BEFORE THE AUCKLAND UNITARY PLAN INDEPENDENT HEARINGS PANEL

IN THE MATTER	of the Resource Management Act 1991 and the Local Government (Auckland Transitional Provisions) Act 2010
AND	
IN THE MATTER	of Topic 035: Air quality C5.1
AND	
IN THE MATTER	of the submissions and further submissions set out in the Parties and Issues Report

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STATEMENT OF PRIMARY EVIDENCE OF LOUISE FLEUR WICKHAM ON BEHALF OF AUCKLAND COUNCIL

(AIR QUALITY – REGIONAL AND DISTRICT OBJECTIVES AND POLICIES)

9 FEBRUARY 2015

Index

1. SUMMARY

Auckland Ambient Air Quality Standards

1.1 Auckland Council (the **Council**) is proposing to incorporate existing national environmental standards for air quality (**NESAQ**) and regional air quality targets in the Auckland Regional Plan as Auckland Ambient Air Quality Standards (**AAAQS**). Council is further proposing to introduce three new air quality standards based on recommendations of the World Health Organisation (**WHO**).[1] The AAAQS are not more stringent than the NESAQ.

1.2 The AAAQS simplify existing provisions (which include both national standards and regional targets that were in turn based on national guidelines) and, being based on WHO recommendations, are founded on good science that has been developed in a transparent, documented process by world leading experts in the fields of air pollution and medicine.

1.3 The difference between a 'standard' and a 'guideline' is that a standard is mandatory, whereas a guideline is not. In my opinion based on the:

- seriousness of the adverse health impacts, which include premature mortality, caused by air pollution;
- carcinogenicity of priority pollutants such as PM_{10} and $PM_{2.5}$;[2] and
- observed health effects at levels below the AAAQS,[3]

Auckland air quality management for public health protection warrants the use of a 'standard'.

1.4 At expert conferencing, all parties agreed (with one exception) that the quantitative concentration limits in the AAAQS (including new annual AAAQS for nitrogen dioxide and $PM_{2.5}$) are appropriate for the purposes of public health protection. The one exception is the AAAQS for sulphur dioxide as a 24-hour average (24-hour SO_2 AAAQS).

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[1] **WHO (2006)**. *Air Quality Guidelines Global Update 2005*, World Health Organisation (WHO) Regional Office for Europe, Copenhagen, Denmark.
WHO, (2013). *Review of evidence on health aspects of air pollution – REVIHAAP Project, Technical Report.* WHO Regional Office for Europe, Copenhagen Ø, Denmark

[2] **IARC (2013)**. The carcinogenicity of outdoor air pollution. Loomis, Dana *et al.*, *The Lancet Oncology*, Volume 14, No. 13, p1262–1263, December 2013 [IARC Press release October 2013].
IARC (2012). *Diesel and Gasoline Engine Exhausts and Some Nitroarenes*. Lyon, International Agency for Research on Cancer (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans), Vol. 105 [IARC Press release dated June 2012]

[3] WHO, (2013) at n1 For example, nitrogen dioxide, PM_{10}, $PM_{2.5}$

1.5 The 24-hour SO_2 AAAQS is based on the 2006 WHO global air quality guideline for SO_2 as a 24-hour average. It is lower than the existing New Zealand guideline and could be argued as being more stringent in practice than the 1-hour national air quality standards (albeit over a different time average). I understand the Independent Hearings Panel has queried the basis of any rules more stringent than national standards under s32 of the RMA.[4] I think the 24-hour SO_2 AAAQS is reasonable based on a precautionary approach. Most areas of Auckland will easily meet it. The evidence of Mr Peter Nunns provides a cost benefit analysis that shows the new AAAQS will future proof public health protection and will be achieved at a low cost.[5]

Experts did not agree on implementation aspects of the AAAQS, primarily being concerned that the term 'standard' may preclude granting of consent to industry. Concern over how a standard may be implemented should not negate or detract from the value of the standard itself, particularly with respect to monitoring and reporting on air quality in Auckland.

1.6 As I have stated above the AAAQS incorporates existing national air quality standards and regional targets. There is well established good practice guidance for air quality assessments[6] and a name change from 'regional target' to 'standard' should make no difference to how air quality is assessed. The Council has proposed amendments[7] to clarify that assessments should consider whether a person would be reasonably exposed and this is consistent with national regulations.

Air Quality Overlays

1.7 I support the evidence of Mr Jeremy Wyatt[8] on behalf of Auckland Council regarding the introduction of Air Quality Transport Corridor Separation Overlay. Transport is a major contributor to air pollution emissions in Auckland and there is a substantial body of international and national evidence that shows that exposure to vehicle-related air pollution is harmful

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[4] Hearing Topic 035 Air Quality Parties and Issues Report, 30 January 2015. 035 Air Quality PIR 2015-01-30
[5] Refer evidence of Mr Nunns at paragraph 1.4.
[6] See for example, Ministry for the Environment, 2008b. Good practice guide for assessing discharges to air from industry, June.
[7] Refer statement of evidence of Ms Louise Gobby on behalf of Auckland Council dated 9 February 2015 at Attachment B.
[8] Refer statement of evidence of Mr Jeremy Wyatt on behalf of Auckland Council dated 9 February 2015.

to human health. The selected distances have been based on dispersion modelling using NZTA models to ensure that air quality risk is 'small'.[9]

1.8 I also support the evidence of Mr Wyatt on behalf of Auckland Council regarding the introduction of a Sensitive Activity Restriction Overlay.[10] This provides some measure of assistance to preserving the functions of heavy industry by providing for reduced amenity (associated with heavy industry) and residual industrial emissions.[11] During conferencing, all air quality experts agreed that the selected minimum distance of 500 m was reasonable.

Offsets for Particulate Matter

1.9 I support the (redrafted) [12] proposed policies to require offsets of particulate matter from new significant emitters into polluted airsheds. It is very important to note that the proposed offsets policies will not apply to existing industry, unless that industry wishes to increase emissions. As such, the policies provide for new entrants to the airshed that may otherwise be declined consent because the AAAQS are already breached and the airshed capacity is exceeded.

1.10 The PM_{10} offset policy includes a new four tonne per year threshold to ensure emitters cannot 'get around' the NESAQ requirements by increasing stack heights. This is more stringent than the NESAQ and I understand the Independent Hearings Panel has queried its basis under s32 of the RMA.[13] The new, more stringent, four tonne threshold seeks to make the PM_{10} offset policy fairer so that industry cannot 'game' the rules. It is thus a more efficient and effective policy than that required by the NESAQ.

1.11 I note from the evidence of Mr Nunns[14] on behalf of Auckland Council that the health benefits (in terms of avoided health costs) of both the PM_{10} and $PM_{2.5}$ offsets policies substantially outweigh the likely costs to emitters of new discharges.

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[9] As defined by Environmental Protection UK in Environmental Protection UK (2010). *Development Control: Planning for Air Quality (2010 Update)*, Environmental Protection UK, 2010
[10] Refer evidence of Mr Wyatt.
[11] Residual industrial emissions being fugitive emissions, episodic unanticipated events and/or accidental or emergency emissions (e.g. explosions or fire).
[12] Refer evidence of Ms Gobby at Attachment B.
[13] Hearing Topic 035 Air Quality Parties and Issues Report, 30 January 2015. 035 Air Quality PIR 2015-01-30
[14] Refer statement of evidence of Mr Peter Nunns on behalf of Auckland Council dated 9 February 2015

2. INTRODUCTION

2.1 My name is Louise Wickham. I am a Senior Air Quality Specialist at Emission Impossible Ltd. I have been in this position since April 2011.

2.2 I hold the academic qualifications of Bachelor of Chemical and Materials Engineering from the University of Auckland and a Masters of Environmental Law from the University of Sydney. I am a certified Resource Management Act decision maker (grade = excellent, i.e. top 38%) and a member of the Resource Management Law Association and the Clean Air Society of Australia and New Zealand.

2.3 I have over 20 years' experience in air quality gained in New Zealand, Australia and the United Kingdom and split equally between the private and public sectors. From 2004 to 2011, I was the Ministry for the Environment's senior adviser on air quality. During this time, I was the Ministry's technical lead on air quality matters and played a key role in the introduction, implementation and review of the Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (NESAQ). Whilst at the Ministry I had a strong regulatory focus and, with the cooperation of both industry and other regulatory agencies, I initiated and published the first national wood burner performance review[15] and the first national progress report on regional council compliance with national air quality standards[16]. In addition to this, I have authored, or co-authored, a number of national good practice air quality guidance documents.[17] I represented the Ministry in a number of domestic and international air quality and technical forums.[18] I have also chaired and represented the Ministry in a number of national and Australasian research forums relating to air quality.[19]

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[15] Ministry for the Environment, 2007. National wood burner performance review: Phase 1, June.
Ministry for the Environment, 2008. National wood burner performance review: Phase 2, April.

[16] Ministry for the Environment, 2009. 2008 Report on progress: National Environmental Standards for Air Quality, June.

[17] Ministry for the Environment, 2011. New Zealand domestic solid fuel burner authorisation manual: March 2011 edition, March.
Ministry for the Environment, 2008b. Good practice guide for assessing discharges to air from industry, June.
Ministry for the Environment, 2008c. Good practice guide for assessing discharges to air from land transport, June.
Ministry for the Environment, 2005. Updated Users Guide to Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 (Including Amendments 2005) (second draft) Publication ME695, October.

[18] For example: Environment Protection and Heritage Council (of Australia & New Zealand) Air Quality Working Group, Standards Australia/Standards New Zealand technical committee for wood burners (CS-62; 2004 - 2011), Expert Group on Best Available Techniques /Best Environmental Practices for Stockholm Convention (2006 and 2007), New Zealand National Air Quality Working Group

[19] (Chair, New Zealand) National Environmental Standards Research Advisory Group, (NZ representative) Multicity Mortality and Morbidity Study Research Advisory Group.

2.4 Since 2011 I have continued to provide technical air quality advice to both government and private clients and to publish technical air quality guidance.[20] Full details of my qualifications and relevant past experience are contained in **Attachment A**.

2.5 I was not involved in the original drafting of the Proposed Unitary Plan, however, I have redrafted the offsets and monitoring policies (Policies 19, 21 and 22) and provided input into Policy 1 (regarding exposure and location).[21] I prepared the section 32 analyses for the proposed Air Quality Transport,[22] Industry[23] and Sensitive Activity Separation Overlays.[24] I have also assisted Auckland Council with the preparation of a number of technical air quality reports and general technical advice.[25]

2.6 I provide this evidence in relation to section C5.1 - Air Quality of the Proposed Auckland Unitary Plan.

3. CODE OF CONDUCT

3.1 I confirm that I have read the Code of Conduct for Expert Witness contained in the Environment Court Practice Note and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person.

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[20] For example, Auckland Council, 2014. Use of background air quality data in resource consent applications, GD2014-01, July.
See also Emission Impossible Ltd, 2013. 2013 WHO Review of evidence on health aspects of air pollution – Emission Impossible Ltd Summary prepared for the Ministry of Health, November.
[21] Refer evidence of Ms Gobby at Attachment B.
[22] Auckland Council, 2013. Section 32 Report for the Proposed Auckland Unitary Plan: Part 2.44 Air quality for major roads, September.
[23] Auckland Council, 2013. Section 32 Report for the Proposed Auckland Unitary Plan: Part 2.45 Air quality buffers – heavy industry, September.
[24] Auckland Council, 2013. Section 32 Report for the Proposed Auckland Unitary Plan: Appendix 3.44.1 Air Quality-Transport Separation Corridor Overlay, September.
[25] For example, Emission Impossible Ltd, 2012. Separation Distances for Roads, A discussion document prepared for Auckland Council, 17 July.
Emission Impossible Ltd, 2012b. Separation Distances for Industry, A discussion document prepared for Auckland Council, 9 July.
See also Auckland Council, 2014 at n 20.

4. SCOPE

4.1 I have been asked to prepare evidence in relation to air quality in section C5.1 Air Quality in the PAUP. More specifically, this evidence responds to the submissions made on the proposed:

(a) Auckland Ambient Air Quality Standards (AAAQS);

(b) Air Quality - Transport Separation Corridor Overlay;

(c) Air Quality - Sensitive Area Restriction Overlay; and

(d) Offsets policies for particulate matter.

4.2 I have referred to the following documents in preparing this evidence:

(a) **WHO, (2013)**. *Review of evidence on health aspects of air pollution – REVIHAAP Project, Technical Report*. World Health Organisation (WHO) Regional Office for Europe, Copenhagen Ø, Denmark.

(b) International Agency for Research on Cancer (IARC) publications declaring particulate matter, diesel particulate and air pollution carcinogenic:

(1) **IARC (2013)**. The carcinogenicity of outdoor air pollution. Loomis, Dana *et al.*, *The Lancet Oncology*, Volume 14, No. 13, p1262–1263, December 2013 [IARC Press release October 2013]

(2) **IARC (2012)**. *Diesel and Gasoline Engine Exhausts and Some Nitroarenes*. Lyon, International Agency for Research on Cancer (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans), Vol. 105 [IARC Press release dated June 2012]

(c) **Kuschel *et al.* (2012)**. *Updated Health and Air Pollution in New Zealand Study*. Prepared for Health Research Council of New Zealand, Ministry of Transport, Ministry for the Environment and New Zealand Transport Agency, March 2012.

(d) **US EPA (2010)**. Primary National Ambient Air Quality Standard for Sulfur Dioxide; Final Rule. Part II, *75 Federal Register* 35520, U.S Environmental Protection Agency (U.S EPA), 40 CFR Parts 50, 53 and 58. June 22, 2010

(e) **WHO (2006)**. *Air Quality Guidelines Global Update 2005*, World Health Organisation (WHO) Regional Office for Europe, Copenhagen, Denmark

(f) Review of relevant source apportionment data and emissions inventories (sulphur dioxide, PM_{10}):

(1) **Auckland Council (2014a)**. Future Trends in Motor Vehicle Emissions in Auckland, Auckland Council Technical Report TR2014/028, June 2014, Auckland

(2) **Auckland Council (2014b)**. *Auckland Air Emissions Inventory 2006*, Auckland Council Technical Report TR2014/015, April 2014, Auckland

(3) **GNS Science (2011)**, *Source apportionment of airborne particles in the Auckland region: 2010 Analysis*. Consultancy report prepared by the Institute of Geological and Nuclear Sciences for Auckland Council, November 2011, Auckland.

(g) Section 32 analyses for separation distances for roads and industry

(1) **Auckland Council (2013b)**. *Section 32 Report for the Proposed Auckland Unitary Plan: Part 2.45 Air quality buffers – heavy industry*, September 2013, Auckland.

(2) **Auckland Council (2013c)**. *Section 32 Report for the Proposed Auckland Unitary Plan: Appendix 3.44.1 Air Quality-Transport Separation Corridor Overlay*, September 2013, Auckland.

(h) Discussion documents for separation distances for roads and industry:

(1) **Emission Impossible Ltd (2012)**. *Separation Distances for Roads*, A discussion document prepared for Auckland Council, 17 July 2012, Auckland.

(2) **Emission Impossible Ltd (2012a)**. *Separation Distances for Industry*, A discussion document prepared for Auckland Council, 9 July 2012, Auckland.

(i) Relevant Auckland Council ambient air quality monitoring data (2003 – 2013) (Source: Auckland Council)

(j) Review of consent data (Offsets) (Source: Auckland Council)

(k) Ministry of Health data for asthma:

(1) **Ministry of Health (2008)**. *A Portrait of Health: Key results of the 2006/07 New Zealand Health Survey*, Ministry of Health, June 2008, Wellington.

(l) **Auckland Regional Council (2006)**, *Auckland Regional Freight Strategy*, Auckland Regional Council publication.

4.3 Key assumptions and facts supporting my evidence are as follows:

(a) Auckland Council has excellent air quality and meteorological monitoring data, both in terms of geographical coverage and population exposure. It has some of New Zealand's longest air quality records going back to 1965.

(b) Auckland Council has excellent air emissions inventories, albeit slightly dated for some sources (for example, the most recent air emissions inventory for industry is dated 2006 which is nine years old).

(c) Auckland Council has very good air emissions trend analyses for motor vehicles and domestic fire emissions.

(d) Auckland Council has very good source apportionment analyses. This provides good information on natural sources (as opposed to anthropogenic sources which are addressed in emissions inventories).

(e) The above data have been quality assured and are reasonably robust to support informed conclusions about existing levels of contaminants and to infer reasonable hypotheses for future scenarios.

(f) There is a well-established scientific body of evidence on the health effects of key air contaminants over relevant time averages.

4.4 Specific uncertainties (e.g. causality of the association between daily levels of sulphur dioxide and premature mortality) are discussed in the relevant sections of my evidence below.

4.5 I will be using the following abbreviations:

- **AAAQS** – Auckland Ambient Air Quality Standard(s)
- **IARC** – International Agency for Research on Cancer

- **NESAQ** – National Environmental Standards for Air Quality[26]
- **WHO** – World Health Organisation
- **PM_{10}** – particulate matter less than 10 micrometres in diameter
- **$PM_{2.5}$** – particulate matter less than 2.5 micrometres in diameter
- **SO_2** – sulphur dioxide
- **NO_2** – nitrogen dioxide
- **µg/m^3** – micrograms per cubic metre

4.6 On behalf of the Auckland Council I participated in expert conferencing for this topic on 1 December 2014. A record of the expert conferencing is contained in expert conference joint statements for hearing topic 035 Air Quality. I also attended mediation on 18 and 19 December 2014. A record of the mediation is contained in 'Mediation Joint Statement on Topic 035 – Air Quality'. I understand these documents are all publicly available on the Independent Hearing Panel's website.

4.5 My evidence will cover the following matters

(a) A technical justification for proposed Auckland Ambient Air Quality Standards in Table 1 including:

i. The choice of pollutants, values (i.e. concentration limits) and form (i.e. time average and permissible exceedances);

ii. Difference between a *standard* and a *guideline* (quantification, function and application); and

iii. New ambient standards proposed for nitrogen dioxide, particulate matter less than 2.5 micrometres in diameter ($PM_{2.5}$) and sulphur dioxide in Auckland.

(b) A technical justification for the proposed Air Quality - Transport Separation Corridor Overlay;

(c) A technical justification for the proposed Air Quality - Sensitive Area Restriction Overlay; and

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[26] Resource Management (National Environmental Standards for Air Quality) Regulations 2004.

(d) Clarification and technical justification of offsets policy for new significant industrial emissions of particulate matter in the event of non-compliance with ambient standards.

5. AUCKLAND AMBIENT AIR QUALITY STANDARDS (AAAQS)

5.1 The Auckland Ambient Air Quality Standards (**AAAQS**) are provided in **Table 1** which follows.

5.2 At the RPS level Ms Janet Petersen gave evidence on behalf of Council that the pollutants proposed to be regulated by the AAAQS are identical to existing provisions in the Auckland Regional Plan. These incorporate both national environmental standards for air quality (**NESAQ**)[27] and regional air quality targets (which were in turn based on national air quality guidelines).[28] The AAAQS are not more stringent than the NESAQ.

