Wynnum citizen science air monitoring project

Interim report

April 2019

Queensland Government

Prepared by: Community Engagement, Department of Environment and Science

Disclaimer

This document has been prepared with all due diligence and care, based on the best available information at the time of publication. The department holds no responsibility for any errors or omissions within this document. Any decisions made by other parties based on this document are solely the responsibility of those parties.

Acknowledgements

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Introduction

In 2018, the Department of Environment and Science (the department) partnered with Clean Air Wynnum (CAW) and Bayside Creeks Catchment Group to develop the Wynnum citizen science air monitoring project with the focus of air quality monitoring in the bayside area. The project aims to address public concerns of air quality, and to improve community knowledge and understanding of air monitoring processes and regulation.

Communities play an important role in identifying and addressing environmental issues, and can often make significant contributions through citizen science activities. Citizen science involves public participation and collaboration in scientific research with the aim to increase scientific knowledge. This project enables significant data collection and information gathering by community members (citizens) in partnership with the department's air quality experts and empowers the community to address an environmental concern.

Monitoring and sampling methods were selected by CAW in consultation with air quality experts from the department's Air Quality Sciences to empower the community in decision-making, and increase confidence in monitoring outcomes. CAW was active in determining sampling methods, devices and monitoring sites where air quality was a particular concern to the community. This partnership enabled the community to be active in scientific project design and development, while increasing their knowledge and understanding of air quality monitoring, pollutant sources and data analysis.

Participants from CAW are currently measuring air quality by housing air monitoring devices at their private properties that measure the concentration of airborne particular matter for the duration of the project. To support the analysis of data collected, participants also complete monthly observation logs of localised observations or activities that may affect device readings. Additionally, surface wipe samples were taken and dust gauges installed in various residences selected by CAW.

This report is provided to Clean Air Wynnum by the department to provide interim air monitoring results for the Wynnum citizen science air monitoring project.

Monitoring sites

Twelve monitoring sites were selected by CAW across Wynnum, Hemmant, Tingalpa, Murarrie and Manly to house air monitoring devices (Figure 1). These sites were selected based on their proximity to local train lines and the coal stockpiles and bulk handling, as well as where there was a particular concern for air quality or dust pollution. The selected sites were diverse in location, representing areas that are close to main roads and traffic, recreational areas, train lines or close to the coastline. Four of the twelve sites were selected for dust gauge sampling, and another five sites for surface wipe samples. One surface wipe was conducted in July 2018, with another four samples taken in November 2018.

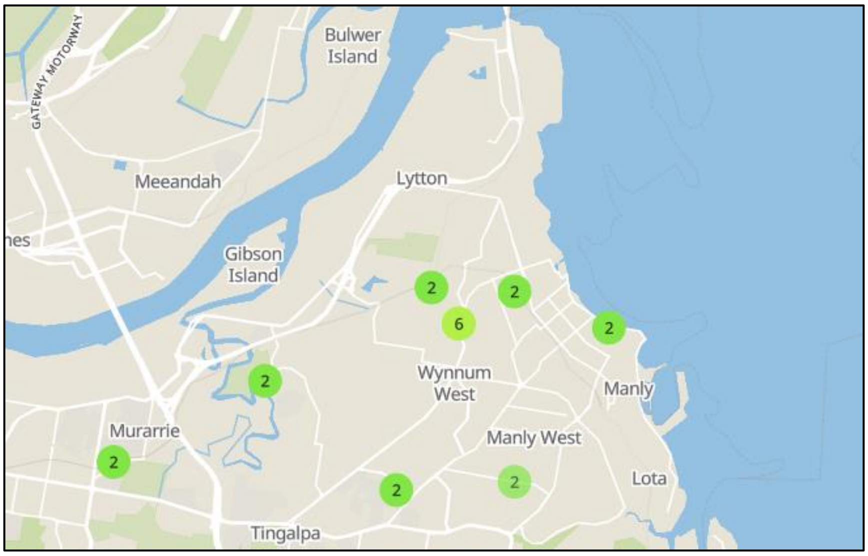

Figure 1: Wynnum citizen science air monitoring project area.

