South Cambridgeshire District Council

Short term air quality in Cambourne

January 2022

Executive Summary

Air quality was monitored in Cambourne using new Zephyr monitoring technology in the period May – November 2021 as part of a study into air quality around primary schools. Monitoring was carried out outside Monkfield Park Primary School, as it is recognised that children are among the most vulnerable to the impacts of air pollution. Cambourne was selected as a monitoring site due to the primary school being located on the main road through Lower Cambourne. It was found that concentrations of the main pollutants, nitrogen dioxide and particulate matter, were comfortably below the national objectives for annual mean concentrations and there were no exceedances of the short-term objectives, representing good air quality. This is in line with long-term concentrations measured across the South Cambridgeshire district and reflects the rural nature of the area. Differences were seen between the holiday periods of the summer holidays and October half term compared to term time, with lower concentrations in the holidays, likely reflecting reduced school traffic. A small reduction in pollutants was also seen during an 'eco-week' organised by the school to coincide with Clean Air Day, when pupils were encouraged to get to school using 'active travel' such as walking or cycling, highlighting the potential to improve air quality. South Cambridgeshire residents can help to improve local air quality through actions such as reducing idling of car engines and increasing walking and cycling where possible. This report can be read alongside the yearly Air Quality Annual Status Report (ASR) and the reports from other localised studies, which are available on our website.

Glossary

Annualisation – a calculation process used to estimate an average concentration for a full year from a shorter period.

Annual mean – the average concentration across a full calendar year.

AQMA – Air Quality Management Area – an area where air pollutant concentrations exceed or are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives.

Continuous monitor/monitoring station – instruments which measure air pollution all the time and therefore can give a concentration attributed to a specific time.

Diffusion tube – small plastic tube containing a metal mesh which is coated with a chemical that absorbs nitrogen dioxide. This is exposed to the air in a fixed location for a known amount of time, usually a month, and then sent to a lab for analysis. This provides an average concentration for the time it is exposed.

Nitrogen dioxide (NO_2) – a gas predominantly formed following the burning of fossil fuels, which can cause irritation of the airways and exacerbate symptoms of other conditions.

Particulate matter ($PM_{2.5}$ and PM_{10}) – the number refers to the size of the particulates in micrometres (one millionth of a metre) – a mix of solid particles and liquid droplets of various sizes and composition, the smallest of which can get into the blood and be transported around the body.

Real-time monitoring – see also continuous monitoring – monitoring which takes place at regular intervals all the time and therefore can give a concentration attributed to a specific time.

$\mu g/m^3$ – micrograms per cubic metre, the standard units of measurement of air pollutants including nitrogen dioxide and particulate matter.

Zephyr – a type of relatively compact and lightweight air pollution sensors that measure harmful gases and particle matter in real-time.

South Cambridgeshire District Council

Update on Zephyr monitor in Cambourne

Introduction

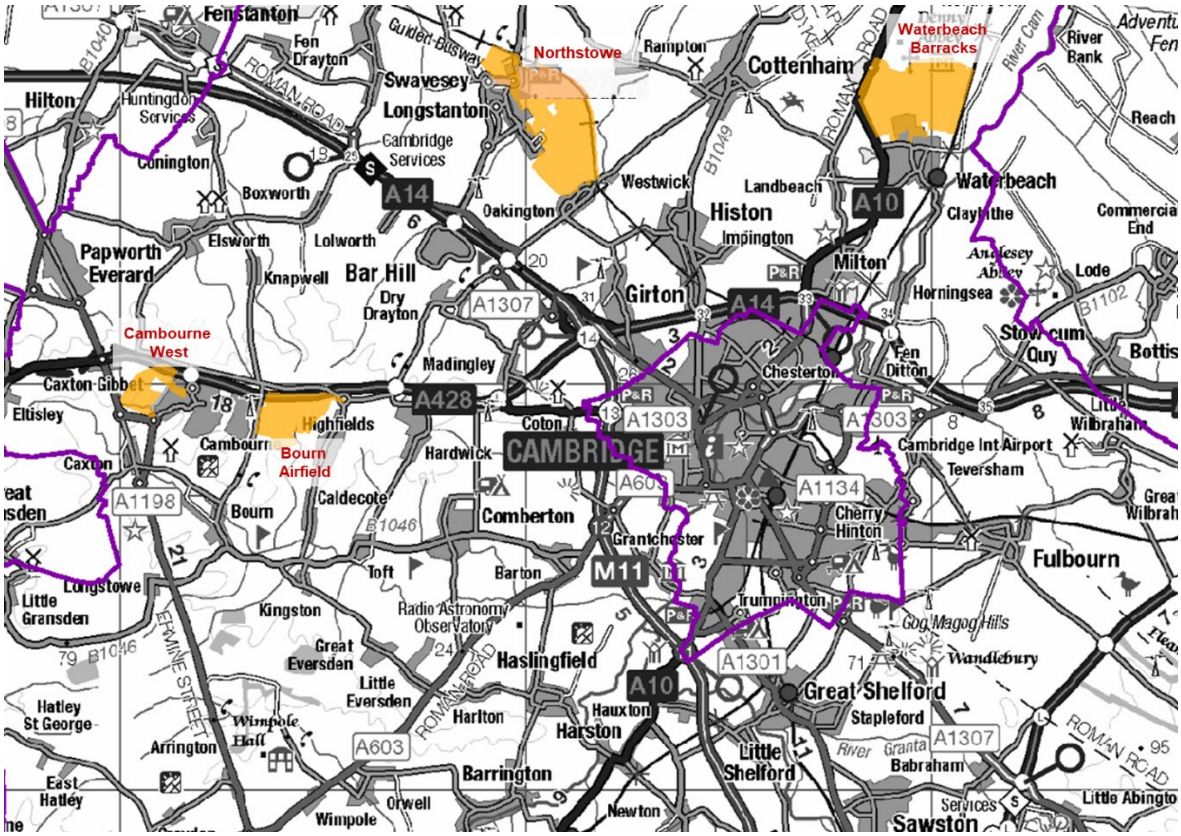
Purpose of this report

This is a report to provide an update on the short-term air quality monitoring study in Cambourne using new Zephyr monitoring technology. Monitoring was carried out in the period May – November 2021. The study was designed to be a short-term study monitoring air quality outside Monkfield Park Primary School as part of South Cambridgeshire District Council's study into air quality around primary schools. It also serves to create additional local awareness of air quality in our area and enable people to make informed choices around how they can impact on improving air quality in their area.

