To Fiza Hafiz, Scientific Officer – State of the Environment

Job Managers - Callum MacKenzie, Thomas McElroy, Darin Sutherland

From Brian Cheyne, Scientific Officer – Air Quality

Document 2089257

Date 20 July 2018

Monitoring of nitrogen oxides (NOx) levels in Taranaki near the NOx emitting sites, year 2017-2018

From 2014 onwards, the Taranaki Regional Council (TRC) has implemented a coordinated region-wide monitoring programme to measure 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

Nitrogen oxides (NOx), a mixture of nitrous oxide (N_2O), nitric oxide (NO) and nitrogen dioxide (NO_2), are produced from natural sources, motor vehicles and other fuel combustion processes. Indoor domestic appliances (gas stoves, gas or wood heaters) can also be significant sources of nitrogen oxides, particularly in areas that are poorly ventilated. 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. 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 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 $\mu g/m^3$.

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 an accurate method for measuring average exposure, with benefits of simplicity of use and relatively low cost. To date more than 720 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 2017-18 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 period

From the average concentration measured, it is possible to calculate a theoretical maximum daily or one hour concentrations that may have occurred during the exposure period. Council data on NOx is gathered over a time period other than exactly 24 hours or one hour. There are mathematical equations used by air quality scientists to predict the maximum concentrations over varying time periods. These are somewhat empirical, in that they take little account of local topography, micro-climates, diurnal variation, etc. Nevertheless, they are applied conservatively and have some recognition of validity.

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 t_2 given a measured concentration for time period t_1). Using the 'worst case' factor of p = 0.20, the monitoring data captured by the Council has been converted to equivalent 'maximum' 1-hour and 'maximum'24-hour exposure levels.

Results

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

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	3.8	13.4	7.1
		AIR007902	2.8	9.9	5.2
	Turangi PS	AIR007822	3.8	13.4	7.1
		AIR007824	3.1	11.0	5.8
	Kaimiro PS	AIR007817	2.2	7.8	4.1
		AIR007818	2.0	7.1	3.7
	Sidewinder PS	AIR007831	1.8	6.4	3.4
		AIR007832	1.8	6.4	3.4
	Maui PS	AIR008201	1.8	6.4	3.4
		AIR008214	2.7	9.5	5.0
	Kupe PS	AIR007827	2.6	9.1	4.9
		AIR007830	2.1	7.4	3.9
	Kapuni PS	AIR003410	3.6	12.7	6.7
		AIR003411	4.0	14.1	7.5
	Cheal PS	AIR007841	2.8	9.9	5.2
		AIR007842	3.7	13.8	6.9
	Waihapa PS	AIR007815	2.4	8.5	4.5
		AIR007816	4.9	17.3	9.2
	Ballance AUP	AIR003401	2.7	9.5	5.0
		AIR003404	2.6	9.2	7.9
	Pohokura PS	AIR003101	1.9	6.7	3.6
		AIR003103	1.4	4.9	2.6
	Rimu PS	AIR012501	2.3	8.1	4.3
		AIR012502	1.8	6.4	3.4
Dairy factory	Fonterra	AIR002410	9.0	31.8	16.8
		AIR002711	9.8	34.6	18.3
		AIR002412	2.0	7.1	3.3
		AIR002413	2.2	7.8	4.1
SEM	NPGHS	AIR000012(SW)	6.1	21.6	11.4
		AIR000012(NE)	5.5	19.4	10.3
National Environmental Standard (NES) and MfE guideline				**200 (NES)**	**100 (MfE)**

