To Fiza Hafiz, Scientific Officer – State of the Environment

Job Managers - Callum MacKenzie, Thomas McElroy, Darin Sutherland

From Brian (Vladislav) Cheyne, Environmental Scientist – Air Quality

Document 2272526

Date 12 June 2019

Monitoring of nitrogen oxides (NOx) levels in Taranaki near the NOx emitting sites, year 2018-2019

From 2014 onwards, the Taranaki Regional Council (TRC) has implemented a coordinated region-wide monitoring programme to measure nitrogen oxides (NOx), not only at individual compliance monitoring sites near industries that emit NOx, but simultaneously at urban sites (the Council regional state of the environment programme) to determine exposure levels for the general population. The programme involves deploying all measuring devices on the same day, with retrieval three weeks later. This approach will assist the Council to further evaluate the effects of local and regional emission sources and ambient air quality in the region.

Nitrogen oxides

NOx, any mixture of nitrous oxide (N_2O), nitric oxide (NO) and nitrogen dioxide (NO_2), are produced from soil, motor vehicles and industrial fuel combustion processes. Indoor domestic appliances (gas stoves, gas or wood heaters) can also be significant sources of nitrogen oxides. NO and NO_2 are of interest because of potential effects on human health.

Nitric oxide is colourless and odourless and is oxidised in the atmosphere to form nitrogen dioxide. Nitrogen dioxide is an odorous, brown, acidic, highly corrosive gas that can affect our health and environment. Nitrogen oxides are critical components of photochemical smog – nitrogen dioxide produces the brown colour of the smog.

Environmental and health effects of nitrogen oxides

Nitrogen dioxide is harmful to vegetation, can fade and discolour fabrics, reduce visibility, and react with surfaces and furnishings. Vegetation exposure to high levels of nitrogen dioxide can be identified by damage to foliage, decreased growth or reduced crop yield.

Nitric oxide does not significantly affect human health. On the other hand, elevated levels of nitrogen dioxide cause damage to the mechanisms that protect the human respiratory tract and can increase a person's susceptibility to, and the severity of, respiratory infections and asthma, particularly in areas that are poorly ventilated. Long-term exposure to high levels of nitrogen dioxide can cause chronic lung disease. It may also affect sensory perception, for example, by reducing a person's ability to smell an odour.

National environmental standards and guidelines

In 2004, national environmental standards (NES) for ambient (outdoor) air quality were introduced in New Zealand to provide a guaranteed level of protection for the health of New Zealanders. The national standard for nitrogen dioxide (NO_2) is set out below.

In any 1-hour period, the average concentration of nitrogen dioxide in the air should not be more than 200 $\mu g/m^3$.

Before the introduction of the national environmental standards, air quality was measured against the existing national air quality guidelines. The national guidelines were developed in 1994 and revised in 2002 following a comprehensive review of international and national research and remain relevant. The national guideline for nitrogen dioxide (NO_2) is set out below.

In any 24-hour period, the average concentration of nitrogen dioxide in the air should not be more than 100 µg/m³.

Nitrogen dioxide limits are also set in the special conditions of resource consents issued by the Council. The consents limits are the same as those imposed under the NES and MfE's guideline.

Measurement of nitrogen oxides

The Taranaki Regional Council has been monitoring nitrogen oxides (NOx) in the Taranaki region since 1993 using passive absorption discs. Research to date indicates that this is a reliable method for measuring average exposure, with benefits of simplicity of use and relatively low cost. To date more than 750 samplers of nitrogen oxides have been collected in Taranaki region. Discs are sent to EUROFINS ELS Ltd. Lower Hutt for analysis. Passive absorption discs are placed at the nominated sites. The gases diffuse into the discs and any target gases (nitrogen dioxide or others) are captured.

In the 2018-2019 year, passive absorption discs were placed on one occasion at 30 sites, staked about two metres off the ground for a period of 21 days, for the purpose of compliance monitoring.