Particulate matter

The project is monitoring both $PM_{2.5}$ and PM_{10} using a new generation of laser particle counters that provide a cheap and accurate way to measure smoke, dust and other particulate air pollution. Twelve devices will be used. Ten participants will house high accuracy portable devices called PurpleAir (Figure 2), and two participants will house ArcHub devices (to be installed). Participants housing the PurpleAir devices were given the choice of where to house the devices (i.e. inside or outside), and chose the specific location on the property. As of February 2019, eight out of the ten PurpleAir devices were installed with the remaining devices planned to be installed in March/April 2019.

The concentration of $PM_{2.5}$ and PM_{10} are reported as **µg/m³** (micrograms per cubic metre of air)**.**

Figure 2: PurpleAir device (www.purpleair.com)

Live PurpleAir data can be accessed on the PurpleAir webpage (select *Raw $PM_{2.5}$ or Raw PM_{10}* measurements): https://www.purpleair.com/map?#12.69/-27.4594/153.15449

To determine any potential health risk, average $PM_{2.5}$ and PM_{10} results are assessed against standards outlined in the *National Environment Protection (Ambient Air Quality) Measure* (NEPM)[1] which act as benchmarks for safe concentrations of particulate matter (Table 1). The NEPM standards are based on 24-hour and 12-month averages of both $PM_{2.5}$ and PM_{10}.

Table 1: Criteria for $PM_{2.5}$ and PM_{10} concentrations as set by the National Environment Protection (Ambient Air Quality) Measure.

Particle size	Time period	Standard
$PM_{2.5}$	24 hours	25µg/m³
	12 months	8 µg/m³
PM_{10}	24 hours	50µg/m³
	12 months	25µg/m³

Dust composition (surface wipes)

Surface wipe samples were collected in July and November 2018 at five of the twelve sites on various surfaces (e.g. table tops, chairs, eaves etc.). This was done by wiping the surface to collect a sample of the particles that had been deposited to determine the composition of the particles. While the sample does help identify what types of particles have settled, the history of the sample is unknown (i.e. how long it has been there).

Samples were analysed independently by the University of Queensland's Materials Performance Laboratory (UQMP) using electron and stereomicroscopy to determine the type (and potential sources) of dust. Proportions of different types of particles were measured based on their surface area coverage, rather than particle mass. This analysis method identifies a range of black-coloured particles (e.g. coal, soot and rubber dust), mineral dust particles (e.g. soil, rock, cement and glass), biological particles (e.g. insects and plants) and other general organic particles (e.g. wood, fibres, and plastics). Compositional analyses can also be an indicator of particle source. For example, black-coloured dust may consist of various particle types such as rubber dust from tyre wear, diesel or petrol emissions from transport, coal or mould.

Dust deposition (gauges)

Four of the participants housed dust gauges for the month of November 2018.

Dust gauges consist of a 2-litre collection bottle and funnel mounted on a PVC stand, designed to collect airborne particles that settle on the internal surface area of the funnel (Figure 3). When samples are collected, insoluble dust is washed from the bottle then filtered, dried and weighed (Figure 4). Dust deposition is measured in **mg/m²/day** (milligrams per square meter per day)**.**

This provides us with a measure of how much dust settles over a given area and time under the influence of gravity (dustfall rate). A guideline of **120mg/m²/day** averaged over one month is commonly used as an indication of dust nuisance.

Figure 3: Removal of dust deposition gauge.

Figure 4: Dust and debris collected in dust gauge in November 2018.

Dust collected from gauges was also analysed by UQMP to determine the composition of the dust, and whether the sample is similar to particles identified in the surface wipes.

[1]National Environment Protection (Ambient Air Quality) Measure https://www.legislation.gov.au/Details/F2016C00215

Results and discussion

$PM_{2.5}$ and PM_{10}

Particulate matter was measured over December 2018 and January 2019 with five PurpleAir devices. Each PurpleAir device is equipped with two laser counters to measure particulate matter simultaneously to provide an indication on the reliability of the measurements. When measuring accurately, both sensors will show the same readings. During January, two PurpleAir devices showed inconsistent readings, indicating that one of the sensors on each device was likely to be affected by debris or insects inside the sensor, causing abnormally high readings. The results from the compromised sensors on each device were therefore not used in analysis due to their inaccuracy. The remaining sensors on both these devices were producing accurate readings (reflecting those taken by other PurpleAirs in the vicinity when graphed), and were used for analysis.

