Government of **Western Australia**
Department of **Water and Environmental Regulation**

Newman dust composition monitoring campaign

Department of Water and Environmental Regulation
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Summary

This report analyses data the Department of Water and Environmental Regulation (the department) collected during a 12-month air quality monitoring campaign in Newman, Western Australia, from 7 July 2018 to 8 July 2019.

Acting on a request from the Shire of East Pilbara, the department's objective was to assess the concentrations of dust, metals and asbestos in the town area. We did not design the campaign to assess how local and regional dust sources contribute to the measured concentrations or try to duplicate existing dust monitoring (as PM_{10}) undertaken in Newman by industry facilities.

Working with shire officers, we collected dust (as total suspended particles, or TSP) using a high-volume air sampler and had its mass and metals content analysed. We also used a sampling pump with asbestos collection cartridges to collect samples for asbestos analysis. We then compared the monitoring data with Australian and international health guidelines.

TSP is not a contemporary measure of the potential health risk posed by airborne dust, but was monitored in this study to provide a conservative assessment of dust composition. Nowadays, airborne dust criteria are focussed on finer particle fractions that are readily inhaled, namely particulate matter with a diameter up to 10 micrometres (PM_{10}) and particulate matter with a diameter up to 2.5 micrometres ($PM_{2.5}$). Continuous ambient monitoring of PM_{10} at two locations in Newman town (including adjacent to the site used for our campaign) and two background locations is undertaken by industry.

The campaign's major findings were:

- The daily average TSP levels were above the historical air quality guideline adopted for the campaign in most samples.
- The daily average levels of the metals analysed detected iron at the highest concentrations. A small number of samples showed elevated manganese levels, however these did not exceed the long-term health guideline value. These results are consistent with the area's mineralogy. The other metals analysed had low levels.
- All samples had asbestos levels below the limit of detection.

The Department of Health has reviewed the results of the monitoring campaign and advised that the measured concentrations of metals and asbestos do not represent a public health risk to the Newman community.

This campaign's elevated concentrations of TSP are consistent with other dust monitoring data that industry has collected in the region.

1 Background

In 2016, the Shire of East Pilbara (the shire) asked us for information about the amount of dust within Newman and the content of that dust; that is, whether it contained asbestos or other substances of concern. In response, the department, in collaboration with the shire, carried out this campaign to monitor for TSP levels, metals and asbestos fibres in the town.

1.1 Campaign objective

The campaign's objective was to assess the ambient levels of these pollutants in Newman for 12 months. We did not design the campaign to assess how local and regional dust sources contribute to the measured concentrations.

1.2 Campaign area

Newman is located 1,200 kilometres north of Perth in the Pilbara region of Western Australia. It has a population of about 5,500 people.

The town's climate is tropical/subtropical arid with a warm dry winter and hot summer, with its main source of rainfall (330 mm annually) being tropical lows and thunderstorms during summer. See Figure 1 for a summary of Newman's climate.

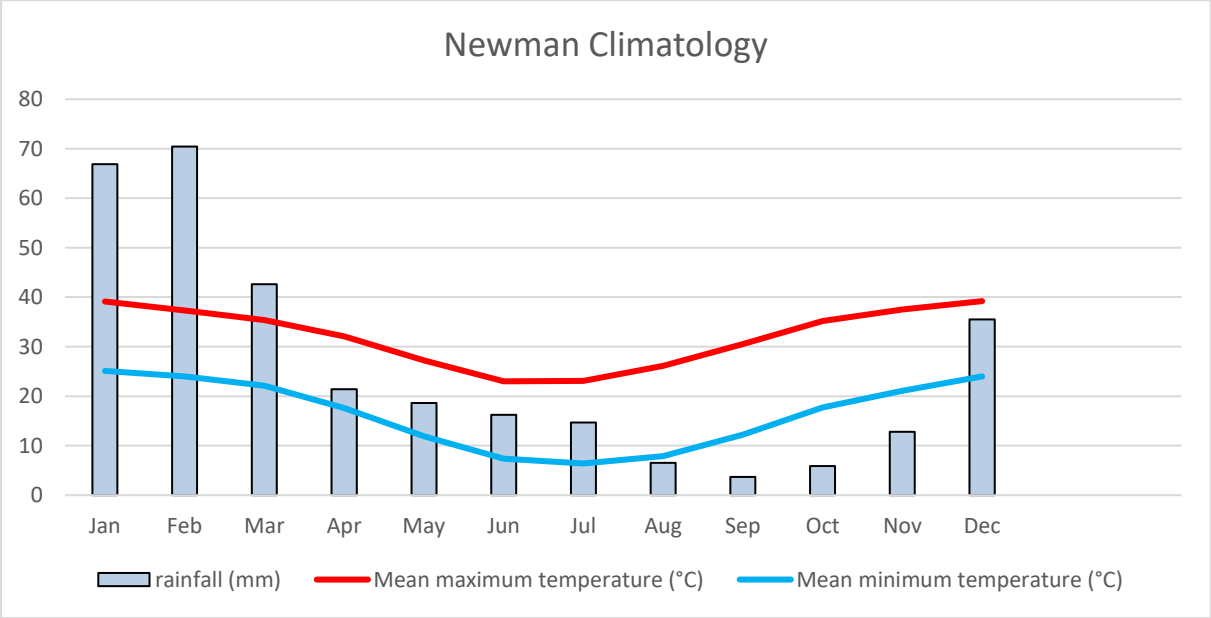

Figure 1: Newman climatology from Bureau of Meteorology (BoM) Newman airport

The region has various dust sources including mining operations, natural events and local activities, each of which may contribute to dust levels in the town.

BHP Iron Ore (BHPIO) has open pit mining operations two kilometres west of the town centre at Mt Whaleback and six kilometres north-east at Eastern Ridge. Other potential local sources of dust include quarrying, concrete batching, power

generation and light industrial areas. Newman also has several unsealed racetracks and racecourses, and is surrounded by unsealed roads.

BHPIO operates existing air quality monitoring stations that measure dust (as PM_{10}) in Newman and at background locations. These monitoring locations were not part of our campaign.

1.3 Dust

Dust is particulate matter (PM) comprising very small solid particles of earth, organic matter, manufactured products or waste matter that may become airborne by natural forces (such as wind) and/or by mechanical processes (such as crushing, grinding, milling, conveying, stockpiling or haulage). PM can also include combustion particles, organic compounds, metals, pollen and mould.

PM is classified into different size fractions based on the particle diameter measured in micrometres (µm). The common size fractions are:

- $PM_{2.5}$ – particulate matter with a diameter up to 2.5 µm.
- PM_{10} – particulate matter with a diameter up to 10 µm.
- Total suspended particulate (TSP) – all particles that are suspended in the atmosphere, including fine and respirable particles (PM_{10} and $PM_{2.5}$) and larger size particles that may settle out of the air causing nuisance impacts, usually measured as those particles having a diameter of up to 50 µm.

Figure 2 shows the $PM_{2.5}$ and PM_{10} size fractions compared with other common materials.

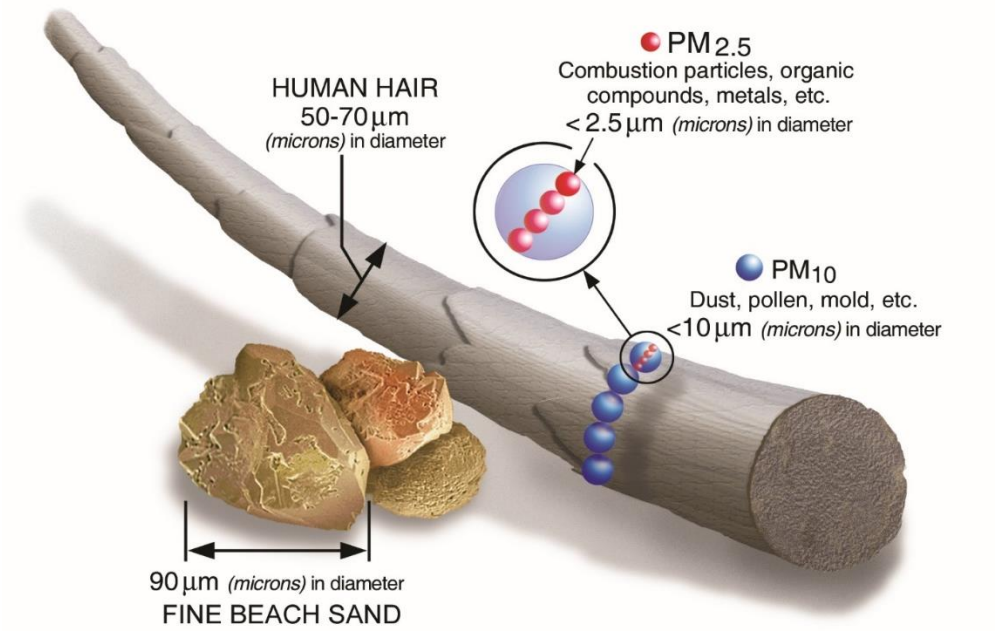

Figure 2. Size comparisons for particulates (USEPA 2018)

TSP is not a contemporary measure of the potential health risk posed by airborne dust, but was monitored in this study to represent the broad range of particles that

would be expected in this environment and provide a conservative assessment of dust composition. Nowadays, airborne dust criteria are focussed on finer particle fractions that are readily inhaled, namely PM_{10} and $PM_{2.5}$. These particle fractions were not within the scope of this monitoring campaign; however, PM_{10} is monitored continuously in Newman by BHPIO as required under licence L4503/1975/14 (Condition 3.6.1). The licence condition requires continuous ambient monitoring of PM_{10} at two locations in Newman town (including adjacent to the site used for our campaign) and two background locations. The PM_{10} data are important when using TSP sampling techniques, to ensure representative data for use in air quality risk assessment. The PM_{10} data in this case are measured at an industry monitoring site and consequently are not included in this report.

1.4 Metals

Metals occur naturally within the earth's crust, mainly in the form of solid metal particles or metals attached to the surface of other particles. Metals are elements and thus cannot be broken down, nor can their properties be altered easily.

Metals enter our bodies through food, drinking water and air. Minute levels of some metals are essential to human health, but high concentrations may be harmful.

We had the TSP samples for this campaign analysed for the presence of metals and compared the results with health guidelines. This was a conservative approach given the health guidelines are typically based on the PM_{10} fraction rather than TSP.

1.5 Asbestos

Asbestos is a mineral that occurs naturally in rock, sediment or soil. It becomes a health risk when its fibres are released into the air and inhaled. When people breath in large numbers of asbestos fibres, this can cause asbestosis, lung cancer and mesothelioma.

The Western Australian Department of Health (DoH) *Guidance note on public health risk management of asbestiform minerals associated with mining* (DoH 2013) helps regulators, consultants and mining companies to identify the public health risks from asbestiform minerals and to assess and manage those risks.

The guidance note has a map that shows areas where asbestiform minerals are likely to be present. Figure 3 shows the high-probability areas are mainly in the Pilbara (Hamersley) and Ord ranges, where the asbestiform material appears as crocidolite (blue) asbestos. While most of these asbestiform minerals are below ground, a potential health risk arises if mining disturbs these areas.

Newman is located within the medium/high probability zone for the presence of asbestiform materials in Western Australia.

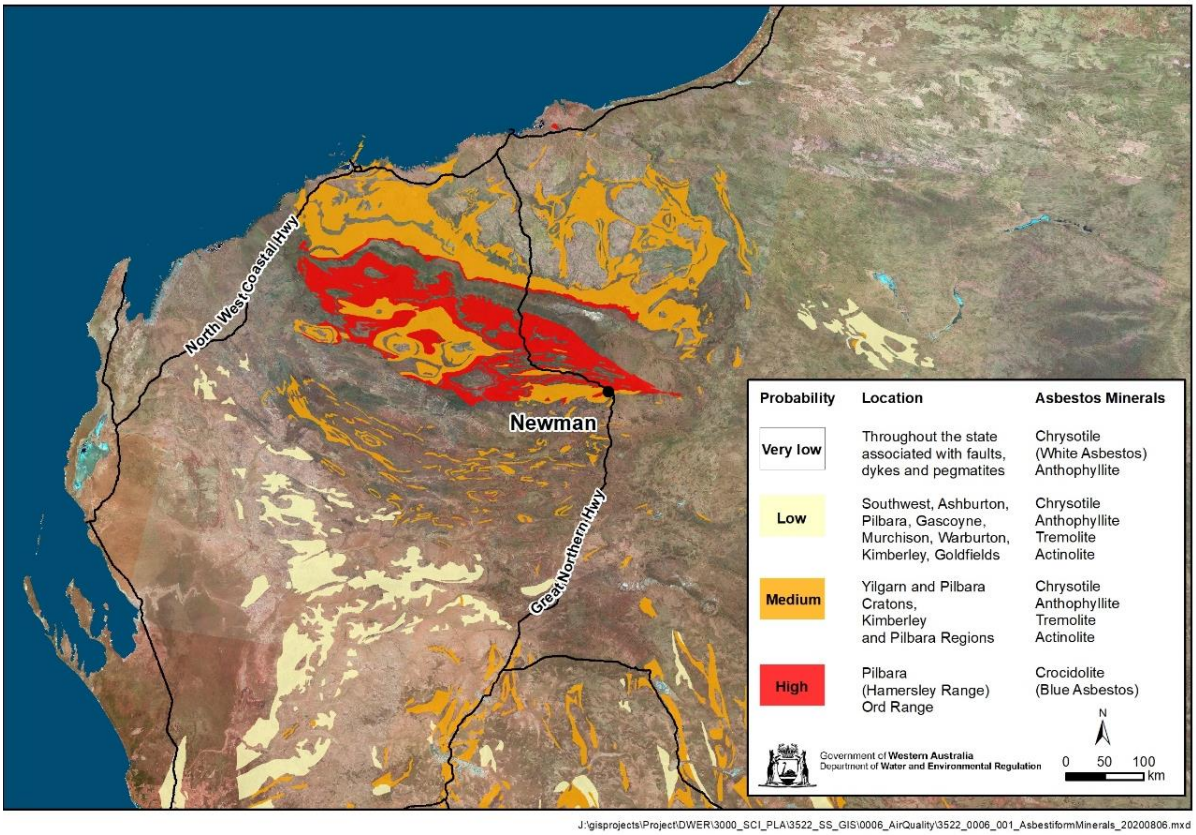

Figure 3: Potential incidence of asbestiform minerals in Western Australia

2 Monitoring campaign's scope

The campaign's scope was to monitor the following for 12 months:

- levels of ambient dust (as TSP) in Newman, and
- the composition of the dust (metals and asbestos).

The department supplied the equipment: a high volume air sampler (HVAS) for TSP sampling and a pump attached to filter cartridges for asbestos sampling (see Figure 4). Department-trained shire officers operated the equipment in a temporary compound next to the BHPIO Newman town monitoring site at 6 Calcott Street (see Figure 5). The monitoring location selected is representative of ambient air quality in the town.

Figure 4: High volume air sampler (left) and asbestos sampling equipment (right).

