How is dust and air quality monitored at Mountsorrel Quarry?

July 2022 to June 2023

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Introduction

It's impossible to run a quarry of any size without raising some dust. However, Tarmac is always working to keep dust at safe and acceptable levels. In this report, DustScanAQ explains how dust is measured and controlled at Mountsorrel Quarry.

As part of their planning consent, Mountsorrel Quarry has a comprehensive Dust Management and Monitoring Plan (DMMP) which outlines the potential sources of on-site dust, the measures that are taken to control dust and how dust and air quality are monitored. This DMP has been agreed with and signed off by the necessary public authorities (Leicestershire County Council (LCC), Charnwood Borough Council (CBC), and the Environment Agency (EA)) and is reviewed at least every two years to ensure it is relevant and up to date. You can read the site's DMMP on the CBC website[1].

The DMMP was prepared by DustScanAQ, which is a small independent dust and air quality consultancy based in Oxfordshire. Formed in 2004, it has been providing monitoring, management and assessment services to Mountsorrel Quarry for well over a decade.

In addition, Tarmac carries out routine health surveillance for their staff to ensure they are working in a safe environment. This health screening is also carried out by independent experts, and the testing is undertaken in accordance with the appropriate guidance from the Health and Safety Executive (HSE). You can read the relevant HSE guidance here[2].

CBC is responsible for ensuring that Air Quality is within the national limits throughout the Borough, which of course includes the communities around Mountsorrel Quarry. You can read about how CBC monitors air quality within the Borough here[3].

It's not just CBC that monitors air quality and dust at Mountsorrel Quarry. You will see in Mountsorrel Quarry's DMMP that there is a network of monitoring devices both on-site and throughout the locality: some of these instruments measure in 'real time', others take samples over weekly or fortnightly periods, and others every month.

The data from these monitors get summarised in monthly 'compliance reports' prepared by DustScanAQ and shared with CBC and other local stakeholders (such as LCC). These reports are necessarily technical, so DustScanAQ has prepared this document so that you can immediately appreciate what the reports are about. On behalf of Tarmac, DustScanAQ will also begin preparing quarterly summaries explaining the data in the compliance reports; these will be shared in due course.

This report summarises the key dust and air quality monitoring results for the period July 2022 to June 2023.

[1] https://www.charnwood.gov.uk/pages/mountsorrel_quarry
[2] https://www.hse.gov.uk/pubns/mdhs/
[3] https://www.charnwood.gov.uk/pages/airpollution

A short introduction to dust and particulate matter

Dust and particulate matter are two environmental factors that have a lot in common, but for the reasons we'll explain below, they frequently need to be measured and thought of in different ways.

In general, 'dust' refers to particles that are big enough to be seen with the naked eye, whilst 'particulate matter' refers to particles that are too small to be seen without magnification.

The size of dust particles and particulate matter is described using microns (µm). For reference, there are one thousand microns in a millimetre.

Dust

From a scientific perspective, 'dust' is regarded as particles up to 75 microns in diameter. In practice, dust particles are big enough to be seen with the naked eye. Because of their size, the particles are too big to be inhaled into the lungs (they get caught by hairs and mucus in your nose and windpipe), but they can still cause visual annoyance or impact.

The two ways dust can cause an impact are:

- Short-lived dust events – such as a big cloud of dust in the air; or
- Longer-term dust deposition – such as dust landing on surfaces, making them visibly soiled.

Dust can be generated by a large number of man-made activities, such as construction, domestic heating, vehicle emissions, quarrying, recycling or agriculture to name a few. It can also be caused by natural phenomena – a good example is the fine red Saharan dust that sometimes deposits across the UK when conditions and wind directions are suitable.

Particulate matter

The term 'particulate matter' refers to particles that are small enough to be inhaled into the lungs. Because individual particles are so small, it's not possible to see particulate matter with the naked eye.

Particulate matter is commonly split into two different sizes: $PM_{2.5}$ and PM_{10}. $PM_{2.5}$ particles are those that measure 2.5 microns in diameter, while PM_{10} are up to 10 microns in diameter. To put that into perspective, a typical human hair is between 50 and 70 microns in diameter. That means you could fit up to thirty $PM_{2.5}$ particles end to end across a human hair, and up to seven PM_{10} particles. In fact, fine particles are so small that they behave more like gases in the air than dust particles, meaning they will stay in the air for a long time.