Between December 2018 and February 2019, **all 24-hour averages of $PM_{2.5}$ were well below the NEPM standard of 25µg/m³ over 24 hours** (Figures 5, 6 and 7). Maximum 24-hour averages for $PM_{2.5}$ over both December and January did not exceed 5µg/m³. The 24 hour average for $PM_{2.5}$ during February was less than 7µg/m³.

Similarly, measurements of PM_{10} over this period were also well within NEPM standards of 50µg/m³ over 24 hours (Figures 5, 6 and 7). Average PM_{10} readings were only marginally greater than $PM_{2.5}$, and did not exceed 8µg/m³ over 24 hours throughout December, January and February.

As the NEPM also outlines standards for $PM_{2.5}$ and PM_{10} over 12 months, particulate matter will also be analysed against annual standards at the conclusion of the Project.

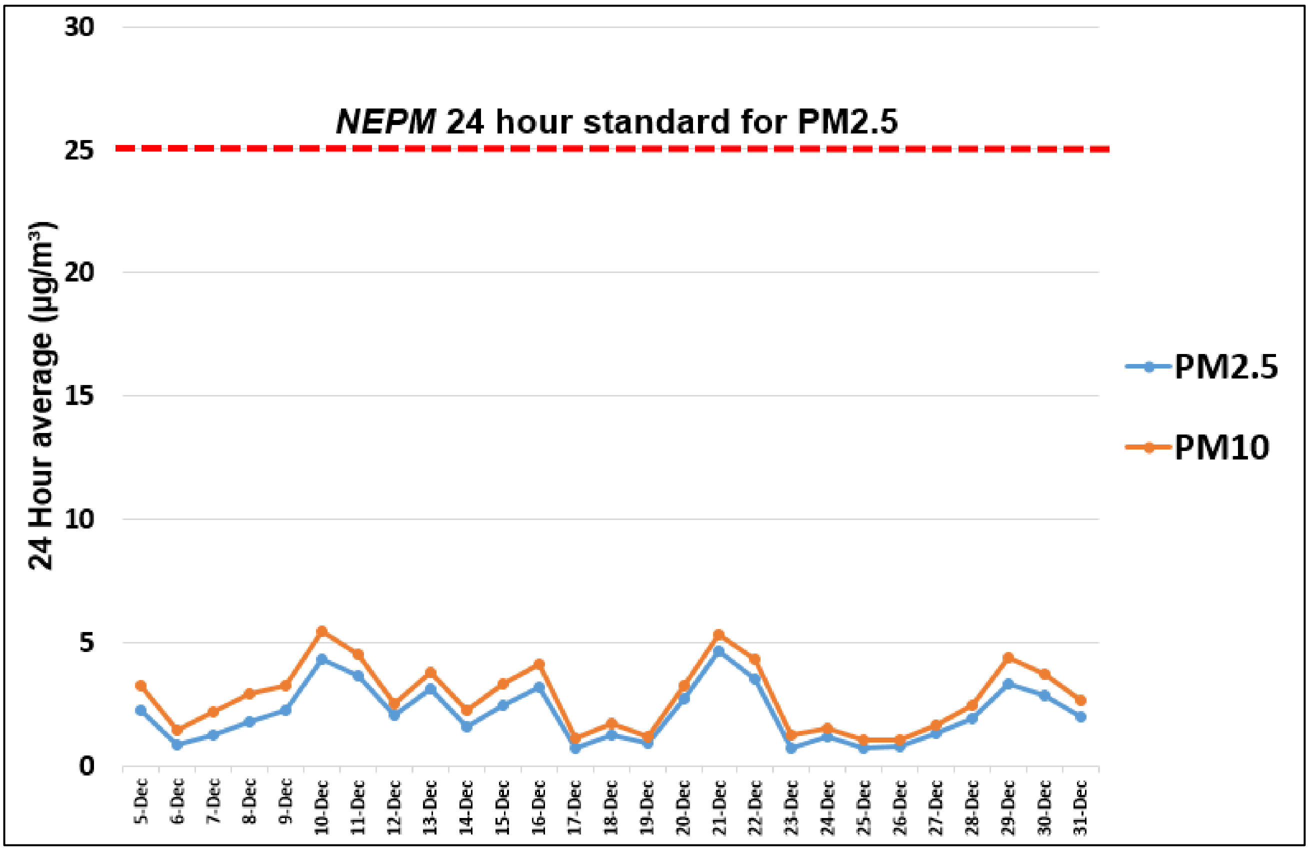

Figure 5: Average $PM_{2.5}$ and PM_{10} measurements over 24 hours during December 2018.