5.3 Council is further proposing to introduce three new air quality standards based on recommendations of the World Health Organisation (**WHO**).[29] These are annual nitrogen dioxide, annual particulate matter less than 2.5 micrometres in diameter ($PM_{2.5}$) and 24-hour sulphur dioxide (SO_2) as shown in **Table 1**.

[27] Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (NESAQ)
[28] Refer statement of evidence of Ms Janet Petersen on behalf of Auckland Council dated 4 November 2014 at paragraphs 5.3 – 5.6, 6.1 – 6.2
[29] **WHO (2006)**. *Air Quality Guidelines Global Update 2005*, World Health Organisation (WHO) Regional Office for Europe, Copenhagen, Denmark.
WHO, (2013). *Review of evidence on health aspects of air pollution – REVIHAAP Project, Technical Report*. WHO Regional Office for Europe, Copenhagen Ø, Denmark

Table 1: Auckland Ambient Air Quality Standards (AAAQS)

Contaminant	Standard* ($\mu g/m^3$)	Averaging Time	Number of permissible exceedances per year
Particles less than 10 microns (PM_{10})	50*	24 hour	1
	20	Annual	0
Particles less than 2.5 microns ($PM_{2.5}$)	25	24 hour	0
	10	Annual	0
Nitrogen dioxide (NO_2)	200 *	1 hour	9
	100	24 hour	0
	40	Annual	0
Carbon monoxide (CO)	10,000 *	8 hours (running mean)	one 8-hour period
	30,000	1 hour	0
Sulphur dioxide (SO_2)	350*	1 hour	9
	570*	1 hour	0
	20	24 hour	0
Ozone (O_3)	150*	1 hour	0
	100	8 hour	0
Lead	0.2	3 month moving average calculated monthly	0
Benzene	3.6	Annual	0
Benzo[a]pyrene	0.0003	Annual	0
1,3-Butadiene	2.4	Annual	0
Formaldehyde	100	30 minutes	0
Acetaldehyde	30	Annual	0
Mercury (inorganic)	0.33	Annual	0
Mercury (organic)	0.13	Annual	0
Chromium VI	0.0011	Annual	0
Chromium metal and Chromium III	0.11	Annual	0
Arsenic (inorganic)	0.0055	Annual	0
Arsine	0.055	Annual	0

Notes

1. Standards highlighted in grey are existing concentration limits in the Auckland Regional Plan.
2. Standards marked with * are existing national air quality standards (NESAQ)

5.4 It is important to understand that ambient air quality standards comprise four aspects, these being;

(a) Name of contaminant (e.g. nitrogen dioxide)

(b) Quantified concentration limit in micrograms per cubic metre (e.g. 200 $\mu g/m^3$)

(c) Time average (e.g. 1 hour)

(d) Permissible exceedances (e.g. 9 permissible exceedances per year)

5.5 The AAAQS for sulphur dioxide (SO_2) as a 24-hour average of 20 micrograms per cubic metre ($\mu g/m^3$) is significantly lower than the national guideline for SO_2 (120 $\mu g/m^3$) previously set by the Ministry for the Environment (MfE) in 2002. Preference has been given to the more recent (2006 WHO global air quality guideline for SO_2 as a 24-hour average because:

(a) The primary focus of WHO is public health protection;

(b) WHO global air quality guidelines are based on good science and have been developed in a transparent, documented process by world leading experts in the fields of air pollution and medicine; and

(c) WHO global air quality guidelines are regularly updated and reviewed in a transparent, documented process by world leading experts in the fields of air pollution and medicine

5.6 Two submitters[30] sought to delete the AAAQS. Other submitters wanted the AAAQS to be amended to reflect only existing national air quality guidelines and/or national air quality standards (i.e. to remove the WHO guidelines).[31]

5.7 The AAAQS are important for Auckland because national air quality standards and guidelines do not cover all pollutants or time averages relevant to Auckland.[32] For example, national air quality standards and guidelines do not provide any health protection for short-term (daily) or long-term (i.e. annual) exposure to $PM_{2.5}$ which is a priority pollutant for

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[30] Stevenson Group Ltd 3682-65 and Sanitarium 4539-17
[31] Transpacific Industries Group [877-5, 877-31], Sanitarium [4359-17], NZ Steel Ltd [868-9], Fulton Hogan Ltd [5776-24], AML Ltd & Allied Concrete [5947-11]
[32] Refer evidence of Janet Petersen at paragraph 6.3

Auckland.[33] Similarly, neither afford any protection from long-term exposure to nitrogen dioxide which is another priority pollutant for Auckland.[34]

5.8 At the expert conferencing all air quality experts agreed that the pollutants in **Table 1** had adverse effects on human health. Experts further agreed unanimously on the values (i.e. concentration limits) and form (i.e. time averages) for all AAAQS except one (the new 24-hour SO_2 AAAQS - this is discussed separately at paragraphs 5.37 – 5.52).[35] In other words, all air quality experts agreed, with the exception of SO_2, that the concentration limits and time averages in **Table 1** are appropriate for the purposes of public health protection.

5.9 However, the experts did not agree with me that it was appropriate to include permissible exceedances per year for each pollutant. That is, all of the experts (except me) preferred column 4 of **Table 1** to be deleted. There was also concern at expert conferencing that the number of permissible exceedances for $PM_{2.5}$ as a 24 hour average (zero) was more stringent than the permissible exceedances for PM_{10} (one) in the NESAQ. My evidence will cover the reasons for my support of the AAAQS in their current form.

Permissible exceedances of AAAQS

5.10 At conferencing, all air quality experts except me requested deletion of column 4 (i.e. permissible exceedances) in **Table 1**.[36] This request followed a lengthy technical discussion about how the AAAQS would be applied during air quality assessments for consent purposes. Some experts were concerned that as a result of column 4, industry would be precluded from being granted consent. These concerns are set out in further detail below at paragraphs 5.13 and 5.23. I disagree with deleting permissible exceedances for two reasons.

5.11 The first reason is purely practical. The AAAQS incorporates air quality standards from the NESAQ, which includes concentration limits, time averages and their associated permissible exceedances (ranging from zero to nine as shown in **Table 1** at paragraph 5.4). If the AAAQS in **Table 1** did not include permissible exceedances, then it would only be a partial

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[33] Refer evidence of Janet Petersen at paragraphs 7.1-7.3
[34] Refer evidence of Janet Petersen at paragraphs 8.1-8.7
[35] Expert Conference Joint Statement for hearing topic 035 – Air Quality, 1 December 2014.
[36] *Ibid.*

incorporation of the NESAQ. This is inconsistent with the NESAQ and has knock on consequences for industry as it could result in the compliance status of an airshed being unclear.

5.12 For example, the NESAQ allows one exceedance of the PM_{10} concentration limit per year. It is thus only after two exceedances that an airshed breaches the regulations and becomes 'polluted'. This in turn triggers offset requirements for new significant discharges of PM_{10}. These offset requirements are also incorporated within the Proposed Auckland Unitary Plan (PAUP). If **Table 1** did not include permissible exceedances then it would be unclear when the offset requirements are triggered. It is thus important that if national air quality standards are to be in the PAUP (as most experts agree that they are)[37], that the associated permissible exceedances are included for clarity and completeness.

5.13 The second reason is that air quality experts who requested deletion of permissible exceedances were focusing on (primarily industrial) air quality assessments only. This in turn was based on concerns that a focus on permissible exceedances would preclude granting of consent (the AAAQS for PM_{10} is regularly exceeded in the Auckland airshed). However, removing the permissible exceedances in response to this concern would be to ignore the other primary function of the AAAQS which is to provide information on the state of Auckland's air quality for the purposes of air quality management. The state of ambient air quality requires consideration of the concentration, time average **and** number of exceedances – permissible or otherwise. This speaks to the difference between a '*standard*' and a '*guideline*' which is discussed further below in paragraphs 5.18 – 5.21.

5.14 Regarding the proposed number of permissible exceedances, I note that the existing (Auckland regional plan) regional air quality targets have no permissible exceedances. Similarly, with the exception of the AAAQS for $PM_{2.5}$ as a daily average, the WHO global air quality guidelines and national ambient air quality guidelines adopted as AAAQS have zero permissible exceedances.[38] It is therefore appropriate that the AAAQS that are based on WHO global air quality guidelines and national ambient air quality guidelines similarly have zero permissible exceedances. I discuss permissible exceedances for the AAAQS for $PM_{2.5}$ below in paragraphs 5.15 – 5.17.

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[37] Some experts considered their inclusion unnecessary duplication.
[38] I note that WHO, (2006) does not specify permissible exceedances for the 24-hour SO_2 guideline. This is discussed in paragraphs 5.51 – 5.52

Permissible exceedances for 24-hour $PM_{2.5}$ AAAQS

5.15 As noted above, there was debate during expert conferencing over the zero permissible exceedance of the AAAQS for $PM_{2.5}$ as a 24-hour average because it is more stringent than the permissible exceedances for PM_{10} in the NESAQ (this is a relevant comparison because $PM_{2.5}$ is a subset of PM_{10}).[39] The NESAQ allows one exceedance of the PM_{10} concentration limit per year to provide for fireworks on Guy Fawkes night.

5.16 The technical justification for the zero permissible exceedances for $PM_{2.5}$ is:

(a) The proposed AAAQS for $PM_{2.5}$ is based on the existing Auckland regional air quality target for $PM_{2.5}$ in the Auckland Regional Plan: Air Land Water which (like all other regional targets) has no specified exceedances. Council has assumed that no specified exceedances is equivalent to zero permissible exceedances.

(b) $PM_{2.5}$ is a better indicator of combustion (i.e. anthropogenic sourced) particulate matter than PM_{10} which also includes natural sources (e.g. wind-blown dust and sea salt).[40]

(c) $PM_{2.5}$ is a priority pollutant in Auckland. It has been classified by the International Agency for Research on Cancer (**IARC**)[41] as a Group I carcinogen based on an increasing risk of lung cancer with increasing levels of exposure to particulate matter.[42] The IARC working group specifically noted whilst the composition of air pollution and levels of exposure can vary dramatically between locations, the conclusions regarding carcinogenicity apply to all regions of the world.

(d) The current state of scientific knowledge, supported by a large body of new studies, strongly suggests that there no 'safe' threshold of $PM_{2.5}$.[43]

(e) New studies have linked long-term exposure to $PM_{2.5}$ to new health outcomes including artherosclerosis, adverse birth outcomes and childhood respiratory disease.[44] There is also emerging evidence that suggests possible links between long-term exposure to $PM_{2.5}$ and

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[39] Expert Conference Joint Statement for hearing topic 035 – Air Quality, 1 December 2014.
[40] WHO, 2006 at para 4.2
[41] The specialised cancer agency of the World Health Organisation
[42] IARC, 2013 at para 4.2
[43] WHO, 2013 at para 4.2
[44] *Ibid.*

neurodevelopment and cognitive function, as well as other chronic disease conditions such as diabetes.[45]

It is therefore, appropriate for the AAAQS for $PM_{2.5}$ to have zero permissible exceedances.

5.17 Despite the above, I am sympathetic to air quality experts' concerns over the apparent disconnect between the two AAAQS for PM_{10} and $PM_{2.5}$. I think some relaxation of stringency may be warranted, given the combustion of fireworks is even more likely to result in an exceedance of $PM_{2.5}$ than PM_{10} on Guy Fawkes night. I further note that WHO global air quality guideline for $PM_{2.5}$ provides for three permissible exceedances. I am therefore, not averse to amending the AAAQS to permit one exceedance per year for $PM_{2.5}$ as a 24-hour average. (**Table 1** still contains zero permissible exceedances for the 24-hr $PM_{2.5}$ AAAQS).

Air quality standards vs guidelines

5.18 All except three[46] of the pollutants which have been included in the AAAQS are already present in the Auckland Regional Plan (either as Auckland regional air quality targets or national standards). Sanitarium [4359-17] sought to have the AAAQS renamed as *guidelines* as opposed to *standards*. I agree it is simpler to refer to these quantitative limits either as standards or guidelines, rather than a mix of both.

5.19 In reality and, as applied to air quality, there is usually no *quantitative* difference between ambient air quality 'guidelines' and ambient air quality 'standards'. This is because both are informed by strong scientific evidence and both often have a very similar purpose – the protection of public health. For example, WHO has set a global air quality guideline for PM_{10} of 50 micrograms per cubic metre as a 24-hour average. WHO states that the guideline is intended:[47]

> *"…to support actions aiming for the optimal achievable level of air quality in order to* ***protect public health*** *in different contexts."*

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[45] *Ibid*.
[46] Annual $PM_{2.5}$, Annual NO_2 and Daily SO_2 as per Table 1 at paragraph 5.1
[47] WHO, 2006 at paragraph 4.2

Similarly, the New Zealand Government has set a national standard for PM_{10} of 50 micrograms per cubic metre as a 24-hour average. The stated purpose of this standard is (MfE, 2011):

> *"…to provide a guaranteed level of **health protection** for all New Zealanders."*

5.20 In my opinion, the only difference between an ambient air quality 'standard' and an ambient air quality 'guideline' is that a standard is mandatory, whereas a guideline is not. As such, air quality experts concerns relate to how the AAAQS will be *implemented*, not the values and form of the standards themselves (on which all parties agree).

5.21 Based on the seriousness of adverse health impacts caused by air pollution, i.e. premature mortality, public health protection warrants the term 'standard'. I will turn now to air quality experts concerns over implementation.

Implementation of air quality standards

5.22 As I have mentioned above the AAAQS serve two functions: one is to provide information on the state of Auckland's ambient air quality through monitoring and reporting. The other is for its use as a tool to conduct air quality assessments.

5.23 It is the assessment function of the AAAQS about which experts are most concerned. Most commonly applied to industry or new, large-scale transport projects, air quality assessment seeks to understand the potential impacts of proposed discharges to air by comparison with ambient air quality standards. Air quality experts are concerned that the proposed AAAQS will be used as a pass/fail (primarily fail) test and that this would be unfairly onerous on industry. In other words they thought that any exceedance of the AAAQS, even if primarily due to background concentrations, would mean that consents for discharges to air would be declined - irrespective of the relative size and potential impact of the discharge itself. This concern relates directly to the mandatory nature of a 'standard' (which should not be exceeded) as opposed to a 'guideline' (which implies adverse effect but may not be 'significant' under the RMA and hence could be permitted).

5.24 Concern over how a standard is implemented, however, should not negate or detract from the value of the standard itself, particularly if the concern only relates to one of the standards functions. Further, using AAAQS as a

pass/fail test for assessment purposes is entirely appropriate in some cases as I will illustrate through some examples.

Example A It would clearly be appropriate to approve ('pass') a proposed discharge of $PM_{2.5}$ that would result in maximum ambient levels of only 1 $\mu g/m^3$, where background concentrations are 15 $\mu g/m^3$, when compared with the AAAQS of 25 $\mu g/m^3$ as a 24-hour average.

Example B Similarly, it would clearly be appropriate to decline ('fail') a proposed discharge of PM_{10} that would result in widespread ambient levels of 45 $\mu g/m^3$, where background concentrations are already 45 $\mu g/m^3$ (i.e. a combined maximum of 90 $\mu g/m^3$) as a 24-hour average, and proposed offsets would be in a separate and geographically remote part of the airshed.

Example C However, a judgement of whether adverse effects are significant or not still needs to be applied where a proposed discharge of $PM_{2.5}$ would result in maximum ambient levels of only 0.5 $\mu g/m^3$, in a location where background concentrations are already 25 $\mu g/m^3$ as a 24-hour average. In this case it would not be appropriate to use the AAAQS as a simple pass/fail test.

5.25 Example C requires a detailed and balanced consideration of a number of factors including (but not limited to):

(a) Actual exposure over the relevant time period;

(b) Whether offsets (which are not mandatory in this example) could be used to mitigate potential impacts on the wider area;

(c) Policy 18a[48] and a judgement of whether it was the discharge that caused ambient air quality to exceed the AAAQS or not.

5.26 Good practice guidance for such consideration is well established[49] and clearly evident as having guided complex decisions on applications for consent for industrial discharges in cases like Example C (e.g., the recent application for consent by New Zealand Starch which is discussed in more detail at paragraph 5.44).

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[48] Refer statement of evidence of Ms Louise Gobby on behalf of Auckland Council dated 9 February 2015 which includes as Attachment B C5.1 of PAUP dated 23 January 2015 as circulated post mediation which states: *Require applications for activities requiring resource consent for air discharges to demonstrate that the discharges will not cause ambient air quality to exceed the AAAQS in Table 1.*

[49] Ministry for the Environment, 2008b and 2008c at paragraph 4.2.

5.27 It is important to note, as highlighted in grey in **Table 1** at paragraph 5.1, that there has been no quantitative change made to the NESAQ in the AAAQS. It is my opinion that comparison with a 'standard' as opposed to a 'guideline' (or Auckland regional air quality target as they were previously referred to in the Auckland Regional Plan) should make no difference at all to its implementation during assessment.

5.28 Example C also speaks to air quality expert concerns expressed during conferencing over the application of the AAAQS at inappropriate locations.[50] Assuming the case of Example B above, it may not be appropriate to decline the proposal if the potential impacts were instead limited to the immediate boundary of the site where no persons would be exposed over the relevant (24-hour) time average. To assist with clarification on this matter, Auckland Council has proposed amendments to Policy 1.[51] These clarify that assessments should consider:

> *"…whether a person would reasonably be exposed over the relevant time period in any part of the airshed (other than the site on which the consent would be exercised)."*

5.29 The proposed amendments are consistent with the Regulation 14(1) of the NESAQ which states that the (national) ambient air quality standards apply:

> "*at any place where people are likely to be exposed to the contaminant"*.

Annual $PM_{2.5}$ AAAQS

5.30 The AAAQS introduces a <u>new</u> annual ambient concentration limit for $PM_{2.5}$ (annual $PM_{2.5}$ AAAQS) of 10 µg/m^3. I support the introduction of this annual $PM_{2.5}$ AAAQS, and the designation of $PM_{2.5}$ as a priority pollutant, for the following reasons:[52]

(a) As I have noted above, particulate matter has been classified by IARC as a Group 1 carcinogen[53] with no known safe threshold (i.e. at any level in ambient air there will be adverse of health effects). The most recent review of evidence of health aspects of air pollution by WHO

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[50] Expert Conference Joint Statement for hearing topic 035 – Air Quality, 1 December 2014.
[51] Refer evidence of Ms Gobby at Attachment B.
[52] I have read the evidence provided by Ms Petersen on behalf of Auckland Council in topic 006 dated 4 November 2015 and endorse the comments she makes.
[53] IARC, 2013 at paragraph 4.2

confirms the causal link between $PM_{2.5}$ and adverse health outcomes in human beings (including premature mortality and morbidity).[54] This consensus on causality is very important. Causality means that one thing causes another thing to occur, in this case – scientists agree that air pollution *causes* adverse health effects. Put simply, this means that people suffer adverse health effects *because* they are exposed to air pollution. That is, a person would not have been made sick, or died at that time, if they had not been exposed to air pollution.

