Air Quality Monitoring

Mossmorran – Summary Report

January – April 2019

2 October 2019

Every day SEPA works to protect and enhance Scotland's environment, helping communities and businesses thrive within the resources of our planet.

We call this **One Planet Prosperity**

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Introduction

SEPA conducted a three month programme of enhanced air quality monitoring around the Mossmorran complex between January and April 2019 to inform relevant public agencies and the community. The aim was to provide up-to-date data and provide public reassurance.

This data helps provide an up-to-date baseline to compare to periods when there is flaring at Mossmorran.

During the monitoring period there was one unplanned elevated flaring event (reported by ExxonMobil Chemical Limited) on 27 January 2019. This resulted in a higher than normal ground flaring rate for a period of 45 minutes and a concurrent period of elevated flaring which lasted for approximately 29 minutes.

For the rest of the time the Mossmorran Complex was in normal operations.

Our data will add to the body of evidence that exists from previous reports and data reviews carried out by a number of organisations, including independent consultants

A monitoring trailer and diffusion tubes were located in four community locations for three months. Locations were discussed and agreed with community representatives, the Mossmorran and Braefoot Bay Independent Air Quality Review Group and the Mossmorran and Braefoot Bay Safety Liaison Committee.

Our full technical report provides more detail about the monitoring SEPA carried out. It will be shared with the Independent Air Quality Review Group (including community representatives), Fife Council, NHS Fife and Health Protection Scotland (HPS). As it is also required by a technical audience, additional information on equipment, methodologies, results and quality control is contained within the appendices.

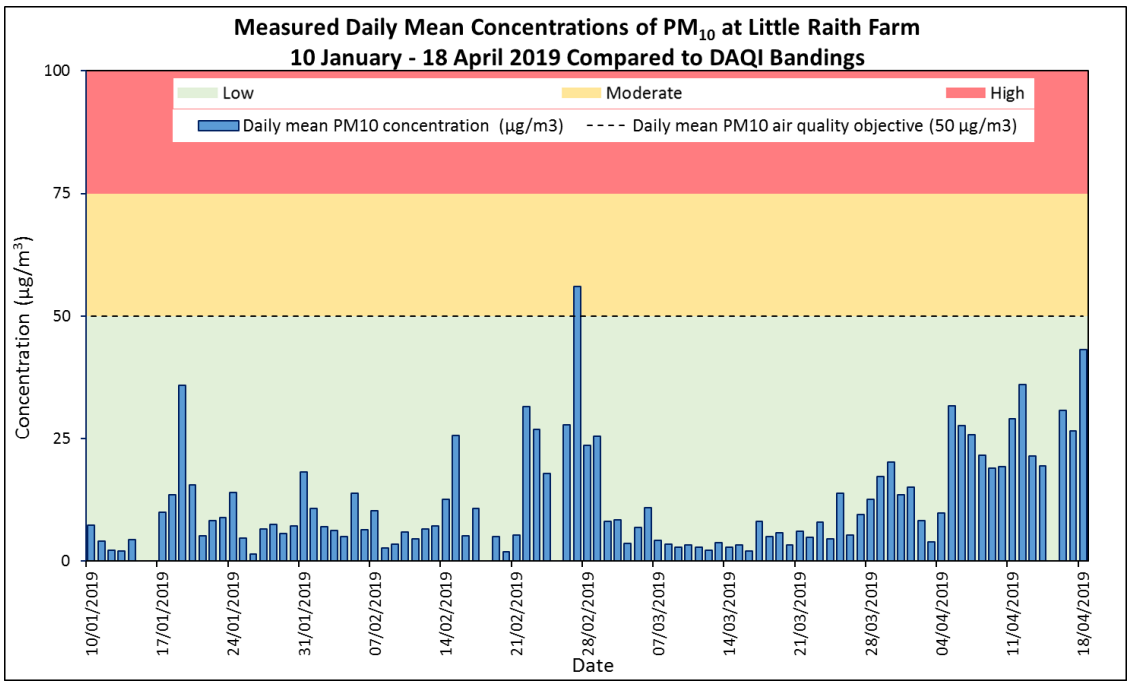
Information about non-site sources of air pollution are included in this report to provide context.