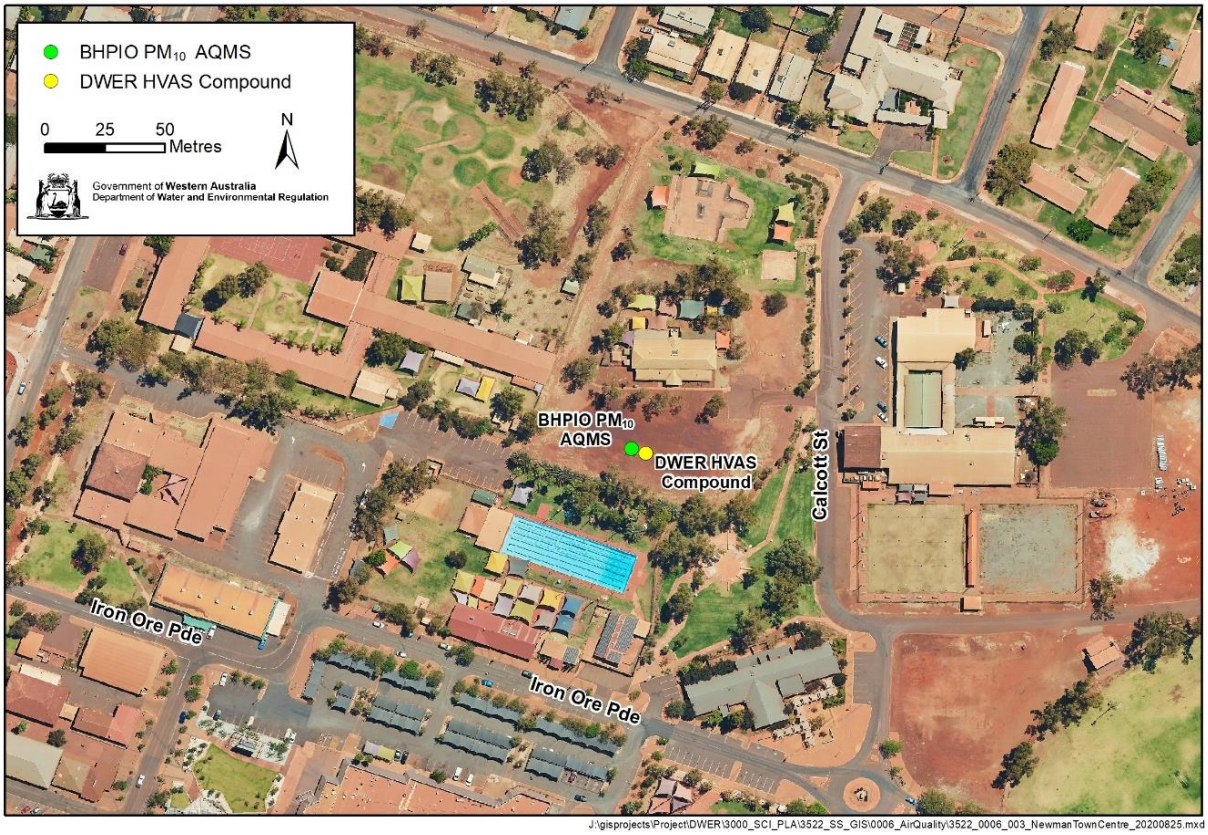

Figure 5: Location of the department's monitoring equipment

3 Monitoring methods

3.1 TSP and metals

We followed Australian Standard AS/NZS 3580.9.3:2003 *Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – TSP – High volume sampler gravimetric method* to collect TSP for a 24-hour period from midnight to midnight once every six days.

The HVAS shown in Figure 4 has a large pump, a flow controller and a filter holder under the lid. It draws about 1.1 cubic metres of air per minute with the sampling rate held constant over the sampling period, depositing TSP in the air onto a quartz fibre filter.

During the campaign shire officers collected 62 samples, five duplicate samples and seven blank samples. A laboratory accredited with the National Association of Testing Authorities, Australia determined the mass of dust and metals on the filters.

3.2 Asbestos

We followed the *Guidance note on the membrane filter method for estimating airborne asbestos fibres – 2005* by the National Occupational Health and Safety Commission (NOHSC) to monitor asbestos, as recommended by DoH.

This method uses a small pump to draw air through a filter cartridge (see Figure 4). The analytical laboratory supplied the filter cartridges to the shire.

Shire officers operated the sampling equipment for six to eight hours during daylight hours, once every six days. They collected 63 samples and six blank filters during the campaign, and sent them to the laboratory for analysis.

The laboratory used analytical method NOHSC:3003 (2005) to measure asbestos, which involves counting the number of fibres on the filter under a powerful microscope. The laboratory counts a fibre when it meets specified dimensions, but does not identify the fibre type during the counting process (i.e. vegetation and other non-asbestos mineral fragments can meet the specified dimensions and be included in the fibre count). If the fibre count is above the assessment criteria, then the laboratory sends the sample for scanning electron microscopy (SEM) analysis, which can provide fibre identification.

4 Results and analysis

4.1 TSP

In the absence of national standards for TSP, for this study we compared TSP concentrations with the Environmental Protection (Kwinana) (Atmospheric Wastes) Regulations 1992 (EPP) Area 'C' standard of 90 µg/m^3 averaged over 24 hours. Area 'C' is mostly a rural and residential area outside the Kwinana Industrial Area buffer zone and includes the town of Kwinana and surrounding suburbs. The Environmental Protection Authority adopted this standard for the Kwinana EPP in 1992, based on the recommended guideline for TSP published by the Australian Government's National Health and Medical Research Council (NHMRC) at the time (EPA 1992). This standard has been adopted for this study as a reference guideline, noting that TSP is no longer the basis of air quality assessment for airborne particles, as discussed in Section 1.3.

During the campaign, daily TSP concentrations were higher than the adopted historical guideline for 32 of the 62 samples collected. The average TSP value for the 12-month period was 103 µg/m^3.

See Figure 6 for a summary of the TSP results. See Table 1 for the dates when the daily TSP concentration was above the adopted historical guideline.

See the laboratory results for TSP in Appendix B and the laboratory reports with the raw data in Appendix C.

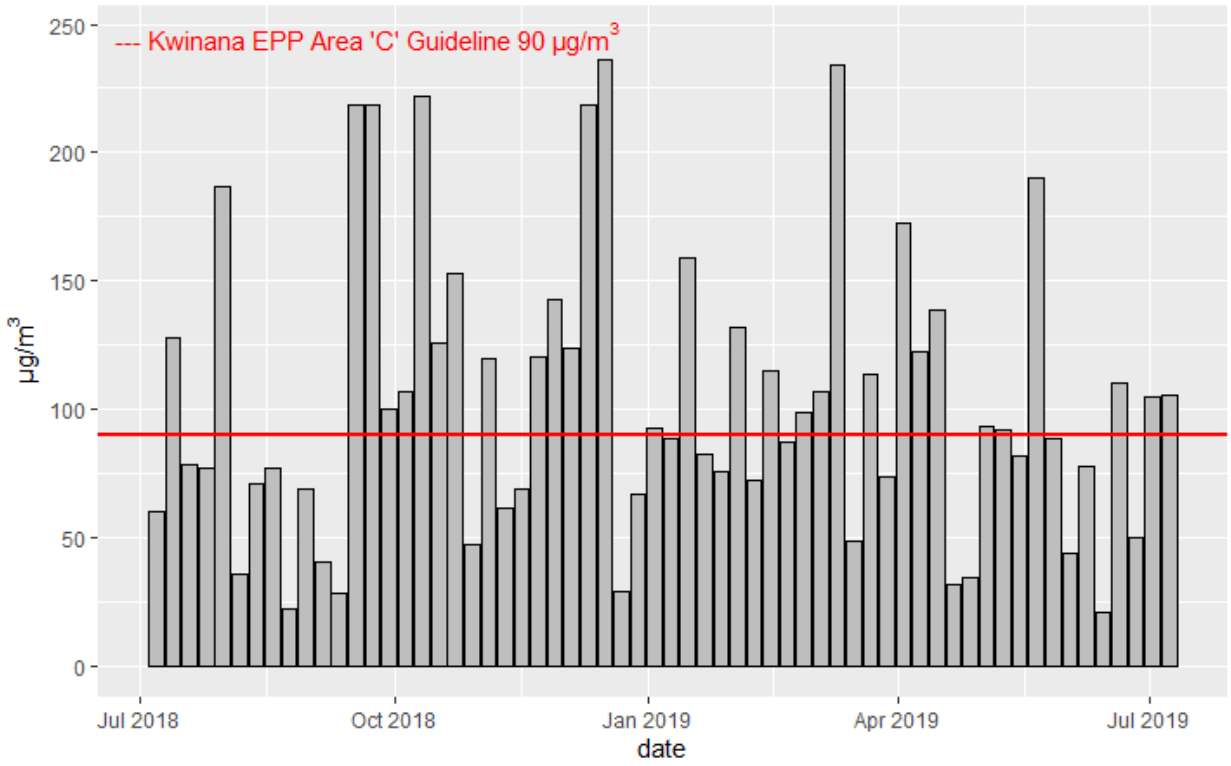

Figure 6: HVAS TSP daily concentrations during the campaign period

Table 1: TSP 24-hour concentrations greater than 90 µg/m³

Date	Concentration (µg/m³)	Date	Concentration (µg/m³)	Date	Concentration (µg/m³)
13/07/2018	128	28/11/2018	143	22/03/2019	114
31/07/2018	187	04/12/2018	124	03/04/2019	172
17/09/2018	219	10/12/2018	219	09/04/2019	122
23/09/2018	218	16/12/2018	236	15/04/2019	139
29/09/2018	100	03/01/2019	93	03/05/2019	93
05/10/2018	107	15/01/2019	159	09/05/2019	92
11/10/2018	222	02/02/2019	132	21/05/2019	190
17/10/2018	126	14/02/2019	115	20/06/2019	110
23/10/2018	153	26/02/2019	99	02/07/2019	105
04/11/2018	120	04/03/2019	107	08/07/2019	106
22/11/2018	120	10/03/2019	234		

We acquired wind data from the Bureau of Meteorology's Newman Airport station and used it to create wind roses. These summarise the occurrence of winds at a location, showing their strength, direction and frequency. See Figure 7 for the different wind characteristics in Newman during the campaign. Given the town does not have the four traditional seasons, we have split the data in Figure 7 into two separate periods (May to October and November to April) to represent the wet and dry seasons.

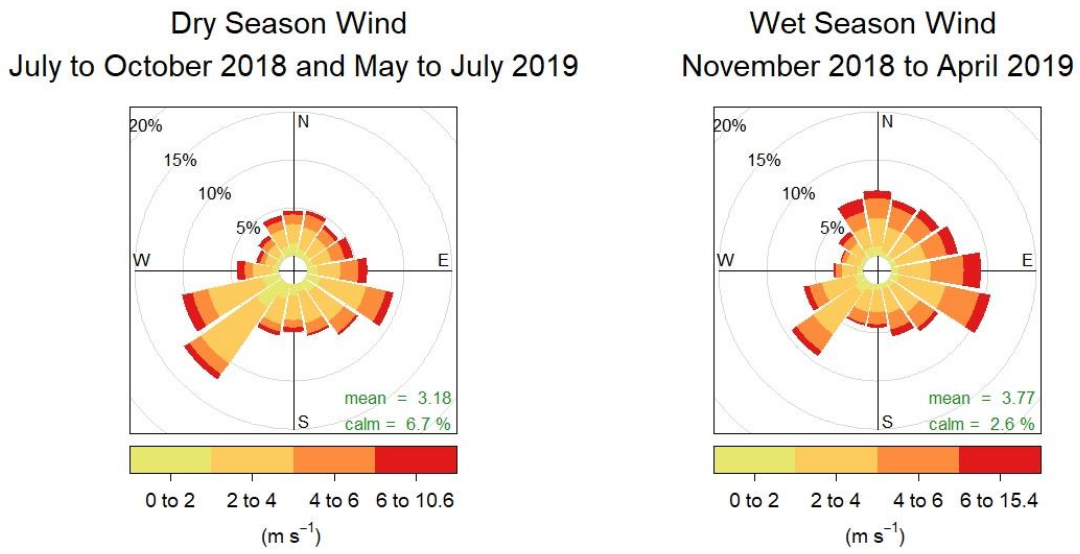

Figure 7: Dry and wet season wind roses for Newman

During the campaign the dry season had frequent winds from the west south-west, south-west and east south-east, with calm periods nearly seven per cent of the time. The wet season had a broadly similar distribution of wind, but with stronger and more frequent winds from the north north-west through to the east south-east. The wet season had a higher average and maximum wind speed with fewer calm periods.

No significant difference in TSP concentrations occurred between the seasons when compared with the campaign average (see Table 2).

Table 2: Seasonal differences in TSP

Campaign period average TSP µg/m^3	Dry season average TSP µg/m^3	Wet season average TSP µg/m^3
103	98	109

4.2 Metals

For previous dust studies in Port Hedland, DoH recommended the analysis of a suite of 19 metals (total chromium, manganese, iron, aluminium, arsenic, boron, barium, calcium, cadmium, cobalt, potassium, lithium, molybdenum, nickel, lead, sulfur, selenium, vanadium and zinc). Because of the similarities in mining products and operations between Port Hedland and Newman, DoH recommended a similar analysis for this campaign. We therefore adopted the same analytical suite.

The results of metals monitoring (see below) are based on the laboratory's analysis of the TSP filter samples. As mentioned, the TSP fraction includes all particulate matter with a diameter up to 50 µm, although the particles small enough to enter human lungs are generally less than 10 µm (PM_{10}).

The ambient air guidelines for metals that we adopted for this campaign are exposure guidelines that either the department uses routinely or that DoH recommends. See Appendix A for the guidelines. Some of the metals analysed are not of toxicological concern in air for this region, so we have not given guidelines for these.

Note that ambient air guidelines are typically based on the PM_{10} fraction of dust in the air, rather than the TSP fraction. As such, this campaign's reported levels of metals are conservative compared with guideline values, as not all the particles sampled are necessarily in the PM_{10} fraction and therefore small enough to be inhaled.

Figure 8 summarises the daily maximum and annual average concentration recorded for each metal analysed. The metals detected at the highest concentrations were iron, aluminium, calcium, boron, potassium and manganese.

