, gasses released by quarry operations such as NO_x and SO_2, can undergo reactions in the atmosphere and form secondary $PM_{2.5}$ particles. Due to their Minuscule size, $PM_{2.5}$ particles can penetrate deep into the lungs, posing significant risks to respiratory and cardiovascular health. The UK air quality targets for these particles are shown in table 1.

Table 1:AQOs relevant to the existing site

Pollutant	Averaging Period	AQO (µg/m^3)	Exceedance Allowance	Percentile Equivalent
PM_{10}	Annual	40	-	-
	24-hour	50	35 per annum	90.4th
$PM_{2.5}$[(a)]	Annual	20[(b)]	-	-
Note	(a) This is a target value set for a 15% reduction in concentrations at urban background aimed to achieve			

	between 2010 and 2020 (b) The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020 amended the annual average Air Quality Objective (AQO) for PM2.5 from 25 µg/m3 to 20 µg/m3 outlined within the Air Quality Standards Regulations (2010 & 2016 Amendments).
Source	Department for Environment Food and Rural Affairs (2016): 'Local Air Quality Management Technical Guidance' (TG.16).

Table 2 shows where the AQO applies. It is crucial to take note of the surrounding areas. Barford has a primary and a pre-school; on the other hand, Wasperton Village has a church hall where many people are likely to spend a noticeable time in the premises.

Table 2: Examples of where the AQO should apply

Averaging Period	Objectives should apply at	Objectives should not apply at
Annual	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
24 Hour	All locations where the annual mean objective would apply, together with hotels and gardens of residential properties(a).	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
1 Hour	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might	Kerbside sites where the public would not be expected to have regular access.

	reasonably have expected to spend one hour or longer.	
Note	(a) "Such locations should represent parts of the garden where relevant public exposure to pollutants is likely, for example where there is seating or play areas. It is unlikely that relevant public exposure to pollutants would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied."	
Source	Department for Environment Food and Rural Affairs (2016): 'Local Air Quality Management Technical Guidance' (TG.16).	

- **NO_2:** It is a harmful air pollutant. It's a reddish-brown gas with a noticeable, irritating smell. NO_2 has serious health impacts, aggravating the respiratory system, increasing susceptibility to infections, and worsening conditions like asthma. Over long periods, it can contribute to cardiovascular problems. Quarries generate NO_2 in several ways; blasting, a key process in mineral extraction, releases nitric oxide (NO) which rapidly becomes NO_2 in the atmosphere. Additionally, the diesel engines powering heavy equipment like excavators and trucks are significant sources of NO_x (a mixture of NO and NO_2). It is very important to note that even dust suppression methods, while necessary, involve machinery that can add to NOx emissions. To safeguard public health, the UK has established air quality standards specifically for NO_2. There's an hourly mean limit of 200 micrograms per cubic meter of air, which shouldn't be exceeded more than 18 times annually. Additionally, there's stricter annual mean limit of 40 micrograms per cubic meter of air.
- According to the Department for Environment Food & Rural Affairs, non-urban UK traffic in 2024 consists of approximately one-third NO_2 and two-thirds NO within the total NO_x emissions. This data underscores the importance of monitoring and mitigating NO_2 emissions, particularly in areas with significant quarrying activities or heavy vehicle traffic.

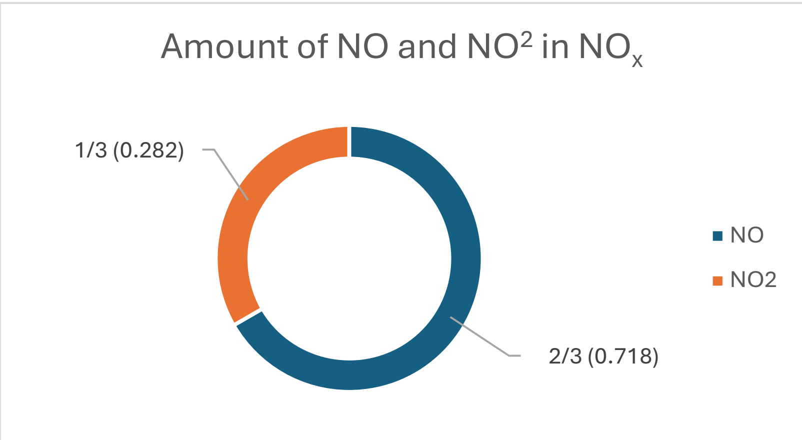

Figure 6~~1~~: Amount of NO and NO_2 in NO_x (Source: NOx to NO2 Calculator | LAQM (defra.gov.uk))