Figure 1 is a useful guide to the size of particles we're dealing with.

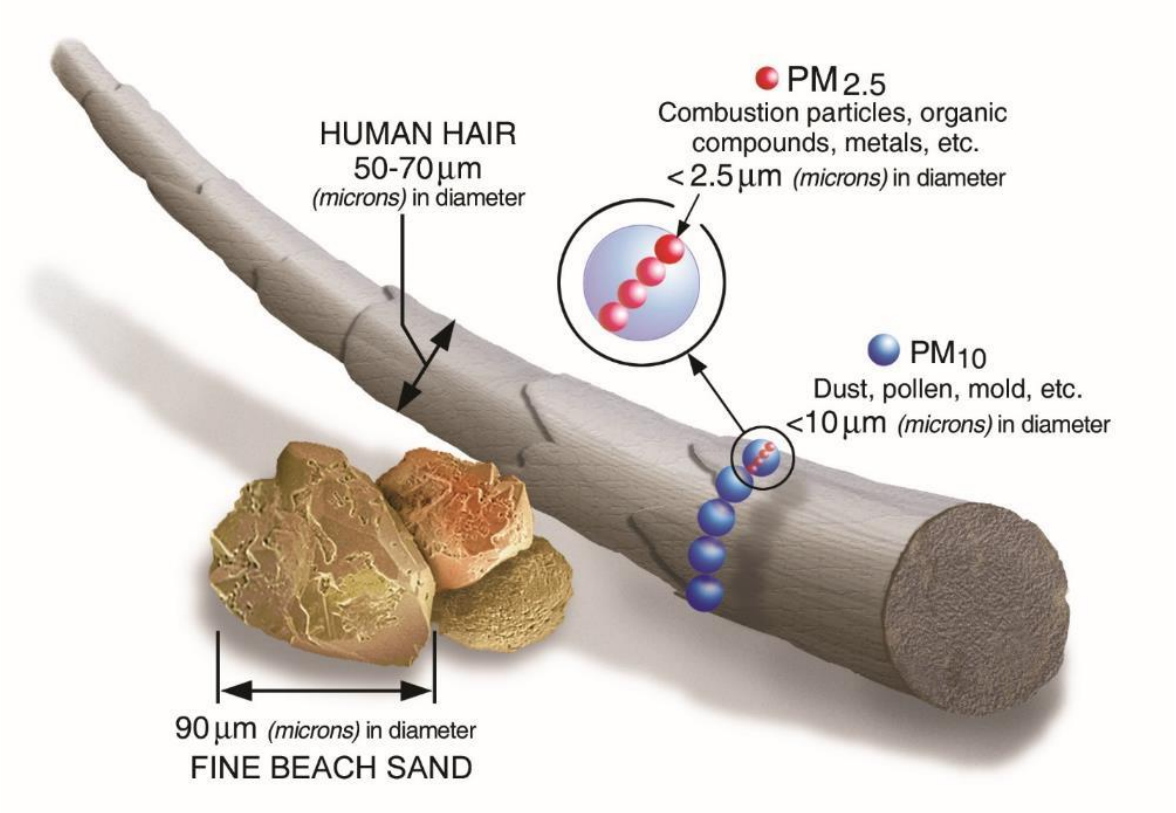

Figure 1: relative sizes of beach sand, human hair, $PM_{2.5}$ and PM_{10} (source, US EPA)[4]

We report the results as an amount of particulate matter per cubic metre (m^3) of air. Because particulate matter is so small and light, we use micrograms (µg) to describe their mass – there are one million micrograms in a gram. You'll see concentrations below that use the unit micrograms per cubic metre (µg/m^3).

[4] https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

How do we measure dust and air quality?

We measure air quality both within the quarry and in the surrounding areas using many different pieces of equipment. There are two permanent installations, as detailed below, and we also occasionally carry out additional particulate matter monitoring at other locations to gather important data on air quality on and around the site.

Measuring particulate matter

$PM_{2.5}$ and PM_{10} concentrations are measured at two locations using Turnkey Osiris devices[5], as seen in Figure 2.

Figure 2: Osiris monitoring locations

We use the Quorn House monitoring location as our 'background' site, away from roads, houses and our quarrying activities. The Hawcliffe Road location is close to the residences at the end of Hawcliffe Road as well as the LCC car park, the industrial sites on Granite Way as well as the load-out section of Mountsorrel Quarry.