Air Quality in South Cambridgeshire

South Cambridgeshire is a rural district which enjoys generally good air quality, with both short-term and long-term pollution levels below the national objectives at all monitored locations. This means we benefit from cleaner air to breathe and less pollution related health problems. The area is undergoing significant growth with major developments to keep up with the increase in demand for housing, including Northstowe (10,000 dwellings), Waterbeach Barracks (6000-10,000 dwellings), Bourn Airfield and Cambourne West, shown in Figure 1. Air quality impacts in the district are mainly related to these areas of growth and the major roads running through the district, including the A14 and M11/A11 corridors, and therefore this remains an important issue.

Figure 1 – Locations of Major Development sites in South Cambridgeshire



Air quality is an important topic as air pollution can impact our health, particularly effecting the most vulnerable, including children and those with underlying conditions. Air quality is monitored across the district using a network of diffusion tubes and continuous monitoring stations, which provide accurate air quality measurements in real-time, in addition to the new Zephyr monitors to be used for short term monitoring. For more information and detail on the importance of air quality and air quality in South Cambridgeshire, please refer to Appendix 1 – Air Quality Frequently Asked Questions or visit our website. Additionally, ideas on how anyone can play a role in improving local air quality can be found in Appendix 2 – How to get Involved with Local Air Quality.

The 'Zephyr' Air Quality Sensor

Zephyr monitors are compact and lightweight air pollution sensors that measure harmful gases and particles in real-time, including the main pollutants of concern

(NO_2 and PM_{10} and $PM_{2.5}$ particulate matter). They can run off internal batteries or be powered by a solar panel and can therefore be fixed in a specific location, mostly commonly a lamp post, or used as a mobile monitor. The sensors provide detailed air quality measurements in real-time to help identify pollution hotspots at a localised level, for example busy junctions. Other potential studies include investigating air quality around schools and looking into the impacts of wood burning stoves. Zephyr sensors can be used in isolation individually or deployed as a network of sensors across a wider area to build up a more detailed picture.[1]

The data from a Zephyr sensor cannot be treated with the same confidence as that from one of our continuous monitor stations, where the data is 'ratified' after checks, however it has been shown to provide accurate indicative measurements and is therefore appropriate for a wide range of studies, including this.

