

Memorandum

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Monitoring of nitrogen oxides (NO_x) levels in Taranaki near the NO_x emitting sites, year 2016-2017

From 2014 onwards, the Taranaki Regional Council (TRC) has implemented a coordinated region-wide monitoring programme to measure NO_x, not only at individual compliance monitoring sites near industries that emit NO_x, but simultaneously at the 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 (NO_x), a mixture of nitrous oxide (N₂O), nitric oxide (NO) and nitrogen dioxide (NO₂), 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 NO₂ 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 (NO₂) is set out below.

In any 1-hour period, the average concentration of nitrogen dioxide in the air should not be more than 200 µg/m³.

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 (NO₂) 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 the resource consents. 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 (NO_x) in the Taranaki region since 1993 using passive absorption discs. Research to date indicates that this is an accurate method, with benefits of simplicity of use and relatively low cost. To date more than 690 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 2016-17 year, passive absorption discs were placed on one occasion at twenty four 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 NO_x 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 t₂ given a measured concentration for time period t₁). Using the 'worst case' factor of p = 0.20, the monitoring data reported above has been converted to equivalent 'maximum' 1-hour and 'maximum' 24-hour exposure levels.

Results

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

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

	Survey at	Site code	NO _x (µg/m ³) Lab. results		NO _x 1/hr (µg/m ³) Theoretical max.		NO _x 24/hr (µg/m ³) Theoretical max.	
Petrochemical	McKee PS	AIR007901		1.2		4.2		2.2
		AIR007902		6.8		23.6		12.5
	Turangi PS	AIR007822		3.2		11.1		5.9
		AIR007824		1.5		5.2		2.8
	Kaimiro PS	AIR007817		0.6		2.1		1.1
		AIR007818		2.4		8.3		4.4
	Sidewinder PS	AIR007831		0.5		1.7		0.9
		AIR007832		1.1		3.8		2.0
	Maui PS	AIR008201		0.4		1.4		0.7
		AIR008214		0.1		0.4		0.2
	Kupe PS	AIR007827		0.4		1.4		0.7
		AIR007830		1.3		4.5		2.4
	Kapuni PS	AIR003410		2.7		9.7		4.5
		AIR003411		8.4		29.2		15.4
	Cheal PS	AIR007841		0.5		1.7		0.9
		AIR007842		7.2		25.0		13.2
Waihapa PS	AIR007815		1.5		3.1		1.6	
	AIR007816		3.0		10.4		5.5	
Ballance AUP	AIR003401		0.5		1.7		0.9	
	AIR003404		4.7		16.3		8.6	
Dairy factory	Fonterra	AIR002410		7.1		24.6		13.0
		AIR002711		7.0		24.3		12.9
		AIR002412		2.2		7.6		4.0
		AIR002413		2.1		7.3		3.9
National Environmental Standard (NES) and MfE guideline			200 (NES)			100 (guideline)		

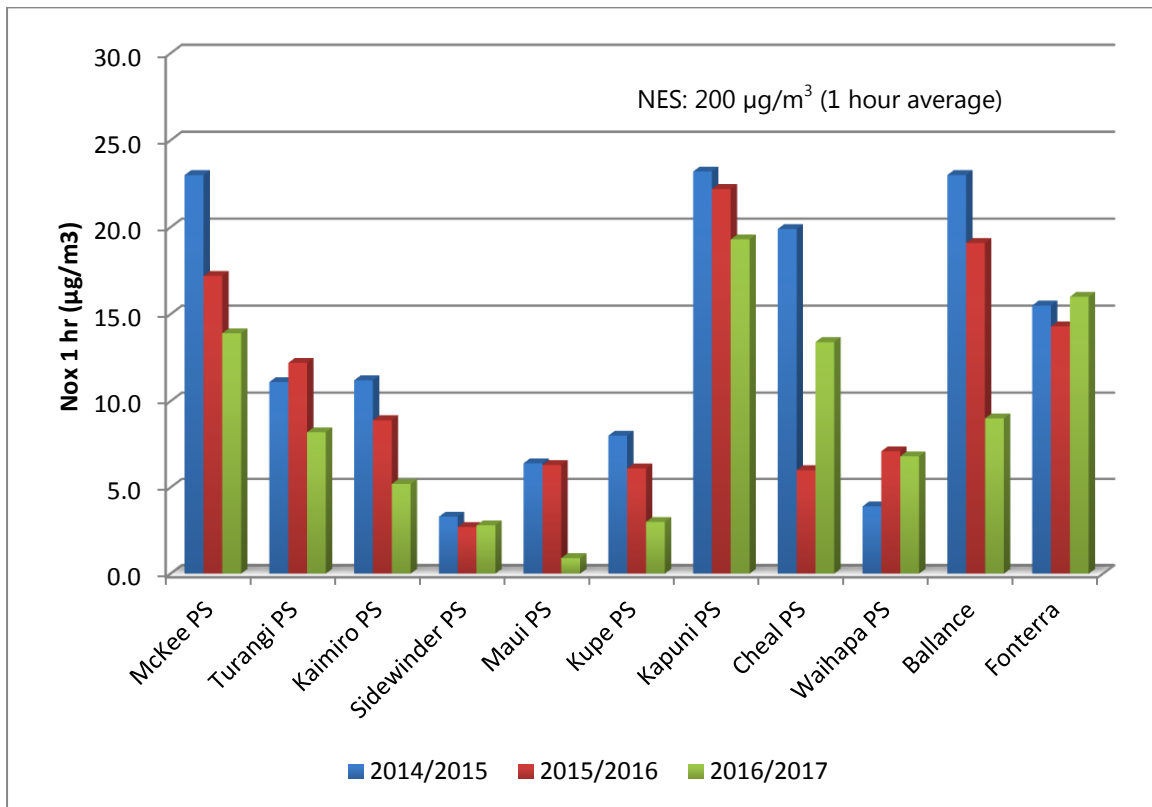


Figure 2 Average NOx levels at 11 surveyed locations throughout the region (year 2016-2017).