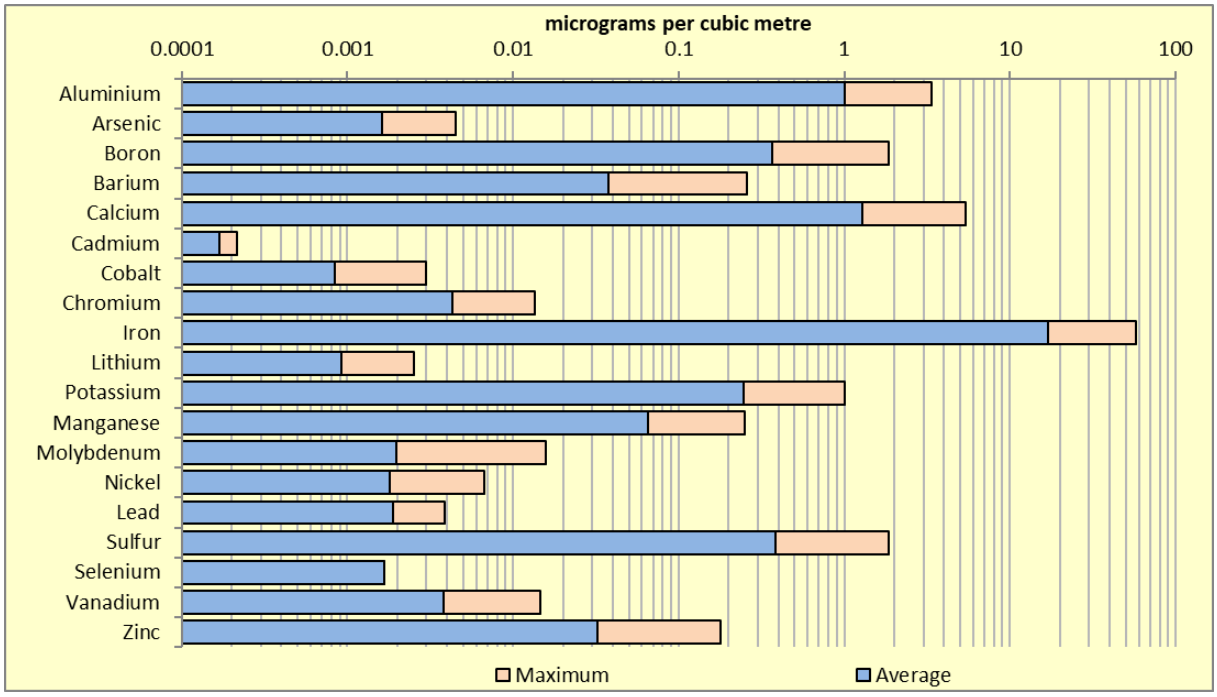

Figure 8: Summary of metals concentration results in log scale

See Table 3 for a summary of the maximum and average results compared with the adopted guidelines. For iron, aluminium and chromium, we made the following assumptions about the form of the metal or the compounds present in the samples:

- Iron (Fe) – we assumed elemental iron as reported by the laboratory was present as hematite (Fe_2O_3), as this is the major ore type in the region.
- Aluminium (Al) – we assumed elemental aluminium as reported by the laboratory was present as aluminium oxide (Al_2O_3), as this is the most common oxide for this metal.
- Chromium (Cr) – we assumed this was present as the trivalent form Cr III, which is more common in the natural environment.

See Appendix B (tabulated data) and Appendix C (laboratory reports) for more detailed information on the monitoring results.

The results show:

- Of the metals analysed, iron was detected at the highest concentrations, reflecting the area's mineralogy. The iron levels detected are below the adopted guideline for iron oxide (as hematite).
- Manganese concentrations exceeded the adopted 24-hour average guideline in three of 62 samples, or five per cent of samples. Yet the annual average was less than 50 per cent of the annual guideline, meaning these 24-hour exceedences are unlikely to result in long-term health effects. The presence of manganese also reflects the area's mineralogy.
- All other metals were detected at levels below the adopted guidelines.

DoH has reviewed these results and advised that the measured concentrations do not represent a public health risk to the Newman community.

Table 3: Summary of the maximum daily and annual average metals concentrations

Substance	Campaign max 24 hour µg/m³	24-hour guideline µg/m³	Annual average µg/m³	Annual average guideline µg/m³
Aluminium (as Al_2O_3)	6.3	10	1.91	N/A
Arsenic (As)	0.005	0.03	0.002	0.003
Boron (B)	1.86	N/A	0.37	N/A
Barium (Ba)	0.26	N/A	0.04	N/A
Calcium (Ca)	5.42	N/A	1.28	N/A
Cadmium (Cd)	0.0002	0.02	0.0002	0.01
Cobalt (Co)	0.003	0.10	0.001	N/A
Chromium (as CrIII)	0.014	0.50	0.004	N/A
Iron (as Fe_2O_3)	82.8	120	24.4	N/A
Lithium (Li)	0.003	N/A	0.001	N/A
Potassium (K)	1.01	N/A	0.25	N/A
Manganese (Mn)	0.25	0.15	0.07	0.15
Molybdenum (Mo)	0.016	12	0.002	N/A
Nickel (Ni)	0.007	0.14	0.002	0.02
Lead (Pb)	0.004	N/A	0.002	0.5
Sulfur (S)	1.84	N/A	0.38	N/A
Selenium (Se)	0.002	N/A	0.002	N/A
Vanadium (V)	0.015	1.00	0.004	N/A
Zinc (Zn)	0.18	50	0.03	N/A

4.3 Asbestos

DoH (2013) recommends a 0.01 fibres per millilitre (f/ml) asbestos air quality limit to protect the public around sites where asbestos is present. This is the practical limit of detection using the membrane filter method detailed in NOHSC:3003(2005), and recommended by DoH for this study. DoH advises that this low limit applies to the public because exposure can be continuous, non-voluntary when it occurs, and may involve more susceptible groups such as children, the aged or the infirm.

The analysis of all the samples collected during the campaign showed fibre counts below the practical limit of detection. See Appendix B for a tabulated summary of the results and Appendix C for the laboratory reports with the raw data.

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5 Conclusion

The conclusions of this monitoring campaign are as follows:

- The daily average TSP levels were above the adopted historical air quality guideline in most samples.
- The daily average levels of the metals analysed detected iron at the highest concentrations. A small number of samples showed elevated manganese levels, however these did not exceed the long-term health guideline value. These results are consistent with the mineralogy of the area. The other metals analysed had low levels.
- All samples had asbestos levels below the limit of detection.

DoH has reviewed the results of the monitoring campaign and advised that the measured concentrations of metals and asbestos do not represent a public health risk to the Newman community.

This campaign's elevated concentrations of TSP are consistent with other dust monitoring data that industry has collected in the region.

6 References

Department of Health (DoH) 2013, *Guidance note on public health risk management of asbestiform minerals associated with mining,* Perth, Western Australia

Department of Health (DoH) 2016, *Port Hedland air quality health risk assessment for particulate matter*, Perth, Western Australia

Environmental Protection Authority (EPA) 1992, *Bulletin 644: Development of an environmental protection policy for air quality at Kwinana*, Perth, Western Australia

Government of Western Australia 1999, Environmental Protection (Kwinana) (Atmospheric Wastes) Regulations 1992, https://www.legislation.wa.gov.au/legislation/statutes.nsf/law_s4417.html

Standards Australia 2015, *AS/NZS 3580.9.3:2015 Methods for sampling and analysis of ambient air Determination of suspended particulate matter – Total suspended particulate matter (TSP) – High volume sampler gravimetric method*, SAI Global

Safe Work Australia © Commonwealth of Australia 2020, *Asbestos*, https://www.safeworkaustralia.gov.au/asbestos

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Toxikos 2010, Air guideline values for selected substances, prepared for the Department of Environment and Conservation, Perth, Western Australia

Toxikos 2012, Air guideline values for selected substances (Group B), prepared for the Department of Environment and Conservation, Perth, Western Australia

United States Environmental Protection Agency 2018, *Particulate matter (PM) pollution,* Research Triangle Park, NC. https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM

7 Shortened forms and glossary

AQMS	Air quality monitoring station. A structure or compound where air quality monitoring equipment is used.
BHPIO	BHP Iron Ore
BoM	Bureau of Meteorology
DoH	Western Australian Department of Health
The department	The department represents the Department of Water and Environmental Regulation and its predecessors such as the former Department of Environment Regulation and former Department of Environment and Conservation
EPA	Environmental Protection Authority of Western Australia
EPP	Environmental Protection Policy
HVAS	High volume air sampler
NEPM	National Environmental Protection Measures (ambient air quality). NEPMs are a special set of national objectives designed to help protect or manage particular aspects of the environment. http://www.nepc.gov.au/nepms
NHMRC	National Health and Medical Research Council. A Commonwealth expert body in health and medical research.
NOHSC	National Occupational Health and Safety Commission. Commonwealth authority now known as Safe Work Australia. The NOHSC acronym is used for naming codes of practice.
PM	Particulate matter
$PM_{2.5}$	Particulate matter with a diameter up to 2.5 µm (micrometres)
PM_{10}	Particulate matter with a diameter up to 10 µm (micrometres)
PQL	The minimum concentration of a compound that can be measured within specified limits of precision and accuracy for a particular laboratory and analytical method
SEM	Scanning electron microscopy. Can be used to identify asbestos fibres and differentiate between other fibre types.
SOEP	Shire of East Pilbara
TSP	Total suspended particulates. Generally defined as all particulate matter with a diameter up to 50 µm.
USEPA	United States Environmental Protection Agency.

Appendices

Appendix A – Ambient air quality guidelines for metals

The guideline values are expressed in micrograms per cubic metre at 0ºC. Those metals for which no guideline is shown are not of toxicological concern in air for the purposes of this study.

Table A-1: Ambient air quality guidelines for metals

Substance	24-hour average ($\mu g/m^3$)	Reference	Annual average ($\mu g/m^3$)	Reference
Aluminium (as Al_2O_3)	10	Toxikos (2010)		
Arsenic (As)	0.03	Toxikos (2010)	0.003	Toxikos (2010)
Boron (B)	N/A			
Barium (Ba)	N/A			
Calcium (Ca)	N/A			
Cadmium (Cd)	0.02	Toxikos (2010)	0.01	Toxikos (2010)
Cobalt (Co)	0.1	WA DoH		
Chromium (as CrIII)	0.5	Toxikos (2010)		
Iron (as Fe_2O_3)	120	WA DoH		
Lithium (Li)	No toxicological guideline established			
Potassium (K)	N/A			
Manganese (Mn)	0.15	Toxikos (2010)	0.15	Toxikos (2010)
Molybdenum (Mo)	12	Toxikos (2010)		
Nickel (Ni)	0.14	WA DoH	0.02	WA DoH
Lead (Pb)			0.5	NEPM
Sulfur (S)	N/A			
Selenium (Se)	N/A			
Vanadium (V)	1	Toxikos (2010)		
Zinc (Zn)	50	Toxikos (2012)		

N/A – not applicable.

Appendix B – Laboratory analysis results

This Appendix contains:

- **Table B-1**: Summary of the laboratory HVAS results for TSP and metals.

  Note that the practical quantitation level (PQL, also known as the limit of detection) for each metal is listed for reference and '< PQL' is recorded for concentrations less than the PQL (i.e. the metal was not detected in the sample). For these samples, half of the PQL value was used for calculating the annual average.
- **Figure B-1 and Figure B-2**: Plots of the concentration results for iron oxide (hematite) and manganese, with the adopted ambient air quality guidelines also shown.
- **Figure B-3**: Summary of asbestos results.

Table B-1: HVAS filter analysis results for TSP and metals

	TSP	Al	As	B	Ba	Ca	Cd	Co	Cr	Fe	Li	K	Mn	Mo	Ni	Pb	S	Se	V	Zn
Annual Guideline			0.003				0.01						0.15		0.02	0.5				
24 hr Guideline	90		0.03				0.02	0.1	0.5				0.15	12	0.14				1	50
Campaign Average	103	1.010	0.002	0.368	0.037	1.278	0.0002	0.001	0.004	17.04	0.001	0.245	0.065	0.002	0.002	0.002	0.384	0.002	0.004	0.032
PQL		0.0030	0.0002	0.0121	0.0012	0.0303	0.0003	0.0012	0.0012	0.003	0.0012	0.0303	0.0012	0.0030	0.0012	0.0030	0.0303	0.0030	0.0012	0.0030
07/07/2018	60	0.1451	0.0012	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	6.859	<PQL	<PQL	0.0206	<PQL	<PQL	<PQL	0.0485	<PQL	0.0019	<PQL
13/07/2018	128	0.2323	0.0020	<PQL	<PQL	<PQL	<PQL	<PQL	0.0023	15.346	<PQL	<PQL	0.0396	<PQL	0.0013	<PQL	0.3989	<PQL	0.0019	<PQL
19/07/2018	78	1.2009	0.0026	0.6346	0.0482	2.4928	<PQL	<PQL	0.0068	14.055	0.0013	0.4102	0.0460	0.0041	0.0026	<PQL	0.5926	<PQL	0.0045	0.0624
25/07/2018	77	<PQL	0.0008	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	5.456	<PQL	<PQL	0.0178	<PQL	<PQL	<PQL	<PQL	<PQL	0.0013	<PQL
31/07/2018	187	1.6522	0.0039	0.2574	<PQL	0.6509	<PQL	<PQL	0.0067	40.046	<PQL	0.0675	0.1066	<PQL	0.0030	<PQL	0.3439	<PQL	0.0060	0.0313
06/08/2018	36	0.2049	0.0007	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	3.825	<PQL	<PQL	0.0130	<PQL	<PQL	<PQL	0.1426	<PQL	<PQL	0.0085
12/08/2018	71	0.4488	0.0015	<PQL	<PQL	<PQL	<PQL	<PQL	0.0023	9.971	<PQL	<PQL	0.0297	<PQL	<PQL	<PQL	0.1448	<PQL	0.0023	<PQL
18/08/2018	77	0.1506	0.0019	<PQL	<PQL	<PQL	<PQL	<PQL	0.0019	11.924	<PQL	<PQL	0.0363	<PQL	0.0018	<PQL	0.1942	<PQL	0.0036	<PQL
24/08/2018	22	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	2.346	<PQL	<PQL	0.0089	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
30/08/2018	69	0.1744	0.0014	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	14.752	<PQL	<PQL	0.0525	<PQL	<PQL	<PQL	0.1184	<PQL	0.0017	<PQL
05/09/2018	41	<PQL	0.0007	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	6.400	<PQL	<PQL	0.0393	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
11/09/2018	28	<PQL	0.0004	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	2.860	<PQL	<PQL	0.0143	<PQL	<PQL	<PQL	0.1384	<PQL	<PQL	<PQL
17/09/2018	219	1.7812	0.0042	<PQL	<PQL	0.4138	<PQL	0.0025	0.0103	50.601	0.0013	0.0644	0.1782	<PQL	0.0050	<PQL	0.5331	<PQL	0.0056	<PQL
23/09/2018	218	1.4183	0.0035	<PQL	<PQL	<PQL	<PQL	0.0019	0.0073	46.386	<PQL	<PQL	0.1284	<PQL	0.0050	0.0034	0.3490	<PQL	0.0056	<PQL
29/09/2018	100	0.3770	0.0019	<PQL	<PQL	<PQL	<PQL	<PQL	0.0040	12.131	<PQL	<PQL	0.0469	<PQL	0.0025	<PQL	0.5227	<PQL	0.0037	<PQL
05/10/2018	107	<PQL	0.0013	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	15.909	<PQL	<PQL	0.0583	<PQL	0.0018	<PQL	<PQL	<PQL	0.0025	<PQL
11/10/2018	222	0.6445	0.0023	<PQL	<PQL	<PQL	<PQL	<PQL	0.0028	39.844	<PQL	<PQL	0.0962	<PQL	0.0031	<PQL	0.2798	<PQL	0.0031	<PQL
17/10/2018	126	0.6961	0.0045	<PQL	<PQL	<PQL	<PQL	<PQL	0.0046	22.797	<PQL	0.2425	0.0833	<PQL	0.0025	<PQL	0.5259	<PQL	0.0050	<PQL
23/10/2018	153	1.4558	0.0032	<PQL	<PQL	<PQL	<PQL	0.0018	0.0071	37.469	0.0018	<PQL	0.1467	<PQL	0.0031	<PQL	0.3416	<PQL	0.0044	<PQL
29/10/2018	47	0.5581	0.0010	<PQL	0.0082	0.6347	<PQL	<PQL	0.0033	6.495	<PQL	0.1930	0.0248	<PQL	<PQL	<PQL	0.5552	<PQL	0.0020	0.0053
04/11/2018	120	1.1749	0.0030	0.1859	0.0214	1.1962	<PQL	0.0012	0.0054	34.702	0.0012	0.2097	0.1229	<PQL	0.0019	0.0034	0.6074	<PQL	0.0031	0.0109
10/11/2018	61	0.2977	0.0020	<PQL	<PQL	<PQL	<PQL	<PQL	0.0014	7.203	<PQL	0.1673	0.0306	<PQL	<PQL	<PQL	0.4534	<PQL	0.0024	<PQL
16/11/2018	69	0.9593	0.0016	0.4669	0.0312	1.0880	<PQL	<PQL	0.0040	12.349	0.0012	0.3195	0.0424	<PQL	0.0012	<PQL	0.8481	<PQL	0.0031	0.0341
22/11/2018	120	1.5667	0.0039	0.6441	0.0415	2.5092	<PQL	0.0012	0.0060	20.145	0.0019	0.4704	0.0978	<PQL	0.0019	<PQL	0.8027	<PQL	0.0057	0.0244
28/11/2018	143	1.5219	0.0037	0.2200	0.0050	1.3045	<PQL	0.0013	0.0061	27.308	0.0019	0.1619	0.0919	<PQL	0.0025	<PQL	0.9393	<PQL	0.0051	0.0065
04/12/2018	124	1.5284	0.0030	0.7413	0.0505	2.6128	<PQL	0.0013	0.0061	23.506	0.0019	0.5507	0.0792	<PQL	0.0019	<PQL	1.8414	<PQL	0.0051	0.0391
10/12/2018	219	3.3439	0.0034	0.0647	<PQL	1.2156	<PQL	0.0012	0.0085	15.022	0.0025	0.5309	0.1231	<PQL	0.0025	<PQL	0.6095	<PQL	0.0146	<PQL
16/12/2018	236	1.8864	0.0037	<PQL	<PQL	0.5999	<PQL	0.0012	0.0067	57.770	0.0012	0.1522	0.2508	<PQL	0.0032	0.0034	0.8030	<PQL	0.0057	<PQL
22/12/2018	29	0.7313	0.0004	0.5059	0.0534	1.8385	<PQL	<PQL	0.0028	2.925	0.0012	0.2743	0.0167	<PQL	<PQL	<PQL	0.4809	<PQL	0.0012	0.0301
28/12/2018	67	1.3922	0.0021	1.0159	0.0698	3.5097	<PQL	<PQL	0.0050	16.077	0.0013	0.5894	0.0937	<PQL	<PQL	<PQL	0.6446	<PQL	0.0033	0.0501
03/01/2019	93	2.0746	0.0032	1.2317	0.0794	4.0229	<PQL	0.0013	0.0081	24.347	0.0019	0.6985	0.1188	<PQL	0.0026	<PQL	1.4092	<PQL	0.0052	0.0541
09/01/2019	88	1.6775	0.0032	1.1550	0.0784	3.9857	<PQL	<PQL	0.0062	17.184	0.0019	0.6282	0.0733	<PQL	0.0013	<PQL	0.9520	<PQL	0.0051	0.0599