3.1. Environmental impact of HGV emissions

The environmental impact of HDV emissions is also significant. NO_x contributes to the formation of ground-level ozone and secondary particulate matter, both of which are harmful pollutants. Ground-level ozone can damage crops, forests, and other vegetation, reducing agricultural yields and biodiversity. Additionally, NO_x and PM contribute to acid rain, which can harm aquatic ecosystems, soil, and buildings.

4. Results and Analysis

4.1. PM_{10} and $PM_{2.5}$

4.1.1. NTU Findings

The work done by Nottingham Trent University details air quality monitoring conducted at various locations near the proposed quarry site and as well as a currently operating quarry site. Readings were collected inside the school at Barford Village. Higher values were observed during school hours compared to non-school hours (figure 4), likely due to increase occupancy and activity.

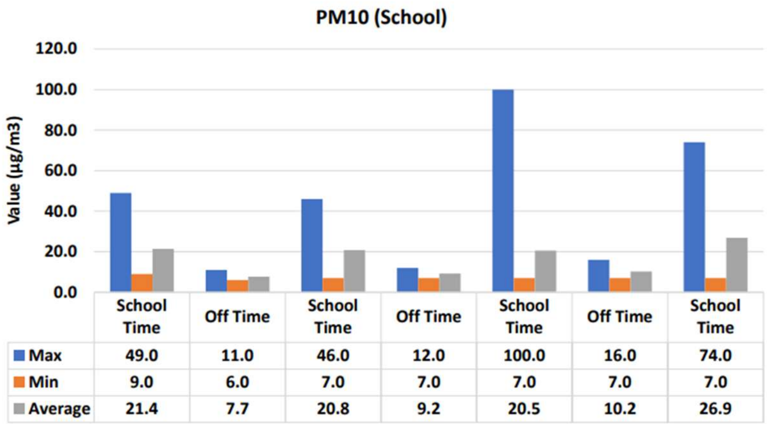

Figure 74: Data analysis for PM_{10} at the school

An unusual spike occurred on the third day. Daily averages showed the highest pollution levels on the fourth day. PM_{10} and $PM_{2.5}$ was monitored in a house on Barford Road for four days. Similar to the school, readings were higher during daytime, suggesting traffic influence. The fourth day again exhibited the highest levels. A two-hour monitoring session captured PM_{10} and $PM_{2.5}$, and SO_2 readings. Both PM_{10} and $PM_{2.5}$ levels decreased over time, while SO_2 levels increased slightly.

Two trials were conducted to assess air quality near an active quarry. The first trial focused on short-term measurements (1 hour) of PM_{10} and $PM_{2.5}$ and NO_2. It is interesting to note that as shown in figure 5, in the first trial as the monitoring devices moved closer to the active quarry, particulate matter readings increased.