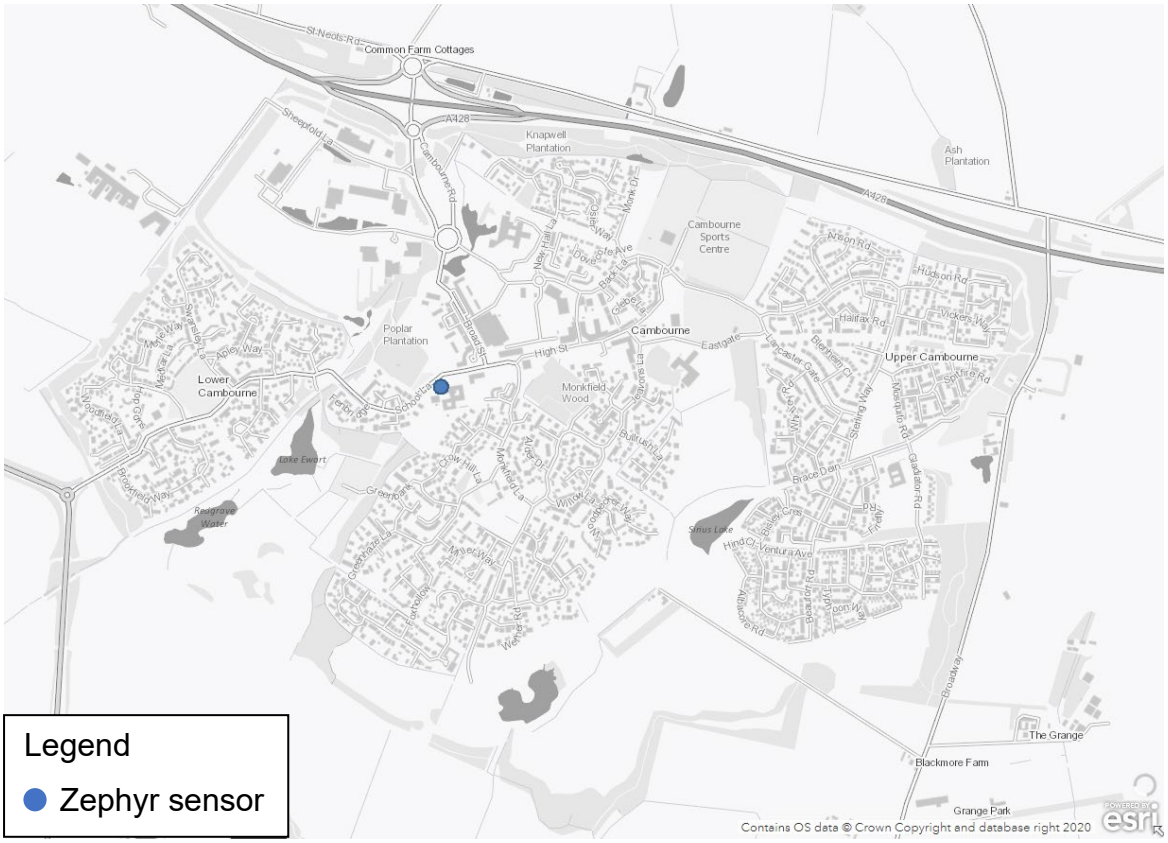
Monitoring Location

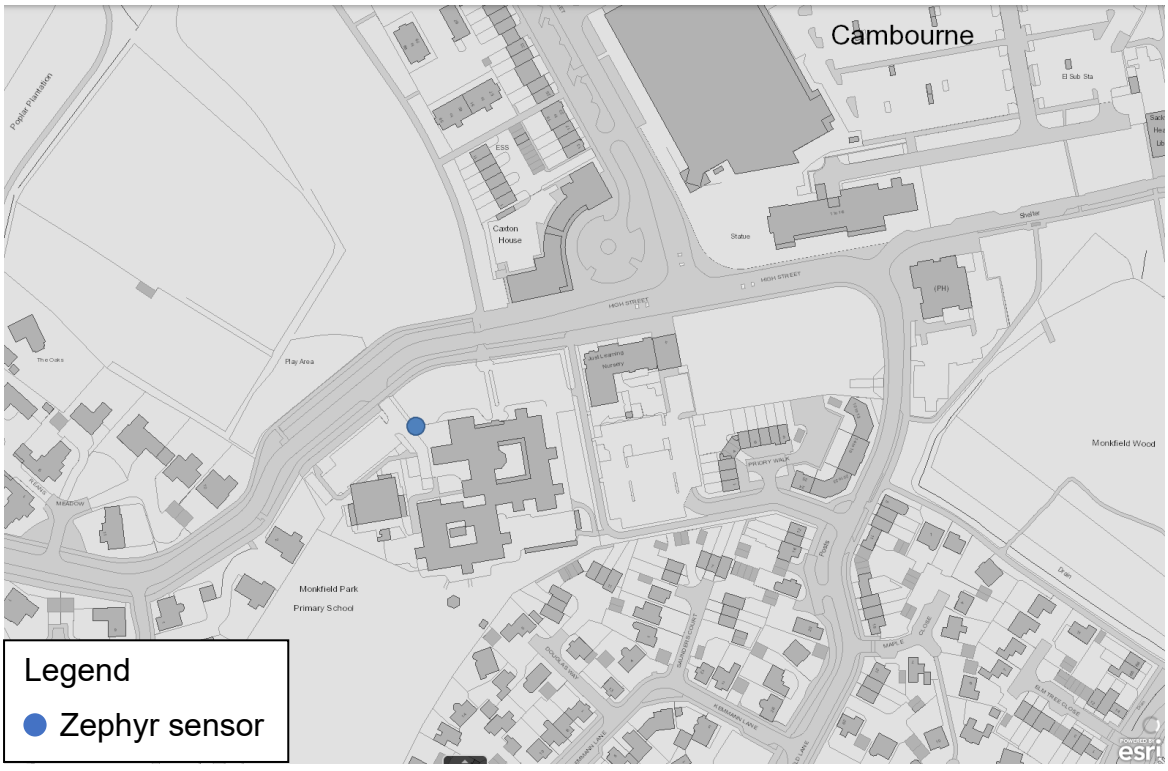
Cambourne was selected as part of a council study looking into air quality around schools. Monkfield Park Primary School was chosen as it is a primary school located on the main road through Lower Cambourne. The major reason for investigating air quality around primary schools is that children are amongst the most vulnerable to the effects of air pollution, which was reflected by the theme of Clean Air Day in 2021 of 'protect our children's health from air pollution'[2]. This is due to children's airways and respiratory systems being less developed than an adult's and because they breathe more rapidly than adults.

The monitor was located on a lamp post within the school grounds of Monkfield Park Primary School, on the path next to the field area, to be representative of the air quality experienced by people within the school grounds. It measured the main pollutants of concern, nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$), among others. The location of the Zephyr can be seen on Figure 2, below.

[1] https://www.earthsense.co.uk/zephyr
[2] https://www.cleanairday.org.uk/

Figure 2 – Location of the Zephyr sensor in Cambourne





Monitoring Data and Comparison with Objectives

The average monthly concentrations measured in the period May to November 2021 are shown in Table 1, below, with the annual mean objective shown for information. The exact date range was from 10th May – 30th November, which followed an initial 'settling in' period of the instrument. This data is also represented in Figure 3.