Measuring dust

There are a number of different ways to measure dust. At Mountsorrel Quarry, we use 'Frisbee' gauges[6], as seen in Figure 3.

[5] https://turnkey-instruments.com/product/osiris/
[6] https://www.i2analytical.com/services/i2-hanby-gauge/dry-foam-frisbee-2/

Figure 3: Depositional and directional dust sampler locations

These gauges measure the amount of dust landing at that location, as well as indicating the direction the dust came from.

Currently we have thirteen locations measuring dust in this manner around the quarry and in the local area. As you can see, a lot of the monitoring locations are situated in residential areas, as these are the areas we wish to monitor closely in order to minimise dust levels as much as possible.

The dust monitoring results are compared against an agreed site threshold value. This threshold value has been agreed with CBC and is contained within the site's DMP. The limit value considers both the amount of dust falling together with the direction it has come from, because our monitoring has shown that there are many other possible dust sources in our locality. If the results are above the threshold values, we investigate the cause. Through the compliance reports mentioned earlier, we report the results of this monitoring to CBC and LCC every month.

On top of this, we regularly carry out 'above and beyond' dust monitoring at four further locations for internal site improvement purposes (see Figure 4). For this, we use DustScan sticky pad dust gauges to measure the amount of dust landing at these locations, as well as the direction from which the dust has come.

Figure 4: 'Above and beyond' sticky pad monitoring locations

What else do we measure on site?

Weather conditions

Finally, weather conditions can have a big impact on dust levels on a quarry. It's typically dustier when it's warm, dry and windy compared to when it's cold, wet and calm. Because of this, we measure weather conditions at two locations: next to the main site offices off Wood Lane, and at Quorn House, using weather stations as shown in Figure 5.

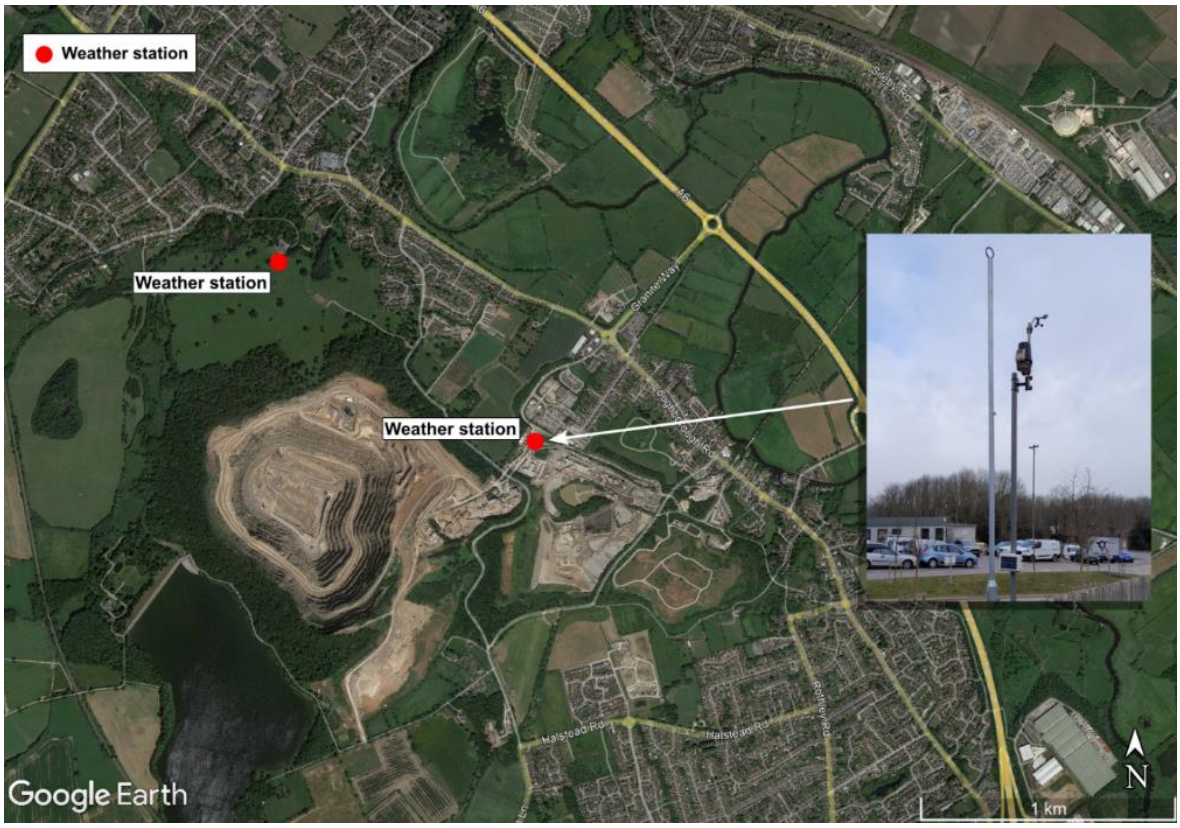

Figure 5: Weather station locations

Rainfall and temperature (July 2022 to June 2023)