(b) WHO's 2013 review of further outlined links between long-term exposure to $PM_{2.5}$ and artherosclerosis, adverse birth outcomes and childhood respiratory disease. Emerging evidence also suggests possible links between air pollution and neurodevelopment and cognitive function, as well as the development of other chronic disease conditions such as diabetes.[55]

(c) Existing annual $PM_{2.5}$ levels in Auckland are below levels stipulated in the AAAQS (refer **Attachment B**) at all monitoring locations across Auckland. The last ten years shows an overall decreasing trend although, levels have stabilised since 2011 and may now be slightly increasing. This underlines the importance of introducing an annual ambient air quality standard for $PM_{2.5}$ in Auckland.

5.31 Whilst the 24-hour average AAAQS for $PM_{2.5}$ has come from the existing Auckland Regional Plan, the proposed annual average AAAQS for $PM_{2.5}$ is **new**. As noted above whilst air quality experts did not agree on the introduction of an annual AAAQS for $PM_{2.5}$ in Auckland, they did agree unanimously on the proposed value of 10 $\mu g/m^3$ for the purposes of public health protection.[56] (This is primarily because it is equivalent to the WHO 2006 global air quality guideline for $PM_{2.5}$ which in turn, is based on good science).

5.32 Auckland Council has published conservative $PM_{2.5}$ 'background' values for every census area unit in the Auckland region.[57] This uses available monitoring data to estimate maximum annual $PM_{2.5}$ levels and it indicates

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[54] WHO, 2013 at paragraph 4.2
[55] *Ibid.*
[56] Expert Conference Joint Statement for hearing topic 035 – Air Quality, 1 December 2014.
[57] Auckland Council, 2014 at n20.

that seven census area units may equal or exceed the annual average AAAQS for $PM_{2.5}$.[58] These areas are (refer **Attachment B**):

- Arch Hill, Auckland Central West, Grafton East, Newton, St Lukes North and St Mary's in Auckland City; and
- Otara South in Manukau City.

5.33 These areas with elevated annual $PM_{2.5}$ are all located close to major transport routes, including Auckland Central West which is impacted by shipping emissions.

5.34 **Attachment B** also shows that Council conservatively estimates 192 census area units may have elevated annual $PM_{2.5}$.[59] This represents around 838,000 people or 59% of Auckland's population.[60] This underlines the importance of establishing an AAAQS for public health protection and classifying $PM_{2.5}$ as a priority pollutant for Auckland.

5.35 As outlined in the evidence of Mr Peter Nunns,[61] the benefit of the proposed annual $PM_{2.5}$ AAAQS is that it helps avoid a scenario in which the health costs of poor air quality increase over time. The costs may include offsetting growth in emissions by replacing older wood fires or investing in cleaner technologies. The costs are consequently more likely to be borne by emitters of new discharges who trigger the $PM_{2.5}$ offsetting requirement. This is discussed paragraph 8.13 below.

5.36 In my opinion, the 24-hour $PM_{2.5}$ AAAQS, which is based on the 2006 WHO $PM_{2.5}$ 24-hour guideline, is reasonable and appropriate for Auckland.

24-hour SO_2 AAAQS

5.37 The AAAQS introduces a <u>new</u> 24-hour average ambient concentration limit for sulphur dioxide (24-hour SO_2 AAAQS) of 20 $\mu g/m^3$. I support the introduction of this 24-hour SO_2 AAAQS for the following reasons:

(a) The 24-hour SO_2 AAAQS is based on the 2006 WHO global air quality guideline for SO_2 as a 24-hour average (2006 WHO SO_2 24-hour guideline).[62] As noted above, WHO guidelines are based on good

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[58] i.e. maximum annual average equal to and/or greater than 10 $\mu g/m^3$
[59] i.e. maximum annual average between 7 and 10 $\mu g/m^3$
[60] Based on 2006 population of 772,800 updated to 2013 using factor of 1.085 :Statistics NZ
[61] Refer statement of evidence of Mr Peter Nunns on behalf of Auckland Council dated 9 February 2014 at paragraph 8.8 – 8.9.
[62] WHO. 2006 at paragraph 4.2

science and have been developed in a transparent, documented process by world leading experts in the fields of air pollution and medicine;

(b) In 2013 WHO reviewed their 2006 WHO SO_2 24-hour guideline in light of recent scientific developments and concluded that it was valid, based on a precautionary approach.[63] I consider that it is reasonable for Auckland Council to similarly take a precautionary approach in setting an AAAQS for SO_2 because:

i. New studies are showing more health effects associated with short-term exposure to SO_2 such as pre-term birth and sudden infant death syndrome.[64]

ii. SO_2 is commonly emitted with other pollutants such as particulate matter, a pollutant for which there is no safe threshold. Actions to reduce SO_2 are therefore very likely to also reduce emissions of particulate matter.

iii. Following emission, SO_2 can form secondary particulate in the atmosphere, therefore actions to reduce SO_2 will also reduce formation of secondary particulate matter. The recently revised US ambient air quality guideline for SO_2 estimated around $15 – 37 billion in co-benefits from reduced exposure to $PM_{2.5}$ formed as secondary particulate from SO_2.[65] These co-benefits dwarfed the estimated direct benefits ($2.2 million) from attainment of the revised ambient standard for SO_2 and indicate the significance of co-benefits from an ambient SO_2 standard.

(c) A review of ambient air quality monitoring and inventory data for Auckland (refer **Attachment C**) indicates that most residential locations in Auckland would easily meet the proposed standard.

5.38 The 24-hour AAAQS for SO_2 is therefore, reasonable on a precautionary basis. Being easy to meet in most locations it will not provide additional health benefits. However, it will future proof public health for future generations and support the Auckland Plan vision of being the most liveable city in the world.

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[63] WHO, 2013 at paragraph 4.2
[64] *Ibid.*
[65] US EPA, 2010 at paragraph 4.2

5.39 A large number of submitters have requested either deletion of the 24-hour SO_2 AAAQS, or amendment to be consistent with the 24-hour SO_2 national guideline of 120 µg/m^3 set by MfE in 2002.[66]

5.40 New Zealand Starch [3230] provided an extensive and technically detailed submission. Their concerns may be summarised as follows:

(a) The 24-hour SO_2 AAAQS will seek to achieve significant reductions in SO_2 emissions in Auckland.

(b) Many industrial sites in Auckland and throughout New Zealand create 24-hour impacts that are close to the site boundary that exceed the 24-hour SO_2 AAAQS. These typically have only very localised impacts.

(c) Achieving compliance with the 24-hour SO_2 AAAQS could require the installation of scrubbing systems that would be very costly for New Zealand Starch and uneconomic for some industries.

(d) The 2006 WHO SO_2 24-hour guideline has not been adopted anywhere else in New Zealand, or internationally.

(e) The 2006 WHO SO_2 24-hour guideline is not sufficiently robust for adoption as an air quality standard in Auckland. Based on their experts' scientific assessment, New Zealand Starch considered the 24-hour SO_2 national guideline should be retained instead. This was considered to be consistent with recent expert reviews in Australia, Canada and the United Kingdom.

5.41 New Zealand Starch was also concerned over the use of the AAAQS as a pass/fail criteria. I have already addressed this at paragraphs 5.23 – 5.24. I turn to the remainder of identified concerns of New Zealand Starch (paragraph 5.40(a) – (e)).

5.42 As I understand it Auckland Council is **not** seeking significant reductions in emissions of SO_2 (paragraph 5.40(a)). Work by Council indicates that few industrial sites have significant emissions of SO_2, and that these are unlikely to exceed the 24-hour SO_2 AAAQS at locations where people live (**Attachment C**). New Zealand Starch's concern that Council will be seeking large SO_2 emissions reductions appears unwarranted.

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[66] New Zealand Starch [3230], New Zealand Steel [868-9], ACI Operations NZ Ltd [852-9], Holcim NZ Ltd [3751-8], Employers & Manufacturers Association [4370-8], Ports of Auckland Ltd [5137-133], Fulton Hogan Ltd [5776-25], Ravensdown Fertiliser Cooperative Ltd [5963-50], Coal Association of NZ and Straterra [6097-13]

5.43 With respect to the potentially localised impacts of SO_2 near industrial site boundaries (paragraph 5.40(b)), Council has proposed amendments to Policy 1.[67] These clarify that all AAAQS only apply to locations where people may reasonably be exposed (refer paragraphs 5.28 – 5.29).

5.44 New Zealand Starch is also concerned that abatement technology will be required following the introduction of the 24-hour SO_2 AAAQS (paragraph 5.40(c)). Based on a recent assessment of environmental effects, it is my understanding that New Zealand Starch does not exceed the 24-hour SO_2 AAAQS at locations where people may reasonably be exposed.[68] In December 2013, New Zealand Starch were granted consent for discharges to air for a period of 15 years. The consent process specifically addressed the 24-hour SO_2 AAAQS and did not require the installation of any abatement technology for SO_2 emissions. The concern about additional abatement being required appears unwarranted.

5.45 The adoption, or lack thereof, of the 2006 WHO SO_2 24-hour guideline by other jurisdictions in New Zealand (paragraph 5.40(d)), or internationally, does not necessarily speak to its value as an AAAQS for Auckland. For example, an important consideration for the introduction of any ambient air quality standard is the likelihood of compliance. Auckland is fortunate that most, if not all, residential locations are likely to meet the 24-hour SO_2 AAAQS. This is not necessarily true of other jurisdictions domestically and internationally.

5.46 The remainder of technical concerns raised by New Zealand Starch air quality experts (paragraph 5.40(e)) are addressed in detail in **Attachment D**. In summary, I do not agree with their air quality experts' (Golder's) conclusion that the 2006 WHO SO_2 24-hour guideline is not robust because that conclusion is based on a review[69] that did not:

(a) Consider recent science, in particular, the 2013 WHO *Review of Evidence on Health Aspects of Air Pollution*[70] which addressed recent scientific evidence specifically in relation to the 2006 WHO SO_2 24-hour guideline;

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[67] Refer evidence of Ms Gobby at Attachment B.
[68] New Zealand Starch, 2013. Application for renewal of air discharge permit, New Zealand Starch Limited, Onehunga, Auckland, 27 May 2013, at page 19. [Maximum predicted 24-hour SO_2 concentration of 3.8 $\mu g/m^3$ at nearest residential area + 8 $\mu g/m^3$ assumed background concentration (Auckland Council, 2014) = 12 $\mu g/m^3$].
[69] Golder Associates, 2014. *Literature Review on Sulphur Dioxide Air Guidelines*, Report prepared by Golder Associates for unstated client, February.
[70] WHO, 2013 at paragraph 4.2

(b) Consider the wider research findings emphasised by WHO in developing the global air quality guidelines in 2006.[71] This is particularly important for SO_2, which is a precursor for secondary particulate formation. As a result the review did not consider lack of threshold effect for particulate, ever increasing range of health effects or possible additional public health protection gained from co-benefits of action to reduce ambient SO_2.

5.47 More importantly Golder's review ignored the stated intent of adopting a precautionary approach. It also made assertions regarding the lack of adoption of the 2006 WHO SO_2 24-hour guideline in Australia, Canada and the United Kingdom that I do not agree with. In most cases because a lack of evidence that a regulator is considering a guideline is not proof positive that regulators have decided *against* adopting a guideline. They are not, therefore, *decisions* as such. Further comments in respect of the Golder's review are contained in **Attachment D**.

5.48 I understand the Independent Hearings Panel has queried:[72]

> *Whether and if so to what extent there is a basis in terms of s32 RMA for the Auckland regional plan provisions to include rules which set higher standards for air quality than are set by national standards?*

5.49 The 24-hour SO_2 AAAQS is a different time average to the (1-hour) national air quality standards for SO_2 (signalled by asterisks in **Table 1**). However, it could be argued that the 24-hour SO_2 AAAQS is more stringent in practice than the NESAQ because it is significantly lower (albeit over a different time average).

5.50 As outlined in the evidence of Mr Nunns,[73] the costs and benefits of the proposed 24-hour SO_2 AAAQS are likely to be minor because all areas (except the waterfront where port-related emissions are exempt from current regulation) already meet the proposed standard.

5.51 One area that has not been raised by submitters is the number of permissible exceedances of the 24-hour SO_2 AAAQS. The 2006 WHO SO_2 24-hour guideline does not specify any permissible exceedances but it does include

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[71] WHO, 2006 at paragraph 4.2
[72] Hearing Topic 035 Air Quality Parties and Issues Report, 30 January 2015. 035 Air Quality PIR 2015-01-30
[73] Refer evidence of Mr Nunns at paragraph 8.16

two interim targets to assist areas struggling to meet the guideline.[74] In my opinion, it would be reasonable:

(a) Based on the time average (24-hours) to apply a 99.9%ile approach to permissible exceedances (i.e. include one permissible exceedance for SO_2 per year in **Table 1** similar to PM_{10} and $PM_{2.5}$); and

(b) Apply the WHO interim targets in a step-wise manner to consent applications with localised areas struggling to meet the 24-hour SO_2 AAAQS. This could be achieved through guidance developed to assist the implementation of the AAAQS.

5.52 In my opinion, the 24-hour SO_2 AAAQS based on the 2006 WHO SO_2 24-hour guideline is reasonable and appropriate for Auckland.

Annual NO_2 AAAQS

5.53 The AAAQS introduces a new annual ambient concentration limit for nitrogen dioxide (**annual NO_2 AAAQS**) of 40 µg/m^3. I support the introduction of this annual NO_2 AAAQS, and the designation of NO_2 as a priority pollutant in Auckland, for the following reasons:

(a) The annual NO_2 AAAQS is based on the 2006 WHO global air quality guideline for NO_2 as an annual average (2006 WHO NO_2 annual guideline).[75] As noted above, WHO global air quality guidelines are based on good science and have been developed in a transparent, documented process by world leading experts in the fields of air pollution and medicine.

(b) In 2013 WHO reviewed their 2006 WHO NO_2 annual guideline in light of recent scientific development and concluded it may need to be revised to be more stringent.[76] This conclusion was based on new studies which showed:

- Associations between long-term exposure to nitrogen dioxide and mortality and morbidity (i.e. illness) at concentration levels that were at or below current EU limit values.

[74] WHO, 2006 at paragraph 4.2
[75] *Ibid.*
[76] WHO, 2013 at paragraph 4.2

- Mechanistic support for a causal interpretation of associated respiratory effects based on chamber and toxicological evidence.

(c) Epidemiological studies show that long-term exposures (i.e. one or more years) to nitrogen dioxide may lead to changes in lung function growth in children, symptoms in asthmatic children and preterm birth.[77]

(d) Nitrogen dioxide is emitted primarily from motor vehicles and industry in Auckland. Despite marked improvements in vehicle technology and tightening of emission and fuel regulations, ambient levels of nitrogen dioxide are not reducing as predicted. Ambient air quality monitoring data for Auckland shows that long-term levels of NO_2 have increased or remained stable since 2007 (refer **Attachment B**).

(e) At present, approximately 54,000 people (almost 4% of Auckland's population)[78] live within 70 m of a regional arterial route or 150 m of a strategic route.[79] Auckland's population is expected to grow significantly in the next few decades. The Auckland Growth Concept proposed to adopt more mixed use zones and higher density dwellings along regional arterials and strategic routes. This means that the long-term exposure of Aucklanders to nitrogen dioxide is likely to increase.

5.54 As outlined in the evidence of Mr Nunns,[80] the benefit of the annual NO_2 AAAQS is that it helps avoid a scenario in which the health costs of poor air quality increase over time. The costs may include offsetting growth in emissions by investing in cleaner technologies or retrofitting older vehicles and are consequently more likely to be borne by emitters of new discharges but only if they trigger a future offsetting requirement (this is not currently required). This is discussed in paragraph 8.16.

5.55 In my opinion the annual NO_2 AAAQS based on the 2006 WHO NO_2 annual guideline is reasonable and appropriate for Auckland.

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[77] CARB 2007. *Review of the California ambient air quality standard for nitrogen dioxide*. Sacramento, California Environmental Protection Agency Air Resources Board.
[78] 2013 Census data.
[79] Auckland Council,2014a. *Future Trends in Motor Vehicle Emissions in Auckland*, TR2014/28, June.
[80] Refer evidence of Mr Nunns at paragraph 8.12 – 8.13

6. AIR QUALITY TRANSPORT CORRIDOR SEPARATION OVERLAY

6.1 I support the evidence of Mr Jeremy Wyatt on behalf of Auckland Council regarding the introduction of an Air Quality Transport Corridor Separation Overlay to separate new early childhood education centres from harmful emissions to air from motor vehicles on busy roads in Auckland.[81] My reasons for this are as follows:

(a) Transport is a major contributor to air pollution emissions in Auckland, contributing 47 per cent of PM_{10}.[82] Air quality in Auckland consistently approaches, and sometimes exceeds the AAAQS. This means that whilst exceedances are not regular, background levels are regularly elevated (i.e. annual public exposure may be significant).

(b) There is a substantial body of international and national evidence that shows that exposure to vehicle-related air pollution is harmful to human health. In 2005, WHO concluded that transport-related air pollution contributes to an increased risk of death, particularly from cardiopulmonary causes.[83] It increases the risk of respiratory symptoms and diseases that are not related to allergies. At that time (2005) only a few studies had been conducted on the effects of transport related air pollution and cardiovascular morbidity, but those available reported a significant increase in the risk of myocardial infarction following exposure. Similarly, a few studies suggested an increased incidence of lung cancer in people with long-term exposure to transport-related air pollution, and adverse outcomes in pregnancy such as premature birth and low birth weight.

(c) Air pollution impacts are determined by how much is emitted, and also how people are exposed. Air pollutants dissipate over distance. Therefore, typically the closer an individual is to the source of pollution the greater their exposure and associated effects are likely to be. A 2008 review of scientific literature found 25 (out of 29) papers reported statistically significant associations between proximity to busy roads with at least one of the following adverse health effects:[84]

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[81] Refer statement of evidence of Mr Jeremy Wyatt on behalf of Auckland Council dated 9 February 2015.
[82] Auckland Regional Council, 2014 at paragraph 4.2
[83] WHO, 2005. *Health effects of transport-related air pollution: summary for policy-makers,* Michal Krzyzanowski, Copenhagen, Denmark.
[84] Boothe V, Shendel D, 2008. Potential health effects associated with residential proximity to freeways and primary roads: review of scientific literature, 1999-2006. *J Environ Health*, 70.8 (April 2008):33-41.

- Increased prevalence and severity of symptoms of asthma and other respiratory diseases;
- Diminished lung function;
- Adverse birth outcomes;
- Childhood cancer; and/or
- Increased mortality risks.