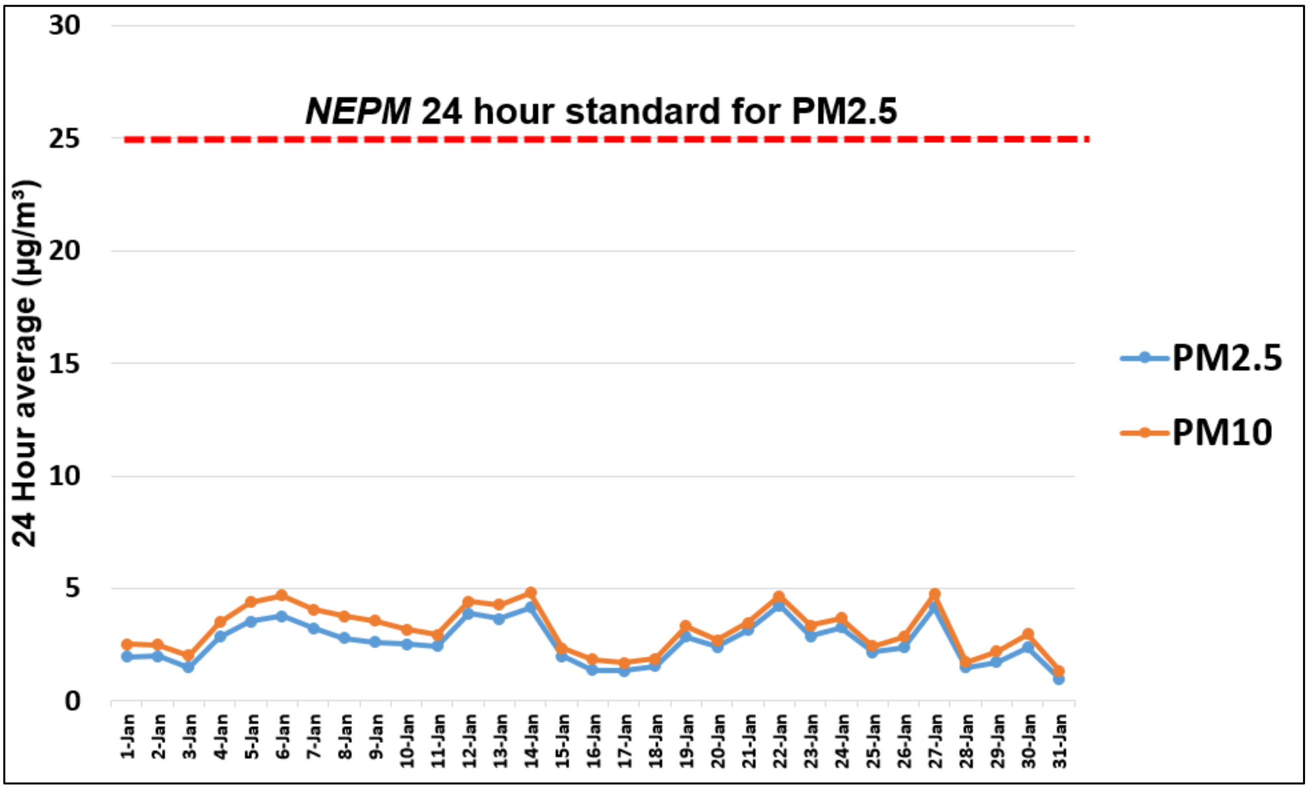

Figure 6: Average $PM_{2.5}$ and PM_{10} measurements over 24 hours during January 2019.