Table B-1: HVAS filter analysis results for TSP and metals (continued)

	TSP	Al	As	B	Ba	Ca	Cd	Co	Cr	Fe	Li	K	Mn	Mo	Ni	Pb	S	Se	V	Zn
Annual Guideline			0.003				0.01						0.15		0.02	0.5				
24 hr Guideline	90		0.03				0.02	0.1	0.5				0.15	12	0.14				1	50
Campaign Average	103	1.010	0.002	0.368	0.037	1.278	0.0002	0.001	0.004	17.04	0.001	0.245	0.065	0.002	0.002	0.002	0.384	0.002	0.004	0.032
PQL		0.0030	0.0002	0.0121	0.0012	0.0303	0.0003	0.0012	0.0012	0.003	0.0012	0.0303	0.0012	0.0030	0.0012	0.0030	0.0303	0.0030	0.0012	0.0030
15/01/2019	159	1.7537	0.0008	1.2464	0.0819	3.5628	<PQL	<PQL	0.0054	14.150	<PQL	0.6993	0.0695	<PQL	0.0019	<PQL	0.7466	<PQL	0.0039	0.0591
21/01/2019	82	0.8479	0.0004	0.7956	0.0497	2.2745	<PQL	<PQL	0.0022	4.559	<PQL	0.4412	0.0203	<PQL	<PQL	<PQL	0.3582	<PQL	0.0019	0.0333
27/01/2019	76	1.3274	0.0005	1.0022	0.0782	3.4180	<PQL	<PQL	0.0034	4.543	<PQL	0.5489	0.0237	<PQL	<PQL	<PQL	0.5386	<PQL	0.0032	0.0501
02/02/2019	132	1.6907	0.0012	1.5083	0.1016	4.2182	<PQL	<PQL	0.0054	20.649	<PQL	0.7003	0.0696	<PQL	0.0019	<PQL	0.4878	<PQL	0.0032	0.0787
08/02/2019	72	1.6449	0.0004	1.3193	0.0908	4.0506	<PQL	<PQL	0.0040	3.073	<PQL	0.6119	0.0237	<PQL	<PQL	<PQL	0.3468	<PQL	0.0032	0.0628
14/02/2019	115	1.2657	0.0008	1.0051	0.0720	3.4265	<PQL	<PQL	0.0040	11.381	<PQL	0.5501	0.0537	<PQL	<PQL	<PQL	0.4117	<PQL	0.0032	0.0503
20/02/2019	87	1.5928	0.0008	1.8471	0.1304	5.3753	<PQL	<PQL	0.0047	8.853	<PQL	0.8743	0.0392	<PQL	<PQL	<PQL	0.6060	<PQL	0.0032	0.0892
26/02/2019	99	2.2468	0.0010	1.8635	0.1380	5.4208	<PQL	<PQL	0.0073	10.178	0.0013	1.0096	0.0548	<PQL	0.0025	<PQL	0.6097	<PQL	0.0051	0.0964
04/03/2019	107	0.7617	<PQL	0.2585	0.1623	0.9934	<PQL	<PQL	0.0015	8.149	<PQL	0.3023	0.0476	<PQL	<PQL	<PQL	0.0387	<PQL	0.0019	0.1137
10/03/2019	234	1.4986	0.0014	<PQL	0.1388	0.4350	<PQL	<PQL	0.0048	26.444	<PQL	0.1865	0.1021	<PQL	0.0026	<PQL	0.1128	<PQL	0.0039	0.1089
16/03/2019	48	1.3227	0.0004	1.4509	0.2565	4.7647	<PQL	<PQL	0.0034	7.453	<PQL	0.8041	0.0230	<PQL	<PQL	<PQL	0.0975	<PQL	0.0019	0.1765
22/03/2019	114	1.4533	0.0008	0.4994	0.1804	1.5910	<PQL	<PQL	0.0047	9.377	<PQL	0.3599	0.0396	<PQL	0.0012	<PQL	0.0985	<PQL	0.0044	0.1257
28/03/2019	74	1.4010	0.0005	1.5379	0.2583	4.1912	<PQL	<PQL	0.0034	9.423	<PQL	0.6858	0.0405	<PQL	0.0013	<PQL	0.2304	<PQL	0.0019	0.1777
03/04/2019	172	0.6738	0.0014	<PQL	0.0048	<PQL	<PQL	<PQL	0.0027	19.408	<PQL	<PQL	0.0608	<PQL	<PQL	<PQL	0.0919	<PQL	0.0038	0.0101
09/04/2019	122	0.8754	0.0009	<PQL	0.0037	0.9382	<PQL	<PQL	0.0040	10.628	<PQL	0.1029	0.0421	<PQL	0.0012	<PQL	0.4786	<PQL	0.0038	0.0147
15/04/2019	139	0.2237	0.0003	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	4.209	<PQL	<PQL	0.0239	<PQL	<PQL	<PQL	<PQL	<PQL	0.0018	<PQL
21/04/2019	32	0.7305	<PQL	0.6117	0.0079	2.4424	<PQL	<PQL	0.0030	4.921	<PQL	0.3054	0.0200	<PQL	<PQL	<PQL	0.2445	<PQL	0.0024	0.0079
27/04/2019	34	0.4878	0.0009	0.2477	0.0031	0.6221	<PQL	<PQL	0.0018	6.438	<PQL	0.1234	0.0243	<PQL	<PQL	<PQL	<PQL	<PQL	0.0024	0.0043
03/05/2019	93	0.8353	0.0013	<PQL	0.0063	0.2218	<PQL	<PQL	0.0050	21.329	<PQL	0.0909	0.0543	<PQL	0.0018	<PQL	0.1494	<PQL	0.0049	0.0209
09/05/2019	92	0.7371	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	0.0049	8.278	<PQL	<PQL	0.0468	<PQL	0.0024	<PQL	0.0664	<PQL	0.0054	0.0068
15/05/2019	82	0.6142	0.0005	<PQL	0.0026	<PQL	<PQL	<PQL	0.0043	16.785	<PQL	<PQL	0.0505	<PQL	0.0018	<PQL	0.0656	<PQL	0.0042	0.0232
21/05/2019	190	3.0202	0.0025	0.1044	0.0195	1.3581	<PQL	0.0030	0.0135	57.917	0.0019	0.3237	0.1861	<PQL	0.0067	0.0038	0.6892	<PQL	0.0110	0.0469
27/05/2019	89	1.3116	0.0012	0.1728	0.0098	1.3816	<PQL	<PQL	0.0074	19.384	<PQL	0.2657	0.0699	<PQL	0.0030	<PQL	0.4475	<PQL	0.0067	0.0157
02/06/2019	44	0.3874	0.0003	<PQL	<PQL	<PQL	<PQL	<PQL	0.0023	9.317	<PQL	<PQL	0.0352	<PQL	<PQL	<PQL	0.0364	<PQL	0.0029	<PQL
08/06/2019	77	0.4983	0.0008	<PQL	<PQL	<PQL	<PQL	<PQL	0.0025	14.995	<PQL	<PQL	0.0634	<PQL	<PQL	<PQL	<PQL	<PQL	0.0048	<PQL
14/06/2019	21	0.2687	<PQL	<PQL	0.0017	<PQL	<PQL	<PQL	0.0023	2.272	<PQL	0.0342	0.0113	<PQL	0.0017	<PQL	0.1563	<PQL	0.0017	0.0115
20/06/2019	110	1.4116	0.0024	<PQL	0.0057	<PQL	<PQL	<PQL	0.0073	33.877	<PQL	0.0699	0.1182	<PQL	0.0024	<PQL	0.3736	<PQL	0.0066	0.0258
26/06/2019	50	0.5098	0.0007	<PQL	0.0072	<PQL	<PQL	<PQL	0.0043	12.616	<PQL	<PQL	0.0759	<PQL	0.0024	<PQL	0.2602	<PQL	0.0036	0.0407
02/07/2019	105	0.7736	0.0031	<PQL	<PQL	<PQL	<PQL	<PQL	0.0066	28.106	<PQL	<PQL	0.0808	0.0158	0.0042	<PQL	0.0524	<PQL	0.0054	0.0276
08/07/2019	106	1.1356	0.0013	<PQL	0.0046	<PQL	<PQL	<PQL	0.0084	23.886	<PQL	<PQL	0.1471	<PQL	0.0030	<PQL	0.2334	<PQL	0.0060	0.0577