(d) A 2010 systematic review by the (US) Health Effects Institute concluded that living close to busy roads appears to be an independent risk factor for the onset of childhood asthma.[85] Further, the evidence is sufficient to infer a causal association between traffic exposure and exacerbation of asthma. Asthma is also common among Auckland children with Maori and Polynesian children disproportionately represented.

(e) As with other pollutants, it appears that newer studies are showing more health effects associated with more health outcomes. For example, a 2011 study of mice exposed to traffic fumes was linked with brain damage, including signs associated with memory loss and Alzheimer's disease.[86]

(f) In March 2012, the updated Health and Air Pollution in New Zealand study estimated 126 premature deaths associated with air pollution from vehicles every year in Auckland.[87]

(g) In June 2012, IARC classified diesel engine exhaust as carcinogenic to humans (Group 1) because exposure is associated with an increased risk for lung cancer.[88] Emissions from diesel vehicles in Auckland are disproportionate emitters of particulate matter, and this source is concentrated on motorways and strategic and primary arterials.

(h) On a weight of evidence approach, I consider that residential proximity to traffic can be associated with adverse health effects.

The studies were from geographically diverse locations including Alaska, Canada, Colorado, France, Germany, Italy, Taiwan, the Netherlands, the United Kingdom and the United States. Adverse effects were reported for traffic counts as low as 5,000 – 9,000 vehicles per day as well as for busy highway averages of up to 93,000 vehicles per day.

[85] Health Effects Institute, 2010. Traffic Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure and Health Effects, Special Report 17, January.

[86] Morgan *et al*., 2011. Glutametergic Neurons in Rodent Models Respond to Nanoscale Particulate Urban Air Pollutants In Vivo and In Vitro, *Environmental Health Perspectives*. 7 April.

[87] Kuschel *et al*., 2012 at paragraph 4.2.

[88] IARC, 2012 at paragraph 4.2.

6.2 In his statement of evidence dated 9 February 2015, Mr Wyatt states that there are 917 early childhood education centres in Auckland (based on 2014 data from the Ministry of Education).[89] Based on available GIS information, he has identified around 180 early childhood education centres (20%) are located within either 70 m of a primary arterial route or 150 m of a motorway or strategic arterial route in Auckland. This is comparable with the earlier Auckland Council estimate of 162 centres within these distances (based on 2008 Ministry of Education data) allowing for population increase.[90] However, it is lower than the ARPHS 2009 estimate of 228 centres (24%) being within these distances. If each centre comprised 40 children, this equates to around 7,000 – 8,000 babies, infants and children exposed to elevated levels of air pollution from traffic whilst in paid care.

6.3 The average exposure of children attending early childhood education centres is around 18 hours per week.[91] Kindercare Learning Centres [7312] have submitted that the exposure of children in centres in these locations is significantly less than at homes located on or close to busy roads. However, motor vehicle pollutants such as particulate matter and diesel particulate are carcinogenic with no 'safe threshold,' therefore any reduction in exposure is desirable. This is especially true for children living close or on busy roads in Auckland.

Why early childhood education centres?

6.4 Kindercare Learning Centres [7312] have queried the application of the Air Quality Transport Corridor Separation overlay only to early childcare centres, stating there is no evidence that children under six are any more susceptible to air pollution than say primary or intermediate age children.

6.5 In fact, the science is very clear that younger children, particularly infants and babies are more vulnerable to air pollution than older sections of the population.[92] In her report to the Minister for the Environment, Dr Deborah Read noted:[93]

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[89] Refer evidence of Mr Wyatt
[90] Emission Impossible Ltd, 2012 at paragraph 4.2
[91] *Ibid.*
[92] WHO, 2006 (Page 78) at paragraph 4.2
[93] Technical Advisory Group, 2011. Air Quality - Getting the Balance Right, Report of the Technical Advisory Group on National Air Quality Standards, 10 November 2009. At Annex 8

This is because younger children are particularly susceptible due to immature lungs, incomplete metabolic systems, immature defence mechanisms, high respiratory infection rates, and a higher respiration rate and therefore higher intake per unit of body weight, and activity patterns which can lead to higher exposure and higher doses reaching the lungs. There is increasing evidence that supports the possibility that much of the morbidity and mortality related to air pollution in children occurs via interactions with respiratory infections which are common among children. Asthma is also common among New Zealand children.

Science behind proposed separation distances

6.6 Submitters I and M Selak Ltd [4798] requested strong evidence to support the introduction of the Air Quality Transport Corridor Separation policy. Zeyin Li [319] considered the choice of 150 m as a separation distance to be excessive, noting that houses are already 50 m within motorways and requested it be changed to 100 m.

6.7 A detailed technical justification for the selected separation distances of 150 m from motorways and strategic arterial routes, and 70 m from primary arterials was provided in an appendix to the section 32 evaluation.[94] This may be summarised as follows:

(a) The predominant view is that the concentrations of pollutants rapidly decline with distance and that the impacts of traffic are largely confined to within 150 – 300 m;[95]

(b) Despite this, elevated levels of pollutants and statistically significant associations have been reported out to and beyond 500 m;[96]

(c) Taking a risk based approach, dispersion modelling using the NZTA air quality screening model[97] for priority pollutants (PM_{10}, $PM_{2.5}$ and nitrogen dioxide) indicates that:

i. Beyond 70 m, all pollutants are at or below 5% of the AAAQS for 95% of all primary arterial routes;[98] and

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[94] Emission Impossible Ltd, 2012 at para 4.2. NB: Name change (only) from 'regional' arterial routes to 'primary' arterial routes.
[95] *Ibid.*
[96] Brunekreef *et al.*, 1997, Gauderman, 2000, 2005 and 2007, Hu *et al.*, 2009, Canadian Ministry of the Environment, 2006, Maheswaren and Elliot, 2003, Roorda-Knape *et al.*, 1998
[97] Now available at: http://air.nzta.govt.nz/screening-model NB: Version 1 of this model (which includes $PM_{2.5}$) was used for the assessment in Emission Impossible Ltd, 2012, at para 4.2. Version 2 does not include $PM_{2.5}$ (which was in any case assumed to be identical to PM_{10} in Version 1).

ii. Beyond 150 m, PM_{10} and $PM_{2.5}$ are at or below 5% of the AAAQS for 95% of all motorways and strategic arterial routes;[99] and

iii. Beyond 150 m, nitrogen dioxide is around 10% of the AAAQS for 95% of all motorways and strategic arterial routes.

iv. As such, the modelling indicates that beyond these distances, the air quality risk level is 'small' for PM_{10} and $PM_{2.5}$.[100]

v. Lower bound modelling indicates that for routes with less than 10,000 vehicles per day, the air quality risk for all pollutants is 'negligible'.[101]

6.8 In my view, therefore, the distances of 70 m and 150 m are appropriate for the Air Quality Transport Corridor Separation policy.

Mitigation of transport emissions

6.9 AMP Capital Property Portfolio Ltd [2575] requested the use of barriers and screens to mitigate emissions to air from motor vehicles, similar to noise. Unfortunately, unlike noise, motor vehicle emissions to air cannot be abated or mitigated by barriers and screens.

6.10 With the possible exception of high efficiency particulate arrestor (HEPA) filters on air conditioning units (which only have limited efficacy against fine particulate matter), I am not aware of any feasible mitigation options for treating motor vehicle emissions (other than at source, e.g. catalytic converters).

6.11 However, building location and centre design can go some way to lessen children's exposure. For example, locating the play area as far from the road as possible. The NZTA web based air quality screening tool is a simple way to calculate the impact of distance. This is why these parameters have been included as assessment criteria in the policy.

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[98] Routes with less than around 33,000 annual average daily traffic (AADT)
[99] Routes with less than around 240,000 annual average daily traffic (AADT)
[100] As defined by Environmental Protection UK in Environmental Protection UK (2010). *Development Control: Planning for Air Quality (2010 Update)*, Environmental Protection UK, 2010
[101] i.e. less than 1% of any AAAQS, *Ibid.*

7. AIR QUALITY SENSITIVE AREA RESTRICTION OVERLAY

7.1 I support the evidence of Mr Wyatt on behalf of Auckland Council regarding the introduction of Sensitive Activity Restriction overlays to preserve the functions of Heavy Industry areas by limiting intensification of nearby sensitivity activities.[102]

7.2 The technical rationale behind industrial separation distances is to provide for:

(a) Reduced amenity associated with heavy industry; and

(b) Residual industrial emissions

7.3 In the case of air quality around heavy industry, amenity effects can arise from:

- Odour which can create objectionable or offensive effects at levels far lower than the concentrations that can harm physical health.
- Smoke which can create nuisance, affect visibility and taint outside materials (e.g. household washing)
- Dust which can soil outside surfaces (such as cars, paintwork and household washing), deposit on flowers, fruit or vegetables, contaminate roof-collected water supplies and deposit inside houses.
- Nitrogen oxides which can combine with other gases in the atmosphere to create brown hazes thereby impacting visibility.

Air quality at levels below standards set to protect human health will not necessarily protect against such amenity effects.

7.4 Residual industrial emissions include fugitive emissions, episodic unanticipated events and/or accidental or emergency emissions (e.g. explosions or fire). These are the 'potential' effects on the environment that must be assessed under Schedule 4 of the RMA.

7.5 In addressing both amenity and residual industrial emissions, separation distances are complimentary, rather than an alternative, to existing resource management processes which require (normal) emissions to air be avoided, remedied or mitigated.

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[102] Refer evidence of Mr Wyatt

7.6 The Sensitive Activity Restriction overlays attempt to ensure that, where feasible, areas of existing reverse sensitivity do not get worse. The minimum distance of 500 m was selected as it is the 50th percentile separation distance of all industrial separation distances reviewed in other jurisdictions in Australasia.[103] As such, it is a rough mean of the types of separation distances considered necessary for industrial emissions of odour dust and, in some cases risk (i.e. residual emissions).

7.7 There was unanimous agreement at air quality expert conferencing on the choice of 500 m as a reasonable separation distance.[104] This reflected a widespread agreement on the scarcity of heavy industrial land in Auckland and the need to provide for the operation of industrial activities with discharges to air (in line with Policy 1c and 1d of RPS).

8. OFFSETS FOR PARTICULATE MATTER

8.1 The offset policies for PM_{10} and $PM_{2.5}$ are intended to provide for **new** industry with significant air discharges of particulate matter in Auckland whilst assisting compliance with the AAAQS for PM_{10} and $PM_{2.5}$ (Objective 2 and Policy 2 in RPS, Objective 6 and Policy 1 in Chapter C5.1). They are intended to be applied as outlined in **Table 2** which follows. It is important to understand that the policies do **not** apply to existing industry, unless that industry wishes to increase its emissions (into an airshed that has already exceeded its capacity).

8.2 The offsets policies make explicit provision for existing requirements for PM_{10} offsets in the NESAQ. However, they have the following additional requirements:

(a) Industries with new emissions of PM_{10} greater than four tonnes per year must also offset emissions in polluted airsheds (irrespective of whether or not it is likely to increase ambient levels of PM_{10} by more than 2.5 $\mu g/m^3$).[105] <u>This requirement is more stringent than the NESAQ.</u>

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[103] Emission Impossible Ltd, 2012 at para 4.2
[104] Expert Conference Joint Statement for hearing topic 035 – Air Quality, 17 December 2014.
[105] As a 24-hour average

(b) If the NESAQ offset requirements are no longer required but the AAAQS for $PM_{2.5}$ is still exceeded (i.e. airshed is polluted for $PM_{2.5}$ but not polluted for PM_{10}) then:

i. Industries with new emissions of $PM_{2.5}$ greater than two tonnes per year must offset emissions; or

ii. Industries with new emissions of $PM_{2.5}$ that are likely to increase ambient levels of PM_{10} by more than 1.25 $\mu g/m^3$ [106] must offset emissions.

This requirement is <u>not</u> more stringent than the NESAQ.[107]

8.3 The technical rationale for these additional requirements is discussed below.

[106] As a 24-hour average
[107] The NESAQ does not regulate $PM_{2.5}$.

Table 2. Comparison of PAUP PM_{10} and $PM_{2.5}$ Offsets Policies with NESAQ

Application	NESAQ offset requirement for PM_{10}	PAUP offset requirement for PM_{10}	PAUP offset requirement for $PM_{2.5}$
Where?	In polluted airsheds only – i.e. airsheds with more than 1 exceedance of the NESAQ for PM_{10} as a 24-hr average[108].	In polluted airsheds only – i.e. airsheds with more than 1 exceedance of the NESAQ for PM_{10} as a 24-hr average.	In polluted airsheds only – i.e. airsheds with any exceedances of the AAAQS for $PM_{2.5}$ as a 24-hr average.
When?	This has been in force since 1 Sept 2012 and will apply until the Auckland Urban airshed is no longer polluted (i.e. achieves 5 years with no more than 1 exceedance of the NESAQ PM_{10} 24-hr standard in any year).	This has been in force since the Unitary Plan was notified and will apply until the Auckland Urban airshed is no longer polluted (i.e. achieves 5 years with no more than 1 exceedance of the NESAQ PM_{10} 24-hr standard in any year).	This will not apply until the Auckland Urban airshed meets the NESAQ for PM_{10} (and then only if the AAAQS for $PM_{2.5}$ is exceeded).
Which?	Resource consents for new or increased PM_{10} discharges. Does **not** apply to existing consented activities with PM_{10} discharges.	Resource consents for new or increased PM_{10} discharges. Does **not** apply to existing consented activities with PM_{10} discharges.	Resource consents for new or increased $PM_{2.5}$ discharges. Does **not** apply to existing consented activities with $PM_{2.5}$ discharges.
Threshold for requiring offsets	Discharges likely to increase 24-hr PM_{10} concentrations by more than 2.5 $\mu g/m^3$ must be offset.	Discharges of more than four tonnes of PM_{10} per annum but which do not trigger the NESAQ 2.5$\mu g/m^3$ concentration limit must be offset. [NB: This is in addition to NESAQ requirements]	Discharges that are likely to increase 24-hr $PM_{2.5}$ concentrations by more than 1.25 $\mu g/m^3$ **OR** Discharges of more than two tonnes of $PM_{2.5}$ per annum must be offset.

PM_{10} four tonne threshold

8.4 The additional requirement to offset new industrial emissions of PM_{10} that exceed four tonnes per year (but do not trigger the NESAQ threshold) in polluted airsheds was introduced to address Council concerns that large emitters may 'get around' the NESAQ requirements for offsets by increasing stack heights. In such cases whilst the ambient threshold is not breached, offsets are not required despite the emission actually being significant.[109] In

[108] There are 12 airsheds in Auckland – only the Auckland urban airshed is currently polluted.
[109] This reflects an inherent limitation of the ambient concentration threshold approach to defining 'significance' in the NESAQ.

this way significant new emissions of PM_{10} may still be introduced to the airshed, thus subverting the original intent of the offsets (i.e. that new emissions are offset to ensure that overall emissions do not increase).

8.5 For example, a recent application would have increased overall PM_{10} emissions to the Auckland airshed by 60 tonnes per annum but, because it was predicted to increase ambient levels of PM_{10} by less than 2.5 $\mu g/m^3$, it was not required to be offset.[110] Total annual industrial emissions of PM_{10} in the Auckland airshed are only around 480 tonnes per year[111] so this was a significant emission.

8.6 The limit of four tonnes PM_{10} per year was selected by council as being indicative of significant emitters in the Auckland airshed as shown in **Figure 1** below.

(NB: When viewing **Figure 1** it is very important to note that offsets are <u>not</u> required for existing industry).

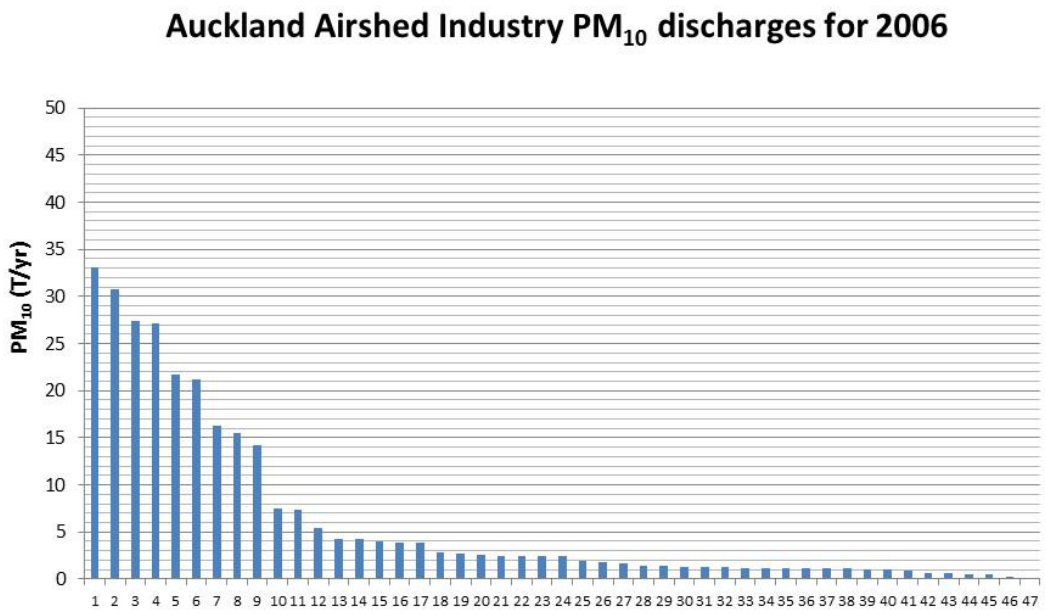

Figure 1 Industrial discharges of PM_{10} in 2006. *Source: Auckland Council*

8.7 The proposed PM_{10} four tonne threshold is more stringent than the PM_{10} offsets requirements in the NESAQ (as permitted by Regulation 28 of the

[110] Personal comms. Mike Harvey, Auckland Council, 24 November 2014
[111] Auckland Council, 2014b at paragraph 4.2

NESAQ). I understand the Independent Hearings Panel has queried its basis under s32 of the RMA.[112]

8.8 As outlined in the evidence of Mr Nunns,[113] the health benefits (in terms of avoided health costs) of the proposed PM_{10} offset policy substantially outweigh the likely costs to emitters of new discharges. The offsets policies specifically provide for new entrants to the airshed and thus provide for economic growth but not at the expense of people's health or the environment. The new (more stringent) four tonne threshold seeks to make the PM_{10} offset policy fairer so that industry cannot 'game' the rules. It is thus a more efficient and effective policy than that required by the NESAQ.