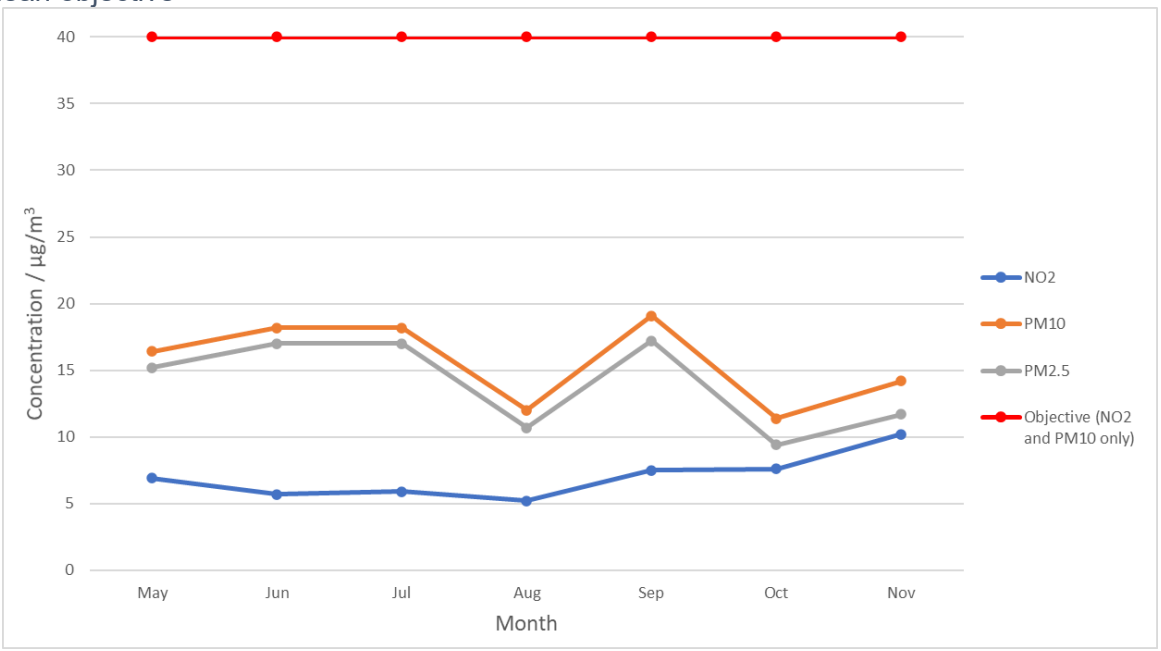
Table 1 – Zephyr Air Quality data – monthly average concentrations

	Pollutant monthly average concentration / µg/m^3		
Month	NO_2	PM_{10}	$PM_{2.5}$
May 2021*	6.9	16.4	15.2
June 2021	5.7	18.2	17.0
July 2021	5.9	18.2	17.0
August 2021	5.2	12.0	10.7
September 2021	7.5	19.1	17.2
October 2021	7.6	11.4	9.4
November 2021	10.2	14.2	11.7
Objective (annual mean)	40	40	25†

* 7/5/2021 – 31/5/2021

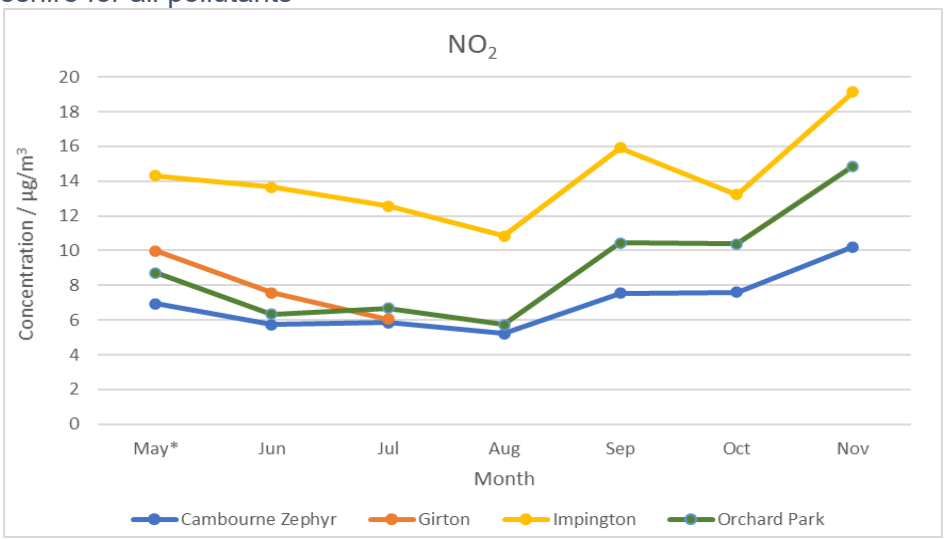
†not part of the Local Air Quality Management (LAQM) requirements

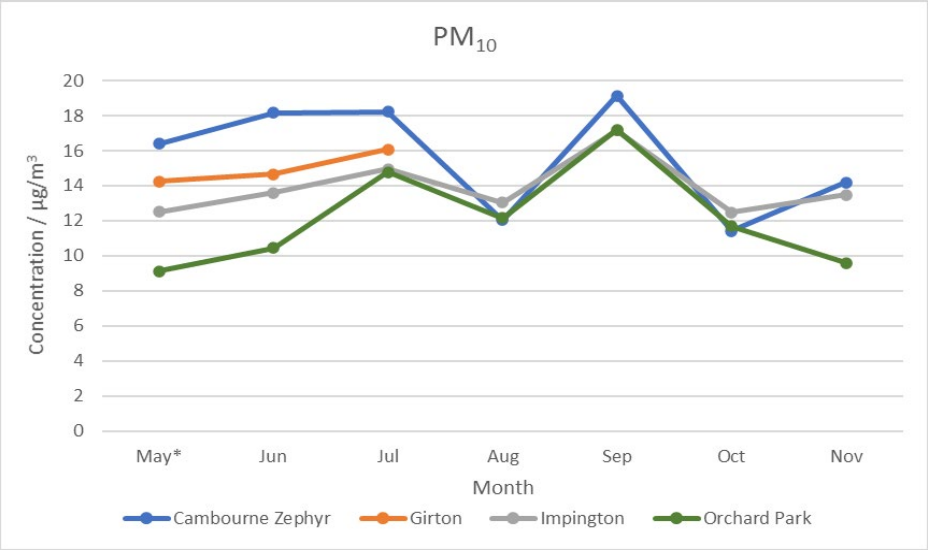
Figure 3 – Zephyr Air Quality data – monthly average concentrations and national annual mean objective