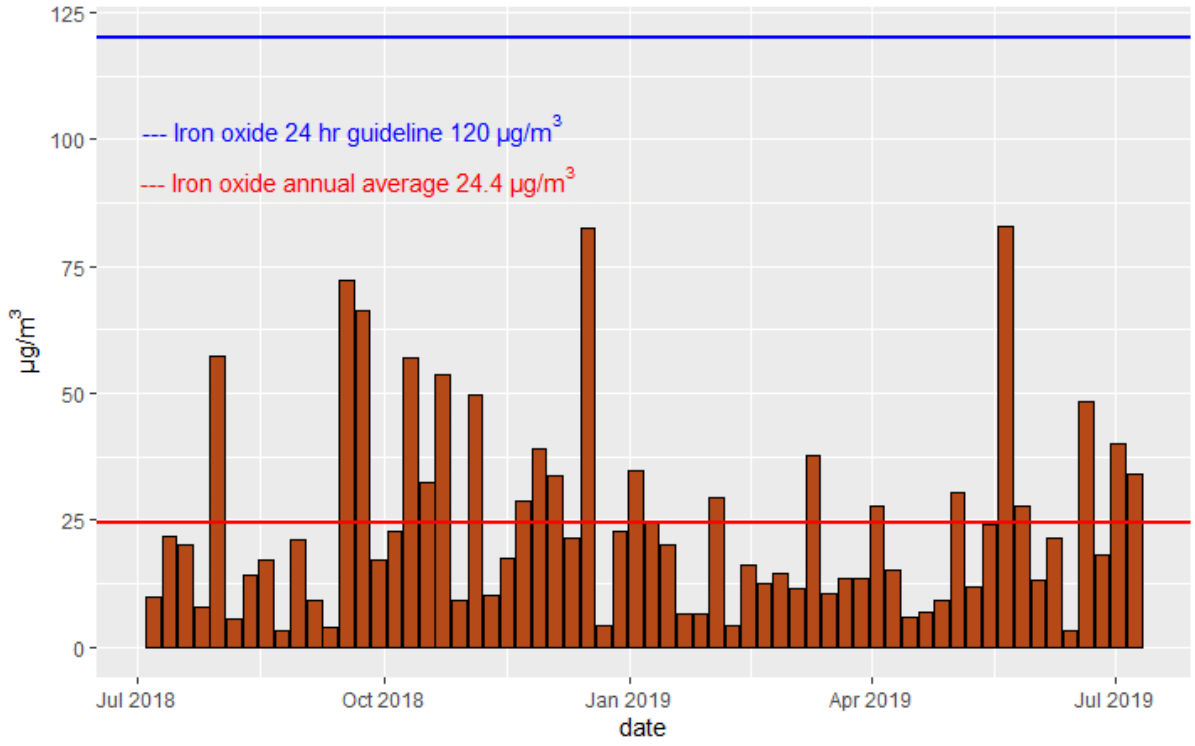

Figure B-1: Iron oxide (as hematite) concentrations in TSP

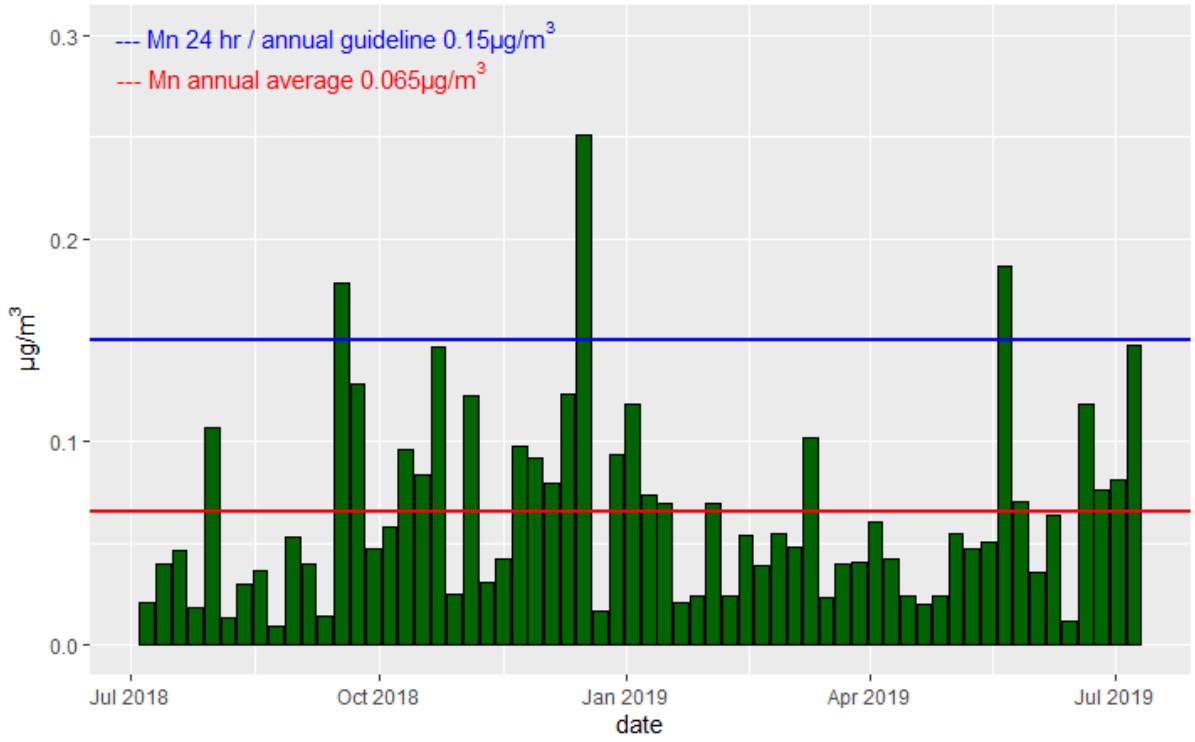

Figure B-2: Manganese concentrations in TSP

Table B-3: Asbestos results summary

Date	Fibres/ml	Date	Fibres/ml	Date	Fibres/ml
07/07/2018	< 0.01	10/11/2018	< 0.01	10/03/2019	< 0.01
13/07/2018	< 0.01	16/11/2018	< 0.01	16/03/2019	< 0.01
19/07/2018	< 0.01	22/11/2018	< 0.01	22/03/2019	< 0.01
25/07/2018	< 0.01	28/11/2018	< 0.01	28/03/2019	< 0.01
31/07/2018	< 0.01	04/12/2018	< 0.01	03/04/2019	< 0.01
06/08/2018	< 0.01	10/12/2018	< 0.01	09/04/2019	< 0.01
12/08/2018	< 0.01	16/12/2018	< 0.01	15/04/2019	< 0.01
18/08/2018	< 0.01	22/12/2018	< 0.01	21/04/2019	< 0.01
24/08/2018	< 0.01	28/12/2018	< 0.01	27/04/2019	< 0.01
30/08/2018	< 0.01	03/01/2019	< 0.01	03/05/2019	< 0.01
05/09/2018	< 0.01	09/01/2019	< 0.01	09/05/2019	< 0.01
11/09/2018	< 0.01	16/11/2018	< 0.01	15/05/2019	< 0.01
17/09/2018	< 0.01	15/01/2019	< 0.01	21/05/2019	< 0.01
23/09/2018	< 0.01	21/01/2019	< 0.01	27/05/2019	< 0.01
29/09/2018	< 0.01	27/01/2019	*	02/06/2019	< 0.01
05/10/2018	< 0.01	02/02/2019	< 0.01	08/06/2019	< 0.01
11/10/2018	< 0.01	08/02/2019	< 0.01	14/06/2019	< 0.01
17/10/2018	< 0.01	14/02/2019	< 0.01	20/06/2019	< 0.01
23/10/2018	< 0.01	20/02/2019	< 0.01	26/06/2019	< 0.01
29/10/2018	< 0.01	28/02/2019	< 0.01	02/07/2019	< 0.01
4/11/2018	< 0.01	04/03/2019	< 0.01	08/07/2019	< 0.01
* filter damaged					

As per NOHSC:3003(2005), when the actual fibre count is less than 10 fibres/100 graticule areas, the count is not significantly above that of background. The results are calculated using the minimum practical lower limit of detection of 10 fibres/100 graticule areas and thus reported as less than the calculated value. SEM scanning to identify fibre types such as asbestos only occur when the fibre count is greater than 10 fibres/100 graticule areas.

Appendix C – Laboratory analysis reports

Appendix C displays the laboratory's analysis reports for TSP, metals and asbestos. Go to our website for a version of this report without Appendix C.

TSP and metals

- Certificate of analysis 214723
- Certificate of analysis 218083
- Certificate of analysis 221043
- Certificate of analysis 225859
- Certificate of analysis 229757

Asbestos

- Certificate of analysis 214722
- Certificate of analysis 218082
- Certificate of analysis 221044
- Certificate of analysis 225860
- Certificate of analysis 229756

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www.mpl.com.au

CERTIFICATE OF ANALYSIS 214723

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	8 HVF
Date samples received	17/08/2018
Date completed instructions received	17/08/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	24/08/2018
Date of Issue	24/08/2018

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Tom Edwards, Occupational Hygiene and Microbiology Supervisor

Authorised By

Todd Lee, Laboratory Manager

Metals in High Volume Filters							
Our Reference			214723-1	214723-2	214723-3	214723-4	214723-5
Your Reference	UNITS	PQL	NMS1	NMS2	NMS3	NMS4	NMS5
Date Sampled			07/07/2018	13/07/2018	19/07/2018	25/07/2018	03/08/2018
Filter No			NMS1	NMS2	NMS3	NMS4	NMS5
Weight of Filter (initial)	mg	0.02	3,603.80	3,608.50	3,605.50	3,598.10	3,594.40
Weight of Filter (final)	mg	0.02	3,698.27	3,806.62	3,727.54	3,716.38	3,594.92
Dust	mg/filter	0.1	94	200	120	120	0.5
Aluminium	µg/filter	5	2,700	2,800	4,300	1,800	2,600
Arsenic	µg/filter	0.4	2.3	3.5	4.4	1.6	0.42
Boron	µg/filter	20	3,600	3,400	5,300	2,400	4,600
Barium	µg/filter	2	310	280	450	210	400
Calcium	µg/filter	50	11,000	11,000	17,000	8,000	14,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	<2	<2	<2	<2	<2
Chromium	µg/filter	2	9	11	18	6	8
Iron	µg/filter	5	11,000	24,000	22,000	8,600	250
Lithium	µg/filter	2	<2	<2	3	<2	<2
Potassium	µg/filter	50	1,800	1,600	2,700	1,200	2,200
Manganese	µg/filter	2	37	66	76	32	5
Molybdenum	µg/filter	5	<5	<5	9	<5	<5
Nickel	µg/filter	2	<2	3	5	<2	<2
Lead	µg/filter	5	<5	<5	<5	<5	<5
Sulfur	µg/filter	50	970	1,500	1,800	740	940
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	4	4	8	3	<2
Zinc	µg/filter	5	250	210	350	150	270

Metals in High Volume Filters					
Our Reference			214723-6	214723-7	214723-8
Your Reference	UNITS	PQL	NMS6	NMS7	NMS8
Date Sampled			31/07/2018	06/08/2018	12/08/2018
Filter No			NMS6	NMS7	NMS8
Weight of Filter (initial)	mg	0.02	3,590.20	3,596.20	3,600.10
Weight of Filter (final)	mg	0.02	3,897.70	3,656.75	3,719.55
Dust	mg/filter	0.1	310	61	120
Aluminium	µg/filter	5	5,300	3,000	3,400
Arsenic	µg/filter	0.4	6.8	1.6	3.0
Boron	µg/filter	20	5,000	4,500	4,600
Barium	µg/filter	2	400	400	390
Calcium	µg/filter	50	15,000	14,000	14,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	2	<2	<2
Chromium	µg/filter	2	19	10	12
Iron	µg/filter	5	66,000	6,700	17,000
Lithium	µg/filter	2	3	<2	<2
Potassium	µg/filter	50	2,300	2,200	2,100
Manganese	µg/filter	2	180	27	55
Molybdenum	µg/filter	5	<5	<5	<5
Nickel	µg/filter	2	6	2	3
Lead	µg/filter	5	6	<5	<5
Sulfur	µg/filter	50	1,500	1,200	1,200
Selenium	µg/filter	5	<5	<5	<5
Vanadium	µg/filter	2	11	3	5
Zinc	µg/filter	5	320	290	270

Method ID	Methodology Summary
DUST-004	Determination of total suspended particulates (TSP) and size selective PM10 – High volume sampler gravimetric methods AS3580.9.3 and AS3580.9.6.
DUST-004	Airborne samples analysed according to AS 2985 for Respirable Dust or AS 3640 for Inhalable Dust. Sample results based on volume data supplied by client. Samples tested as received, *accreditation does not cover sampling.
METALS-006	Determination of various metals on filters by ICP-AES and Hg by CV-AAS using NIOSH 7300, 7301 & 7303 and in-house METALS-006/025. Some PQLs reported may be higher than the laboratory PQL stated due to different or lower air volumes sampled by client.

QUALITY CONTROL: Metals in High Volume Filters					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Aluminium	µg/filter	5	METALS-006	<5	1	2700	2200	20	112	[NT]
Arsenic	µg/filter	0.4	METALS-006	<0.4	1	2.3	1.9	19	98	[NT]
Boron	µg/filter	20	METALS-006	<20	1	3600	3300	9	111	[NT]
Barium	µg/filter	2	METALS-006	<2	1	310	270	14	114	[NT]
Calcium	µg/filter	50	METALS-006	<50	1	11000	9900	11	108	[NT]
Cadmium	µg/filter	0.5	METALS-006	<0.5	1	<0.5	<0.5	0	104	[NT]
Cobalt	µg/filter	2	METALS-006	<2	1	<2	<2	0	108	[NT]
Chromium	µg/filter	2	METALS-006	<2	1	9	7	25	110	[NT]
Iron	µg/filter	5	METALS-006	<5	1	11000	8600	24	106	[NT]
Lithium	µg/filter	2	METALS-006	<2	1	<2	<2	0	114	[NT]
Potassium	µg/filter	50	METALS-006	<50	1	1800	1500	18	109	[NT]
Manganese	µg/filter	2	METALS-006	<2	1	37	28	28	110	[NT]
Molybdenum	µg/filter	5	METALS-006	<5	1	<5	<5	0	114	[NT]
Nickel	µg/filter	2	METALS-006	<2	1	<2	<2	0	111	[NT]
Lead	µg/filter	5	METALS-006	<5	1	<5	<5	0	108	[NT]
Sulfur	µg/filter	50	METALS-006	<50	1	970	790	20	107	[NT]
Selenium	µg/filter	5	METALS-006	<5	1	<5	<5	0	109	[NT]
Vanadium	µg/filter	2	METALS-006	<2	1	4	3	29	110	[NT]
Zinc	µg/filter	5	METALS-006	<5	1	250	220	13	106	[NT]

Result Definitions

DOL	Samples rejected due to particulate overload
RPF	Sample rejected due to pump failure
RFD	Sample rejected due to filter damage
RUD	Sample rejected due to uneven deposition
PQL	Practical quantitation limit

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from 'Australian Drinking Water Guidelines', published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL – any RPD is acceptable; >5xPQL – 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab is not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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CERTIFICATE OF ANALYSIS 218083

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	12 HV Filters
Date samples received	31/10/2018
Date completed instructions received	31/10/2018
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	07/11/2018
Date of Issue	07/11/2018
Reissue Details	This report replaces R00 created on 07/11/2018 due to: Correction in Arsenic Result Data

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Results Approved By
Tom Edwards, Occupational Hygiene and Microbiology Supervisor

Authorised By

Todd Lee, Laboratory Manager

Metals in High Volume Filters							
Our Reference			218083-1	218083-2	218083-3	218083-4	218083-5
Your Reference	UNITS	PQL	NMS9	NMS10	NMS11	NMS12	NMS13
Date Sampled			12/08/2018	24/08/2018	30/08/2018	05/09/2018	11/09/2018
Filter No			NMS9	NMS10	NMS11	NMS12	NMS13
Weight of Filter (initial)	mg	0.02	3,593.20	3,589.80	3,598.50	3,599.80	3,589.80
Weight of Filter (final)	mg	0.02	3,721.50	3,629.60	3,714.70	3,668.50	3,637.80
Dust	mg/filter	0.1	130	40	120	69	48
Aluminium	µg/filter	5	3,800	3,100	3,900	3,000	3,400
Arsenic	µg/filter	0.4	3.7	1.0	2.9	1.7	1.2
Boron	µg/filter	20	4,700	5,000	5,300	4,500	5,500
Barium	µg/filter	2	410	430	460	380	460
Calcium	µg/filter	50	16,000	16,000	17,000	14,000	17,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	<2	<2	<2	<2	<2
Chromium	µg/filter	2	15	10	14	11	12
Iron	µg/filter	5	20,000	4,500	25,000	11,000	5,200
Lithium	µg/filter	2	2	<2	2	<2	<2
Potassium	µg/filter	50	2,400	2,300	2,600	2,100	2,500
Manganese	µg/filter	2	66	22	94	71	30
Molybdenum	µg/filter	5	7	<5	<5	<5	<5
Nickel	µg/filter	2	4	<2	3	2	<2
Lead	µg/filter	5	<5	<5	<5	<5	<5
Sulfur	µg/filter	50	1,600	1,200	1,500	1,200	1,500
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	7	2	4	3	3
Zinc	µg/filter	5	300	310	330	290	330

Metals in High Volume Filters							
Our Reference			218083-6	218083-7	218083-8	218083-9	218083-10
Your Reference	UNITS	PQL	NMS14	NMS15	NMS16	NMS17	NMS18
Date Sampled			17/09/2018	23/09/2018	26/09/2018	29/09/2018	05/10/2018
Filter No			NMS14	NMS15	NMS16	NMS17	NMS18
Weight of Filter (initial)	mg	0.02	3,592.20	3,649.10	3,643.40	3,661.90	3,669.00
Weight of Filter (final)	mg	0.02	3,941.90	3,997.00	3,645.80	3,824.80	3,841.90
Dust	mg/filter	0.1	350	350	2.4	160	170
Aluminium	µg/filter	5	6,300	5,700	3,600	4,100	3,200
Arsenic	µg/filter	0.4	7.2	6.2	0.61	3.6	2.7
Boron	µg/filter	20	5,500	4,700	5,800	4,700	3,600
Barium	µg/filter	2	450	390	530	420	320
Calcium	µg/filter	50	18,000	16,000	18,000	16,000	12,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	5	4	<2	<2	<2
Chromium	µg/filter	2	28	23	12	18	13
Iron	µg/filter	5	81,000	74,000	580	20,000	26,000
Lithium	µg/filter	2	4	3	2	3	<2
Potassium	µg/filter	50	2,800	2,600	2,800	2,700	2,000
Manganese	µg/filter	2	290	210	7	82	100
Molybdenum	µg/filter	5	<5	<5	<5	<5	<5
Nickel	µg/filter	2	9	9	<2	5	4
Lead	µg/filter	5	7	8	<5	<5	<5
Sulfur	µg/filter	50	2,100	1,800	1,300	2,100	1,300
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	10	10	<2	7	5
Zinc	µg/filter	5	340	300	360	310	230

Metals in High Volume Filters				
Our Reference			218083-11	218083-12
Your Reference	UNITS	PQL	NMS19	NMS20
Date Sampled			11/10/2018	17/10/2018
Filter No			NMS19	NMS20
Weight of Filter (initial)	mg	0.02	3,666.40	3,658.10
Weight of Filter (final)	mg	0.02	4,021.80	3,861.10
Dust	mg/filter	0.1	360	200
Aluminium	µg/filter	5	4,500	4,600
Arsenic	µg/filter	0.4	4.3	7.8
Boron	µg/filter	20	4,500	5,000
Barium	µg/filter	2	380	450
Calcium	µg/filter	50	15,000	17,000
Cadmium	µg/filter	0.5	<0.5	<0.5
Cobalt	µg/filter	2	2	2
Chromium	µg/filter	2	16	19
Iron	µg/filter	5	64,000	37,000
Lithium	µg/filter	2	3	3
Potassium	µg/filter	50	2,300	3,100
Manganese	µg/filter	2	160	140
Molybdenum	µg/filter	5	<5	<5
Nickel	µg/filter	2	6	5
Lead	µg/filter	5	6	<5
Sulfur	µg/filter	50	1,700	2,100
Selenium	µg/filter	5	<5	<5
Vanadium	µg/filter	2	6	9
Zinc	µg/filter	5	280	330

Method ID	Methodology Summary
DUST-004	Determination of total suspended particulates (TSP) and size selective PM10 – High volume sampler gravimetric methods AS3580.9.3 and AS3580.9.6.
DUST-004	Airborne samples analysed according to AS 2985 for Respirable Dust or AS 3640 for Inhalable Dust. Sample results based on volume data supplied by client. Samples tested as received, *accreditation does not cover sampling.
METALS-006	Determination of various metals on filters by ICP-AES and Hg by CV-AAS using NIOSH 7300, 7301 & 7303 and in-house METALS-006/025. Some PQLs reported may be higher than the laboratory PQL stated due to different or lower air volumes sampled by client.