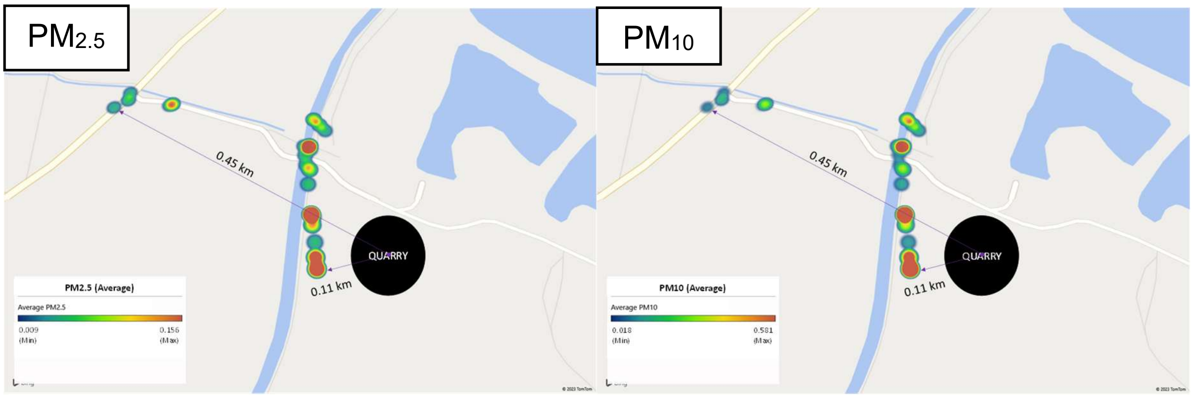

Figure 85: A map shows the location of the average PM_{10} and $PM_{2.5}$ readings taken by devices.

In the second trial which involved a longer monitoring period, other variables such as direction of the wind was considered as shown in figure 6.

Figure 96: This map shows the fixed point in yellow circle and the path used to collect data in the last hour

Fixed-point measurements taken 0.65 km from the quarry under low wind conditions revealed relatively low and stable concentrations of PM_{10}, $PM_{2.5}$, and NO_2. However, as shown in figure 7, mobile monitoring closer to the quarry showed higher levels of PM_{10} and $PM_{2.5}$, partially influenced by nearby farming activities.

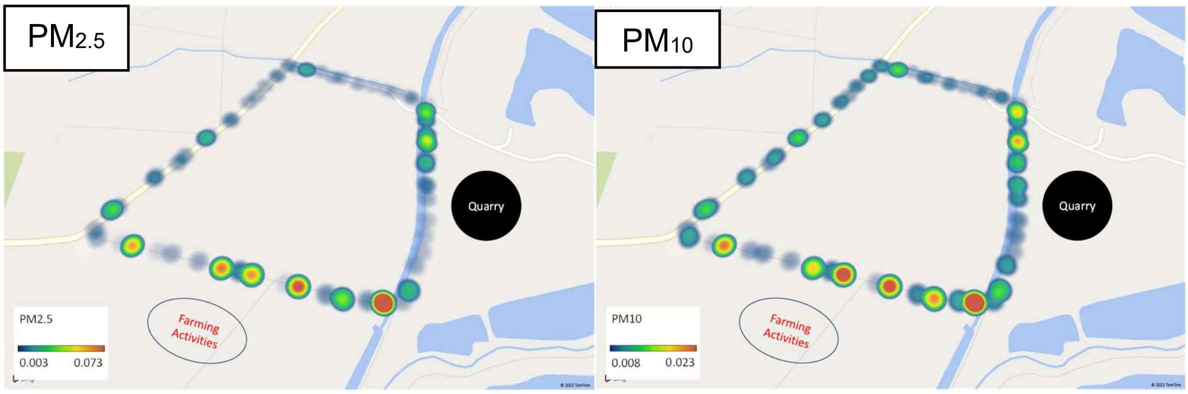

Figure 107: PM_{10} and $PM_{2.5}$ colour map

Overall, both trials suggest that quarry operations contribute to elevated levels of particulate matter in the immediate vicinity. The impact of farming activities on PM levels was evident, particularly during the second trial.

4.1.2. DS Findings

DS examined baseline particulate matter conditions using a combination of sources. Firstly, Defra's modelled background data claims that ambient PM_{10} and $PM_{2.5}$ concentrations in the area are quite low, suggesting minimal risk of exceeding annual air quality objectives due to the quarry operations alone. To supplement this, the report includes site-specific monitoring conducted near the proposed development site (Wasperton) as shown in figure 8. This real-time monitoring claimed average PM_{10} levels around 15µg/m^3, with occasional spikes likely attributed to agricultural activities in August rather than typical quarry operations.