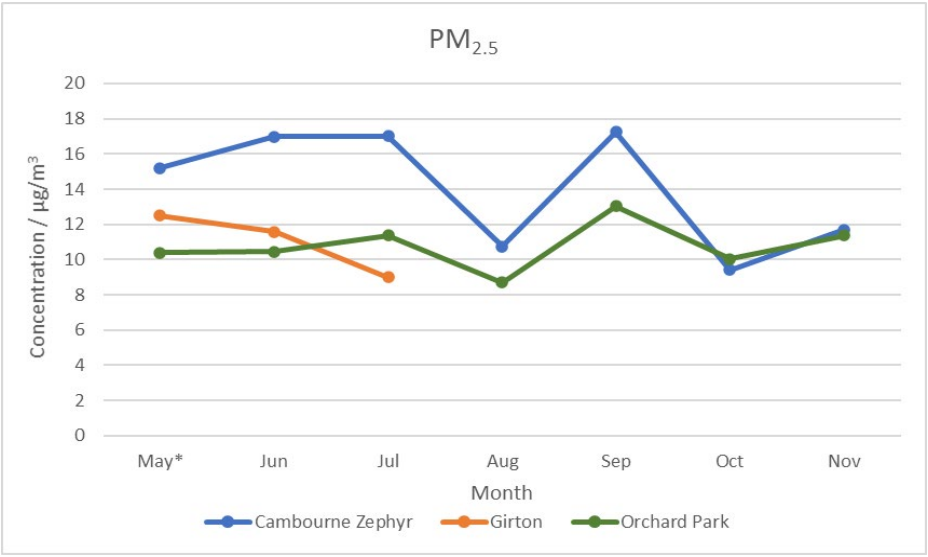


The data recorded in Cambourne was also compared to that recorded in the same monitoring period by the Council's automatic monitoring stations for each pollutant. As shown in Figure 4, below, the data and trends recorded by the Cambourne Zephyr are consistent with those seen at other monitoring locations across the district, although the PM levels appear relatively high. This suggests that there can be a reasonably high degree of confidence in the data collected by the Zephyr monitor.

Figure 4 – Comparison of Cambourne Zephyr data to automatic monitoring sites in South Cambridgeshire for all pollutants







In addition, the average concentrations of each pollutant for the whole period May – November were calculated and then 'annualised' to give estimated annual mean concentrations to allow better comparison to the annual mean objectives. Annualisation is a calculation process used to estimate an average concentration for a full year from a shorter period, such as the approximately 6 months in this study. This is done to avoid the annual average being influenced by short-term events or seasonal changes, such as one day of high pollution like bonfire night, or pollution concentrations often being higher in the winter than the summer. The data was annualised using 2020 data from a range of continuous monitoring background sites and is shown in Table 2, below. Full annualisation details are available in Appendix 3 – Annualisation of short-term data.

Table 2 – Zephyr Air Quality Data – annualised annual mean concentrations – 2020 annual mean

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
Measured data average May – Nov	7.0	15.6	13.9
Annualisation factor	1.21	1.02	1.07
Annualised annual mean – Cambourne Zephyr	**8.5**	**15.9**	**14.9**
Objective (annual mean)	40	40	25*

*not part of the Local Air Quality Management (LAQM) requirements

As shown in Table 1 and Table 2, the long-term annual mean concentrations of the main pollutants of concern at the Cambourne Zephyr are significantly below the national objectives for NO_2 and PM_{10}, indicating good air quality. The $PM_{2.5}$ concentration is above the ambitious World Health Organisation guidelines announced in September 2021, although it remains well below the current UK objective of 25 µg/m^3 (this objective does not form part of the Local Air Quality Management regime which covers local authorities). It was noted that the $PM_{2.5}$ value was found to be slightly higher than the typical proportion of the PM_{10} values. It is unclear why this is the case, with no obvious sources identified, although possibilities include local building work, higher national $PM_{2.5}$ levels than anticipated or instrument error. Given the uncertainty, it may be considered prudent to monitor again in Cambourne at a later date, following further studies to understand the equipment more.

Typically, $PM_{2.5}$ is a pollutant that is more regional than local as it can travel long distances suspended in the air. Therefore, its concentration is often more impacted by national and regional sources and less by local factors than other pollutants (such as nitrogen dioxide).

The Zephyr also allows measurements of the short-term concentrations of pollutants, which are studied through 1-hour means for NO_2 and 24-hour means for PM_{10}.

These are presented and compared to the national objectives in Table 3, below. The short-term objectives are presented as hourly/daily concentrations that should not be exceeded more than a certain number of times in a year. There is currently no short-term objective for $PM_{2.5}$.

Table 3 – Zephyr Air Quality data – short-term average concentrations

Month	Number of exceedances of short-term objective	
	NO_2 1-hour mean	PM_{10} 24-hour mean
May 2021	0	0
June 2021	0	0
July 2021	0	0
August 2021	0	0
September 2021	0	0
October 2021	0	0
November 2021	0	0
Objective	200 µg/m^3*	50 µg/m^3**

*Not to be exceeded more than 18 times a year

**Not to be exceeded more than 35 times per year

As shown in Table 3, there were no exceedances of the short-term objectives for NO_2 or PM_{10}. The relevant maximum short-term concentrations of the pollutants were also recorded. For NO_2 the maximum 1-hour concentration measured during the six-month period was 64.4 µg/m^3, which occurred during the evening rush hour on a weekday in November; this is well under the 200 µg/m^3 threshold and was the only 1-hour concentration above 60 µg/m^3 recorded. For PM_{10}, the maximum 24-hour concentration recorded was 38.7 µg/m^3, recorded on the 9th September, which is below the 50 µg/m^3 objective. This was at the end of a spell of warm weather and high pressure in England at the beginning of September and is likely a reflection that high pressure leads to still air, which allows pollutant levels to build up without being dispersed by wind or rain, leading to higher concentrations.