Discussion

The calculated 1-hour and 24-hour theoretical maximum concentrations (using a power law exponent of 0.2) ranged from 0.4 µg/m³ to 29.2 µg/m³ and 0.2 µg/m³ to 15.4 µg/m³ respectively. The highest results in 2016-17 monitoring year were obtained from the NOx emitting sites at four different locations:

1. In 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. And around the Cheal production station.

All values were 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.

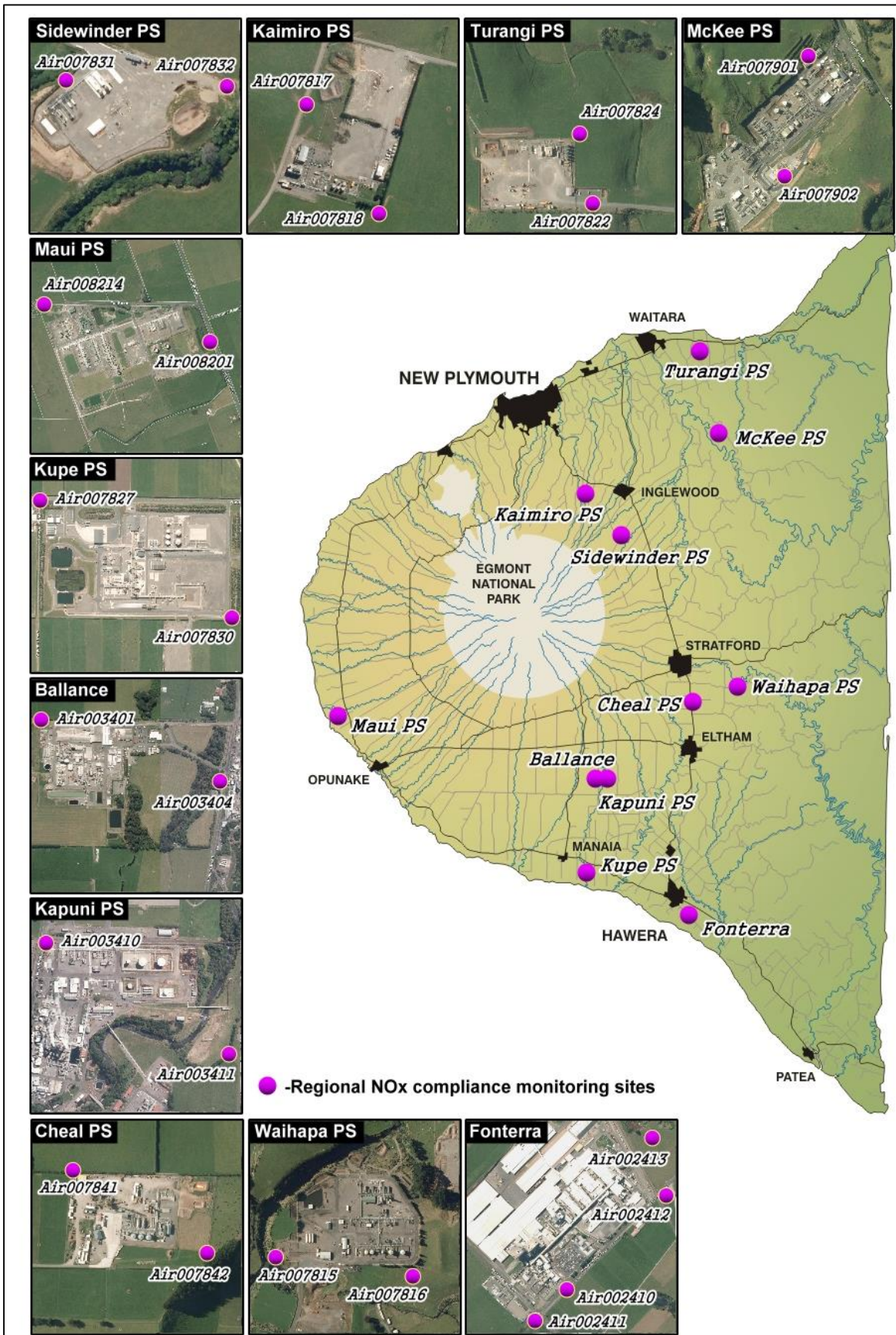


Figure 1 NOx monitoring sites in Taranaki Region, 2016-2017

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 NO_x 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	<i>excellent</i>	<i>good</i>	<i>acceptable</i>	<i>alert</i>	<i>action</i>

Table 3 Categorisation of results (2016-2017 monitoring year)

National Environmental Standard for NO ₂ = 200 µg/m ³ - 1 hour average.		
Category	Measured values	
Excellent	<10% of the NES, (0-20µg/m ³)	19 (79%)
Good	10-33% of the NES, (20-66µg/m ³)	5 (21 %)
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		24 (100%)

Conclusion

The monitoring showed that 79% of the 1-hour average results fell into Ministry's 'excellent' categories and 21% 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/m³.

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.