QUALITY CONTROL: Metals in High Volume Filters						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Aluminium	µg/filter	5	METALS-006	<5	1	3800	3800	0	102	[NT]
Arsenic	µg/filter	0.4	METALS-006	<0.4	1	3.7	3.4	8	112	[NT]
Boron	µg/filter	20	METALS-006	<20	1	4700	4800	2	102	[NT]
Barium	µg/filter	2	METALS-006	<2	1	410	410	0	105	[NT]
Calcium	µg/filter	50	METALS-006	<50	1	16000	16000	0	97	[NT]
Cadmium	µg/filter	0.5	METALS-006	<0.5	1	<0.5	<0.5	0	99	[NT]
Cobalt	µg/filter	2	METALS-006	<2	1	<2	<2	0	100	[NT]
Chromium	µg/filter	2	METALS-006	<2	1	15	14	7	102	[NT]
Iron	µg/filter	5	METALS-006	<5	1	20000	20000	0	100	[NT]
Lithium	µg/filter	2	METALS-006	<2	1	2	2	0	103	[NT]
Potassium	µg/filter	50	METALS-006	<50	1	2400	2400	0	100	[NT]
Manganese	µg/filter	2	METALS-006	<2	1	66	65	2	102	[NT]
Molybdenum	µg/filter	5	METALS-006	<5	1	7	<5	33	106	[NT]
Nickel	µg/filter	2	METALS-006	<2	1	4	4	0	103	[NT]
Lead	µg/filter	5	METALS-006	<5	1	<5	<5	0	102	[NT]
Sulfur	µg/filter	50	METALS-006	<50	1	1600	1500	6	98	[NT]
Selenium	µg/filter	5	METALS-006	<5	1	<5	<5	0	114	[NT]
Vanadium	µg/filter	2	METALS-006	<2	1	7	7	0	101	[NT]
Zinc	µg/filter	5	METALS-006	<5	1	300	290	3	100	[NT]

Result Definitions

DOL	Samples rejected due to particulate overload
RPF	Sample rejected due to pump failure
RFD	Sample rejected due to filter damage
RUD	Sample rejected due to uneven deposition
PQL	Practical quantitation limit

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from 'Australian Drinking Water Guidelines', published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from '2018 TLVs and BEIs', as published by ACGIH (where available).

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL – RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL – RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates).

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab is not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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CERTIFICATE OF ANALYSIS 221043

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	15 Hi Vol Filters
Date samples received	14/01/2019
Date completed instructions received	14/01/2019

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	21/01/2019
Date of Issue	21/01/2019

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Results Approved By
Todd Lee, Laboratory Manager, Perth

Authorised By

Todd Lee, Laboratory Manager

Metals in High Volume Filters							
Our Reference			221043-1	221043-2	221043-3	221043-4	221043-5
Your Reference	UNITS	PQL	NMS21	NMS22	NMS23	NMS24	NMS25
Date Sampled			23/10/2018	29/10/2018	04/11/2018	10/11/2018	16/11/2018
Filter No			NMS21	NMS22	NMS23	NMS24	NMS25
Weight of Filter (initial)	mg	0.02	3,651.30	3,649.10	3,645.70	3,642.10	3,601.50
Weight of Filter (final)	mg	0.02	3,899.60	3,723.70	3,838.70	3,745.50	3,715.90
Dust	mg/filter	0.1	250	75	190	100	110
Aluminium	µg/filter	5	5,400	3,700	4,900	3,600	4,600
Arsenic	µg/filter	0.4	5.6	2.0	5.3	3.8	3.1
Boron	µg/filter	20	5,400	5,600	6,300	5,100	6,800
Barium	µg/filter	2	430	470	520	440	540
Calcium	µg/filter	50	17,000	18,000	20,000	16,000	20,000
Cadmium	µg/filter	0.5	0.6	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	4	<2	3	<2	<2
Chromium	µg/filter	2	20	13	17	11	15
Iron	µg/filter	5	60,000	10,000	55,000	12,000	20,000
Lithium	µg/filter	2	4	2	3	2	3
Potassium	µg/filter	50	2,500	2,800	3,000	3,000	3,200
Manganese	µg/filter	2	240	43	200	56	74
Molybdenum	µg/filter	5	<5	<5	<5	<5	<5
Nickel	µg/filter	2	6	2	4	<2	3
Lead	µg/filter	5	7	<5	8	<5	<5
Sulfur	µg/filter	50	1,700	1,900	2,100	1,900	2,500
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	8	4	6	5	6
Zinc	µg/filter	5	320	340	370	310	410

Metals in High Volume Filters							
Our Reference			221043-6	221043-7	221043-8	221043-9	221043-10
Your Reference	UNITS	PQL	NMS26	NMS27 FIELD BLANK	NMS28	NMS29	NMS30
Date Sampled			22/11/2018	26/11/2018	28/11/2018	04/12/2018	10/12/2018
Filter No			NMS26	NMS27	NMS28	NMS29	NMS30
Weight of Filter (initial)	mg	0.02	3,599.20	3,601.90	3,597.20	3,597.20	3,599.10
Weight of Filter (final)	mg	0.02	3,792.40	3,606.80	3,824.80	3,794.50	3,947.40
Dust	mg/filter	0.1	190	4.9	230	200	350
Aluminium	µg/filter	5	5,500	3,200	5,400	5,400	8,300
Arsenic	µg/filter	0.4	6.7	0.54	6.3	5.2	5.8
Boron	µg/filter	20	7,000	6,300	6,300	7,100	6,100
Barium	µg/filter	2	550	510	490	560	460
Calcium	µg/filter	50	22,000	19,000	20,000	22,000	20,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	3	<2	3	3	3
Chromium	µg/filter	2	18	9	18	18	22
Iron	µg/filter	5	32,000	420	43,000	37,000	24,000
Lithium	µg/filter	2	4	<2	4	4	5
Potassium	µg/filter	50	3,400	2,800	2,900	3,500	3,500
Manganese	µg/filter	2	160	7	150	130	200
Molybdenum	µg/filter	5	<5	<5	<5	7	<5
Nickel	µg/filter	2	4	<2	5	4	5
Lead	µg/filter	5	5	<5	<5	6	7
Sulfur	µg/filter	50	2,400	1,200	2,600	4,000	2,100
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	10	<2	9	9	24
Zinc	µg/filter	5	390	370	360	410	320

Metals in High Volume Filters							
Our Reference			221043-11	221043-12	221043-13	221043-14	221043-15
Your Reference	UNITS	PQL	NMS31	NMS32	NMS33	NMS34	NMS35
Date Sampled			16/12/2018	22/12/2018	28/12/2018	03/01/2019	09/01/2019
Filter No			NMS31	NMS32	NMS33	NMS34	NMS35
Weight of Filter (initial)	mg	0.02	3,605.90	3,605.60	3,597.60	3,600.70	3,600.20
Weight of Filter (final)	mg	0.02	3,980.50	3,656.30	3,704.40	3,748.40	3,741.80
Dust	mg/filter	0.1	370	51	110	150	140
Aluminium	µg/filter	5	6,000	4,200	5,100	6,200	5,600
Arsenic	µg/filter	0.4	6.3	1.2	3.7	5.5	5.4
Boron	µg/filter	20	6,000	6,800	7,400	7,800	7,700
Barium	µg/filter	2	480	570	580	600	600
Calcium	µg/filter	50	19,000	21,000	23,000	24,000	24,000
Cadmium	µg/filter	0.5	0.6	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	3	<2	<2	3	2
Chromium	µg/filter	2	19	13	16	21	18
Iron	µg/filter	5	91,000	5,000	25,000	38,000	27,000
Lithium	µg/filter	2	3	3	3	4	4
Potassium	µg/filter	50	2,900	3,100	3,500	3,700	3,600
Manganese	µg/filter	2	400	33	150	190	120
Molybdenum	µg/filter	5	<5	<5	<5	<5	<5
Nickel	µg/filter	2	6	<2	2	5	3
Lead	µg/filter	5	8	<5	<5	<5	<5
Sulfur	µg/filter	50	2,400	1,900	2,100	3,300	2,600
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	10	3	6	9	9
Zinc	µg/filter	5	350	400	420	430	440

Method ID	Methodology Summary
DUST-004	Determination of total suspended particulates (TSP) and size selective PM10 – High volume sampler gravimetric methods AS3580.9.3 and AS3580.9.6.
DUST-004	Airborne samples analysed according to AS 2985 for Respirable Dust or AS 3640 for Inhalable Dust. Sample results based on volume data supplied by client. Samples tested as received, *accreditation does not cover sampling.
METALS-006	Determination of various metals on filters by ICP-AES and Hg by CV-AAS using NIOSH 7300, 7301 & 7303 and in-house METALS-006/025. Some PQLs reported may be higher than the laboratory PQL stated due to different or lower air volumes sampled by client.

QUALITY CONTROL: Metals in High Volume Filters						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Aluminium	µg/filter	5	METALS-006	<5	1	5400	6400	17	99	[NT]
Arsenic	µg/filter	0.4	METALS-006	<0.4	1	5.6	8.1	36	102	[NT]
Boron	µg/filter	20	METALS-006	<20	1	5400	6100	12	103	[NT]
Barium	µg/filter	2	METALS-006	<2	1	430	490	13	106	[NT]
Calcium	µg/filter	50	METALS-006	<50	1	17000	20000	16	95	[NT]
Cadmium	µg/filter	0.5	METALS-006	<0.5	1	0.6	<0.5	18	98	[NT]
Cobalt	µg/filter	2	METALS-006	<2	1	4	5	22	100	[NT]
Chromium	µg/filter	2	METALS-006	<2	1	20	24	18	97	[NT]
Iron	µg/filter	5	METALS-006	<5	1	60000	77000	25	101	[NT]
Lithium	µg/filter	2	METALS-006	<2	1	4	4	0	108	[NT]
Potassium	µg/filter	50	METALS-006	<50	1	2500	2900	15	97	[NT]
Manganese	µg/filter	2	METALS-006	<2	1	240	300	22	103	[NT]
Molybdenum	µg/filter	5	METALS-006	<5	1	<5	<5	0	100	[NT]
Nickel	µg/filter	2	METALS-006	<2	1	6	8	29	99	[NT]
Lead	µg/filter	5	METALS-006	<5	1	7	7	0	99	[NT]
Sulfur	µg/filter	50	METALS-006	<50	1	1700	2000	16	98	[NT]
Selenium	µg/filter	5	METALS-006	<5	1	<5	<5	0	99	[NT]
Vanadium	µg/filter	2	METALS-006	<2	1	8	10	22	100	[NT]
Zinc	µg/filter	5	METALS-006	<5	1	320	370	14	97	[NT]

Result Definitions

DOL	Samples rejected due to particulate overload
RPF	Sample rejected due to pump failure
RFD	Sample rejected due to filter damage
RUD	Sample rejected due to uneven deposition
PQL	Practical quantitation limit

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from 'Australian Drinking Water Guidelines', published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from '2018 TLVs and BEIs', as published by ACGIH (where available).

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL – RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL – RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates).