In addition to the overall picture outlined above, two specific time periods were studied. These were the week of Clean Air Day 2021, 14–18th June, when the school organised an eco-week where 'active journeys', e.g. walking and cycling, were encouraged and a comparison of the data from term time to the school's summer holidays (23rd July – 2nd Sept) and October half term (25–29th Oct). The eco week data was compared to the rest of June (with the week of Clean Air Day excluded).

As can be seen in Table 4, below, pollutant concentrations were considerably lower during the school holidays than term time, with a 29% reduction in nitrogen dioxide concentrations and around 20% reductions in particulate matter. A similar pattern was seen for the October half term, Table 5, with even bigger reductions in concentrations seen, 30% for nitrogen dioxide and 45-50% for particulate matter. This is also shown in Figure 5. This suggests that traffic related to the school likely has a significant impact on the air quality, although other factors such as weather conditions during these periods may also have played a role.

Table 4 – Comparison of pollutant concentrations between the summer holidays and term time

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
Summer holidays	5.3	13.1	11.7
Term time	7.5	16.4	14.6
Difference (%)	**29.5**	**20.5**	**19.8**

Table 5 – Comparison of pollutant concentrations between October half term and term time

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
October half term holiday	5.2	9.0	7.3
Term time	7.5	16.4	14.6
Difference (%)	**30.3**	**45.0**	**49.8**

Figure 5 – Comparison of pollutant concentrations between term time and school holidays

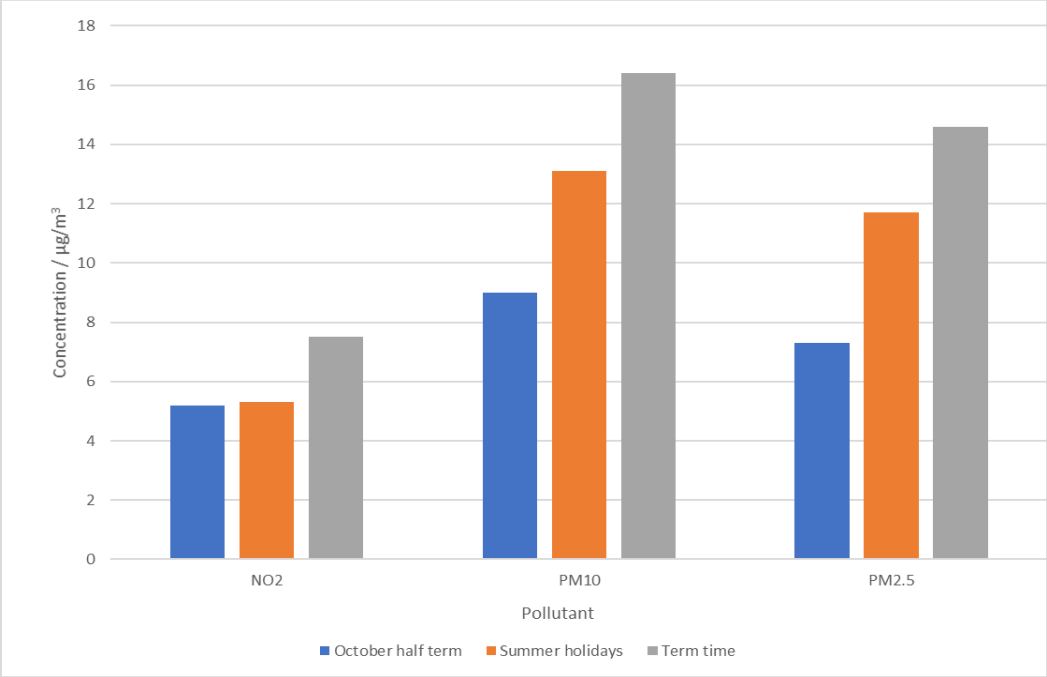


Table 6 shows that there was a small reduction in concentrations of nitrogen dioxide and particulate matter during the school's 'eco-week', 14–18th June, compared to the average concentrations in the rest of June (excluding the week being studied, i.e 1–13th and 19–30th June). This week was organised by Monkfield Park Primary School to include Clean Air Day 2021, which occurred on the 17th June.

Table 6 – Comparison of pollutant concentrations between the 'eco-week' and the rest of June

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
Week of Clean Air Day – 'Eco week'	5.66	17.1	16.0
Rest of June	5.74	17.8	16.6
Difference (%)	**1.4**	**3.6**	**3.8**