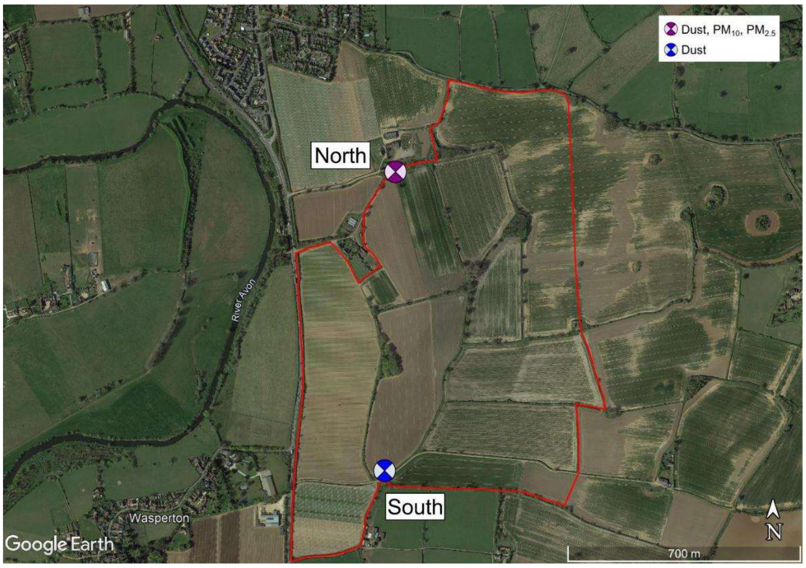

Figure 118: Dust and particulate matter monitoring locations, Wasperton (Source: DustScanAQ Dust assessment report, August 2022)

For further insights, the report analyses proxy data from Wolston Fields Quarry as shown in figure 9 – similarly, actively operating sand and gravel extraction. Strangely, the average PM_{10} concentrations at Wolston Fields were lower 8.5µg/m^3 even with the ongoing quarrying activities. DS claims that with appropriate mitigation measures, potential PM_{10} impacts at the proposed site can likely be well-managed. Regarding $PM_{2.5}$, both the Wasperton site and Wolston Fields Quarry showed low average concentrations (4.47 µg/m^3 and 4.75 µg/m^3 respectively), comfortably within the annual air quality objective.

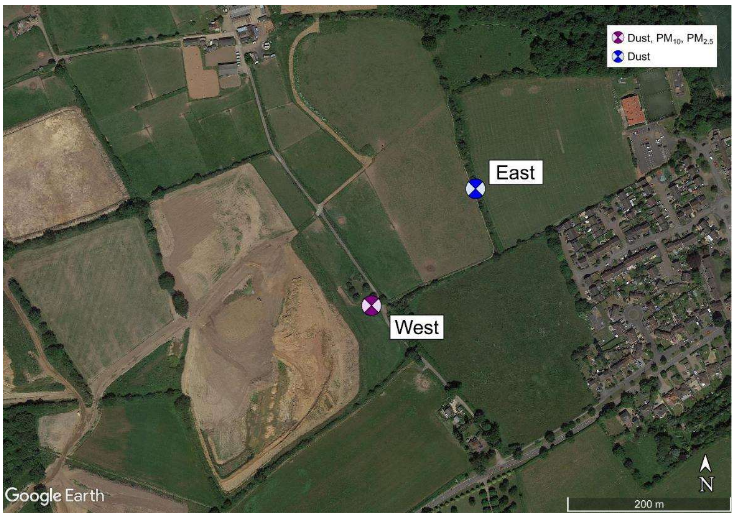

Figure 129: Dust and particulate matter monitoring locations, Wolston Fields Quarry.

4.1.3. Comparison and Critical Evaluation

The data collected by NTU and DS Company provides valuable insights into the current air quality conditions in Barford and the potential impact of the proposed quarry. However, their interpretations and conclusions differ significantly.

Nottingham Trent University's findings highlight a clear correlation between school activities and elevated levels of PM_{10}, $PM_{2.5}$, and NO_2. This raises concerns about the potential health impacts of students and staff, especially considering the spikes observed on the fourth day of monitoring. Additionally, the data collected from the house on Barford Road and the main road itself suggests that existing traffic already contributes to elevated particulate matter levels in the area.