Conversion of exposure result to standardised exposure time periods

Sampling is conducted over various lengths of time. The issue is therefore that of estimating an indicative equivalent exposure concentration over alternative time periods of interest (eg as referenced in guidelines or other criteria). For comparison with the Ministry for the Environment short-term guideline for BTEX, from the average concentration measured, it is desirable to consider what an indicative theoretical maximum one-hour or 24-hour concentration might be. There are mathematical equations used by air quality scientists to predict equivalent concentrations over varying time periods. These are somewhat empirical, in that they take little account of local topography, micro-climates, variations in activity processes, diurnal variation, etc. Nevertheless, they are conservative (they tend to over-estimate) and have some recognition of validity as a screening tool for a steady-state source. One formula in general use is of the form:

$$C(t_2) = C(t_1) \times \left(\frac{t_1}{t_2}\right)^p$$

where C(t) = the average concentration during the time interval t, and p = a factor lying between 0.17 and 0.20. When converting from longer time periods to shorter time periods, using p = 0.20 gives the most conservative estimate (i.e. the highest calculated result for time period t2 given a measured concentration for time period t1).

Using the 'worst case' factor of p = 0.20, the monitoring data reported herein have also been converted to equivalent 'maximum' one hour and 24-hour exposure levels. These should not be considered accurate estimates of what actually occurred, but can give an indication of any risk of exceedance of criteria.

levels.

Results

The location of the NOx monitoring sites are shown in Figure 2 and the details of the NOx results are presented in Table 1 and Figure 1.

Table 1 Actual (laboratory) and recalculated ambient NOx results, NES and MfE guideline

	Survey at	Site code	NOx(µg/m3) Lab. results	NOx 1/hr (µg/m3) Theoretical max.	NOx 24/hr (µg/m3) Theoretical max.
Petrochemical	McKee PS	AIR007901	4.2	14.6	7.7
Petrochemical	McKee PS	AIR007902	4.9	17.0	9.0
Petrochemical	Turangi PS	AIR007822	0.6	2.1	1.1
Petrochemical	Turangi PS	AIR007824	4.4	15.3	8.1
Petrochemical	Kaimiro PS	AIR007817	6.9	23.9	12.7
Petrochemical	Kaimiro PS	AIR007818	8.2	28.5	15.1
Petrochemical	Sidewinder PS	AIR007831	3.5	12.1	6.4
Petrochemical	Sidewinder PS	AIR007832	2.9	10.1	5.3
Petrochemical	Maui PS	AIR008201	1.5	5.2	2.8
Petrochemical	Maui PS	AIR008214	1.1	3.8	2.0
Petrochemical	Kupe PS	AIR007827	1.2	4.2	2.2
Petrochemical	Kupe PS	AIR007830	2.5	8.7	4.6
Petrochemical	Kapuni PS	AIR003410	5.0	17.4	9.2
Petrochemical	Kapuni PS	AIR003411	10.2	35.4	18.7
Petrochemical	Cheal PS	AIR007841	4.2	14.9	7.7
Petrochemical	Cheal PS	AIR007842	6.4	22.2	11.8
Petrochemical	Waihapa PS	AIR007815	3.2	11.1	5.9
Petrochemical	Waihapa PS	AIR007816	4.4	15.3	8.1
Petrochemical	Ballance AUP	AIR003401	3.9	13.5	7.2
Petrochemical	Ballance AUP	AIR003404	14.7	51.0	27.0
Petrochemical	Pohokura PS	AIR003101	2.2	7.6	4.0
Petrochemical	Pohokura PS	AIR003102	2.3	8.0	4.2
Petrochemical	Rimu PS	AIR012501	2.2	7.6	4.0
Petrochemical	Rimu PS	AIR012502	3.2	11.1	5.9
Dairy factory	Fonterra	AIR002410	11.5	39.9	21.1
Dairy factory	Fonterra	AIR002711	5.5	19.1	10.1
Dairy factory	Fonterra	AIR002412	4.0	13.9	7.3
Dairy factory	Fonterra	AIR002413	4.3	14.9	7.9
SEM	NPGHS	AIR000012(SW)	9.6	33.3	17.6
SEM	NPGHS	AIR000012(NE)	7.6	26.4	14.0
National Environmental Standard (NES) and MfE guideline				**200 (NES)**	**100 (MfE)**