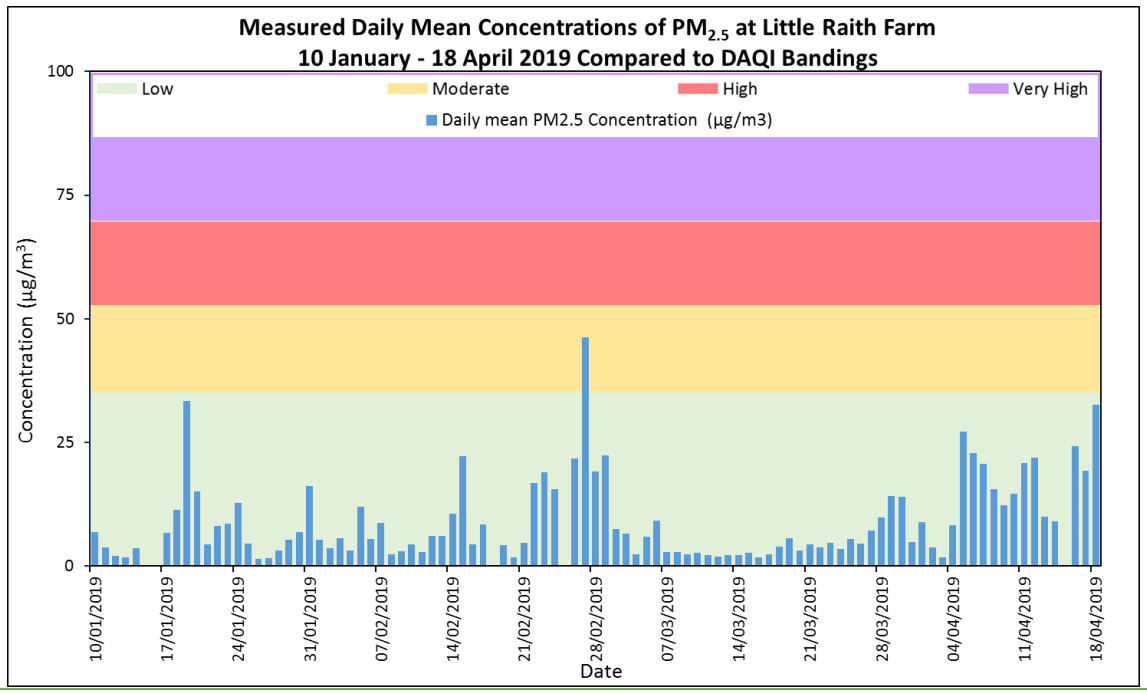
Summary of results

Further detail on all our monitoring can be found in our full Technical Report.

The only time air quality objective concentrations were exceeded was on 27 February when both PM_{10} and $PM_{2.5}$ exceeded their 24 hour mean (average) air quality objective concentration. This is attributed to a pollution event arriving in the UK from the continent, which affected large parts of the UK. More detail is available on page 11 and 12.

These graphs show the particulate matter results compared with daily air quality index bands. Both are shown on the same scale for comparison. More detail is given in the full results section of this report on page 12.





The tables below show the results for pollutants measured using the monitoring trailer. These are compared to the air quality objectives when relevant.

Pollutant	Particulate Matter PM_{10}	Particulate Matter $PM_{2.5}$	Carbon Monoxide CO	Nitrogen Dioxide NO_2	Sulphur Dioxide SO_2
Units	(µg m^{-3})	(µg m^{-3})	(mg m^{-3})	(µg m^{-3})	(µg m^{-3})
Averaging Period	24 hours	Annual mean	8 hours (running)	1 hour	15 min
Average	12.2	9.2	0.0	9.5	1.0
Maximum	56.0	46.2	0.2	59.1	36.7
Air Quality Objective Concentration	50.0	10.0	10.0	200.0	266.0

Less than (<) means the measurement was lower than our equipment could measure.