DS's assessment at the intended site where the quarry is proposed to be developed, in the sample of 134 days, considers the average PM_{10} concentration (14 µg/m^3) to be key indicator of the healthiness of the air quality. However, the maximum daily average is 84.80 µg/m^3 which is well above the AQO (annually 40 µg/m^3). This raises questions about the suitability of relying solely on average values to assess potential health risks. As shown in Figure 8, DS has chosen to conduct measurements in a rural area with minimal urban development as the baseline which might skew the results. Such a location inherently experiences lower pollution levels compared to a more built-up area, making it difficult to accurately assess the existing air quality baseline in areas where people live and work.

Conversely, NTU's research focused on air quality assessment within the nearest village, Barford, which is only 400m away from the proposed quarry site, and a primary school merely 700m distant from the edge of the quarry shown in figure 1. The findings reveal that even without an active quarry, the government's target for PM_{10}, a key pollutant, is exceeded well over the 40 µg/m^3 threshold on multiple occasions throughout the day at the Barford primary school. Figure 4 clearly illustrates a consistent pattern reading during school hours, underscoring the potential impact on air quality within the school environment. Additionally, measurements taken at a house on Barford Road indicate that PM_{10} values have reached 50% of the government's target, emphasizing the potential for existing air quality concerns in the area.

4.2. NO_2 Emissions

Figure 2 (taken from a video screenshot) displays NO concentration measurements from an air quality monitoring system attached to a car, demonstrating a significant increase when stopping and starting at bus stops. This scenario directly compares to the proposed quarry truck movements. The figure indicates NO spikes over 10,000 μg/m^3 when starting and stopping, with an average of around 2,000 μg/m^3 during travel as shown in figure 3.

Figure 132: NO emission when a bus starts and stops (Source: https://www.youtube.com/watch?v=-6QKPkAMHp4)

Figure 143: NO emission of a moving bus (Source: https://www.youtube.com/watch?v=-6QKPkAMHp4)

Using Figure 1, we can convert NO to NO_2. The starting spikes equate to 5,000 μg/m^3 of NO_2, while the average during travel is 1,000 μg/m^3. These figures significantly exceed the UK air quality standard hourly mean limit of 200 μg/m3 (with a maximum of 18 exceedances annually).

Table 1 shows the consequences of the different assumptions made on the increment of NO_2 emissions

Table 31: Emissions and exceedances considering different Scenarios

Lorries tonne	Number of lorries	Trips per hour	Hourly NO_2 during stop and start (μg/m^3)	Number of daily exceedances (limit ×18 per year)	Hourly NO_2 during travel (μg/m^3)	Number of daily exceedances (limit ×18 per year)
30	22	3	18,000	90	3,000	15
25	30	4	20,000	100	4,000	20
18	40	5	25,000	125	5,000	25
Standard	200	25	125,000	625	25,000	125

The figures in Table 1 are concerning, especially since the emissions and exceedances have been calculated based only on one-way trips. These numbers will likely increase further when restoration activities begin 3-4 years into the project.

This matter needs more attention as the planning application proposes a traffic signal-controlled junction on the A429. This will cause lorries to stop and start more frequently, resulting in more spikes in NO_2 emissions.

Based on the methodology's calculations, the quarry development is projected to increase HGV traffic with 4 or more rigid axles by 27 vehicles per day. Adding this to the 2023 baseline of 66 (already considered high), the estimated total for 2025 is 93 HGVs. This potential increase raises concerns regarding traffic volume and its associated impacts, including road wear, noise pollution, and safety risks for other road users.

Further analysis indicates that the daily operation of these HGVs, especially under the scenario of 200 trips per day using standard lorries and 32 trips (25t lorry) could lead to significant congestion on local roads. This would be further exacerbated when restoration commences with the importation of infill, The cumulative effect of these additional trips is likely to exacerbate existing traffic conditions, particularly during peak hours. Additionally, the increased frequency of lorry movements could contribute to higher emissions levels, impacting air quality in the surrounding areas.