8.9 At conferencing, air quality experts all agreed that the offset policy as notified had inadvertently introduced inconsistencies with the existing offset requirements of the NESAQ.[114] Accordingly, I have redrafted the policy to be true to the intent as outlined above and in **Table 2**.[115] This has necessitated an additional, minor technical amendment to Policy 19 for monitoring of air quality to clarify that reporting of compliance with the AAAQS will exclude exceedances caused by exceptional circumstances beyond the reasonable control of Council.[116]

$PM_{2.5}$ Offsets

8.10 The additional requirement for offsets for $PM_{2.5}$ largely mirrors the existing requirements of the NESAQ, albeit as applied to $PM_{2.5}$ (which is a subset of PM_{10}). It is important to note that the $PM_{2.5}$ offsets will only be required in the event that an airshed is polluted for $PM_{2.5}$ – but not polluted for PM_{10}. This is to avoid doubling up on the regulatory requirements for related pollutants because industrial emissions are typically 90% $PM_{2.5}$.

8.11 It is also important to note that the intent of the $PM_{2.5}$ offsets is for Council to provide for new entrants to the airshed (by avoiding having to decline consent because the $PM_{2.5}$ standard is breached and the new entrant seeks to add more $PM_{2.5}$ emissions). The offsets are **not** required for existing

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[112] Hearing Topic 035 Air Quality Parties and Issues Report, 30 January 2015. 035 Air Quality PIR 2015-01-30
[113] Refer evidence of Mr Nunns at paragraph 9.10
[114] Expert Conference Joint Statement for hearing topic 035 – Air Quality, 17 December 2014.
[115] Refer evidence of Ms Gobby at Attachment B.
[116] *Ibid.*

industry (unless they wish to increase existing consented levels of $PM_{2.5}$). The $PM_{2.5}$ offsets are not more stringent than the NESAQ.[117]

8.12 The technical rationale for the $PM_{2.5}$ offsets policy relies on it being a priority pollutant that currently exceeds the 24-hour $PM_{2.5}$ AAAQS (refer **Attachment B**) in the Auckland urban airshed.[118] This is where the majority of people live in Auckland so it is important to ensure their health is not adversely impacted by providing for new industry.

8.13 As outlined in the evidence of Mr Nunns,[119] the health benefits (in terms of avoided health costs) of the proposed $PM_{2.5}$ offset policy substantially outweigh the likely costs to emitters of new discharges.

8.14 A number of submitters sought to delete this policy in its entirety whilst others requested it not be more stringent than the national environmental standards for air quality.[120] Such requests ignore that $PM_{2.5}$ is a priority pollutant in Auckland and is a carcinogen for which there is no safe threshold.

Offsets for other pollutants

8.15 Mighty River Power sought the addition of a new policy to enable the use of offsets for other contaminants to assist compliance with the national environmental standards for air quality. Council provided relief in proposed Policy 24.[121]

8.16 As outlined in the evidence of Mr Nunns,[122] the policy providing for offsets for other pollutants (including NO_2) is likely to pose little or no cost on emitters of new discharges because offsets are not required at this stage. If these offsets were required at a future date, then costs and benefits would be appropriately assessed then.

9. CONCLUSION

9.1 The proposed Auckland Ambient Air Quality Standards (**AAAQS**) are identical to existing provisions in the Auckland Regional Plan, incorporating

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[117] The NESAQ does not regulate $PM_{2.5}$
[118] NB: This is not to be confused with annual average $PM_{2.5}$ which is currently below the AAAQS at all monitoring locations in Auckland.
[119] Refer evidence of Mr Nunns at paragraph 9.13
[120] New Zealand Health Association Limited trading as Sanitarium Health and Wellbeing Company [4359-18], PACT Group (New Zealand) Limited [7109-2], New Zealand Steel Ltd [868-46], Stevenson Group Ltd [3682-66].
[121] Refer evidence of Ms Gobby at Attachment B.
[122] Refer evidence of Mr Nunns, at paragraph 9.15

both national environmental standards for air quality (**NESAQ**) and regional air quality targets. They are not more stringent than the NESAQ.

9.2 During conferencing air quality experts agreed that the AAAQS concentration limits are appropriate for health protection purposes. However, air quality experts do not agree to the mandatory nature of air quality 'standards' and expressed concerns over aspects of implementation. In my opinion based on the:

- seriousness of the adverse health impacts, which include premature mortality, caused by air pollution;
- carcinogenicity of priority pollutants such as particulate matter less than 2.5 micrometres in diameter ($PM_{2.5}$); and
- observed health effects at levels below the AAAQS,

Auckland air quality management for public health protection warrants the use of 'standard'. I further consider that concerns over implementation should not detract from the value of a standard, particularly with respect to monitoring and reporting on air quality in Auckland.

9.3 Council is also proposing three new AAAQS – annual nitrogen dioxide (NO_2), annual $PM_{2.5}$ and 24-hour sulphur dioxide (SO_2). The 24-hour SO_2 AAAQS (which has proved contentious) is based on the 2006 WHO global air quality guideline for SO_2 as a 24-hour average. It is lower than the existing New Zealand guideline and could be argued as being more stringent in practice than the 1-hour national air quality standards (albeit over a different time average). I understand the Independent Hearings Panel has queried the basis of any rules more stringent than national standards under s32 of the RMA.[123] I think the 24-hour SO_2 AAAQS is reasonable based on a precautionary approach. Most areas of Auckland will easily meet it. The evidence of Mr Nunns provides a cost benefit analysis that shows the new AAAQS will future proof public health protection and will be achieved at a low cost.[124]

9.4 I support the introduction of the Air Quality Transport Corridor Separation Overlay. There is strong scientific evidence that exposure to vehicle-related air pollution is harmful to human health. The selected distances have been based on dispersion modelling using NZTA models to ensure that air quality

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[123] Hearing Topic 035 Air Quality Parties and Issues Report, 30 January 2015. 035 Air Quality PIR 2015-01-30
[124] Refer evidence of Mr Nunns at paragraph 1.4.

risk is 'small'. The application of the overlay to new early childhood education centres goes some way to protecting the most vulnerable part of our community, small children and babies, whilst in paid care.

9.5 I support the introduction of Sensitive Activity Restriction overlays. This provides some measure of assistance to preserving the functions of heavy industry by providing for reduced amenity (associated with heavy industry) and residual industrial emissions.[125] During conferencing, all air quality experts agreed that the selected minimum distance of 500 m was reasonable.

9.6 I support the (redrafted) [126] policies to require offsets of particulate matter from new significant emitters into polluted airsheds. It is very important to note that the proposed offsets policies will not apply to existing industry, unless that industry wishes to increase emissions. As such, the policies provide for new entrants to the airshed that may otherwise be declined consent because the AAAQS are already breached and the airshed capacity is exceeded.

9.7 The PM_{10} offset policy includes a new four tonne per year threshold to ensure emitters cannot 'get around' the NESAQ requirements by increasing stack heights. This is more stringent than the NESAQ and I understand the Independent Hearings Panel has queried its basis under s32 of the RMA.[127] The new, more stringent, four tonne threshold seeks to make the PM_{10} offset policy fairer so that industry cannot 'game' the rules. It is thus a more efficient and effective policy than that required by the NESAQ. I note from the evidence of Mr Nunns[128] on behalf of Auckland Council that the health benefits (in terms of avoided health costs) of both the PM_{10} and $PM_{2.5}$ offsets policies substantially outweigh the likely costs to emitters of new discharges.

9.8 I support the remainder of detail with respect to air quality objectives and policies as set out in section C5.1 Air Quality of the PAUP for the additional reasons set out in my evidence.

LOUISE WICKHAM

9 FEBRUARY 2015

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[125] Residual industrial emissions being fugitive emissions, episodic unanticipated events and/or accidental or emergency emissions (e.g. explosions or fire).
[126] Refer evidence of Ms Gobby at Attachment B.
[127] Hearing Topic 035 Air Quality Parties and Issues Report, 30 January 2015. 035 Air Quality PIR 2015-01-30
[128] Refer statement of evidence of Mr Nunns on behalf of Auckland Council dated 9 February 2015

ATTACHMENT A

CURRICULUM VITAE LOUISE WICKHAM

Career Summary

Senior Air Quality Specialist, Emission Impossible Ltd, (since early 2011)

Senior Analyst, Ministry for the Environment, New Zealand (8 years)

Senior Policy & Programmes Officer, NSW Environment Protection Authority, Australia (2 years)

Senior Engineer - Air Quality, URS Australia Pty Ltd, Australia (4 years)

(Contract) **Environmental Engineer,** Environment Protection Authority Victoria, Australia (3 months)

(Contract) **Senior Engineer – Air Quality**, Woodward-Clyde NZ Ltd, New Zealand (3 months)

Business Area Manager – Air Quality, RSK Environment Ltd, United Kingdom (2 years)

(Contract) **Project Manager**, Dames & Moore, United Kingdom (3 months)

Environmental Engineer, Woodward-Clyde NZ Ltd, New Zealand (3 years)

Undergraduate Engineer, Tasman Pulp & Paper, New Zealand (9 months)

Qualifications

Master of Environmental Law, University of Sydney, Australia, 2003

Bachelor of Chemical and Materials Engineering, University of Auckland, New Zealand, 1993

Certificate in Resource Management Act 1991 decision making (grade = excellent), Ministry for the Environment, New Zealand, 2013 (current until 31 Dec 2015)

Affiliations

Advisory Board Member, School of Chemical and Materials Engineering, University of Auckland

Former Editorial Board Member, Journal of the Clean Air Society of Australia & New Zealand

Member, Resource Management Law Association

Member, Clean Air Society of Australia & New Zealand

Employment History and Highlights

since April 2011

Emission Impossible Ltd, Senior Air Quality Specialist

Providing specialist advice to a range of clients on the improved management of air quality and industrial emissions.

Example projects include:

- Commissioner for Auckland Council Hearing for air discharge permit for proposed intensive egg laying facility in Patumahoe (Decision January 2015)
- Commissioner for Hawke's Bay Regional Council Hearing for air discharge permit for proposed tyre pyrolysis plant in Napier (2014)
- Odour monitoring of two wastewater treatment plants for Tauranga City Council (2014). Co-author with Paul Baynham of AirQuality Ltd
- Odour monitoring of five pumping stations for Tauranga City Council (2014). Co-author with Paul Baynham of AirQuality Ltd
- Section 32 Cost and Benefit Analysis for proposed separation distances between busy roads and new childcare centres in the Proposed Auckland Unitary Plan for Auckland Council (2013)
- *Masterton and Carterton Domestic Fire Emissions Inventory*, (co-author with Surekha Sridhar), Report prepared for Wellington Regional Council (2013)
- Technical summary on 2013 World Health Organisation Review of evidence on health aspects of air pollution for the Ministry of Health. Presentation of summary and key findings for New Zealand to National Health Protection Forum (2013).
- Technical summary on 2013 World Health Organisation *Review of evidence on health aspects of air pollution* for the Ministry of Health. Presentation of summary and key findings for New Zealand to National Health Protection Forum, November 2013
- Assessment of Environmental Effects of Discharges to Air – Stevensons East Tamaki concrete batching plant, September 2013
- Follow-up assessment of Ngāpuna Dust Reduction Plan for Bay of Plenty Regional Council, June 2013
- Pre-lodgement review (against Section 88 of the Resource Management Act) for Environmental Protection Agency on the proposed Basin Reserve improvements by NZTA
- Economic assessment of proposal by Otago Regional Council to mandate 15 year retirement of bus contracts (in partnership with Jagadish Guria), September 2012
- Development of code of environmental practice for odour control from wastewater treatment systems for the Government of Samoa, June 2012
- Separation Distances for Roads – A Discussion Document for Auckland Council, July 2012
- Discussion document on separation distances for industry for Auckland Council to consider amenity and health impacts of industrial emissions on sensitive parts of the population, July 2012
- Development of offsets policy for the Rotorua Airshed for Bay of Plenty Regional Council, February 2012

- Development of dust management plans for 33 commercial and industrial sites in Rotorua for BOPRC. Workshop and liaison with industry on behalf of BOPRC.
- Officers Decision Report for Auckland Council on application for resource consent by Auckland Foam, January 2012
- Pre-lodgement review (against Section 88 of the Resource Management Act) for Environmental Protection Agency on the proposed MacKays to Peka Peka Expressway, January 2012
- Development of an Odour Management Plan for the proposed upgrade of the Greytown wastewater treatment plant on behalf of South Wairarapa District Council, October 2011
- Preparation of an Assessment of Environmental Effects (Air Quality) for the proposed upgrade of the Greytown wastewater treatment plant on behalf of South Wairarapa District Council (pending), October 2011
- Officers Decision Report (air quality only, co-author) for Auckland Council on application for resource consent by Matakana Metals, September 2011

Example publications include:

- Technical summary of 2013 WHO *Review of evidence on health aspects of air pollution* for the Ministry of Health. , November 2013.
- *Separation Distances for Roads*: Discussion Document for Auckland Council, July 2012.
- *Code of Environmental Practice: Odour Control from Wastewater Treatment Systems*, Ministry of Natural Resources and Environment, Samoa, June 2012.
- *Rotorua Offsets Programme: Draft Guidance for Industry and BOPRC* for Bay of Plenty Regional Council, February 2012 (available on request).
- (Co-author) *Background Air Quality for Resource Consent Applications: Draft for Consultation*, Ref: GD 2011/002, September 2011. Available on request from Auckland Council.
- Clean Air Society of Australia and New Zealand (2011). *Air Quality Regulation and Odour Management in Australia & New Zealand 2011*, June 2011.

2004 to 2011

Ministry for the Environment, Senior Analyst – Air Quality

Providing specialist advice to the Minister for the Environment on air quality policy and regulation in New Zealand. Representing the Ministry for the Environment in regulatory fora, research steering groups, special interest groups, technical advisory panels and industry groups.

Example projects include:

- Revision and update of New Zealand's national air quality standards. This included:
  - Project management of regulatory amendment
  - Preparation of briefings, cabinet papers, regulatory impact statements
  - Updating cost benefit analyses to reflect amended policy
  - Specialist advice to Minister for the Environment
  - Specialist advice to technical reference groups drafting regulations
  - Specialist advice to technical advisory group reporting to Minister

- Review of implementation of the national air quality standards by regional councils in New Zealand.
- National audit of wood burners (2006 Phase 1 and 2, commenced 2011 audit).
- Preparation of Users Guide to National Air Quality Standards (2004, update 2005)
- Peer review of numerous Ministry publications including all air quality website related information
- Project management, peer review and publication of New Zealand air quality best practice guidance

Example representative and relationship roles include:

- Environment Protection and Heritage Council (EPHC) of Australia and New Zealand Air Quality Working Group (reporting to EPHC Steering Committee and Ministerial Council)
- New Zealand National Air Quality Working Group
- Joint research steering groups (New Zealand Transport Agency, Health Research Council-Ministry for the Environment-Ministry of Health-Ministry of Transport, Foundation for Research, Science and Technology)
- Liaison with New Zealand Home Heating Association Executive (manufacturers)
- Joint Australia/New Zealand Technical Standards Committee for wood burner test methods (CS-62)

Example publications include:

Ministry for the Environment (2011). *Revised National Environmental Standards for Air Quality – Section 32 Evaluation*, Ministry for the Environment, March 2011.

Ministry for the Environment (2011). *Proposed Amendments to the National Environmental Standards for Air Quality Report on Submissions*, Publication ME1037, Ministry for the Environment, January 2011.

Ministry for the Environment (2010). *Regulatory Impact Statement: Amending the PM_{10} Air Quality Standards*, Ministry for the Environment, November 2010.

Ministry for the Environment (2009). *2008 Report on Progress: National Environmental Standards for Air Quality*, Publication ME945, Ministry for the Environment, June 2009.

Ministry for the Environment (2008). Co-author *Good Practice Guide for Assessing Discharges to Air from Industry,* Publication ME880, Ministry for the Environment, June 2008.

Ministry for the Environment (2008). *Good Practice Guide for Assessing Discharges to Air from Industry: Report on Submissions on Draft for Consultation*, Publication ME882, Ministry for the Environment, June 2008.

Ministry for the Environment (2008). Co-author *Good Practice Guide for Assessing Discharges to Air from Land Transport,* Publication ME881, Ministry for the Environment, June 2008.

Ministry for the Environment (2008). *Good Practice Guide for Assessing Discharges to Air from Land Transport: Report on Submissions on Draft for Consultation*, Publication ME883, Ministry for the Environment, June 2008.

Ministry for the Environment (2008). *National Wood Burner Performance Review: Phase 2*, Publication ME875, Ministry for the Environment, April 2008.

Ministry for the Environment (2007). *National Wood Burner Performance Review: Phase 1*, Publication ME815, Ministry for the Environment, June 2007.

Ministry for the Environment (2005). Co-author *Updated Users Guide to Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 (Including Amendments 2005) (second draft)* Publication ME695, Ministry for the Environment, October 2005.

Ministry for the Environment (2004). Co-author *Good Practice Guide for Atmospheric Dispersion Modelling*, Publication ME522, Ministry for the Environment, June 2004.

2002 to 2004

NSW Environment Protection Authority, Senior Policy & Programmes Officer

Project manager for remake (update) of State regulations for industrial emissions to air. Liaison with industry, international review of industrial emissions best practice, public consultation, specialist advice for State Government.

Example projects include:

- Overall responsibility for developing an update to the *Clean Air (Plant and Equipment) Regulation 1997* through an amendment to the *Protection of the Environment (Clean Air) Regulation 2002*.
- Project manager for small boiler combustion analysis and tune-up for 500 combustion units in western and south-western Sydney to reduce emissions of oxides of nitrogen.

1998 to 2002

URS Australia Pty Ltd, Senior Engineer – Air Quality

Wide range of air pollution consultancy projects focussing on industrial emissions. This included preparation of air quality assessments for environmental impact statements and odour investigations. Co-ordinator for URS Asia Pacific Air Quality Team (13 specialists).

Example projects include:

- Air quality assessment for Environmental Impact Statement for Orica's proposed hexachlorobenzene (toxic) waste destruction facility in Botany, NSW. Preparation of submission for Commission of Inquiry and ongoing specialist advice.
- Odour investigation using measurement and analysis by dynamic dilution olfactometry for a composting facility in South Sydney. Computer dispersion modelling of emissions and workshop with local community.
- Mass balancing and assessment of emissions (including hazardous pollutants) from a confectionary manufacturer in Capetown, South Africa on behalf of Pfizer International. Project required attendance of a training session in New York to meet Pfizer reporting requirements.
- Odour investigations including monitoring and dispersion modelling for:
    - a former gas works site undergoing extensive remediation in Mortlake, Sydney
    - the largest chicken manure fertiliser manufacturing facility in Australasia (Wyee, New South Wales)
    - large domestic waste landfill (Jacks Gully) in southern Sydney

- Contract review, audit and technical assistance for 4-year ambient air quality monitoring programme around 3 power stations in central Queensland.

1998 (3 months)

Environment Protection Authority Victoria, (Contracted) Environmental Engineer

Study of the regulatory options available to the Environment Protection Authority, Victoria, for the control of emissions from industry and area sources. Focus on regulatory policy in use both here in Australia and around the world.

Publication:

Environment Protection Authority Victoria (1998). Co-author *Exploring the Possibilities*, EPA Victoria. 1998.