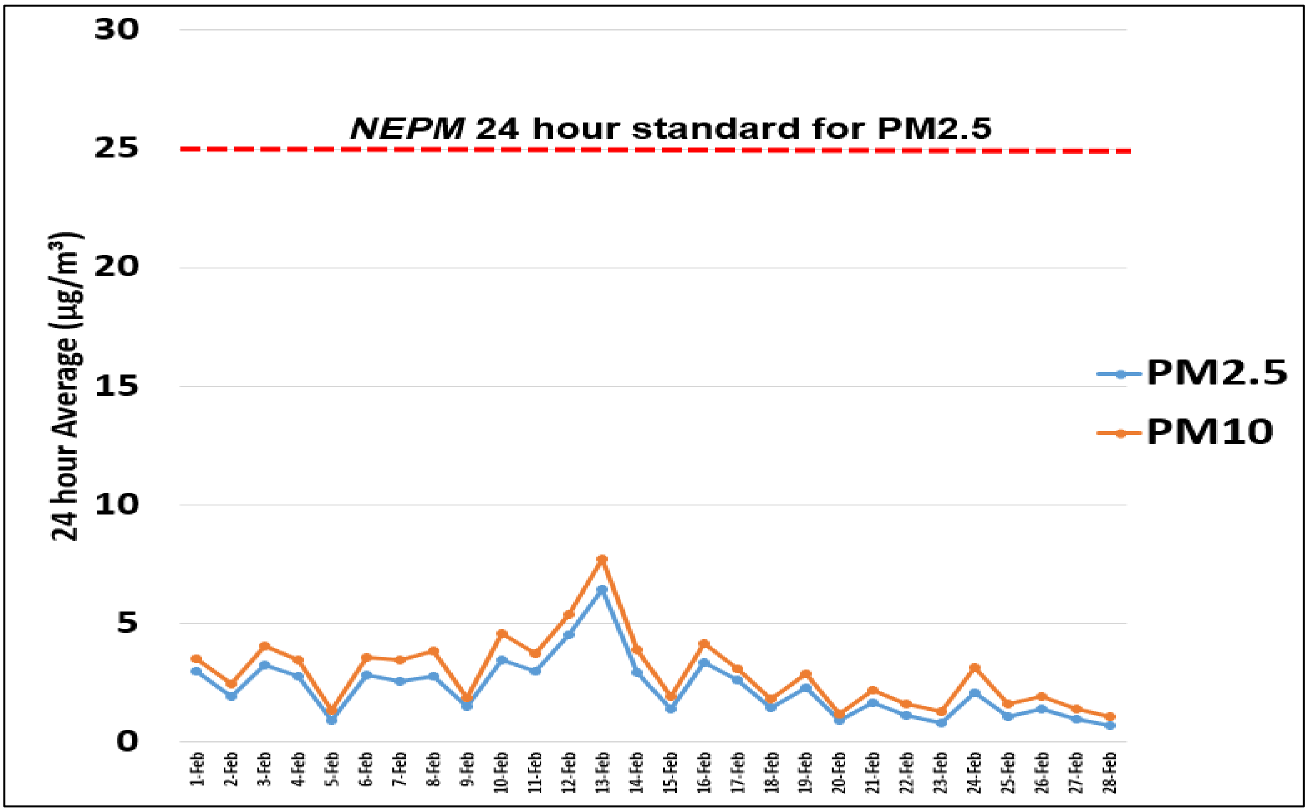

Figure 7: Average $PM_{2.5}$ and PM_{10} measurements over 24 hours during February 2019.

Dust composition

Seven surface wipe samples were taken at five sites across Wynnum, Wynnum West, Tingalpa, and Murarrie (Table 2). **Mineral dust and black rubber dust** were identified in the highest average proportions (Figure 8).

Five out of seven samples consisted mostly of **mineral dust from soil or rock (34-71%)**. Soil or rock dust can be a result of events such as roadworks or windblown dust from unsealed roads. The remaining two samples mostly consisted of a combination of soil or rock dust with either rubber dust or fibres. Rubber dust was also a significant component in four samples (25-40%), with small proportions detected in all other samples. Black rubber dust from tyre wear is common near roadways, and can be windblown into residential areas. Under microscope, rubber dust (elongated, irregular black particles) can be differentiated from other black coloured particles such as coal (Figure 9).