It is also important to note that, assuming a 15-year timeframe, infill importation will begin approximately 3-4 years after extraction starts and will run concurrently with extraction for around 12 years. Vehicle movements resulting from the importation of inert materials for site restoration have not been included in the calculations due to uncertainties regarding the timing and size of the vehicles. However, for the majority of the quarry's operational life, vehicle emissions are likely to exceed the figures currently calculated.

Based on the measurements conducted by Combustion[4], it is easy to picture how a single lorry can affect the air quality of the surroundings. Figure 12 shows the air quality just before an HGV passes by the meter. The NO concentration in the air seems to be low.

However as shown in figure 13, as the HGV has passed by the meter, the NO concentration jumps up to 1000 µg/m^3.

Figure 1512: NO concentrations before the lorry pass by the meter

[4] https://cambustion.com/

Figure 16~~13~~: NO concentration seconds after a lorry passes by the meter

Traffic congestion on the A429, will have a significant increase in lorry emissions which can occur during stop-start conditions. Studies by the European Environment Agency (EEA) indicate that urban driving with frequent stops and starts can lead to up to a 30% rise in NOx emissions compared to free-flowing traffic[5].

5. Conclusion and Recommendations

The United Kingdom ranks among the highest in Europe when it comes to particulate and gas emissions originating from the mining and quarrying sector (Fugiel et al., 2017).

The air quality assessments conducted by NTU and DS present contrasting views on the potential impact of the proposed Smiths Concrete Ltd quarry near Wasperton. While DS's assessment suggests minimal risk of exceeding air quality objectives, NTU's findings raise significant concerns about the potential health impacts on the surrounding communities, particularly Barford.

NTU's data reveals a strong link between school activities and heightened levels of PM_{10}, $PM_{2.5}$, and NO_2, raising concerns about the health risks for students and staff. Air quality measurements taken at the school demonstrate that the government's target for PM_{10} (40 μg/m^3) is exceeded multiple times a day. Moreover, existing traffic in the area already contributes to elevated PM levels, with day 4's average PM_{10} level surpassing the government's maximum allowable limit by 25%. Measurements indicate that PM_{10} levels reached approximately 70 μg/m^3 at a distance of 300m from the school and exceeded 200 μg/m^3 at the quarry. Consequently, the average PM_{10} level in the vicinity of the quarry consistently surpasses the government's target.

Conversely, DS's assessment, while based on a longer monitoring period, relies on average values and data from rural location, potentially underestimating the impact on areas with higher population density. Their findings do not adequately address the potential for daily spikes in pollutant levels, as observed by NTU.

[5] https://www.eea.europa.eu/en/analysis/indicators/greenhouse-gas-emissions-from-transport

Furthermore, the wind rose analysis reveals wind from South and South-west that could carry pollutants from the proposed quarry towards Barford and Wasperton, thereby exacerbating the potential health risks for residents in these areas.

The issue of nitrogen dioxide (NO_2) emissions from quarry operations poses a substantial public health risk. The data presented in Figure 1, coupled with the projected lorry traffic shown in table 1, strongly suggests that the development would lead to significant and frequent exceedances of the UK's air quality standards for NO2. The potential health impacts of these emissions, particularly on vulnerable populations such as children and those with respiratory conditions, cannot be ignored.

In Conclusion, relying solely on irrelevant data and average values may not accurately reflect the real-world impacts of the proposed quarry. The NTU data provides a more comprehensive and concerning picture of the potential air quality degradation and associated health risks for nearby communities. This underscores the importance of considering relevant data and prioritizing the health and well-being of residents when assessing the environmental impact of industrial developments.

To ensure a comprehensive assessment, a more thorough air quality evaluation is recommended. This should include expanded monitoring locations and a detailed wind pattern analysis. The impact of increased HGV movements also needs careful consideration. Gathering additional data from other quarries could provide valuable information for comparison.