Pollutant measured by diffusion tube	**Air Quality Objectives Annual mean**	**Donibristle**	**Cowdenbeath**	**Lochgelly**	**Little Raith Farm**
		Average Measured Concentration (µg m^{-3})			
Benzene	3.25	0.5	0.8	0.6	0.7
1,3-Butadiene	2.25	<0.2	0.2	<0.2	<0.2
Nitrogen Dioxide	40	13.9	23.0	14.1	17.4

Pollutant measured by diffusion tube	**Donibristle**	**Cowdenbeath**	**Lochgelly**	**Little Raith Farm**
	Average Measured Concentration (µg m^{-3})			
Toluene	<1.2	1.2	<1.2	<1.2
Ethylbenzene	<1.3	<1.3	<1.3	<1.3
Xylene	1.4	1.4	1.6	1.4
	Average Measured Concentration (parts per billion - ppb)			
Total Hydrocarbons	7.1	7.0	7.6	6.7

What is particulate matter?

Particulate matter is made up of a number of components, including chemical substances, and soil and dust particles and comes from both human-made and natural sources. It consists of substances, which are released directly from the source into the atmosphere, and secondary components, which are formed in the atmosphere by chemical reactions.

Particulate matter is not made up of one type of substance, it is a classification of particles by size. It is measured in micrometres (µm). A human hair is approximately 100µm wide.

Larger particles are generally filtered in the nose and throat, but particulate matter smaller than about 10 micrometres (μm) can be inhaled, which is why these are the ones measured for air quality monitoring.

- PM_{10} means the particles are 10μm or smaller. The measurement of this figure includes $PM_{2.5}$.
- $PM_{2.5}$ means the particles are 2.5μm or smaller.

Particulate levels can vary for a variety of reasons, such as rush hour traffic, building work, elevated pollen levels and emissions from industrial processes.

How we have presented our results

Equipment focussed on the measurement of combustion-related air pollutants and a range of volatile organic compounds (VOCs) – such as benzene.

Several of these compounds have associated health-related air quality standards and objectives against which the monitoring results have been compared.

Similarly, the results, where appropriate, have been compared against the UK's Department for Environment, Food and Rural Affairs (Defra) Daily Air Quality Index (DAQI).

Summary of relevant daily air quality indices (adapted from *https://uk-air.defra.gov.uk/air-pollution/daqi*)

Band:	Low	Low	Low	Moderate	Moderate	Moderate	High	High	High	Very High	Units
Pollutant Index:	1	2	3	4	5	6	7	8	9	10	
$PM_{2.5}$ (24 hour mean)	0 - 11	12 - 23	24 - 35	36 - 41	42 - 47	48 – 53	54 – 58	59 – 64	65 – 70	≥ 71	μg m^{-3}
PM_{10} (24 hour mean)	0 - 16	17 - 33	34 - 50	51 - 58	59 - 66	67 – 75	76 – 83	84 – 91	92 – 100	≥ 101	μg m^{-3}
NO_2 (1 hour mean)	0 - 67	68 - 134	135 - 200	201 - 267	268 - 334	335 – 400	401 – 467	468 – 534	535 – 600	≥ 601	μg m^{-3}
SO_2 (15 min mean)	0 - 88	89 - 177	178 - 266	267 - 354	355 - 443	444 - 532	533 - 710	711 - 887	888 - 1064	≥ 1065	μg m^{-3}