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab is not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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CERTIFICATE OF ANALYSIS 225859

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	19 HV Filter
Date samples received	30/04/2019
Date completed instructions received	30/04/2019
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	07/05/2019
Date of Issue	08/05/2019

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Results Approved By
Joshua Lim, Operations Manager

Authorised By

Michael Kubiak, Laboratory Manager

Metals in High Volume Filters							
Our Reference			225859-1	225859-2	225859-3	225859-4	225859-5
Your Reference	UNITS	PQL	NMS36	NMS37	NMS38	NMS39	NMS40
Date Sampled			10/01/2019	15/01/2019	21/01/2019	25/01/2019	27/01/2019
Filter No			NMS36	NMS37	NMS38	NMS39	NMS40
Weight of Filter (initial)	mg	0.02	3,605.00	3,599.80	3,601.10	3,605.40	3,594.90
Weight of Filter (final)	mg	0.02	3,628.80	3,853.70	3,737.10	3,615.10	3,722.90
Dust	mg/filter	0.1	24	250	140	9.7	130
Aluminium	µg/filter	5	2,200	4,200	2,800	1,600	3,600
Arsenic	µg/filter	0.4	<0.4	1.5	0.87	<0.4	0.97
Boron	µg/filter	20	4,300	5,100	4,400	3,400	4,800
Barium	µg/filter	2	330	360	310	250	360
Calcium	µg/filter	50	12,000	14,000	12,000	9,100	14,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	<2	<2	<2	<2	<2
Chromium	µg/filter	2	6	13	8	5	10
Iron	µg/filter	5	1,400	22,000	7,200	190	7,300
Lithium	µg/filter	2	<2	2	<2	<2	<2
Potassium	µg/filter	50	1,700	2,200	1,800	1,200	2,000
Manganese	µg/filter	2	10	110	34	3	40
Molybdenum	µg/filter	5	<5	<5	<5	<5	<5
Nickel	µg/filter	2	<2	4	<2	<2	<2
Lead	µg/filter	5	<5	<5	<5	<5	<5
Sulfur	µg/filter	50	620	1,600	1,000	480	1,300
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	<2	7	4	<2	6
Zinc	µg/filter	5	210	250	210	170	240

Metals in High Volume Filters							
Our Reference			225859-6	225859-7	225859-8	225859-9	225859-10
Your Reference	UNITS	PQL	NMS41	NMS42	NMS43	NMS44	NMS45
Date Sampled			02/02/2019	08/02/2019	14/02/2019	20/02/2019	26/02/2019
Filter No			NMS41	NMS42	NMS43	NMS44	NMS45
Weight of Filter (initial)	mg	0.02	3,600.40	3,600.20	3,601.00	3,600.00	3,595.30
Weight of Filter (final)	mg	0.02	3,813.00	3,722.50	3,790.50	3,745.00	3,757.80
Dust	mg/filter	0.1	210	120	190	140	160
Aluminium	µg/filter	5	4,100	4,100	3,500	4,000	5,000
Arsenic	µg/filter	0.4	2.1	0.77	1.4	1.4	1.8
Boron	µg/filter	20	5,500	5,300	4,800	6,100	6,100
Barium	µg/filter	2	390	380	350	440	450
Calcium	µg/filter	50	15,000	15,000	14,000	17,000	17,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	<2	<2	<2	<2	<2
Chromium	µg/filter	2	13	11	11	12	16
Iron	µg/filter	5	32,000	5,000	18,000	14,000	16,000
Lithium	µg/filter	2	<2	<2	<2	<2	3
Potassium	µg/filter	50	2,200	2,100	2,000	2,500	2,700
Manganese	µg/filter	2	110	40	87	64	88
Molybdenum	µg/filter	5	<5	<5	<5	<5	<5
Nickel	µg/filter	2	4	<2	2	<2	5
Lead	µg/filter	5	<5	<5	<5	<5	<5
Sulfur	µg/filter	50	1,200	1,000	1,100	1,400	1,400
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	6	6	6	6	9
Zinc	µg/filter	5	280	260	240	300	310

Metals in High Volume Filters							
Our Reference			225859-11	225859-12	225859-13	225859-14	225859-15
Your Reference	UNITS	PQL	NMS46	NMS47	NMS48	NMS49	NMS50
Date Sampled			04/03/2019	10/03/2019	16/03/2019	22/03/2019	31/03/2019
Filter No			NMS46	NMS47	NMS48	NMS49	NMS50
Weight of Filter (initial)	mg	0.02	3,597.00	3,602.10	3,601.20	3,597.80	3,595.50
Weight of Filter (final)	mg	0.02	3,772.60	3,972.00	3,686.30	3,785.40	3,720.00
Dust	mg/filter	0.1	180	370	85	190	120
Aluminium	µg/filter	5	2,700	3,800	3,600	3,800	3,700
Arsenic	µg/filter	0.4	1.1	2.9	1.4	2.0	1.6
Boron	µg/filter	20	3,900	3,400	5,800	4,300	5,900
Barium	µg/filter	2	290	250	440	320	440
Calcium	µg/filter	50	11,000	10,000	17,000	12,000	16,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	<2	2	<2	<2	<2
Chromium	µg/filter	2	8	13	11	13	11
Iron	µg/filter	5	13,000	41,000	12,000	15,000	15,000
Lithium	µg/filter	2	<2	<2	<2	<2	<2
Potassium	µg/filter	50	1,700	1,500	2,500	1,800	2,300
Manganese	µg/filter	2	77	160	39	65	66
Molybdenum	µg/filter	5	<5	<5	<5	<5	<5
Nickel	µg/filter	2	<2	5	<2	3	3
Lead	µg/filter	5	<5	<5	<5	<5	<5
Sulfur	µg/filter	50	1,100	1,200	1,200	1,200	1,400
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	4	7	4	8	4
Zinc	µg/filter	5	200	190	300	220	300

Metals in High Volume Filters						
Our Reference			225859-16	225859-17	225859-18	225859-19
Your Reference	UNITS	PQL	NMS51	NMS52	NMS53	NMS54
Date Sampled			28/03/2019	03/04/2019	09/04/2019	15/04/2019
Filter No			NMS51	NMS52	NMS53	NMS54
Weight of Filter (initial)	mg	0.02	3,498.50	3,490.10	3,488.30	3,496.00
Weight of Filter (final)	mg	0.02	3,501.70	3,772.10	3,689.60	3,726.60
Dust	mg/filter	0.1	3.2	280	200	230
Aluminium	µg/filter	5	1,600	2,600	2,900	1,900
Arsenic	µg/filter	0.4	0.81	3.0	2.2	1.3
Boron	µg/filter	20	3,700	2,900	3,200	2,100
Barium	µg/filter	2	39	45	43	27
Calcium	µg/filter	50	10,000	8,900	11,000	7,100
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	<2	<2	<2	<2
Chromium	µg/filter	2	6	10	12	7
Iron	µg/filter	5	310	31,000	17,000	7,000
Lithium	µg/filter	2	<2	<2	<2	<2
Potassium	µg/filter	50	1,300	1,100	1,400	910
Manganese	µg/filter	2	3	99	69	41
Molybdenum	µg/filter	5	<5	<5	<5	<5
Nickel	µg/filter	2	<2	<2	3	<2
Lead	µg/filter	5	<5	<5	<5	<5
Sulfur	µg/filter	50	1,100	1,200	1,800	1,100
Selenium	µg/filter	5	<5	<5	<5	<5
Vanadium	µg/filter	2	<2	7	7	4
Zinc	µg/filter	5	24	39	46	23

Method ID	Methodology Summary
DUST-004	Determination of total suspended particulates (TSP) and size selective PM10 – High volume sampler gravimetric methods AS3580.9.3 and AS3580.9.6.
DUST-004	Airborne samples analysed according to AS 2985 for Respirable Dust or AS 3640 for Inhalable Dust. Sample results based on volume data supplied by client. Samples tested as received, *accreditation does not cover sampling.
METALS-006	Determination of various metals on filters by ICP-AES and Hg by CV-AAS using NIOSH 7300, 7301 & 7303 and in-house METALS-006/025. Some PQLs reported may be higher than the laboratory PQL stated due to different or lower air volumes sampled by client.

QUALITY CONTROL: Metals in High Volume Filters					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Aluminium	µg/filter	5	METALS-006	<5	1	2200	2000	10	113	[NT]
Arsenic	µg/filter	0.4	METALS-006	<0.4	1	<0.4	<0.4	0	111	[NT]
Boron	µg/filter	20	METALS-006	<20	1	4300	3800	12	110	[NT]
Barium	µg/filter	2	METALS-006	<2	1	330	300	10	117	[NT]
Calcium	µg/filter	50	METALS-006	<50	1	12000	11000	9	107	[NT]
Cadmium	µg/filter	0.5	METALS-006	<0.5	1	<0.5	<0.5	0	106	[NT]
Cobalt	µg/filter	2	METALS-006	<2	1	<2	<2	0	110	[NT]
Chromium	µg/filter	2	METALS-006	<2	1	6	6	0	108	[NT]
Iron	µg/filter	5	METALS-006	<5	1	1400	1800	25	111	[NT]
Lithium	µg/filter	2	METALS-006	<2	1	<2	<2	0	111	[NT]
Potassium	µg/filter	50	METALS-006	<50	1	1700	1500	12	106	[NT]
Manganese	µg/filter	2	METALS-006	<2	1	10	12	18	112	[NT]
Molybdenum	µg/filter	5	METALS-006	<5	1	<5	<5	0	116	[NT]
Nickel	µg/filter	2	METALS-006	<2	1	<2	<2	0	107	[NT]
Lead	µg/filter	5	METALS-006	<5	1	<5	<5	0	107	[NT]
Sulfur	µg/filter	50	METALS-006	<50	1	620	630	2	109	[NT]
Selenium	µg/filter	5	METALS-006	<5	1	<5	<5	0	118	[NT]
Vanadium	µg/filter	2	METALS-006	<2	1	<2	<2	0	112	[NT]
Zinc	µg/filter	5	METALS-006	<5	1	210	210	0	106	[NT]

Result Definitions

DOL	Samples rejected due to particulate overload
RPF	Sample rejected due to pump failure
RFD	Sample rejected due to filter damage
RUD	Sample rejected due to uneven deposition
PQL	Practical quantitation limit

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from 'Australian Drinking Water Guidelines', published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from '2018 TLVs and BEIs', as published by ACGIH (where available).

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL – RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL – RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates).

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab is not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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CERTIFICATE OF ANALYSIS 229757

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	15 HV Filters
Date samples received	16/07/2019
Date completed instructions received	16/07/2019
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	23/07/2019
Date of Issue	23/07/2019

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Results Approved By
Tom Edwards, Occupational Hygiene and Microbiology Supervisor

Authorised By

Michael Kubiak, Laboratory Manager

Metals in High Volume Filters							
Our Reference			229757-1	229757-2	229757-3	229757-4	229757-5
Your Reference	UNITS	PQL	NMS55	NMS56	NMS57	NMS58	NMS59
Date Sampled			21/04/2019	27/04/2019	03/05/2019	09/05/2019	15/05/2019
Filter No			NMS55	NMS56	NMS57	NMS58	NMS59
Weight of Filter (initial)	mg	0.02	3,500.30	3,504.70	3,492.40	3,485.10	3,479.80
Weight of Filter (final)	mg	0.02	3,557.10	3,565.40	3,647.60	3,640.10	3,618.60
Dust	mg/filter	0.1	57	61	160	160	140
Aluminium	µg/filter	5	4,600	4,200	4,700	4,600	4,400
Arsenic	µg/filter	0.4	1.8	3.6	4.2	2.1	2.9
Boron	µg/filter	20	8,100	7,500	6,800	5,800	5,900
Barium	µg/filter	2	92	84	88	72	83
Calcium	µg/filter	50	26,000	23,000	22,000	19,000	20,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	<2	<2	<2	<2	<2
Chromium	µg/filter	2	15	13	18	18	17
Iron	µg/filter	5	8,500	11,000	35,000	14,000	28,000
Lithium	µg/filter	2	4	3	3	4	3
Potassium	µg/filter	50	3,400	3,100	3,000	2,800	2,700
Manganese	µg/filter	2	39	46	94	83	89
Molybdenum	µg/filter	5	<5	<5	<5	<5	<5
Nickel	µg/filter	2	2	2	4	5	4
Lead	µg/filter	5	<5	<5	<5	<5	<5
Sulfur	µg/filter	50	3,000	2,600	2,800	2,700	2,700
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	5	5	9	10	8
Zinc	µg/filter	5	67	61	87	65	92

Metals in High Volume Filters							
Our Reference			229757-6	229757-7	229757-8	229757-9	229757-10
Your Reference	UNITS	PQL	NMS60	NMS61	NMS62	NMS63 Blank	NMS64
Date Sampled			21/05/2019	27/05/2019	02/06/2019	07/06/2019	08/06/2019
Filter No			NMS60	NMS61	NMS62	NMS63	NMS64
Weight of Filter (initial)	mg	0.02	3,479.60	3,487.90	3,487.30	3,484.40	3,470.50
Weight of Filter (final)	mg	0.02	3,793.90	3,636.70	3,565.60	3,488.60	3,601.80
Dust	mg/filter	0.1	310	150	78	4.2	130
Aluminium	µg/filter	5	8,300	5,500	4,100	3,400	4,200
Arsenic	µg/filter	0.4	6.1	4.0	2.7	2.1	3.4
Boron	µg/filter	20	7,200	7,300	6,300	7,100	5,700
Barium	µg/filter	2	110	94	77	79	77
Calcium	µg/filter	50	24,000	24,000	20,000	22,000	18,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	6	<2	<2	<2	<2
Chromium	µg/filter	2	32	22	14	10	14
Iron	µg/filter	5	95,000	32,000	16,000	390	25,000
Lithium	µg/filter	2	6	4	3	3	3
Potassium	µg/filter	50	3,400	3,300	2,700	2,900	2,700
Manganese	µg/filter	2	310	120	65	6	110
Molybdenum	µg/filter	5	<5	<5	<5	<5	<5
Nickel	µg/filter	2	12	6	3	<2	3
Lead	µg/filter	5	9	<5	<5	<5	<5
Sulfur	µg/filter	50	3,700	3,300	2,700	2,600	2,500
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	19	12	6	<2	9
Zinc	µg/filter	5	130	79	56	54	58

Metals in High Volume Filters							
Our Reference			229757-11	229757-12	229757-13	229757-14	229757-15
Your Reference	UNITS	PQL	NMS65	NMS66	NMS67	NMS68	NMS69
Date Sampled			14/06/2019	20/06/2019	26/06/2019	02/07/2019	08/07/2019
Filter No			NMS65	NMS66	NMS67	NMS68	NMS69
Weight of Filter (initial)	mg	0.02	3,476.40	3,493.00	3,479.40	3,488.20	3,489.40
Weight of Filter (final)	mg	0.02	3,515.20	3,677.60	3,565.40	3,666.00	3,669.10
Dust	mg/filter	0.1	39	180	86	180	180
Aluminium	µg/filter	5	3,900	5,700	4,200	4,700	5,300
Arsenic	µg/filter	0.4	1.7	6.1	3.3	7.3	4.3
Boron	µg/filter	20	6,900	6,600	6,200	5,700	5,800
Barium	µg/filter	2	83	88	90	81	87
Calcium	µg/filter	50	22,000	21,000	20,000	19,000	19,000
Cadmium	µg/filter	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	µg/filter	2	<2	2	<2	<2	2
Chromium	µg/filter	2	14	22	17	21	24
Iron	µg/filter	5	4,200	56,000	21,000	47,000	40,000
Lithium	µg/filter	2	3	4	3	3	4
Potassium	µg/filter	50	3,000	3,000	2,700	2,500	2,600
Manganese	µg/filter	2	25	200	130	140	250
Molybdenum	µg/filter	5	<5	<5	<5	29	<5
Nickel	µg/filter	2	4	5	5	8	6
Lead	µg/filter	5	<5	7	<5	<5	5
Sulfur	µg/filter	50	2,900	3,200	3,000	2,700	3,000
Selenium	µg/filter	5	<5	<5	<5	<5	<5
Vanadium	µg/filter	2	4	12	7	10	11
Zinc	µg/filter	5	74	96	120	100	150

Method ID	Methodology Summary
DUST-004	Determination of total suspended particulates (TSP) and size selective PM10 – High volume sampler gravimetric methods AS3580.9.3 and AS3580.9.6.
DUST-004	Airborne samples analysed according to AS 2985 for Respirable Dust or AS 3640 for Inhalable Dust. Sample results based on volume data supplied by client. Samples tested as received, *accreditation does not cover sampling.
METALS-006	Determination of various metals on filters by ICP-AES and Hg by CV-AAS using NIOSH 7300, 7301 & 7303 and in-house METALS-006/025. Some PQLs reported may be higher than the laboratory PQL stated due to different or lower air volumes sampled by client.