By incorporating these recommendations, a more accurate understanding of the potential impacts of the proposed quarry can be achieved, ensuring informed decision-making that prioritizes the health and well-being of the community and the protection of the environment.

An introduction to C4FF, Professor Reza Ziarati, and Amir Sed, along with the acknowledgement, can be found in the annex.

Annexes

A.1. Introduction to C4FF, Professor Reza Ziarati, and Amir Sed

The Centre for Factories of the Future (C4FF), a research development and innovation company, has been actively involved in numerous national and international air quality projects, contributing significantly improved air quality in towns and cities. Its chairman, Professor Reza Ziarati, has authored over 600 papers and articles. Starting with RZ's ground-breaking new series of variable geometry ICEs (Internal Combustion Engines) outlined in his PhD Thesis (1979). His PhD work led to more improved matching of ICEs to turbocharges/superchargers. Later his work led to matching of fuel injection equipment (FIE) to turbocharged diesel engines (IMechE Paper 1983 – The benefits were high injection pressures, more power and less CO_2 and but higher NOx - https://www.c4ff.co.uk/history/papers/High_pressure_fuel_injection_system.pdf). This was followed by a paper in 1995 (RZ's MIRA AutoTech Paper 1995 – Matching FIE and Turbochargers to ICEs which led to improved engine efficiencies (https://www.c4ff.co.uk/history/papers/AutoTech_95_paper.pdf) with the specific aim of decreasing fuel use and reducing the fossil fuel combustion pollutants.

Professor Ziarati also studied air quality in several cities (for instance see Bath City Pollution probe - https://www.c4ff.co.uk/history/papers/Bath_Pollution_Probe.pdf) where he found that some cities such as Bath suffered from immense and harmful pollutions both from passing air and due to unregulated transport through the city. He offered an intermediate solution – hybrid engine propulsion (https://www.c4ff.co.uk/history/papers/Green_Machine.jpg as a practical means to reduce pollution in the towns and cities. His work led to the first hybrid car and bus designs in the UK.

He wrote the ground breaking Emerging Transportation Systems paper in 1995 (https://www.c4ff.co.uk/history/papers/Emerging_transportation_system.pdf) and asked to present it to the House of Lord representatives. He was awarded the House of Lords sponsored IRTE National Diploma (Design and Use of Hybrid Vehicles (https://www.c4ff.co.uk/history/awards/National_Diploma-Hybrid_Vehicles.pdf). He also highlighted the impact of new transport systems (https://www.c4ff.co.uk/history/papers/Impact_of_new_transport_system.pdf) and published several other papers on these new systems and was awarded several prizes including the prestigious Mackensie Junner Technical Award (https://www.c4ff.co.uk/history/awards/Design_and_Use_of_Hybrid_Vehicles_National_Prize.pdf).

He was invited to the Buckingham Palace to meet the Queen in recognition of his work on less polluting and more efficient Factories of the Future (https://www.c4ff.co.uk/history/awards/Invitation_from_Queen.pdf).

In recent years he has been working on several studies sponsored by the UN/IMO, EU and the UK Government (for instance see IMechE COP26 paper - A Strategy to

Deliver Sustainable Transport System - https://marifuture.org/Publications/Papers/imeche-transport-hierarchy-report.pdf) and has written papers as part of the MariEMs, IdealShip, IdeaPort, GreenShip and ISM projects to improve energy use of ships and ports with a specific aim of reducing harmful pollutions and GHGs such as CO_2. He has published several books/chapters on climate change, good examples can be found at https://marifuture.org/Publications/Papers.aspx, https://marifuture.org/Publications/Articles.aspx and https://marifuture.org/Reports/Development-Papers.aspx

There are numerous papers and reports online and in www.c4ff.co.uk, www.manufuture.org and www.marifuture.org about RZ's work on making the transport systems less polluting and more efficient. His hybrid engine designs were considered stepping-stones means to full electric car introduction and are still valid solutions as they immediately relieve towns and cities from severe poor air quality. He has set up several projects to engage schools and communities in climate change actions (there are several papers and reports in www.inspire-group.org and www.cwairquality.com).