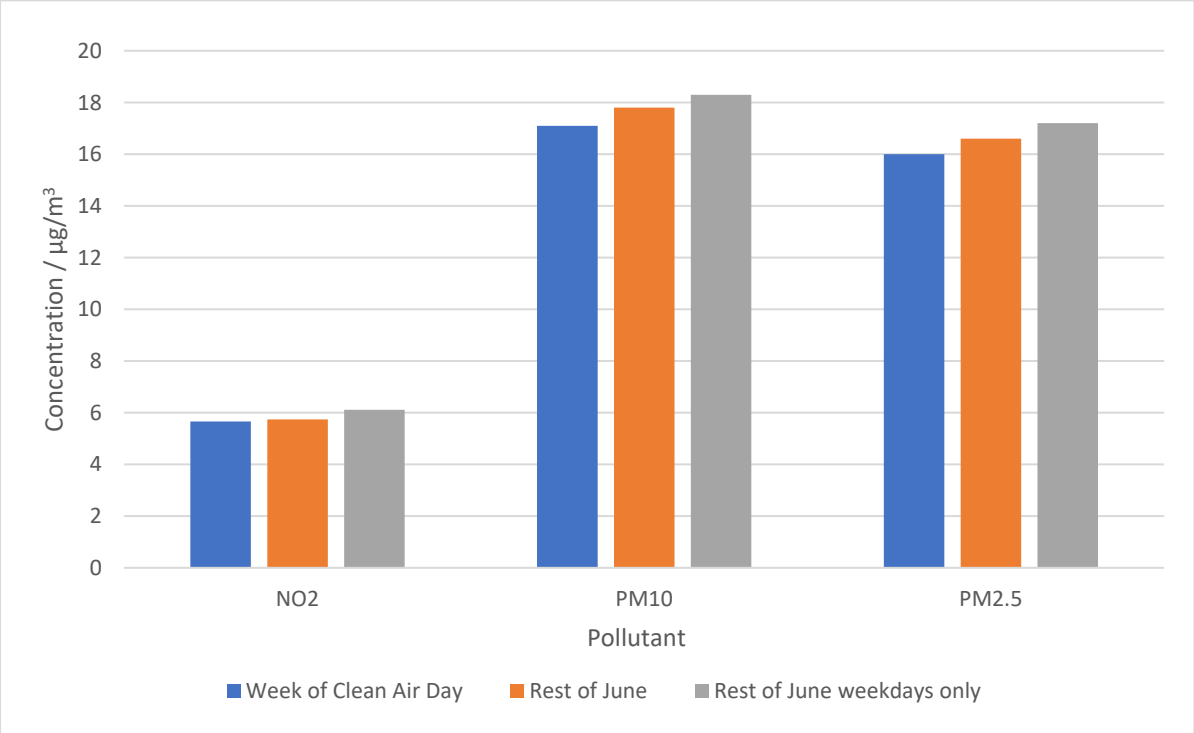
However, as shown in Table 7, when this comparison was made with only other weekdays in June (considered be a more like-for-like comparison with the eco-week around Clean Air Day) it was seen that there was a more significant decrease in concentrations during the eco-week. The reductions in concentrations improved to

over 7% for nitrogen dioxide and $PM_{2.5}$ and over 6% for PM_{10}. This likely further demonstrates the impact of school-run traffic and therefore highlights the potential for improvements in air quality from active travel such as cycling or walking rather than driving. This comparison is summarised in Figure 6.

Table 7 – Comparison of pollutant concentrations between the 'eco-week' and weekdays only in the rest of June

	Pollutant average concentration / µg/m^3		
	NO_2	PM_{10}	$PM_{2.5}$
Week of Clean Air Day – 'Eco week'	5.66	17.1	16.0
Rest of June weekdays only	6.11	18.3	17.2
Difference (%)	**7.3**	**6.4**	**7.2**

Figure 6 – Comparison of pollutant concentrations between the 'eco-week', the rest of June and weekdays only in the rest of June



Summary

The data measured by the Zephyr real-time monitor in the period May – November 2021 shows that the air quality in Cambourne remains good, with estimated annual mean concentrations (as well as the measured monthly averages) of the main pollutants of concern well below the national objectives. There were no exceedances of the short-term national objectives. It was found that concentrations of pollutants were lower during the summer holidays and October half term than term time and during an eco-week where active travel was encouraged. This highlights the impacts of school-run traffic and the potential air quality benefits of cycling and walking over driving. The data from the Zephyr was generally consistent with that from the rest of the monitoring sites in the district during the monitoring period, which provides confidence in the instrument. This also matches the general patterns seen across the South Cambridgeshire district of good air quality. However, due to the importance of air quality and its links to health, it remains important to both monitor air quality across the district and take actions to improve air quality in our area. Ideas on how to play a role in improving local air quality can be found in Appendix 2.

Appendix 1 – Air Quality Frequently Asked Questions

Why is air quality important?

There are a number of reasons air quality is important. In particular, polluted air is the biggest environmental threat to health in the UK. It is linked to up to 36,000 deaths per year from long-term exposure[3]. The main impacts of poor air quality are contributing to heart and lung conditions, but air quality has also been linked to a wide range of issues[4]. Air pollution also particularly effects the most vulnerable, including children and older people and those with existing lung and heart conditions. Air quality also strongly links to climate change, as many of the causes of the issues are the same, such as the burning of fossil fuels. This means that actions taken to improve air quality also helps prevent climate change.

How does the Council monitor air quality?

South Cambridgeshire District Council operates a monitoring network of over 30 locations across the district, made up of diffusion tubes and three continuous monitoring sites, which measure air quality accurately in real-time. This existing monitoring network allows the long-term monitoring of trends and changes in air quality across the district. Live data from the three continuous monitoring stations are available at https://scambs-airquality.ricardo-aea.com/. In addition, the Council has purchased three Zephyr air quality sensors which provide real-time measurements for the main pollutants of concern from a single monitor. These can be used for shorter-term monitoring to identify hotspots of pollution or be used in a range of targeted studies to complement our existing monitoring network. The first of these instruments was installed in Harston, with subsequent monitors installed in Cambourne, Northstowe, Histon and most recently Swavesey.

[3] Defra. Air quality appraisal: damage cost guidance, July 2020
[4] Public Health England. Air Quality: A Briefing for Directors of Public Health, 2017

What else does the Council do around air quality?

As well as monitoring air quality, the Council acts to improve air quality through its Green to the Core focus, including an air quality strategy designed to go beyond simply meeting the national objectives, Zero Carbon Community Grants to fund community initiatives to improve sustainability, such as encouraging and enabling cycling which in turn helps air quality, and by considering air quality during the planning process[5,6]. Ideas on how anyone can play a role in improving local air quality can be found in Appendix 2 – How to get Involved with Local Air Quality.

What are the main pollutants of concern?

The main pollutants of concern are:

- Nitrogen Dioxide (NO_2) – a gas predominantly formed following the burning of fossil fuels, which can cause irritation of the airways and exacerbate symptoms of other conditions
- Particulate Matter (PM_{10} and $PM_{2.5}$), where the number refers to the size of the particulates in micrometres – a mix of solid particles and liquid droplets of various sizes and composition, the smallest of which can get into the blood and be transported around the body[7]

What are the air quality objectives?