As seen in Figure 6, rain and temperature varied quite a bit between July 2022 and June 2023. There were some long dry periods in July and August 2022, and in January, February and March 2023. Some extended wet periods were recorded in September to November 2022, and more recently in March 2023. Temperatures were very high in July last year and got very cold in December.

Both warm and cold periods can be challenging for dust control. In open areas like on the haul roads water is used (from both fixed sprays, and mobile tankers) to suppress dust. In hot weather, water quickly evaporates off haul roads and stockpiles, so the site has to be very vigilant in these conditions. During cold periods, ice can coat roads and some of the water pipes can freeze, limiting our abilities for dust suppression.

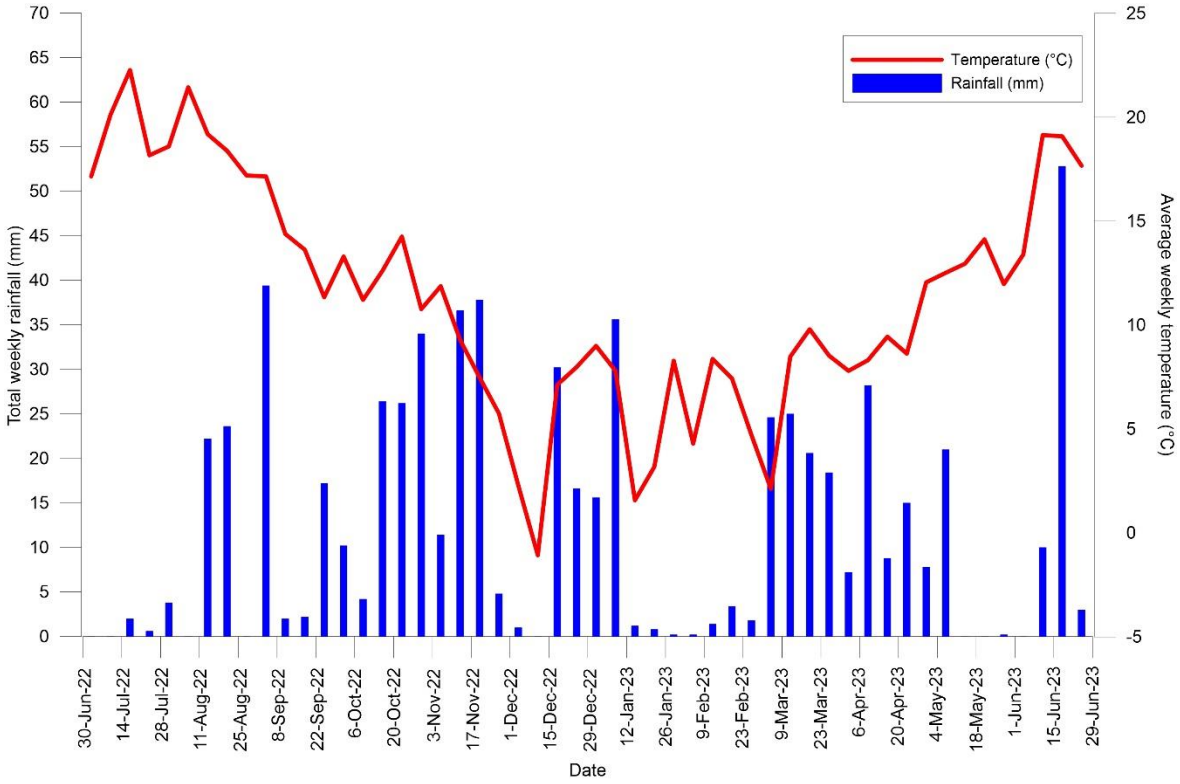

Figure 6: Weekly average temperature and total rainfall, July 2022 to June 2023

Wind speed and direction (July 2022 to June 2023)

Dust is transported by air, so it's really important to measure the direction and strength of the winds at Mountsorrel Quarry. The strength of the winds has a big impact on how much dust can be carried in the air – stronger winds can transport more dust than lighter winds.