1997 -1998 (3 months)

Woodward Clyde (NZ) Ltd, (Contracted) Environmental Engineer

Industrial air pollution consultancy.

1996 -1997

RSK Environment Ltd (UK), Business Area Manager – Air Quality

Manager for a team of four air quality specialists. Wide range of air pollution consultancy projects with a focus on industrial emissions and urban emissions inventories.

Example projects include:

- Environmental impact assessment (air quality) for a pipeline from Baku to the Georgia border, Azerbaijan.
- Offshore investigation into NOx emissions from gas turbines on Elf Piper B platform in the North Sea, UK. Emissions estimation using US EPA emission factors adjusted for local conditions, modelled using SCREEN for (surprisingly good) comparison with ambient measurements using NOx diffusion tubes.
- Project Manager for the preparation of industrial air emissions inventories on behalf of the UK Department of the Environment, Transport and the Regions (DETR) for the following metropolitan areas;
    - Glasgow
    - Greater Manchester
    - Leeds/Bradford
    - Merseyside
    - Middlesborough
    - Newcastle
    - Portsmouth/Southampton
    - Port Talbot/Swansea

    - West Midlands

- Project Manager for the completion of an industrial emissions inventory for Greater London under a contract with the South Eastern Institute for Public Health (UK).
- VOCs emissions testing, environmental auditing, cleaner production initiatives study for a car care products manufacturer in Newquay, UK.
- Asbestos testing for a newly commissioned offshore drilling rig, Baku, Azerbaijan.
- Preparation and delivery of training course in atmospheric dispersion modelling for Elf on emissions from an oil terminal on Orkney Islands, UK.

Example publications include:

London Research Centre (1998). Co-author *Portsmouth/Southampton, Merseyside and Port Talbot/Swansea Atmospheric Emissions Inventory*, London Research Centre, London, UK, 1998.

London Research Centre (1997). Co-author *Greater Manchester Atmospheric Emissions Inventory*, London Research Centre, London, UK, June 1997.

1996 (3 months)

Dames & Moore, (Contracted) Project Manager

Due diligence auditing for a variety of industrial and corporate facilities, UK.

1993 -1995

Woodward-Clyde (NZ) Ltd, Air Pollution Engineer

Wide variety of air quality consultancy projects with a focus on the preparation of assessment of environmental effects for consent applications under the Resource Management Act 1991 and odour investigations. The majority of projects utilised atmospheric dispersion modelling techniques.

Example projects include:

- Environmental impact assessment (discharges to air) for
    - a large emulsions and resins manufacturer in Auckland, NZ.
    - two can coating facilities in Auckland, NZ. Preparation of emissions inventory, chemicals and odour testing, dispersion modelling, liaison with regulatory authority and assessment of abatement control.
    - a lead smelting operation, Auckland NZ. Metals testing, dispersion modelling and obtaining resource consent.
    - Mobil (N.Z.) bulk oil terminal and grease and lubricants mixing facility in Wellington, NZ.
- Task Leader for Environmental Impact Assessment (discharges to air) for six Dairy milk processing facilities in the Waikato, NZ. Dispersion modelling of suspended and deposited particulate and criteria pollutants. Preparation of assessment of environmental effects to support (successful) application for resource consent.

- Odour investigation for a sausage casings manufacturer in Auckland, NZ. Measurement and analysis by dynamic dilution olfactometry, assessment of pilot plant scrubber, review of alternative abatement technologies including ozone treatment and biofiltration.
- Odour investigation using measurement and analysis by dynamic dilution olfactometry for a composting facility in the Waikato, NZ.
- Odour investigation into emissions from Calciner and CO Absorption tower at Du Pont's hydrogen peroxide manufacturing facility in the Waikato, NZ. Gas Chromatography with Mass Spectroscopy was used to identify a range of aldehydes and ketones.
- Atmospheric dispersion study of sulphur dioxide emissions from a fertiliser plant, Dunedin, NZ.

Models used include:

- AUSPLUME (Gaussian Plume Dispersion Model)
- ISC3 (US EPA Dispersion Model)
- CALMET/CALPUFF (US EPA Complex Terrain Dispersion Models)
- SCREEN (US EPA Screening Dispersion Model)
- CTSCREEN (US EPA Complex Terrain Screening Dispersion Model)
- TSCREEN (US EPA Toxic Release Screening Dispersion Model)
- CHARM (Radian International Complex Hazardous Release Model)
- SLAB (US National Technical Information Centre Dense Gas dispersion model - flat terrain)
- DEGADIS (US EPA Dense Gas Dispersion Model)

Other specialised training

- Certificate in Resource Management Act 1991 decision making (grade = excellent), Ministry for the Environment, New Zealand, 2013 (current until 31 Dec 2015)
- CALMET/CALPUFF (complex terrain modelling) training course, Brisbane, 2000
- Odour Workshop (EPA Vic), Melbourne, 1998
- Air Quality Management in European Cities (South Eastern Institute of Public Health), London, UK, July 1997
- Offshore Survival Training Course (OPITO certified to UK OOA guidelines), Aberdeen, UK, 1997
- Complex Hazardous Air Release Model (CHARM), Users Training Course, Kaiserslaten, Germany, 1997
- Integrated Pollution and Prevention Control Conference (IBC), London, UK, 1996
- 40 hr Health and Safety Training Course for Hazardous Waste Sites (Woodward-Clyde)

ATTACHMENT B

Ambient levels of $PM_{2.5}$ and nitrogen dioxide (NO_2) in Auckland

Figure B-1 and **B-2** which follow, present annual average $PM_{2.5}$ concentrations for a variety of monitoring locations (roadside, port, urban and rural) in Auckland between 2003 and 2013. The data shows that existing annual $PM_{2.5}$ levels in Auckland are below the AAAQS at all monitoring locations. The last ten years shows an overall decreasing trend although, levels have stabilised since 2011.

Figure B3 disaggregates annual average $PM_{2.5}$ data to estimated, and monitored, annual average levels by census area unit.[129]

Figure B-4 and **B-5** presents maximum 24-hour average (peak daily) $PM_{2.5}$ for a variety of monitoring locations (roadside, port, urban and rural) in Auckland between 2003 and 2013.[130] **Figure B-6** attempts to remove inter-annual variability by presenting peak daily $PM_{2.5}$ as a three-year rolling average for the two sites with the longest data record (Khyber Pass Rd and Queen Street - both of which are traffic sites). **Figure B-7** presents the annual number of exceedances of the 24-hour $PM_{2.5}$ AAAQS. **Figure B-7** also includes a five-year rolling average of exceedances to remove inter-annual variability and for consideration of the $PM_{2.5}$ Offsets Policy (which is predicated on a five-year rolling average number of exceedances).

The data show that existing peak daily $PM_{2.5}$ levels in Auckland are highly location dependent, with significant inter-annual variability and no clear trend. Peak daily $PM_{2.5}$ levels at roadside sites range from 10 – 40 $\mu g/m^3$ and exceed the 24-hour $PM_{2.5}$ AAAQS (25 $\mu g/m^3$) between one and eight times a year. The smoothed data in **Figures B-6** and **B-7** show a slight overall decreasing trend in peak daily $PM_{2.5}$ that, like annual $PM_{2.5}$, may have stabilised since 2011. However, this overall trend has exceptions - peak daily $PM_{2.5}$ appears to be increasing at Khyber Pass Rd and Patumahoe.

Figure B-8 shows passive nitrogen dioxide concentrations across the Auckland (central) region have increased or remained stable since monitoring commenced in 2007. **Figure B-10** presents continuous nitrogen dioxide monitoring undertaken by Auckland Council showing similar trends.

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[129] Auckland Council, 2014 at n20
[130] NB: All data exclude exceptional events in 2009 (Australian dust storm)

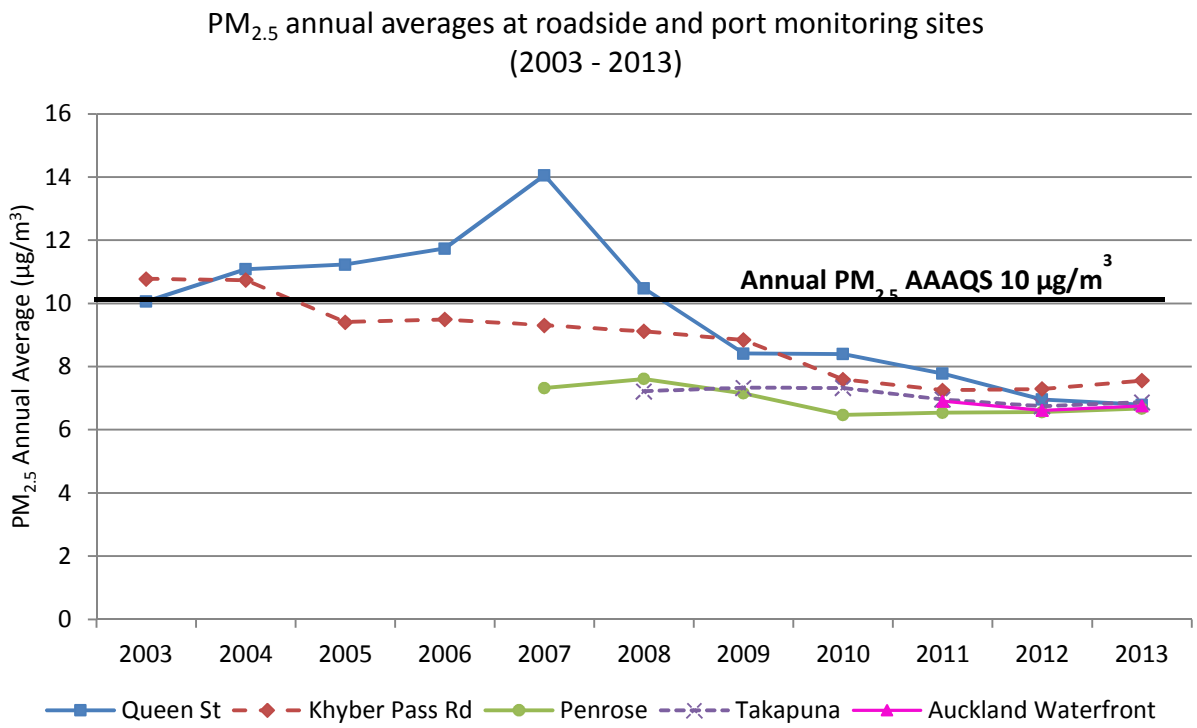

Figure B-1 Annual average $PM_{2.5}$ at roadside and port monitoring locations, 2003 – 2013. Source: Auckland Council

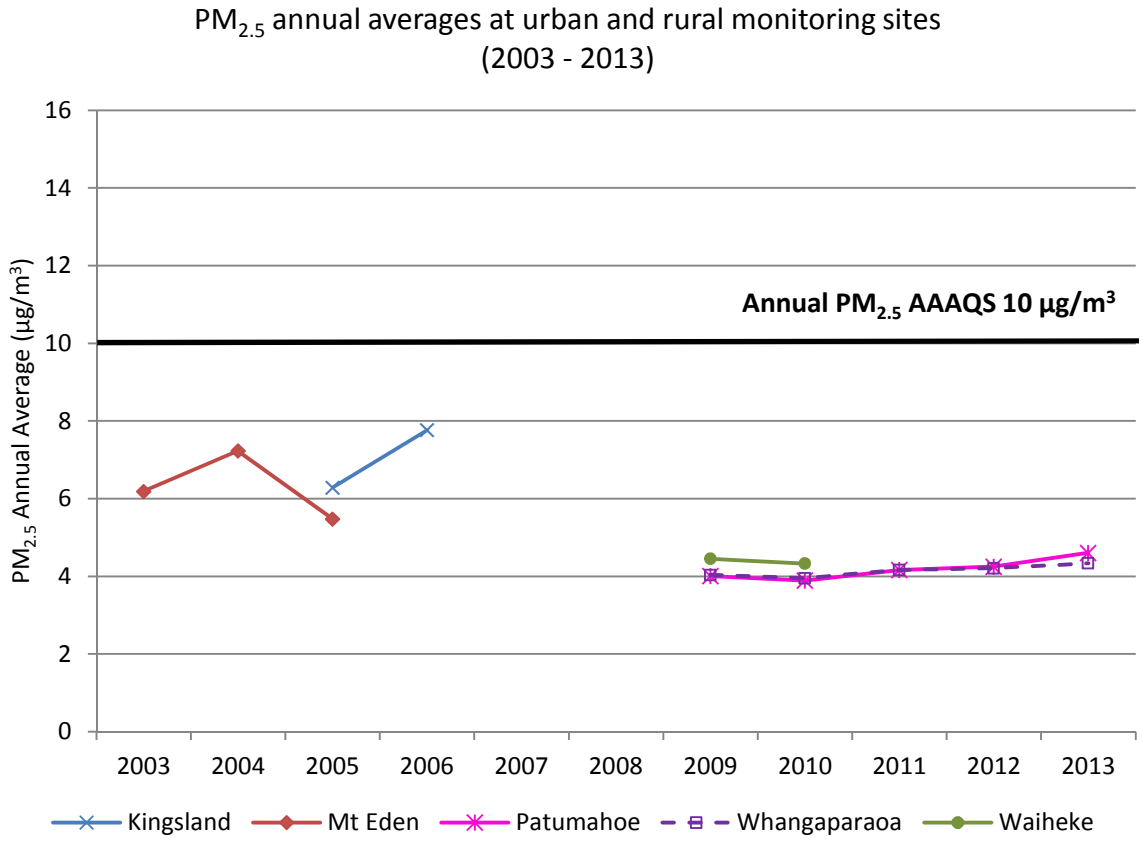

Figure B-2 Annual average $PM_{2.5}$ at urban and rural monitoring locations, 2003 – 2013. Source: Auckland Council

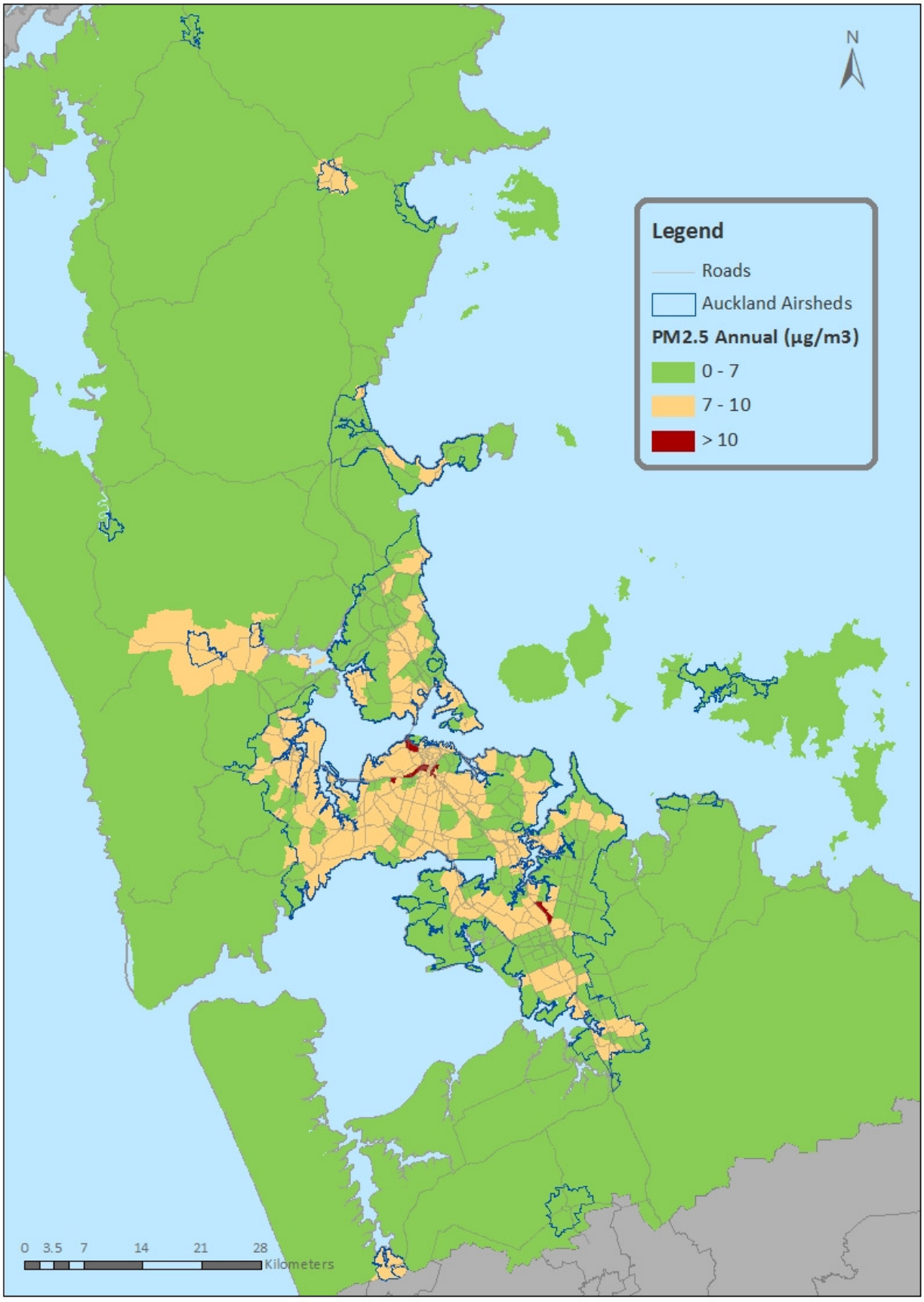

Figure B-3 Estimated and monitored annual $PM_{2.5}$ (µg/m^3) by census area unit.
Source: Auckland Council

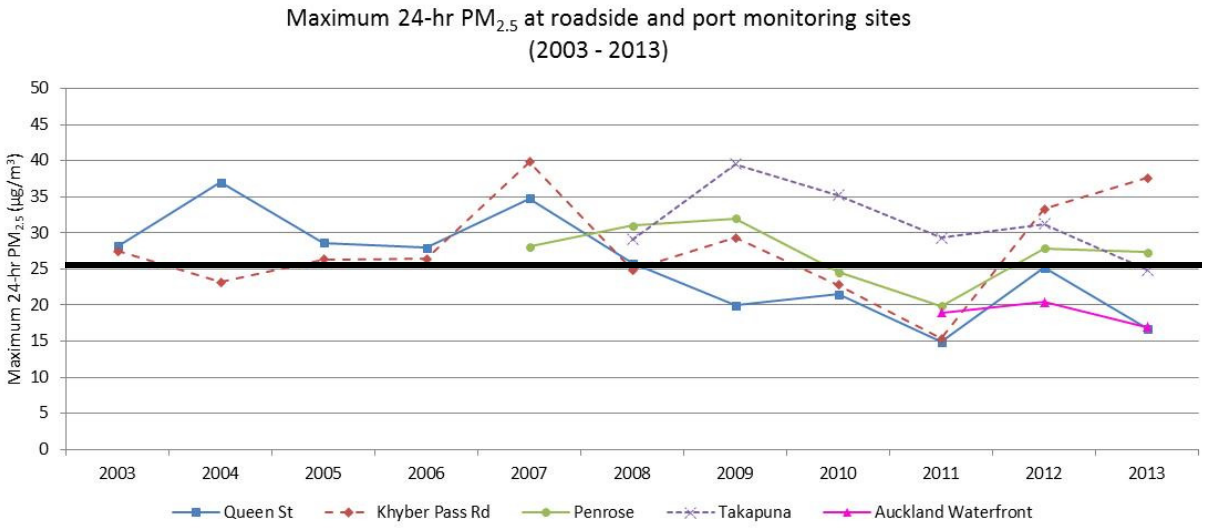

Figure B-4 Maximum 24-hour average $PM_{2.5}$ at Auckland roadside and port monitoring locations, 2003-2013. Source: Auckland Council [131]