Under the supervision of Professor Reza Ziarati, Amir Sed, has been involved inair quality projects and conferences, such as the Climate Change Action for Air Quality Conference at Coventry University, organised by C4FF. Driven by a passion for addressing climate change, Amir pursued a Master degree in renewable energy engineering in the UK. Following the successful completion of a project commissioned by the International Maritime Organization (IMO), UN, Amir has co-authored two papers, one presented at the prestigious MT'24 international conference at UPC, Spain and the other to be presented at IAMU international conference at MIT, US, in September 2024. He is currently working on an EU funded project (OPTIMISM) concerning safety and environment protection and on a UK Government project making confined spaces safer for seafarers using VR technology.

A.2. Acknowledgement

We would like to extend our sincere gratitude to Dr Chris Morrow for his invaluable contribution in reviewing the report and suggesting essential revisions, which greatly enhanced its quality. We also wish to express our appreciation to Dr Malcolm Eykyn for providing the crucial information and data necessary for the completion of this report. Additionally, we acknowledge the efforts of everyone involved in the process, whose dedication and support were instrumental in bringing this report to fruition. Their collective input has been critical in ensuring the accuracy and comprehensiveness of this report.

A.3.National Air Quality Objectives

National air quality objectives and European Directive limit and target values for the protection of human health

Pollutant	Applies	Objective	Concentration measured as[1]	Date to be achieved by (and maintained thereafter)	European Obligations	Date to be achieved by (and maintained thereafter)
Nitrogen dioxide	UK	200 µg/m³ not to be exceeded more than 18 times a year	1 hour mean	31 December 2005	200 µg/m³ not to be exceeded more than 18 times a year	1 January 2010
	UK	40 µg/m³	annual mean	31 December 2005	40 µg/m³	1 January 2010
Ozone	UK	100 µg/m³ not to be exceeded more than 10 times a year	8 hour mean	31 December 2005	Target of 120 µg/m³ not to be exceeded by more than 25 times a year averaged over 3 years	31 December 2010
Sulphur dioxide	UK	266 µg/m³ not to be exceeded more than 35 times a year	15 minute mean	31 December 2005	-	-
	UK	350 µg/m³ not to be exceeded more than 24 times a year	1 hour mean	31 December 2004	350 µg/m³ not to be exceeded more than 24 times a year	1 January 2005
	UK	125 µg/m³ not to be exceeded more than 3 times a year	24 hour mean	31 December 2004	125 µg/m³ not to be exceeded more than 3 times a year	1 January 2005

National air quality objectives and European Directive limit and target values for the protection of human health

Pollutant	Applies	Objective	Concentration measured as [10]	Date to be achieved by (and maintained thereafter)	European Obligations	Date to be achieved (by and maintained thereafter)
Particles (PM_{10})	UK	50 µg/m³ not to be exceeded more than 35 times a year	24 hour mean	31 December 2004	50 µg/m³ not to be exceeded more than 35 times a year	1 January 2005
	UK	40 µg/m³	annual mean	31 December 2004	40 µg/m³	1 January 2005
	Indicative 2010 objectives for PM_{10} (from the 2000 strategy and Addendum) have been replaced by an exposure reduction approach for $PM_{2.5}$ (except in Scotland – see below)					
	Scotland	50 µg/m³ not to be exceeded more than 7 times a year	24 hour mean	31 December 2010	50 µg/m³ not to be exceeded more than 35 times a year	1 January 2005
	Scotland	18 µg/m³	annual mean	31 December 2010	40 µg/m³	1 January 2005
Particles ($PM_{2.5}$) Exposure Reduction	UK (except Scotland)	25 µg/m³		2020	Target value - 25 µg/m³	2010
	Scotland	10 µg/m³	annual mean	31 December 2020	Limit value - 25 µg/m³	1 January 2015
	UK urban areas	Target of 15% reduction in concentrations at urban background		Between 2010 and 2020	Target of 20% reduction in concentrations at urban background.	Between 2010 and 2020