Figure 7 is a wind rose from Mountsorrel Quarry from July 2022 to June 2023. Using colour (light green to red) it shows the speed of winds recorded, and using the length of each segment, it shows the frequency of winds recorded from each direction. It's important to read wind roses in the right way, in that they show the direction from which the wind was blowing. With this in mind, we can see that between July 2022 to June 2023, winds were most commonly blowing from the south, with smaller amounts of wind recorded from the southwest and other directions.

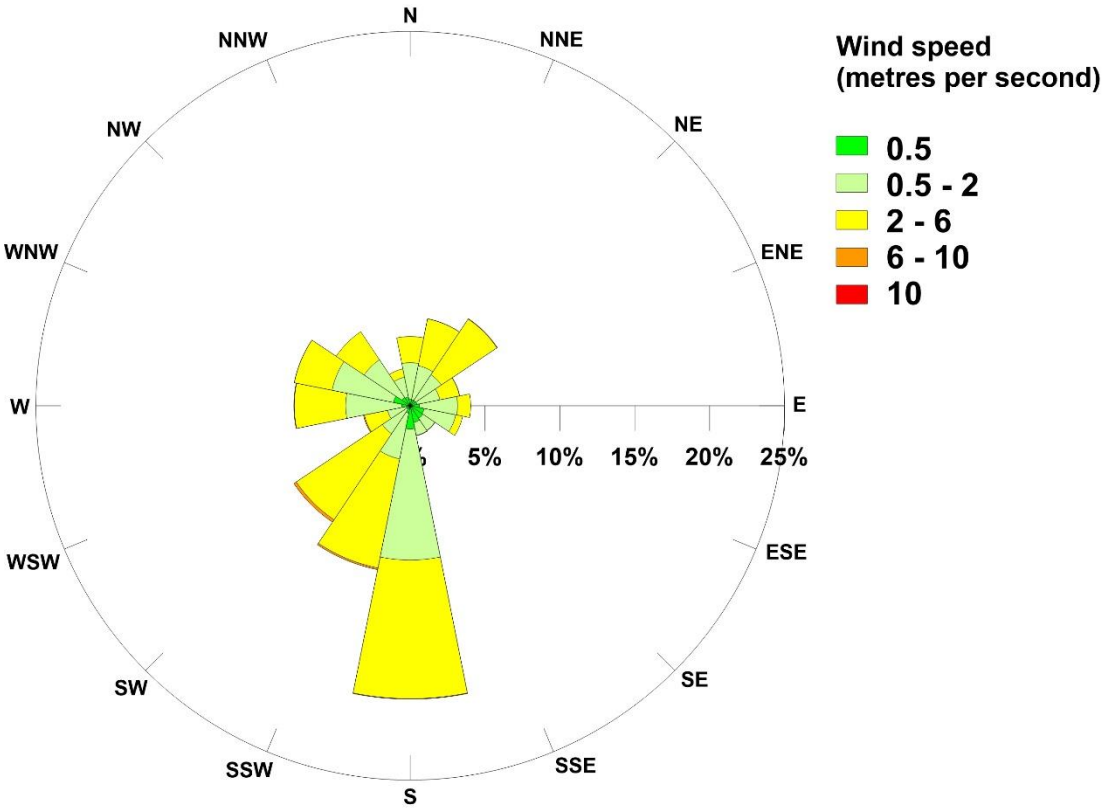

Figure 7: Wind speed and direction, Mountsorrel Quarry and surrounding area, July 2022 to June 2023

Dust and particulate matter levels – July 2022 to June 2023

Deposited dust – how much is landing?

To investigate how dust rates vary, we can compare the monitoring results against the site limit level agreed with CBC (125 mg/m^2/day). If the dust rate is below the site limit level, this means everything is going to plan. If the rate is above the limit, the site investigates the possible causes and tries to fix the issue as soon as possible.

The pie charts overlaid on the map in Figure 8 show how many times between July 2022 and June 2023 that the limit was exceeded at each monitoring location. As you can see, all but two of the locations were below the limit at all times during this period.