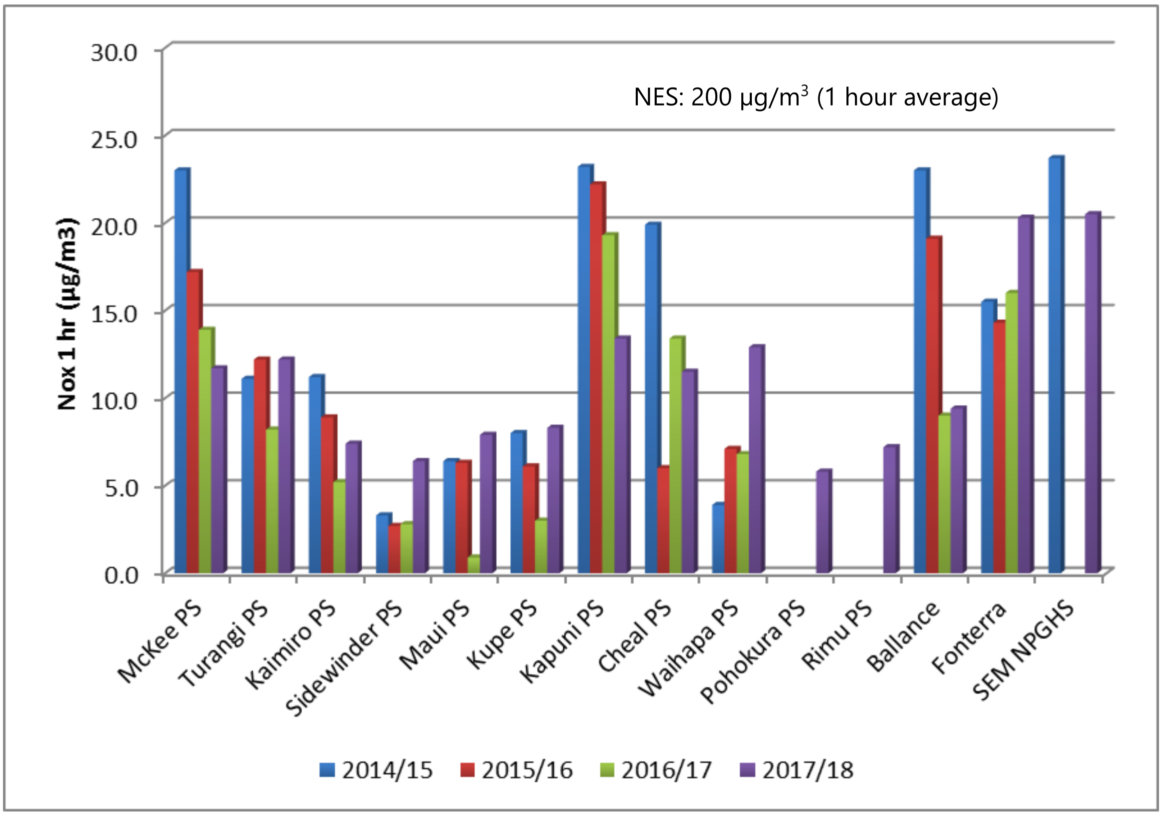

Figure 2 Average NOx levels at 14 surveyed locations throughout the region (year 2017-2018).

Discussion

The calculated 1-hour and 24-hour theoretical maximum concentrations (using a power law exponent of 0.2) ranged from 5.0µg/m^3 to 34.6 µg/m^3, and from 2.6 µg/m^3 to 18.3 µg/m^3 respectively (Table 1). The highest results in 2017-18 monitoring year were obtained from the NOx emitting sites at five different locations:

1. In the Kapuni heavy industrial area around the STOS production station.
2. Around the Fonterra's Whareroa co-generation plant.
3. From the sites at McKee production station.
4. Around the Waihapa production station.
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.

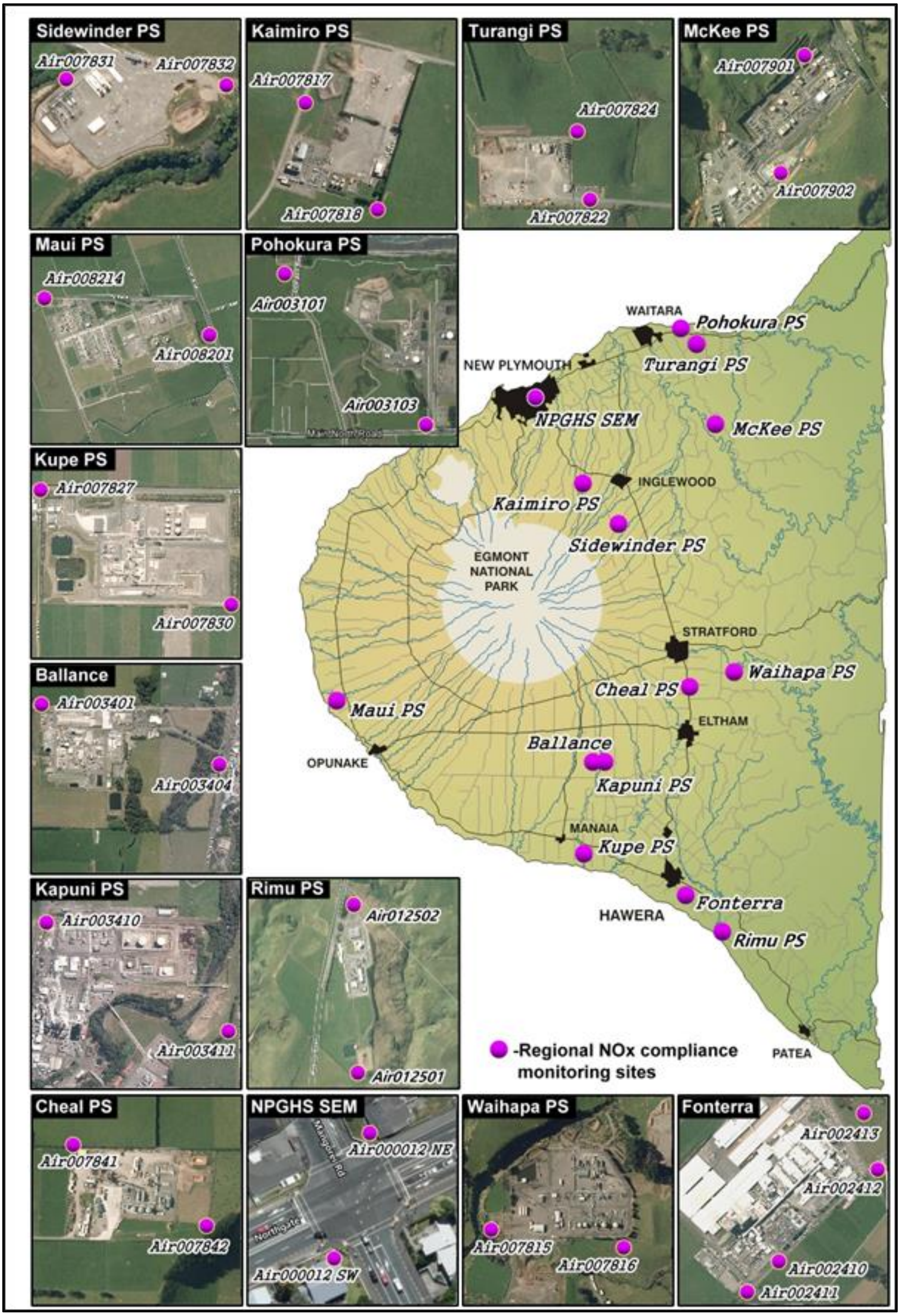

Figure 1 NOx monitoring sites in Taranaki Region, 2017-2018

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 (2017-2018 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)	**27** (90%)
Good	10-33% of the NES, (20-66µg/m^3)	**3** (10 %)
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 90% of the 1-hour average results fell into Ministry's 'excellent' categories and 3% 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.