Monitoring Method

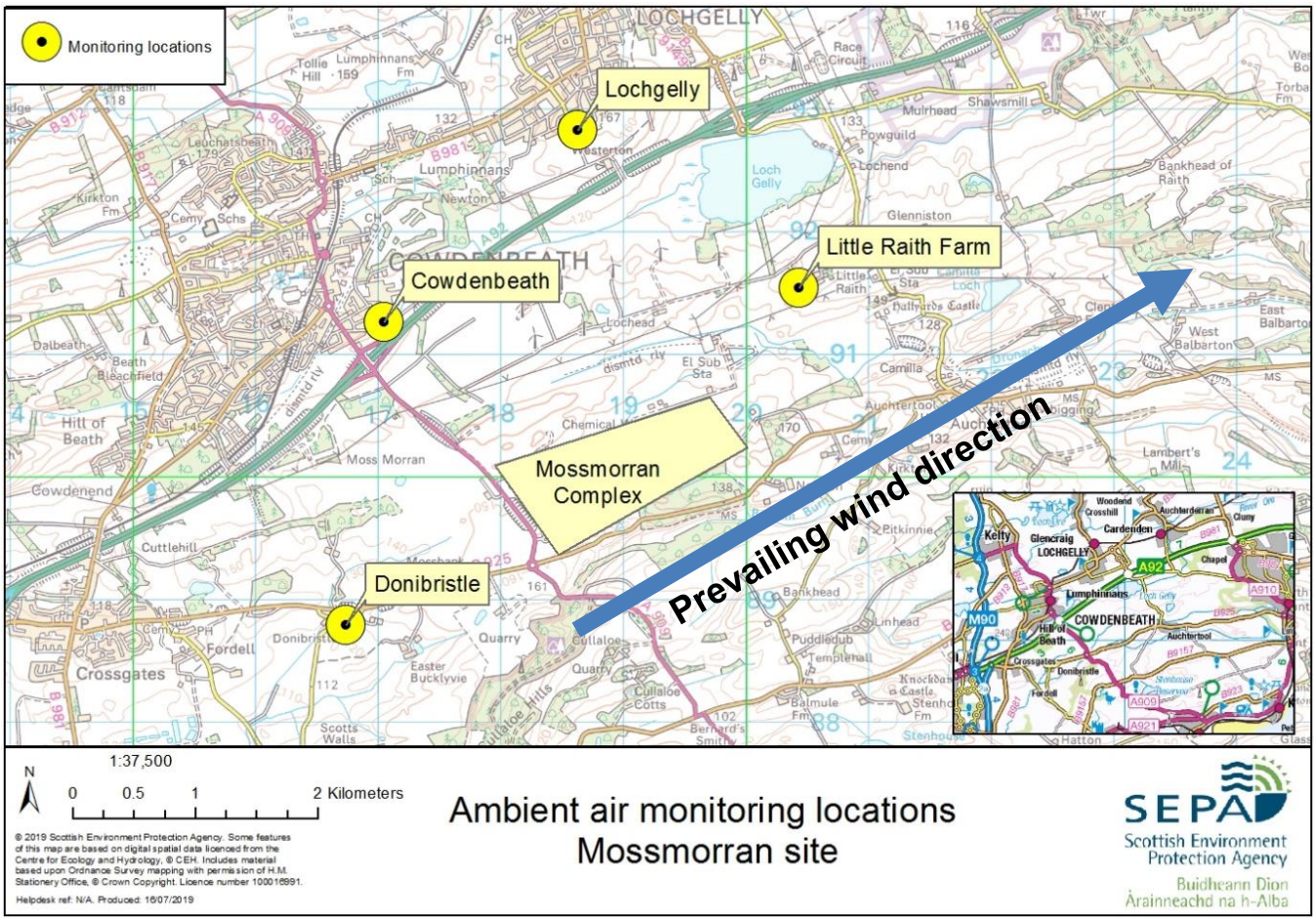
SEPA measured concentrations of pollutants in the ambient air using the SEPA long term air monitoring trailer and diffusion tubes over the period 10 January 2019 to 18 April 2019. Prior to commencing monitoring, the details of the environmental monitoring proposal were discussed with NHS Fife and Health Protection Scotland.

Details of the measurement equipment and methodologies and a photographic record of each monitoring location are available in the Appendices of our Technical Report.

Monitoring location summary

Monitor location	**Position in relation to Mossmorran Complex**	**Non-site related sources of air pollutants**
Little Raith Farm	North East	Farming activities and traffic
Watters Crescent, Lochgelly	North	Domestic and commercial combustion and traffic
Watson Street, Cowdenbeath	North West	Domestic and commercial combustion and traffic
Donibristle	South West	Domestic combustion, farming activities and traffic

Map of the air quality monitoring locations near Mossmorran, showing the most common (prevailing) wind direction.



At Little Raith Farm and in Lochgelly, Donibristle and Cowdenbeath there were:

- Diffusion tubes for nitrogen dioxide;
- Diffusion tubes for a range of volatile organic compounds, namely benzene, toluene, ethyl benzene, xylene, total hydrocarbons (C_4 to C_{10}) and 1,3-butadiene

At Little Raith Farm there was also a trailer and weather station monitoring continuously for:

- Carbon monoxide (CO);
- Nitrogen dioxide (NO_2);
- Sulphur dioxide (SO_2);
- Particulate Matter PM_{10};
- Particulate Matter $PM_{2.5}$;
- Wind speed;
- Wind direction

The monitoring investigation was carried out for a continuous period of three months. To ensure the wind patterns during the deployment were representative, a comparison was done with measured wind speeds and directions at a nearby official Met Office meteorological station.