No significant coal particle proportions were detected, with only trace amounts (less than 1%) of coal identified in samples at a Wynnum Esplanade property. As the history of this sample is unknown, it is possible that these trace amounts of coal have been present on the surface for a number of years, and not a recent deposition.

Small proportions of insect and plant debris, cement dust and fibres were also detected across samples, which is common in domestic environments.

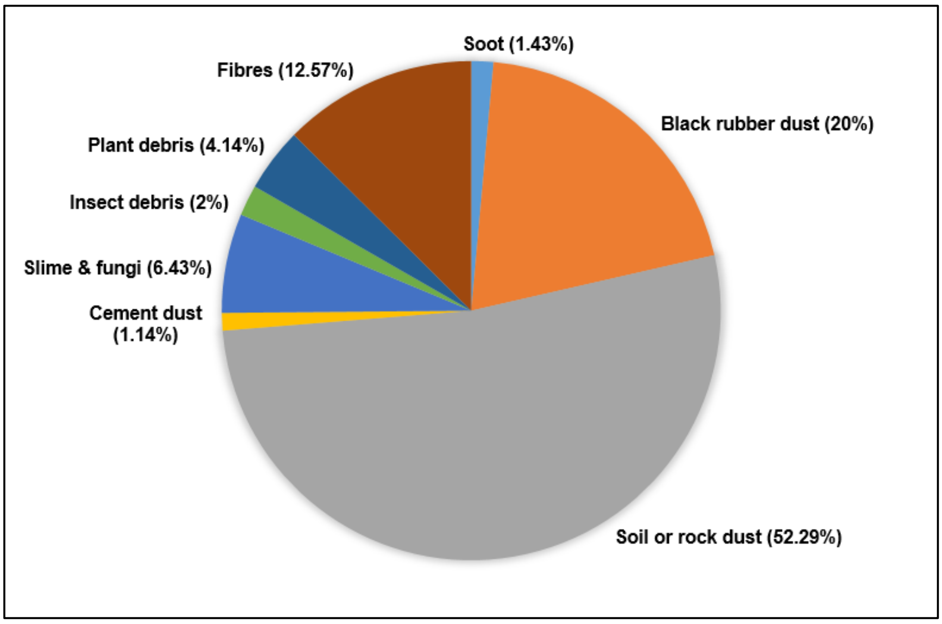

Figure 8: Average particle types across seven surface wipe samples in the Wynnum area.

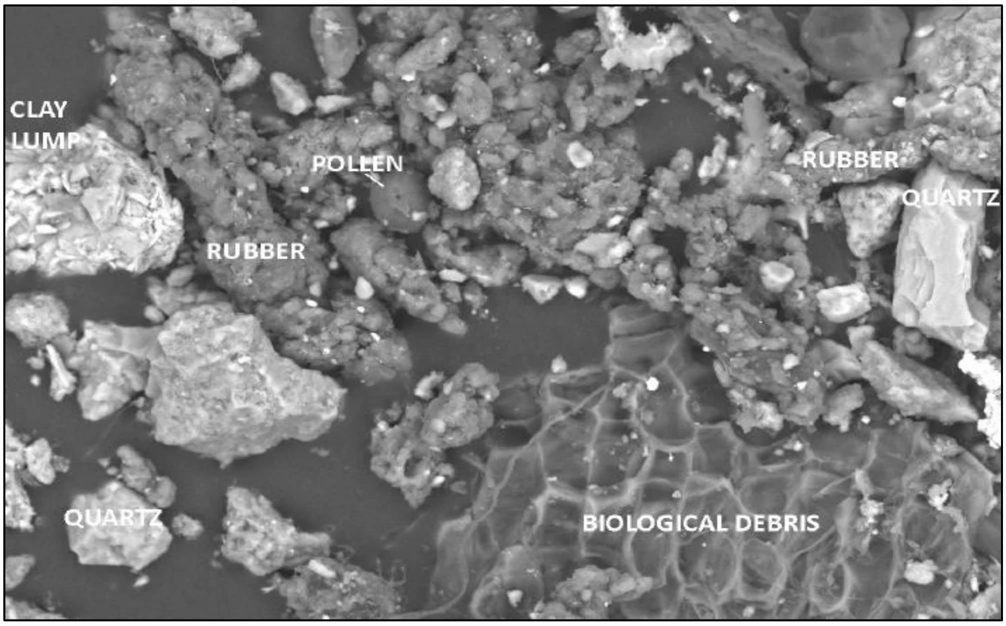

Figure 9: Microscope image (Sample #17625) showing particle types.