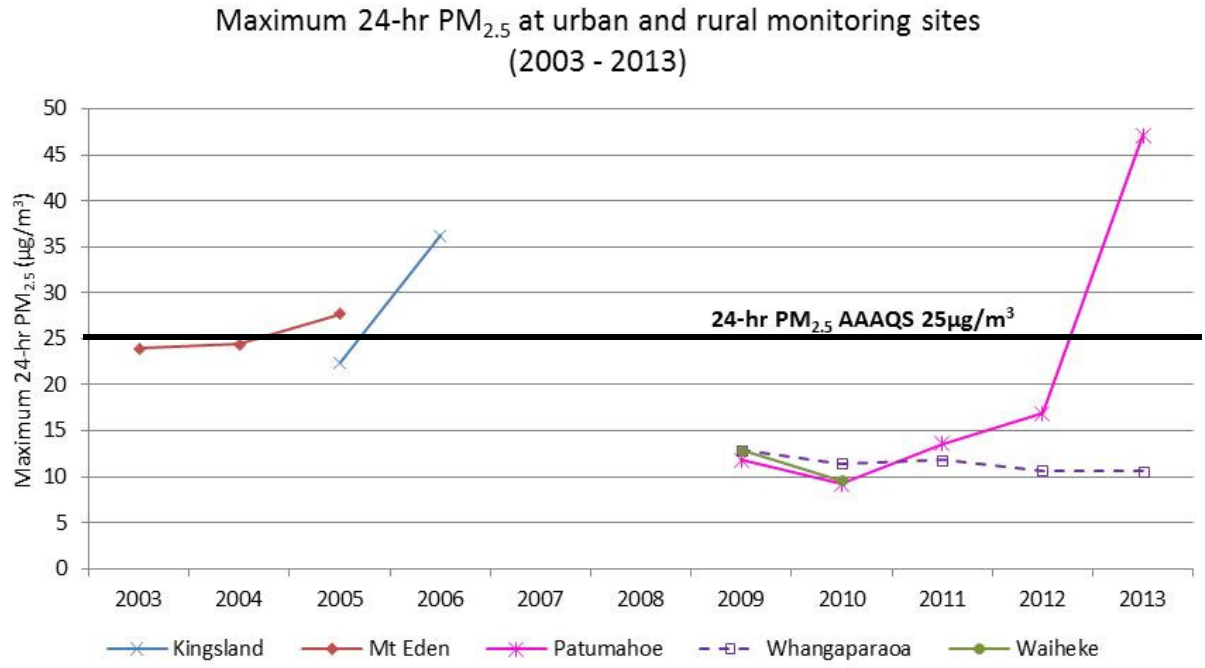

Figure B-5 Maximum 24-hour average $PM_{2.5}$ at Auckland urban and rural monitoring locations, 2003-2013. Source: Auckland Council

[131] NB: All data exclude exceptional events in 2009 (Australian dust storm)

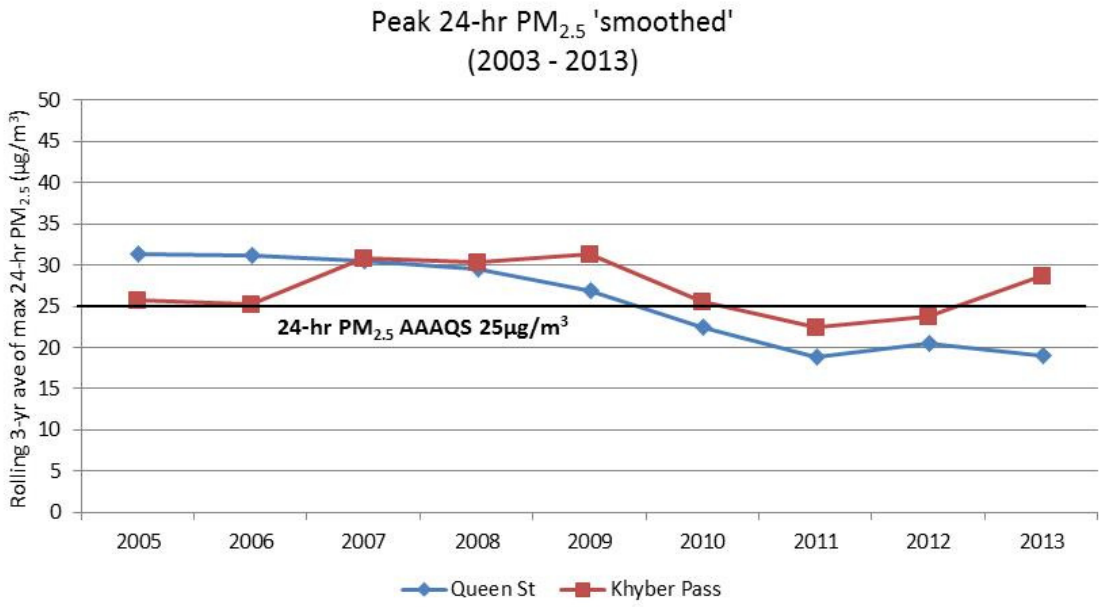

Figure B-6 Maximum 24-hour $PM_{2.5}$ as a rolling three-year average, 2003-2013.
Source: Auckland Council

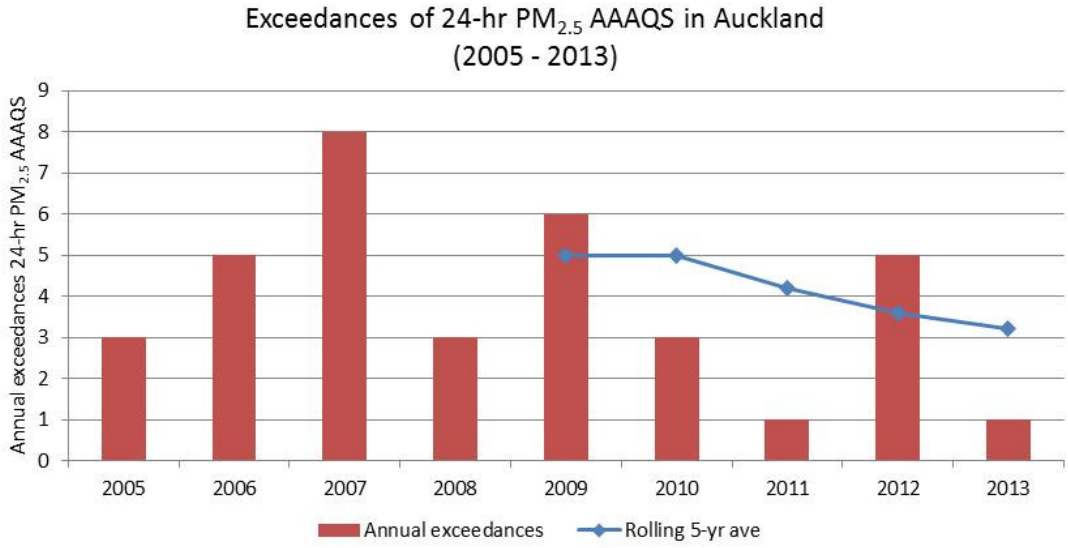

Figure B-7 Annual exceedances of 24-hour $PM_{2.5}$ AAAQS, 2005-2013.
Source: Auckland Council [132]

[132] NB: excludes exceptional events and multiple exceedances in same airshed on same day

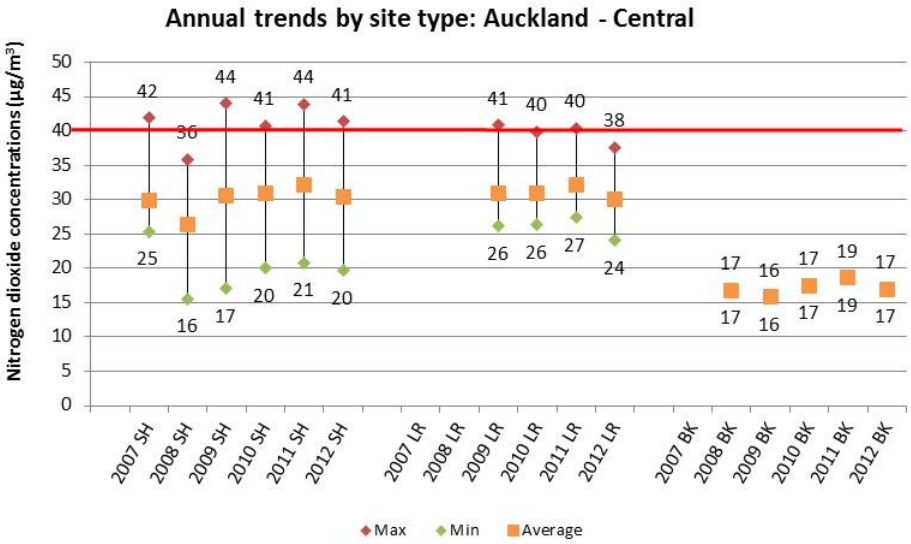

Figure B-8: Maximum, minimum monthly and annual average NO_2 values in Auckland – Central (Source: NZTA, 2013) [133]

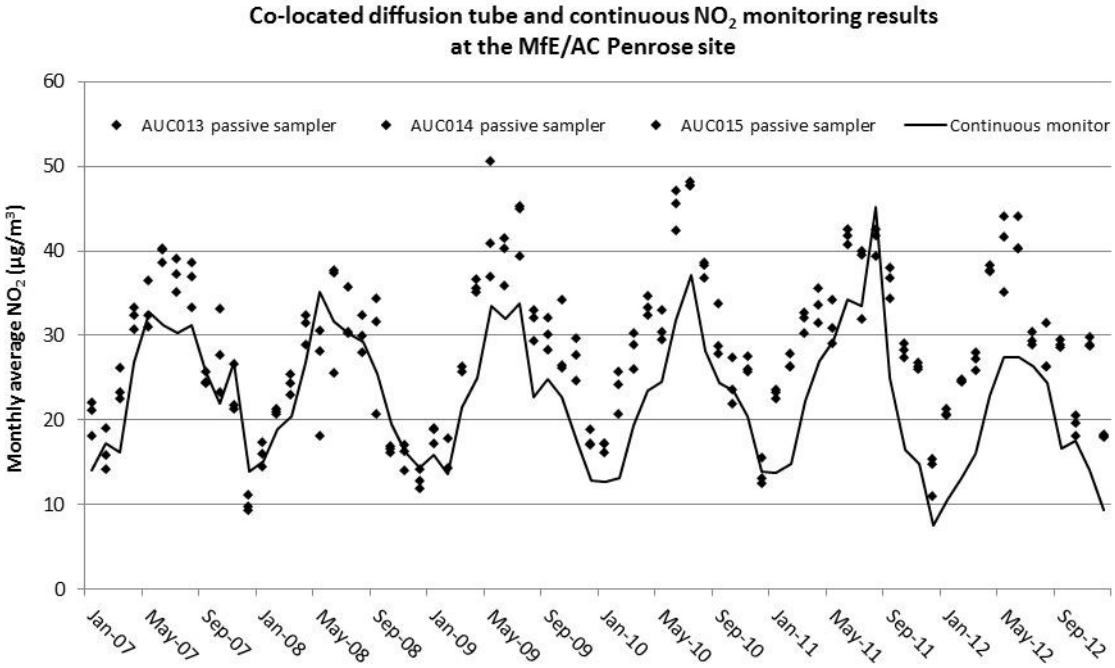

Figure B-9: Comparison of passive monitoring (triplicate results) and continuous monitoring results at Penrose in Auckland.
(Source: NZTA, 2013)

[133] NZTA, 2013. *Ambient air quality (nitrogen dioxide) monitoring network – Annual report 2007-2012*, October.

ATTACHMENT C

Regional compliance with 24-hour average AAAQS for sulphur dioxide

C1. Thirty years of continuous monitoring at Penrose has shown that typical daily levels of sulphur dioxide (SO_2) have significantly reduced in Auckland over this period as shown in **Figure C-1**. Penrose is an industrial area of Auckland. However, the monitoring location is also located close (around 100 m) to the southern motorway.[134] Ambient air quality data from this location is therefore, considered representative of vehicles and industry. This drop in ambient SO_2 levels in Penrose follows a long-term trend away from coal and heavy fuel oil to natural gas for industrial use, and successive reductions in sulphur in automotive fuels.

C2. In 2010, Auckland Council commenced monitoring on the Auckland Waterfront. Ambient SO_2 levels from the waterfront monitoring site are presented in **Figure C-2** for comparison with Penrose data. The waterfront monitoring site is situated between Queens Wharf (where cruise ships berth) and Captain Cook's Wharf (where roll-on roll-off ships berth). This is also close (around 100 m) to Queen Street. Ambient air quality data from the Auckland Waterfront is therefore, considered representative of vehicles and shipping emissions.

C3. **Figure C-2** shows that daily levels of SO_2 measured at the waterfront are significantly elevated in comparison with Penrose. There were 13 exceedances of the 24-hour SO_2 AAAQS in 2011[135], another 13 exceedances in 2012 and nine exceedances in 2013. These elevated levels are likely due to emissions from container and cruise ships at the waterfront.

C4. Passive monitoring undertaken by Auckland Council (**Figure C-3**), indicates that typical levels of SO_2 are low and that widespread breaches of the 24-hour SO_2 AAAQS are unlikely to occur. However, SO_2 is a source-specific pollutant and its effects can be extremely localised. This means that whilst regional levels may be low, specific locations may still experience peak concentrations that exceed the 24-hour SO_2 AAAQS.

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[134] Annual average daily traffic was 140,380 in 1985 (Auckland Regional Council, 2006) and 158,270 in 2013 (NZTA SpatialViewer).

[135] NB: 2011 only measured 73% valid data (2012 and 2013 measured > 98% valid data)