For NO_2 and PM_{10} national objective levels have been set which must be achieved by local authorities, otherwise an Air Quality Management Area (AQMA) must be declared for the objective which is being exceeded. Objectives have been set for both long-term concentrations (measured as annual means) and short-term concentrations (hourly means for NO_2 and daily means for PM_{10}). South Cambridgeshire District Council currently has one AQMA, along the A14 between Bar Hill and Milton, which was declared in 2008 for NO_2 annual mean and PM_{10} 24-

[5] Being green to our core https://www.scambs.gov.uk/your-council-and-democracy/performance-and-plans/our-business-plan/
[6] Zero Carbon Communities Grant https://www.scambs.gov.uk/community-development/grants/zero-carbon-communities-grant/.
[7] Defra, Clean Air Strategy, 2019

hour mean. It is proposed to revoke this AQMA in early 2022 due to sustained compliance with the relevant objectives in line with Defra guidance and the Council's constitution. The Air Quality Objectives applicable to local authorities through the Local Air Quality Management (LAQM) requirements in England are set out in Table 8. In addition, local authorities are expected to work towards reducing emissions and concentrations of $PM_{2.5}$ (particulate matter with a diameter of 2.5 µm or less), although there is currently no legal objective for local authorities.

Table 8 – Air Quality Objectives in England

Pollutant	Air Quality Objective – Concentration	Air Quality Objective – Measured as
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
Nitrogen Dioxide (NO_2)	40 µg/m^3	Annual mean
Particulate Matter (PM_{10})	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean
Particulate Matter (PM_{10})	40 µg/m^3	Annual mean
Sulphur Dioxide (SO_2)	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean
Sulphur Dioxide (SO_2)	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean
Sulphur Dioxide (SO_2)	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean

If air pollution is a result of vehicles utilising the A14, how can local residents change this?

There are a number of way local residents can have an impact on air quality through everyday actions, such as those mentioned in Appendix 2 – How to get Involved with Local Air Quality. Many of these are very small changes that can add up to a big impact.

Appendix 2 – How to get Involved with Local Air Quality

Annual reports and details on air quality monitoring are available on our website, https://www.scambs.gov.uk/environment/pollution/air-pollution/local-air-quality-management/, and you can share your views via our email address, air.quality@scambs.gov.uk.

Although air quality in the South Cambridgeshire District is generally good, with concentrations below the objectives, there are actions we can all take to improve it further. Ways you can help to improve air quality in South Cambs include:

- Minimise car use wherever possible:
    - Avoid using your car for short trips (under 2 miles) - short trips are very polluting as modern engines needs to reach a very high temperature to work efficiently; on short trips it won't reach that temperature.
    - For short journeys try cycling or walking more often – this helps you stay healthy and saves you money in fuels costs.
    - For longer journeys consider public transport options.
    - Use journey-planning apps such as MyBusTrip or MotionMap for travel by bus, train, walking and cycling.
- Switch it off – don't leave your car engine idling if you are stationary e.g. waiting to pick someone up, in a traffic jam or waiting at level crossings.
- When driving, use techniques that help you use less fuel, like driving more slowly and smoothly.
    - You could use 10% less fuel by following the tips on the AA website http://www.theaa.com/motoring_advice/fuels-and-environment/drive-smart.html.
    - Like switching your engine off when stationary, this will not only reduce your emissions of air pollution but will save fuel and therefore money too!
- Consider making your next vehicle an electric vehicle.
- Join a car club or car-share regularly.
- Consider working at home where possible – the first Covid-19 lockdown showed widespread improvements in the air quality as the amount people travelled reduced.

- Use less energy at home – consider a smart meter to monitor usage and be aware of boiler standards.
- Opt for ‘green energy’ tariffs where available or switch to renewable sources of heating or power.
- Reduce the use of solid fuel stoves and open fires – domestic burning is now the single biggest source of particulate matter pollution in the UK (greater than traffic and industry).
    - If you are burning wood or coal ensure any fuel used meets the new standards of moisture content and emissions – more information is available at https://woodsure.co.uk/are-you-ready-to-burn/
- Make your children aware of the impact that day to day activities have on air quality.

Appendix 3 – Annualisation of short-term data

Annualisation is a calculation process used to estimate an average concentration for a full year from a shorter period, such as the 6 months in this study. Annualisation ratios are worked out as a ratio of the average concentration in a full year (annual mean (Am)) to the average in the actual monitoring period measured (period mean (Pm)), using data from background continuous sites. The average concentration from the Zephyr data during the monitoring period is then multiplied by that ratio to give an estimate of the average concentration at the Zephyr for a full year.

The data from the period May to November 2021 was annualised according to the process set out in box 7.9 of Defra's Local Air Quality Management Technical Guidance (TG16). Continuous monitoring background sites were used for the annualisation calculations. Full year data for 2021 is not yet available therefore 2020 data was used for the annual mean concentrations.

NO_2:

Background Site	Annual mean (Am)	Period mean (Pm)	Ratio (Am/Pm)
Orchard Park	10.6	8.9	1.19
Wicken Fen	6.7	4.7	1.41
Northampton Spring Park	9.3	8.9	1.04
Norwich Lakenfields	9.8	8.3	1.19
Average ratio	-	-	1.21

PM_{10}:

Background Site	Annual mean (Am)	Period mean (Pm)	Ratio (Am/Pm)
Orchard Park	12.2	12.3	0.99
Norwich Lakenfields	12.8	12.3	1.04
Average ratio	-	-	1.02

$PM_{2.5}$:

Background Site	Annual mean (Am)	Period mean (Pm)	Ratio (Am/Pm)
Northampton Spring Park	10.3	9.6	1.08
Norwich Lakenfields	8.3	7.8	1.07
Average ratio	-	-	1.07