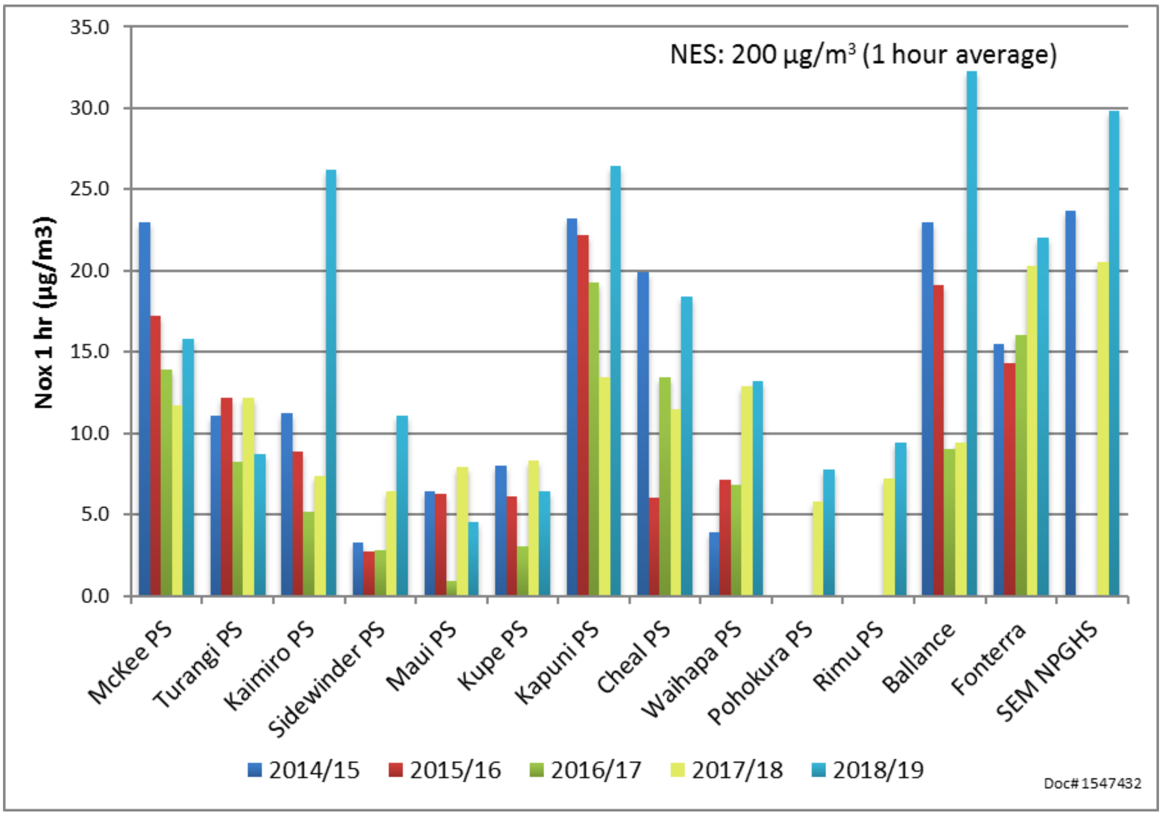

Figure 1 Average NOx levels at 14 surveyed locations throughout the region (year 2018-2019)

Discussion

The calculated 1-hour and 24-hour theoretical maximum concentrations (using a power law exponent of 0.2) ranged from 2.1 µg/m^3 to 51.0 µg/m^3, and from 1.1 µg/m^3 to 27.0 µg/m^3 respectively (Table 1). The highest results in the 2018-2019 monitoring year were obtained at five different locations:

1. In the Kapuni heavy industrial area around the Kapuni production station.
2. Around the Kapuni 'Ballance' Agri-Nutrients
3. From the site at Kaimiro production station
4. Around the Fonterra's Whareroa co-generation plant.
5. And In New Plymouth's urban area near a busy traffic intersection.

All values were well within the National Environmental Standards, Ministry for the Environment Ambient Air Quality Guidelines and the respective resource consents limits. This continues the pattern found in previous years.