QUALITY CONTROL: Metals in High Volume Filters						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Aluminium	µg/filter	5	METALS-006	<5	1	4600	[NT]		104	[NT]
Arsenic	µg/filter	0.4	METALS-006	<0.4	1	1.8	1.8	0	[NT]	[NT]
Boron	µg/filter	20	METALS-006	<20	1	8100	[NT]		106	[NT]
Barium	µg/filter	2	METALS-006	<2	1	92	[NT]		107	[NT]
Calcium	µg/filter	50	METALS-006	<50	1	26000	[NT]		100	[NT]
Cadmium	µg/filter	0.5	METALS-006	<0.5	1	<0.5	[NT]		98	[NT]
Cobalt	µg/filter	2	METALS-006	<2	1	<2	[NT]		98	[NT]
Chromium	µg/filter	2	METALS-006	<2	1	15	[NT]		104	[NT]
Iron	µg/filter	5	METALS-006	<5	1	8500	[NT]		102	[NT]
Lithium	µg/filter	2	METALS-006	<2	1	4	[NT]		107	[NT]
Potassium	µg/filter	50	METALS-006	<50	1	3400	[NT]		101	[NT]
Manganese	µg/filter	2	METALS-006	<2	1	39	[NT]		105	[NT]
Molybdenum	µg/filter	5	METALS-006	<5	1	<5	[NT]		114	[NT]
Nickel	µg/filter	2	METALS-006	<2	1	2	[NT]		104	[NT]
Lead	µg/filter	5	METALS-006	<5	1	<5	[NT]		103	[NT]
Sulfur	µg/filter	50	METALS-006	<50	1	3000	[NT]		103	[NT]
Selenium	µg/filter	5	METALS-006	<5	1	<5	<5	0	[NT]	[NT]
Vanadium	µg/filter	2	METALS-006	<2	1	5	[NT]		102	[NT]
Zinc	µg/filter	5	METALS-006	<5	1	67	[NT]		105	[NT]

Result Definitions

DOL	Samples rejected due to particulate overload
RPF	Sample rejected due to pump failure
RFD	Sample rejected due to filter damage
RUD	Sample rejected due to uneven deposition
PQL	Practical quantitation limit

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from 'Australian Drinking Water Guidelines', published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from '2018 TLVs and BEIs', as published by ACGIH (where available).

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL – RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL – RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates).

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab is not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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CERTIFICATE OF ANALYSIS 214722

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	8 cowls
Date samples received	17/08/2018
Date completed instructions received	17/08/2018
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	20/08/2018
Date of Issue	20/08/2018

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Asbestos Approved By
Analysed by Approved Counter: Lalanee Rupasinghe
Results Approved By
Lalanee Rupasinghe, OH Lab Analyst

Authorised By

Todd Lee, Laboratory Manager

Airborne Fibre Counts						
Our Reference		214722-1	214722-2	214722-3	214722-4	214722-5
Your Reference	UNITS	NMS01	NMS02	NMS03	NMS04	NMS05
Date Sampled		07/07/2018	13/07/2018	19/07/2018	25/07/2018	31/07/2018
Fibres	-	0	0	0	0	0
Fields	-	100	100	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts				
Our Reference		214722-6	214722-7	214722-8
Your Reference	UNITS	NMS06	NMS07	NMS08
Date Sampled		31/07/2018	06/08/2018	12/08/2018
Fibres	-	0	0	0
Fields	-	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854

Method ID	Methodology Summary
ASB-002	Estimation of Airborne Asbestos Fibres by the Membrane Filter Method. Filters examined in accordance with NOHSC:3003 (April 2005) Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres and Envirolab Group in-house method ASB-2. The microscope constant for Carl Zeiss Axio Lab.A1 (Sydney Laboratory) calculated using 25mm filter is 48593. The microscope constant for Olympus BX41 (Perth Laboratory) calculated using 25mm filter is 46981. The microscope constant for Leica DM1000 (Perth Laboratory) calculated using 25mm filter is 46981. These constants are to be used to calculate fibres/mL concentration for asbestos fibre air monitoring filters. If less than 10 fibres/100 graticule areas is observed, the figure of 10 fibres/100 graticule areas is the minimum that can be used to calculate airborne fibre concentration as per NOHSC 3003(2005).

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CERTIFICATE OF ANALYSIS 218082

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	13 Cowls
Date samples received	31/10/2018
Date completed instructions received	31/10/2018
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	01/11/2018
Date of Issue	01/11/2018

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Asbestos Approved By
Analysed by Approved Counter: Lalanee Rupasinghe
Results Approved By
Lalanee Rupasinghe, OH Lab Analyst

Authorised By

Todd Lee, Laboratory Manager

Airborne Fibre Counts						
Our Reference		218082-1	218082-2	218082-3	218082-4	218082-5
Your Reference	UNITS	NMS09	NMS10	NMS11	NMS12	NMS13
Date Sampled		18/08/2018	24/08/2018	30/08/2018	05/09/2018	11/09/2018
Type of sample		Cowl	Cowl	Cowl	Cowl	Cowl
Fibres	-	0	0	0	1.0	0
Fields	-	100	100	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts						
Our Reference		218082-6	218082-7	218082-8	218082-9	218082-10
Your Reference	UNITS	NMS14	NMS15	NMS16	NMS17	NMS18
Date Sampled		17/09/2018	23/09/2018	29/09/2018	29/09/2018	05/10/2018
Type of sample		Cowl	Cowl	Cowl	Cowl	Cowl
Fibres	-	0	0	0	0	2.0
Fields	-	100	100	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts				
Our Reference		218082-11	218082-12	218082-13
Your Reference	UNITS	NMS19	NMS20	NMS21
Date Sampled		11/10/2018	17/10/2018	23/10/2018
Type of sample		Cowl	Cowl	Cowl
Fibres	-	0	1.0	0
Fields	-	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854

Method ID	Methodology Summary
ASB-002	Estimation of Airborne Asbestos Fibres by the Membrane Filter Method. Filters examined in accordance with NOHSC:3003 (April 2005) Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres and Envirolab Group in-house method ASB-2. The microscope constant for Carl Zeiss Axio Lab.A1 (Sydney Laboratory) calculated using 25mm filter is 48593. The microscope constant for Olympus BX41 (Perth Laboratory) calculated using 25mm filter is 46981. The microscope constant for Leica DM1000 (Perth Laboratory) calculated using 25mm filter is 46981. These constants are to be used to calculate fibres/mL concentration for asbestos fibre air monitoring filters. If less than 10 fibres/100 graticule areas is observed, the figure of 10 fibres/100 graticule areas is the minimum that can be used to calculate airborne fibre concentration as per NOHSC 3003(2005).

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CERTIFICATE OF ANALYSIS 221044

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	13 Cowls
Date samples received	14/01/2019
Date completed instructions received	14/01/2019
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	15/01/2019
Date of Issue	15/01/2019

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Asbestos Approved By
Analysed by Approved Counter: Lalanee Rupasinghe
Results Approved By
Lalanee Rupasinghe, OH Lab Analyst

Authorised By

Todd Lee, Laboratory Manager

Airborne Fibre Counts						
Our Reference		221044-1	221044-2	221044-3	221044-4	221044-5
Your Reference	UNITS	NMS22	NMS23	NMS24	NMS26	NMS27
Date Sampled		29/10/2018	04/11/2018	10/11/2018	22/11/2018	28/11/2018
Type of sample		Cowl	Cowl	Cowl	Cowl	Cowl
Fibres	-	0	0	0	0	0
Fields	-	100	100	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts						
Our Reference		221044-6	221044-7	221044-8	221044-9	221044-10
Your Reference	UNITS	NMS28	NMS29	NMS30	NMS31	NMS32
Date Sampled		28/11/2018	04/12/2018	10/12/2018	16/12/2018	22/12/2018
Type of sample		Cowl	Cowl	Cowl	Cowl	Cowl
Fibres	-	0	0	0	0	0
Fields	-	100	100	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts				
Our Reference		221044-11	221044-12	221044-13
Your Reference	UNITS	NMS33	NMS34	NMS35
Date Sampled		28/12/2018	03/01/2019	09/01/2019
Type of sample		Cowl	Cowl	Cowl
Fibres	-	0	0	1.0
Fields	-	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854

Method ID	Methodology Summary
ASB-002	Estimation of Airborne Asbestos Fibres by the Membrane Filter Method. Filters examined in accordance with NOHSC:3003 (April 2005) Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres and Envirolab Group in-house method ASB-2. The microscope constant for Carl Zeiss Axio Lab.A1 (Sydney Laboratory) calculated using 25mm filter is 48593. The microscope constant for Olympus BX41 (Perth Laboratory) calculated using 25mm filter is 46981. The microscope constant for Leica DM1000 (Perth Laboratory) calculated using 25mm filter is 46981. These constants are to be used to calculate fibres/mL concentration for asbestos fibre air monitoring filters. If less than 10 fibres/100 graticule areas is observed, the figure of 10 fibres/100 graticule areas is the minimum that can be used to calculate airborne fibre concentration as per NOHSC 3003(2005).

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CERTIFICATE OF ANALYSIS 225860

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	19 Cowls
Date samples received	30/04/2019
Date completed instructions received	30/04/2019
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	02/05/2019
Date of Issue	02/05/2019

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Asbestos Approved By
Analysed by Approved Counter: Leona Naing
Results Approved By
Tom Edwards, Occupational Hygiene and Microbiology Supervisor

Authorised By

Michael Kubiak, Laboratory Manager

Airborne Fibre Counts							
Our Reference			225860-1	225860-2	225860-3	225860-4	225860-5
Your Reference	UNITS	PQL	NMS25	NMS36	NMS37	NMS38	NMS39
Date Sampled			16/11/2018	15/01/2019	21/01/2019	27/01/2019	27/01/2019
Fibres	-		2.0	1.0	1.0	2.0	RFD
Fields	-		100	100	100	100	RFD
Effective Filter Area	mm^2		368.9845	368.9845	368.9845	368.9845	[NA]
Graticule Area	mm^2		0.007854	0.007854	0.007854	0.007854	[NA]

Airborne Fibre Counts							
Our Reference			225860-6	225860-7	225860-8	225860-9	225860-10
Your Reference	UNITS	PQL	NMS40	NMS41	NMS42	NMS43	NMS44
Date Sampled			02/02/2019	08/02/2019	14/02/2019	20/02/2019	28/02/2019
Fibres	-		2.0	5.0	4.0	0	0
Fields	-		100	100	100	100	100
Effective Filter Area	mm^2		368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2		0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts							
Our Reference			225860-11	225860-12	225860-13	225860-14	225860-15
Your Reference	UNITS	PQL	NMS45	NMS46	NMS47	NMS48	NMS49
Date Sampled			04/03/2019	10/03/2019	16/03/2019	22/03/2019	28/03/2019
Fibres	-		1.0	1.0	3.0	3.0	0
Fields	-		100	100	100	100	100
Effective Filter Area	mm^2		368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2		0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts						
Our Reference			225860-16	225860-17	225860-18	225860-19
Your Reference	UNITS	PQL	NMS50	NMS51	NMS52	NMS53
Date Sampled			28/03/2019	03/04/2019	09/04/2019	15/04/2019
Fibres	-		1.0	4.0	1.0	0
Fields	-		100	100	100	100
Effective Filter Area	mm^2		368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2		0.007854	0.007854	0.007854	0.007854

Method ID	Methodology Summary
ASB-002	Estimation of Airborne Asbestos Fibres by the Membrane Filter Method. Filters examined in accordance with NOHSC:3003 (April 2005) Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres and Envirolab Group in-house method ASB-2. The microscope constant for Carl Zeiss Axio Lab.A1 (Sydney Laboratory) calculated using 25mm filter is 48593. The microscope constant for Olympus BX41 (Perth Laboratory) calculated using 25mm filter is 46981. The microscope constant for Leica DM1000 (Perth Laboratory) calculated using 25mm filter is 46981. These constants are to be used to calculate fibres/mL concentration for asbestos fibre air monitoring filters. If less than 10 fibres/100 graticule areas is observed, the figure of 10 fibres/100 graticule areas is the minimum that can be used to calculate airborne fibre concentration as per NOHSC 3003(2005).

Result Definitions

DOL	Samples rejected due to particulate overload
RPF	Sample rejected due to pump failure
RFD	Sample rejected due to filter damage
RUD	Sample rejected due to uneven deposition
PQL	Practical quantitation limit

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from 'Australian Drinking Water Guidelines', published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from '2018 TLVs and BEIs', as published by ACGIH (where available).

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL – RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL – RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates).

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab is not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

RFD: Sample no: 5 rejected due to filter damage.

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CERTIFICATE OF ANALYSIS 229756

Client Details

Client	Department of Water & Environmental Regulation
Attention	[redacted]
Address	(DWER), Locked Bag 33 Cloisters Square, PERTH, WA, 6850

Sample Details

Your Reference	**Newman Study**
Number of Samples	15 Cowls
Date samples received	16/07/2019
Date completed instructions received	16/07/2019
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Report Details

Date results requested by	17/07/2019
Date of Issue	17/07/2019

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Asbestos Approved By
Analysed by Approved Counter: Lalanee Rupasinghe
Results Approved By
Lalanee Rupasinghe, OH Lab Analyst

Authorised By

Michael Kubiak, Laboratory Manager

Airborne Fibre Counts						
Our Reference		229756-1	229756-2	229756-3	229756-4	229756-5
Your Reference	UNITS	NMS54	NMS55	NMS56	NMS57	NMS58
Date Sampled		21/04/2019	27/04/2019	03/05/2019	09/05/2019	15/05/2019
Type of sample		Cowl	Cowl	Cowl	Cowl	Cowl
Fibres	-	1.0	0	1.0	0	0
Fields	-	100	100	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts						
Our Reference		229756-6	229756-7	229756-8	229756-9	229756-10
Your Reference	UNITS	NMS59	NMS60 Blank	NMS61	NMS62	NMS63
Date Sampled		21/05/2019	27/05/2019	27/05/2019	02/06/2019	08/06/2019
Type of sample		Cowl	Cowl	Cowl	Cowl	Cowl
Fibres	-	0	0	0	0	0
Fields	-	100	100	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854	0.007854	0.007854

Airborne Fibre Counts						
Our Reference		229756-11	229756-12	229756-13	229756-14	229756-15
Your Reference	UNITS	NMS64	NMS65	NMS66	NMS67	NMS68
Date Sampled		14/06/2019	20/06/2019	26/06/2019	02/07/2019	08/07/2019
Type of sample		Cowl	Cowl	Cowl	Cowl	Cowl
Fibres	-	0	0	0	0	0
Fields	-	100	100	100	100	100
Effective Filter Area	mm^2	368.9845	368.9845	368.9845	368.9845	368.9845
Graticule Area	mm^2	0.007854	0.007854	0.007854	0.007854	0.007854

Method ID	Methodology Summary
ASB-002	Estimation of Airborne Asbestos Fibres by the Membrane Filter Method. Filters examined in accordance with NOHSC:3003 (April 2005) Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres and Envirolab Group in-house method ASB-2. The microscope constant for Carl Zeiss Axio Lab.A1 (Sydney Laboratory) calculated using 25mm filter is 48593. The microscope constant for Olympus BX41 (Perth Laboratory) calculated using 25mm filter is 46981. The microscope constant for Leica DM1000 (Perth Laboratory) calculated using 25mm filter is 46981. These constants are to be used to calculate fibres/mL concentration for asbestos fibre air monitoring filters. If less than 10 fibres/100 graticule areas is observed, the figure of 10 fibres/100 graticule areas is the minimum that can be used to calculate airborne fibre concentration as per NOHSC 3003(2005).