This showed that the wind speeds and wind directions during the monitoring period at Little Raith Farm are representative of the general wind profile in this region.

Further technical and scientific information is available in our Technical Report.

Main Local Sources of Air Pollution

The Mossmorran Complex

The Mossmorran complex comprises of Shell UK Limited's Fife Natural Gas Liquids (NGL) Plant and ExxonMobil Chemical Limited's Fife Ethylene Plant (FEP).

The NGL separates natural gas liquids, received via pipeline from the Shell St Fergus Plant near Peterhead, into its ethane, propane, butane and natural gasoline components.

The ethane is piped to the neighbouring FEP site where it is 'cracked' to produce ethylene. The complex can operate 24 hours a day, 365 days a year.

The facilities at Mossmorran are regulated under Pollution Prevention and Control permits issued by SEPA. These permits specify the conditions for protection of the environment under which the facilities must operate.

The Mossmorran complex has the potential to emit a range of combustion gases and volatile organic compounds (VOC) into the ambient air, during normal operation and during any flaring activities.

Traffic

The A92 road runs approximately southwest-to-northeast, passing between the Mossmorran site to the south and the town of Lochgelly to the north. This is a busy A-road with continuous traffic during daytime and for much of the night-time.

Traffic on local roads, especially in the larger towns of Lochgelly and Cowdenbeath, will also contribute air pollutants.

The main air pollutants associated with traffic are particulate matter and nitrogen dioxide. Exhaust gases can also include hydrocarbons such as benzene, toluene, and xylene.

Typical daytime traffic patterns can result in peak emissions during normal rush-hour times.

Other local sources of air pollutants

Domestic and commercial combustion – Mainly related to fossil fuel or wood-burning heating systems. This can also include bonfires. These activities will all contribute to airborne particulate matter.

Farming and agriculture – Farm machinery and livestock movements which disturb soils are likely to generate significant quantities of airborne particles, mainly PM_{10}. Exhaust emissions from farm

machinery will also contribute nitrogen dioxide (NO_2), $PM_{2.5}$ and PM_{10}. Farming activities, such as manure or fertiliser spreading, and livestock feeding activities will also generate airborne particulate matter.

Regional and national pollution events

Under some meteorological conditions, air polluted with particulate matter (PM and $PM_{2.5}$) from the continent may circulate over the UK – a condition known as the long range transportation of air pollution.

There was one such event during this monitoring period which affected several areas in Scotland and across the UK https://airqualitynews.com/2019/02/27/air-pollution-in-london-set-to-worsen-today-as-mayor-issues-high-alert/

Other “transboundary” events that can affect air quality include Saharan dust, wildfires and volcanic ash.

Results

Carbon monoxide, nitrogen dioxide, particulate matter and sulphur dioxide – measured at Little Raith Farm, near Auchtertool

The continuous analysers at Little Raith Farm give an indication of the air pollutant levels in this area, which is downwind of the Mossmorran site during prevailing winds, blowing from a south westerly direction.

As the air monitoring equipment was located on a working farm, air pollutants from farming operations will have contributed to the measured pollutant levels, most significantly nitrogen dioxide and particulate matter.

The site was also likely to receive pollutants associated with passing traffic from the A92, during westerly and northerly winds, again most significantly nitrogen dioxide and particulate matter.

The short term air quality objectives and DAQI for particulate matter are based on 24 hour averages; whilst for nitrogen dioxide they are based on hourly averages and for sulphur dioxide they are based on 15 minute average.

Pollutant	Particulate Matter PM_{10}	Particulate Matter $PM_{2.5}$	Carbon Monoxide CO	Nitrogen Dioxide NO_2	Sulphur Dioxide SO_2
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Maximum	56.0	46.2	0.2	59.1	36.7
Air Quality Objective Concentration	50.0	10.0	10.0	200.0	266.0

Particulate matter PM_{10}: All the 24 hour PM_{10} mean concentrations measured over the monitoring period were within the low banding for daily air quality, except on 27 February when this day was within the moderate (4) DAQI band (51-58µg m^{-3}).