Table 2: Compositional analysis for seven surface wipe samples across five sites in Wynnum, Wynnum West, Tingalpa and Murarrie.

PARTICLE IDENTITY		PERCENTAGE (%)							
CATEGORY	**PARTICLE TYPE**	**#17625 (Wynnum)**	**#17640 (Wynnum Esplanade)**	**#17642 (Wynnum Esplanade)**	**#17643 (Tingalpa)**	**#17645 (Murarrie)**	**#17646 (Murarrie)**	**#17649 (Wynnum West)**	**Average**
BLACK	Coal	-	Trace	Trace	-	-	-	-	0
	Soot	Trace	-	Trace	Trace	Trace	Trace	10	1.43
	Black rubber dust	**40**	**35**	Trace	**25**	**30**	5	5	20
INORGANICS & MINERALS	Mineral dust (Soil/rock)	**25**	**50**	**65**	**70**	**51**	**34**	**71**	**52.29**
	Mineral dust (fly ash)	Trace	-	-	-	-	Trace	-	0
	Mineral dust (cement)	-	4	Trace	-	-	-	4	1.14
	Glass fragments	Trace	-	Trace	-	-	-	-	0
BIOLOGICAL	Slime & fungi	15	7	10	Trace	-	3	10	6.43
	Insect debris	5	2	Trace	2	2	3	Trace	2
	Plant debris	10	2	7	3	2	5	Trace	4.14
GENERAL ORGANIC TYPES	Wood dust	Trace	Trace	Trace	Trace	Trace	Trace	-	0
	Fibres	5	Trace	18	Trace	15	**50**	Trace	12.57
	Paint	-	-	-	-	Trace	-	-	0
	Plastic fragments	Trace	Trace	Trace	-	-	-	-	0
*Trace amounts refer to proportions less than 1%									

Dust deposition

Dustfall rate

Deposited dust is characterised by insoluble solids, ash and combustible matter (Table 3). Insoluble solids refer to the fraction of total particles deposited which are not water-soluble, and are typically responsible for dust nuisance impacts. The guideline of 120mg/m²/day over one month refers to insoluble solids. Ash refers to the insoluble dust fraction that remains after heating the sample (850°C for 30 minutes), and combustible matter refers to the part of the insoluble fraction which is lost on heating the sample.

The average dustfall rate across all gauges was **75mg/m²/day for the month of November 2018**, with the highest dustfall rate being 86mg/m²/day (Table 3).

Table 3: Average dustfall rates (mg/m²/day) across four deposition gauges in November 2018 (33 sampling days).

	Dustfall rate (mg/m²/day)		
Gauge location	**Ash**	**Combustible matter**	**Insoluble solids**
CAW2 (Wynnum)	59	27	**86**
CAW3 (Wynnum)	46	24	**70**
CAW4 (Tingalpa)	52	23	**74**
CAW5 (Murarrie)	53	14	**67**
Average	53	22	**75**

Composition

Dry dust samples collected from the four dust gauges were also analysed by UQMP to determine their composition (Table 3). The majority of each sample consisted of **mineral dust from soil or rock (>70%)**, with small amounts of plant and insect debris, rubber dust, slime and fungi occurring in all samples (Figure 10). Minor to trace amounts of coal were detected in samples, with an average of 2% across the four dust gauge samples. These minor amounts of coal are potentially a result of windblown soil dust already containing trace amounts of coal from ground surfaces outside the rail corridor and surrounding areas.