At Stn 9 (at the top of Hawcliffe Road), dust results were above the limit level for two out of twelve months during this period. The three exceedances were recorded in October 2022 and February 2023. As Figure 6 shows, these exceedances correlate with periods of relatively little rainfall. The results of each investigation into exceedances are detailed in the relevant compliance reports.

At Stn 1B (to the south of Kinchley Lane), the limit level was exceeded once and was found to be due to farming activities in the field, rather than quarrying.

Figure 8: Frequency of high dust levels, July 2022 to June 2023

Particulate matter

The concentration of particulate matter ($PM_{2.5}$ and PM_{10}) in the air is measured by Tarmac at two locations near Mountsorrel Quarry.

$PM_{2.5}$ and PM_{10} concentrations can be compared against Air Quality Objectives (AQOs)[7]. These are set by the Department for Environment, Food and Rural Affairs (DEFRA). The AQOs for England and Wales for $PM_{2.5}$ and PM_{10} are set out below.

Table 1: Air Quality Objectives for $PM_{2.5}$ and PM_{10}

Pollutant	Averaging Period	AQO (µg/m^3)	Exceedance Allowance
$PM_{2.5}$	Annual	12	-
PM_{10}	Annual	40	-
	Daily	50	35 per year

$PM_{2.5}$ and PM_{10} both have annual AQOs, of 12 µg/m^3 and 40 µg/m^3 each, while PM_{10} has a daily AQO of 50 µg/m^3, not to be exceeded more than 35 times per year. If fewer than 35 days are recorded above 50 µg/m^3, the daily AQO is not exceeded, but if more than 35 days are recorded, then that would be considered an exceedance of the AQO.

$PM_{2.5}$

Figure 9 presents the results of $PM_{2.5}$ monitoring at Hawcliffe Road and Quorn House from July 2022 to June 2023. The charts represent the annual average $PM_{2.5}$ concentration as a percentage of the annual $PM_{2.5}$ AQO, listed in Table 1, whilst the average concentration is given in the centre of each chart.

Both locations recorded annual averages below the AQO (5.8 µg/m^3 at Quorn House, and 6.8 µg/m^3 at Hawcliffe Road). It's worth pointing out that the difference in $PM_{2.5}$ concentration between the two locations is quite small, despite the two monitors being in very different locations. This tells us that the quarry (along with other industrial sources nearby) does not generate a lot of $PM_{2.5}$ particles, and that the local concentration of $PM_{2.5}$ is driven more by regional sources such as road traffic and combustion, rather than quarrying or construction. If the quarry was a significant source of $PM_{2.5}$, we would expect the results at Hawcliffe Road to be a lot higher than at Quorn House due to how close it is to our operations.

[7] https://uk-air.defra.gov.uk/assets/documents/Air_Quality_Objectives_Update.pdf

Figure 9: $PM_{2.5}$ monitoring summary, Hawcliffe Road and Quorn House, July 2022 to June 2023

PM_{10}

Figure 10 presents the results of PM_{10} monitoring at Hawcliffe Road and Quorn House during the same period. The chart represents the annual average PM_{10} concentration as a percentage of the annual PM_{10} AQO in Table 1. Both the annual concentration and the number of days where the average was above 50 µg/m^3 are shown in the centre of each chart.

Both locations were well within the AQO for PM_{10}, as shown in Figure 10. As Quorn House is a background location (a long way away from dust sources) the average concentration is lower than at Hawcliffe Road. Hawcliffe Road is closer to dust sources (such as the quarry, busy roads and other businesses and sites) so we would expect to see higher concentrations here. The average concentration for July 2022 to June 2023 at Hawcliffe Road was just under half of the annual AQO (19.1 µg/m^3), whilst at Quorn House the annual average concentration was just 20 % of the annual AQO (8.1 µg/m^3).

Figure 10: PM_{10} monitoring summary, Hawcliffe Road and Quorn House, July 2022 to June 2023

Figure 10 also shows that during this monitoring period, at Quorn House there were no days where the average concentration was higher than 50 µg/m^3. At Hawcliffe Road during this period, 26 days were recorded above this value. Importantly, this means that both locations did not exceed the daily AQO for PM_{10} (in other words, neither location recorded more than 35 days with average concentrations of 50 µg/m^3 or higher).

Conclusion

We hope this overview of the dust and air quality monitoring we carry out at Mountsorrel Quarry is useful and informative. If you have any questions after reading this report, please feel free to email the quarry directly at mountsorrelquarryfeedback@tarmac.com.