Particulate matter $PM_{2.5}$: All the 24 hour $PM_{2.5}$ mean concentrations measured over the monitoring period were within the low DAQI band (0-35µg m^{-3}), except on 27 February when this day was within the moderate (5) DAQI band (42-47µg m^{-3}).

The higher particulate matter levels on 27 February coincided with a period of elevated particulate levels across Scotland.

As an illustration, on the same day the rural background site at Auchencorth Moss, near Penicuik (situated in a remote area) measured a 24 hour mean PM_{10} concentration of 37µg m^{-3}. This is considerably higher than the 2018 annual mean PM_{10} concentration of 7µg m^{-3}.

It is likely this was caused by the long range transport of pollution as reported in the media.

Donibristle, Cowdenbeath, Lochgelly and Little Raith Farm.

Diffusion tube results give an indication of the air pollutant levels in the area they are positioned. The diffusion tube results presented in Table 5 are the mean values of data collected over the three month monitoring period. The individual two week average diffusion tube results are presented in Appendix D of our Technical Report.

Diffusion tube monitoring does not show how pollutants vary over the short term (e.g. hourly or daily averages).

Measurements that are less than (<) mean they were below the limit of detection. For example, the limit of detection for 1,3-butadiene is 0.2 µg $m^{-3.}$ Results below the limit of detection were somewhere between 0.0 and 0.2 but the equipment cannot be more precise.

Benzene, 1,3-Butadiene and Nitrogen Dioxide

Mean diffusion tube-measured air pollutant concentrations at Donibristle, Cowdenbeath, Lochgelly and Little Raith Farm – with air quality objectives

Pollutant measured by diffusion tube	**Air Quality Objectives Annual mean**	**Donibristle**	**Cowdenbeath**	**Lochgelly**	**Little Raith Farm**
		Average Measured Concentration (µg m^{-3})			
Benzene	3.25	0.5	0.8	0.6	0.7
1,3-Butadiene	2.25	<0.2	0.2	<0.2	<0.2
Nitrogen Dioxide	40	13.9	23.0	14.1	17.4

Nitrogen dioxide at Cowdenbeath is likely to be higher due to the proximity of the A92 and other local traffic sources. However, it is still well below the air quality objective.

Little Raith Farm - The average nitrogen dioxide concentration measured by diffusion tube is higher than that measured by the continuous analyser. The continuous analyser is a more accurate methodology than the diffusion tube monitoring – however this information is helpful as a location comparison.

Mean diffusion tube-measured air pollutant concentrations at Donibristle, Cowdenbeath, Lochgelly and Little Raith Farm – no air quality objectives

Pollutant measured by diffusion tube	Donibristle	Cowdenbeath	Lochgelly	Little Raith Farm
	Average Measured Concentration (µg m^{-3})			
Toluene	<1.2	1.2	<1.2	<1.2
Ethylbenzene	<1.3	<1.3	<1.3	<1.3
Xylene	1.4	1.4	1.6	1.4
	Average Measured Concentration (parts per billion - ppb)			
Total Hydrocarbons	7.1	7.0	7.6	6.7

There are no short or long term national air quality objectives or daily air quality indices for toluene, ethylbenzene, xylene and total hydrocarbons. These were measured to allow comparison against data collected in previous studies, and to aid any future comparisons.

Conclusions

- There were no breaches of any of the air quality objectives.
- The air quality objectives relate to air quality monitored over the period of a year, partly to account for the seasonal variation in winds. This study was limited to a period of three months and therefore relies on the period being representative to allow for the data to compare to the objectives. We have demonstrated that the wind conditions during the monitoring period were representative of the general wind patterns in the area. This strengthens the comparison between the measured data and the objectives, giving a useful indication of the air quality over the longer term.
- All measurements were in the low band of the Daily Air Quality Index for all applicable pollutants, with the exception of particulate matter (PM_{10} and $PM_{2.5}$) which were in the moderate DAQI band on one day (27 February 2019). This coincides with a period of elevated particulate matter across Scotland, probably caused by long range transport of pollution.
- Where there are no air quality standards or DAQI for the remaining pollutants measured, the results are presented for historical or future comparisons.