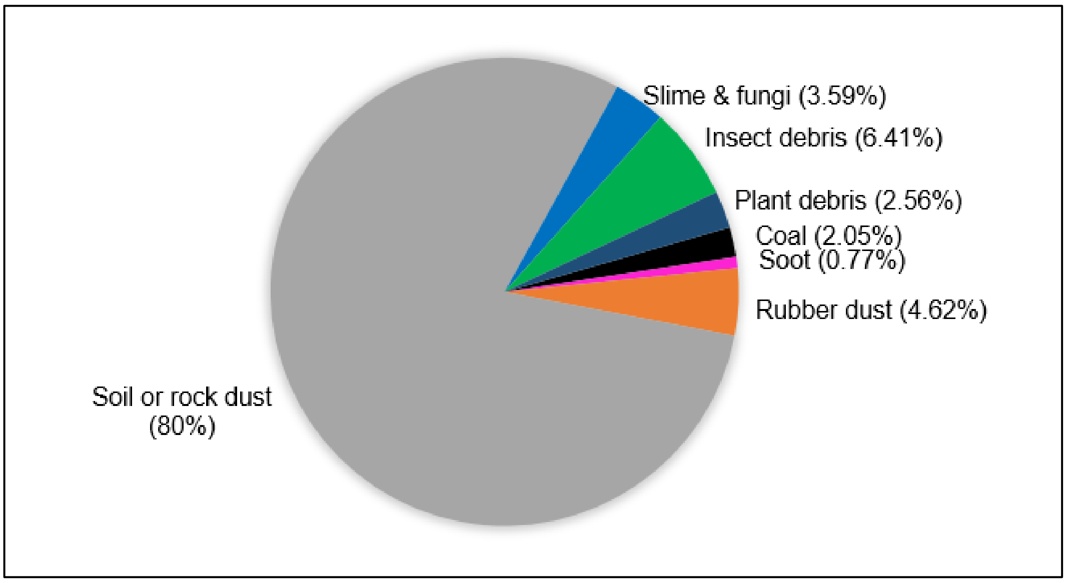

Figure 10: Average particle types across four dust gauge samples in the Wynnum area.

A small proportion of copper sludge was identified in all samples, although is not present in the air environment but is formed from a copper sulfate algaecide added to the gauge to prevent the growth of algae. For this reason, the copper sludge particle component was removed from the averages shown in Figure 10 (other particle averages were proportionally recalculated). Proportions of copper sludge found in each sample are presented in Table 4.

Table 4: Compositional analysis for 4 dust gauge samples collected in November 2018, inclusive of copper sludge.

PARTICLE IDENTITY		PERCENTAGE (%)				
CATEGORY	**PARTICLE TYPE**	**#17894 (CAW 2)**	**#17895 (CAW 3)**	**#17896 (CAW 4)**	**#17897 (CAW 5)**	**Average**
BLACK	Coal	4	1	3	Trace	2
	Soot	2	Trace	Trace	1	0.75
	Black rubber	9	5	2	2	4.5
INORGANICS & MINERALS	Mineral dust	**70**	**80**	**83**	**79**	**78**
	Mineral dust	Trace	-	-	-	0
	Copper	3	2	2	3	2.5
BIOLOGICAL	Slime & fungi	5	3	3	3	3.5
	Insect debris	5	7	5	**8**	6.25
	Plant debris	2	2	2	4	2.5
GENERAL ORGANIC TYPES	Wood dust	-	-	Trace	-	0
	Fibres	Trace	Trace	Trace	Trace	0
	Paint	-	Trace	-	-	0
	Plastic	Trace	-	Trace	Trace	0
*Trace amounts refer to proportions less than 1%						

While these results provide an indication of particle types that have settled over one month, it is only representative of one point in time, and at a particular location. It may be necessary to repeat dust gauge sampling again during the project to affirm results, or to determine other factors that may influence particles (e.g. meteorological conditions, wind direction etc).

Conclusions

Data collected by residents and members of Clean Air Wynnum for the first three months of the project demonstrated no exceedances of the NEPM or guidelines in terms of particulate matter concentrations or dust deposition. Composition of dust sampled also consisted of particles expected to be found in residential or domestic samples.

While these results provide a valid indication of air quality and dust pollution in the Wynnum area, monitoring will be ongoing throughout 2019 to increase the validity of results and to account for seasonal or meteorological change. This longer term data collection will provide a better assessment of local air quality.

The next report will be provided to CAW by the department in mid-2019.