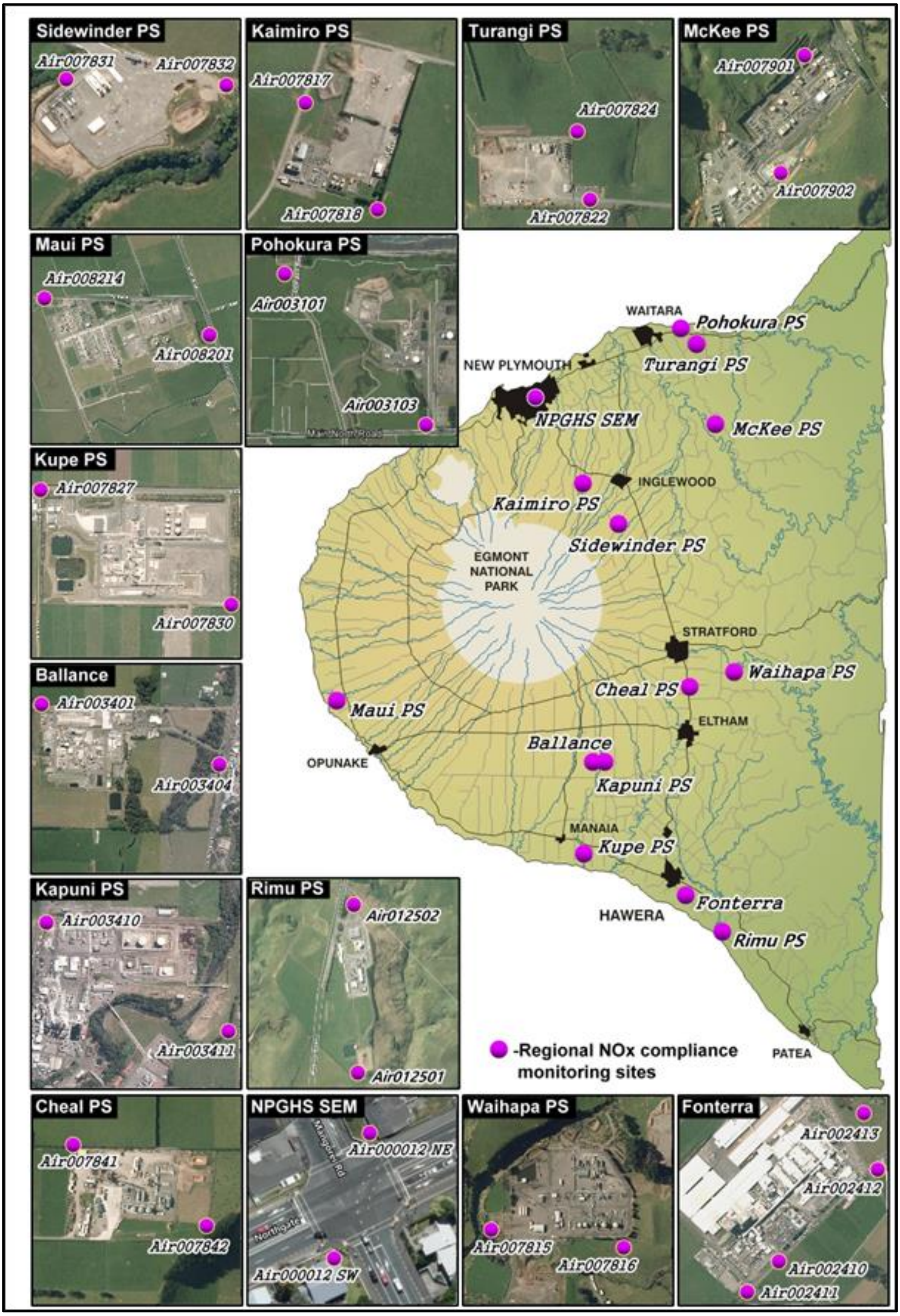

Figure 2 NOx monitoring sites in Taranaki Region, 2018-2019

Ministry for the Environment environmental performance indicator

Ministry for the Environment uses an environmental performance indicator to categorise air quality. These categories are set out in Table 2 and further details of the entire NOx results are set out in Table 3.

Table 2 Environmental Performance Indicator air quality categories

Measured value	Less than 10% of NES	10-33% of NES	33-66% of NES	66-100% of NES	More than 100% of NES
Category	excellent	good	acceptable	alert	action

Table 3 Categorisation of results (2018-2019 monitoring year)

National Environmental Standard for NO2 = 200 µg/m3- 1 hour average.		
Category	**Measured values**	
Excellent	<10% of the NES, (0-20µg/m^3)	**22** (73%)
Good	10-33% of the NES, (20-66µg/m^3)	**8** (27 %)
Acceptable	33-66% of the NES, (66-132 µg/m^3)	**0** (0%)
Alert	66-100% of the NES, (132-200 µg/m^3)	**0** (0%)
Total number of samples		**30** (100%)

Conclusion

The monitoring showed that across all sites monitored, 73% of the 1-hour average results fell into Ministry's 'excellent' categories and 27% of the results lay within Ministry's 'good' category. No results ever entered the 'acceptable' or 'alert' categories, i.e., no results ever exceeded the National Environmental Standard of 200µg/m^3.

These results, and all regional monitoring to date, have shown that Taranaki has very clean air, and on a regional basis there are no significant pressures upon the quality of the air resource.