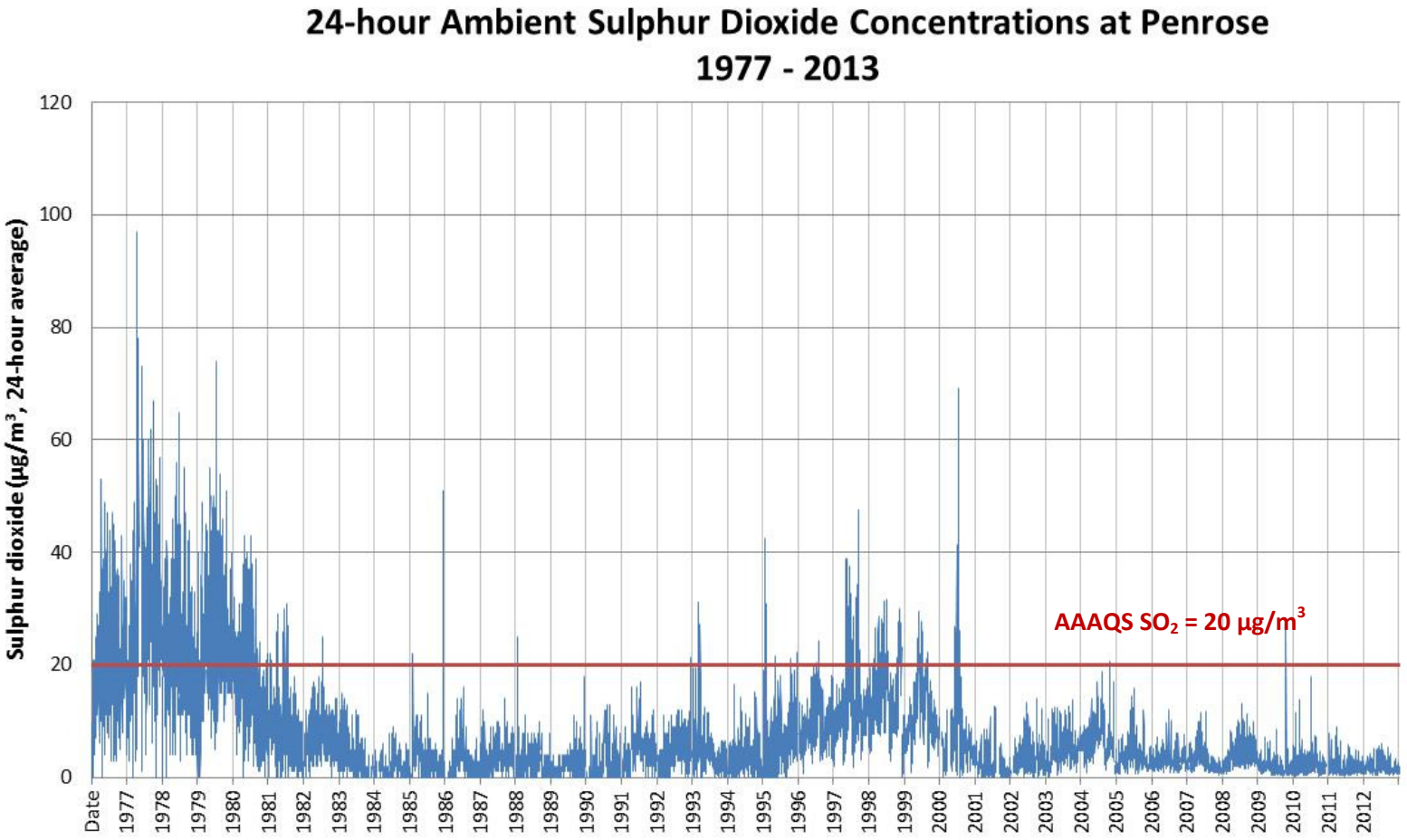


Figure C-1 **Daily SO_2 at Penrose, 1977 – 2013.** Source: Auckland Council

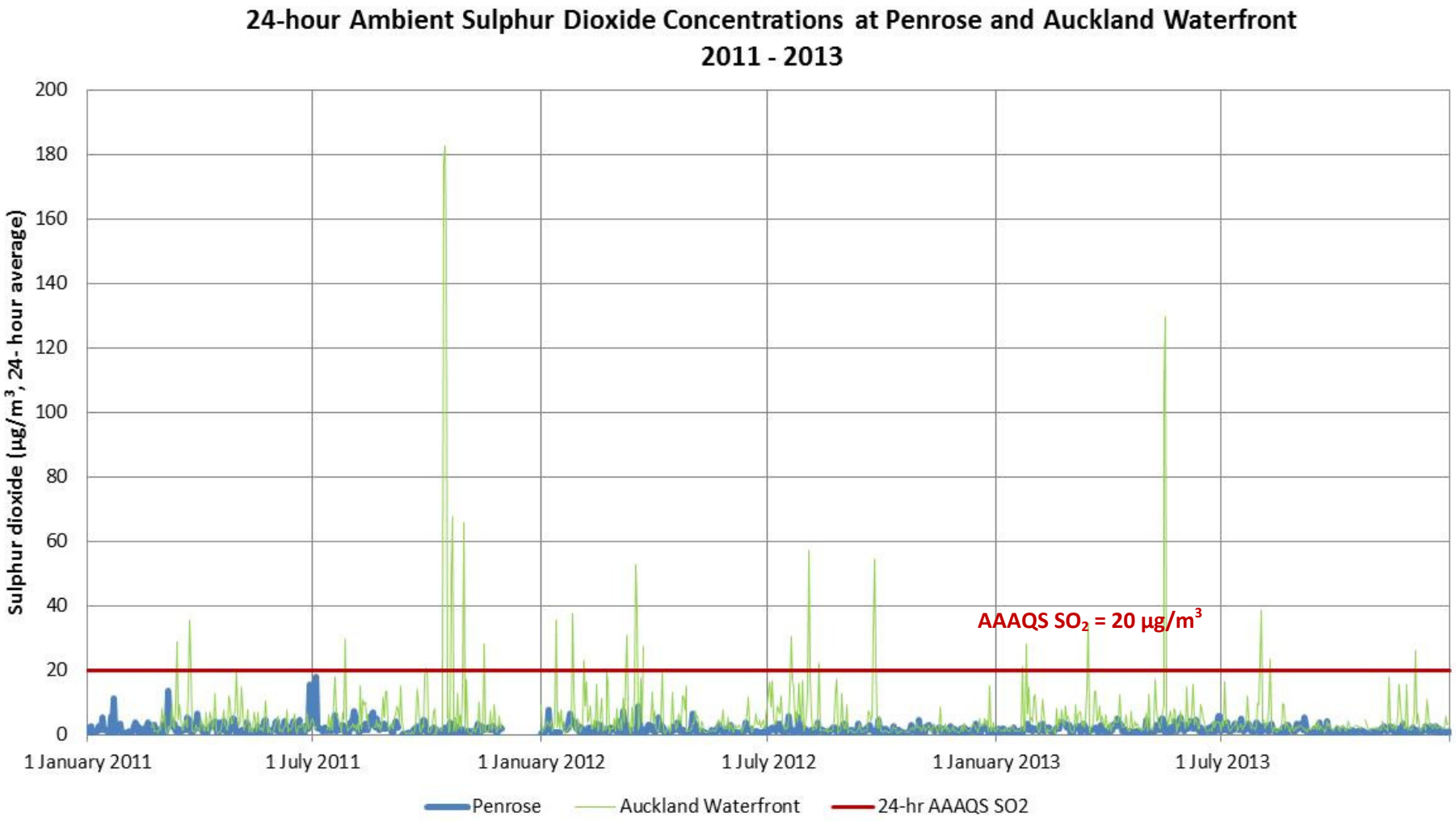
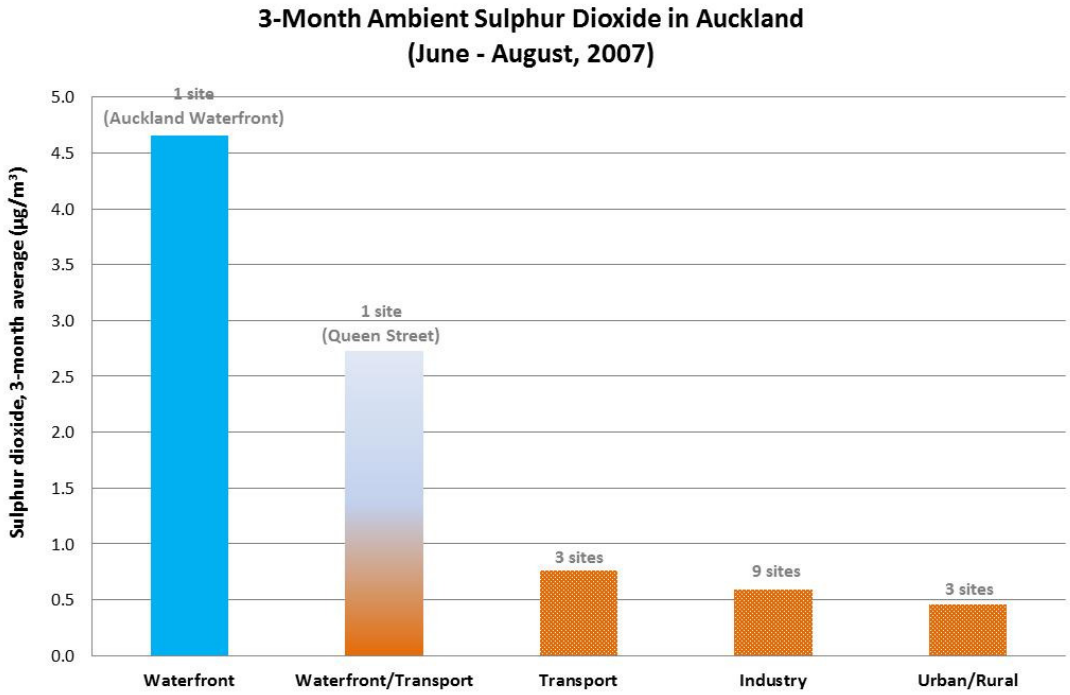
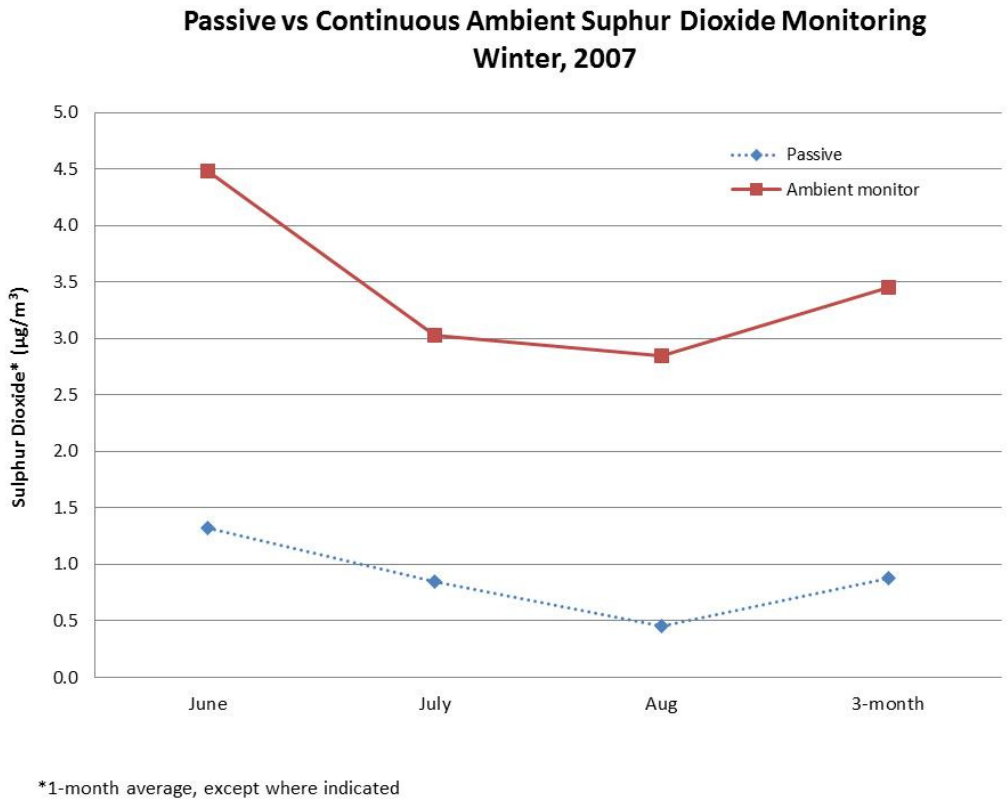


Figure C-2 **Daily SO_2 at Penrose and Auckland Waterfront, 2011 – 2013.** Source: Auckland Council





*1-month average, except where indicated

Figure C-3 Passive SO_2 Monitoring in Auckland.
Source: Auckland Council

C5. The primary sources of SO_2 in Auckland are the combustion of fossil fuels containing sulphur, and industrial processes (**Figure C-4**). The top three sources of SO_2 in Auckland, in order, are as follows:

- Combustion of heavy fuel oil (shipping)
- Industrial processes
- Combustion of diesel (motor vehicles and rail)

C6. **Table C-1** presents estimates for key SO_2 sources in Auckland by location. This shows that transport emissions are spread over large areas, whilst industry sources are location specific.

Table C-1 Location of key anthropogenic sources of SO_2 in Auckland. (Source: Auckland Council)

Source	Location	Annual SO_2 (tonnes/year)*
Transport (2011)		
Ships	Auckland waterfront	1,210
Motor vehicles	Auckland-wide	240
Rail	Rail corridors	170
Aircraft	Mangere**	60
Pleasure boats	Coastal marine area	20
	Subtotal Transport	**1,700**
Industry (2011)		
Bitumen	East Tamaki, Manurewa, Mt Wellington, Silverdale	20
Bricks & glass	New Lynn, Penrose	50
Chemical	Manukau central, Mt Wellington	2
Food/animal products	Mt Wellington, Penrose	15
Metals	Favona, Mt Wellington, Waiuku	860
Power	East Tamaki, Penrose	10
Raw materials	Henderson, Waitakere	0.2
Waste	East Tamaki, Mangere Bridge, Onehunga	20
	Subtotal Industry	**980**
Total Transport & Industry		**2,680**
Total All Sources (including domestic)		**2,990**

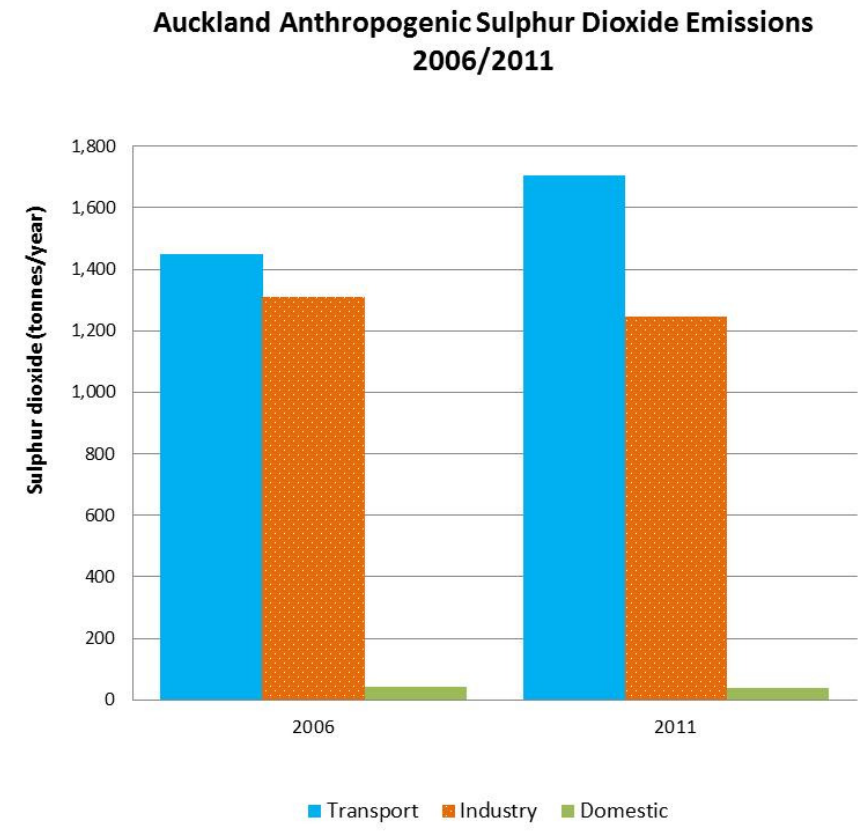
*Values have been rounded and may not add exactly
** Lesser numbers of aircraft also operate from Ardmore and Whenuapai

C7. Monitoring at the Auckland Waterfront has recorded multiple exceedances of the 24-hour SO_2 AAAQS (around 12 per year).[136] Given the close proximity of Ports of Auckland to residential locations (i.e. < 50 m in some locations) it is reasonable to expect that some people may be exposed to levels of SO_2 above the 24-hour SO_2 AAAQS. In the absence of any mitigation it is reasonable to conclude that such exceedances will continue, and may increase, with future Port expansion.

C8. An Auckland Council review (unpublished) indicates that few industrial sites have significant emissions of SO_2, and further that these are unlikely to exceed the 24-hour SO_2 AAAQS at locations where people live.

C9. The available data indicates that most, if not all, residential locations in Auckland (except Auckland Waterfront) would easily meet the 24-hour SO_2 AAAQS.

[136] Based on three years monitoring data (2011-2013)



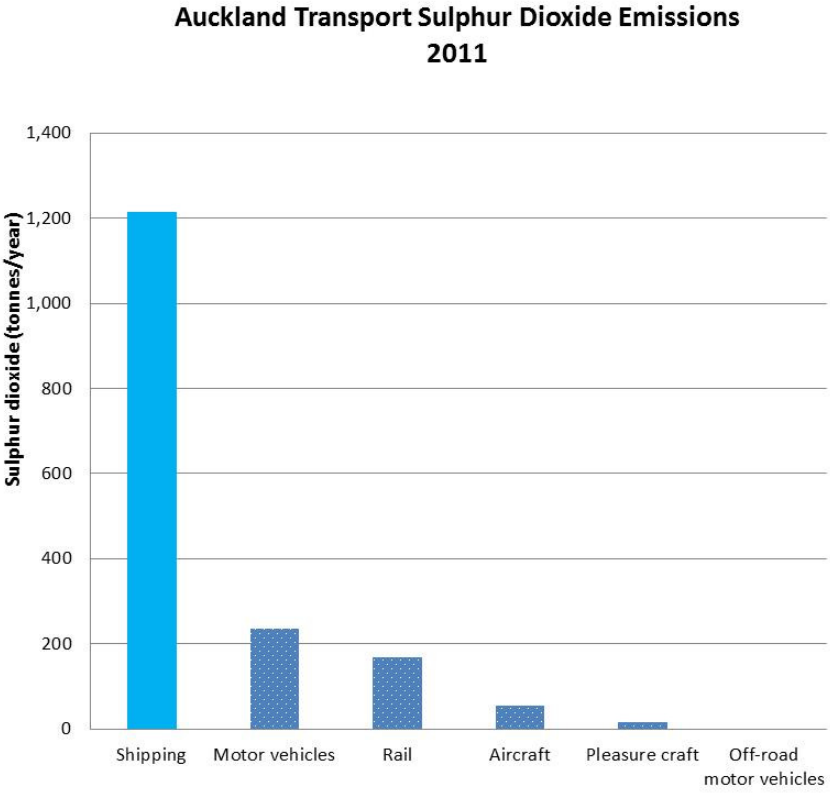


Figure C-4 **Auckland anthropogenic SO_2 emissions**
Source: (Auckland Council)

ATTACHMENT D

Golder Associates technical concerns with 24-hour SO_2 AAAQS

Robustness of precautionary approach

D.1 New Zealand Starch [3230] submitted a review by Golder Associates NZ Ltd (Golder review) that concluded that the precautionary approach of the 2006 WHO global air quality guideline for SO_2 as a 24-hour average (2006 WHO SO_2 24-hour guideline) was deficient because (paraphrased):[137]

i. *The concentration response relationships in the population based studies are weak or non-existent and causal relationships between long-term effects and sulphide dioxide exposure have not been established.*

I note that this ignores the significant body of recent science developed since the WHO guideline was published in 2006.[138]

ii. *Other pollutants may contribute to associations between sulphur dioxide and mortality.*

This ignores the intent of a precautionary approach which states that lack of evidence does not justify inaction). [139]

iii. *If the intent of the guideline is to protect against acute health effects then a precautionary approach would be to limit peak concentrations through a 1-hour guideline.*

This appears to misunderstand the intent of the guideline which is not to intended to protect against very short-term (i.e. 10-15 minute) acute health effects and may arise from the lack of recent science in the Golder review. The clinical and experimental evidence discussed in the Golder review is dominated by papers published before 1995 and focuses primarily on bronchoconstriction effects in asthmatics exposed to short-term (**10-15 minute**) SO_2. The epidemiological evidence discussed in the

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[137] Golder Associates, 2014 at n68.
[138] WHO, 2013 at para 4.2. In particular refer to Table 11, p147.
[139] *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.*
Rio Declaration on Environment and Development, United Nations Conference on Environment and Development, Rio de Janeiro, June 1992.

Golder review appears to rely heavily on the 2008 US integrated science assessment[140] which was used to develop a **1-hour** (US) national ambient air quality standard.

D.2 Importantly it is not what is in the review that is of issue, it is what is **not** in the review. For example, the Golder review did not:

(a) Consider recent science, in particular, the *Review of Evidence on Health Aspects of Air Pollution*[141] which addressed scientific evidence published after 2005 specifically in relation to the 2006 WHO SO_2 **24-hour** guideline;[142]

(b) Consider the wider research findings emphasised by WHO in developing the global air quality guidelines.[143] This is particularly important for SO_2, which is a precursor for secondary particulate formation. As a result the Golder review did not consider the lack of threshold effect for particulate, ever increasing range of health effects or possible additional public health protection gained from co-benefits of action to reduce ambient SO_2.

Adoption of WHO guideline in other jurisdictions

D.3 The Golder review made several statements regarding other jurisdictions views of the 2006 WHO 24-hr SO_2 guideline that I consider warrant a detailed response.

United Kingdom

D.4 In 2011, the UK Committee on the Medical Effects of Air Pollutants Standards Advisory Subgroup reviewed the UK air quality index (COMEAP, 2011).[144] The air quality index refers to **15-minute average** exposures of SO_2 – **and other pollutants** – to indicate 'low', 'moderate', 'high' and 'very high' levels of air pollution. Here are their conclusions in full (COMEAP, 2011):

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[140] US EPA, 2008. *Integrated Science Assessment for Sulfur Oxides – Health Criteria*.
[141] WHO, 2013 at para 4.2
[142] I note that the most recent literature in the 2013 WHO Review cites 8 out of 10 papers reporting positive associations for all-cause mortality and SO_2 with five of these being statistically significant. I have reviewed nine of these papers (the Polish study Rabczenko D *et al*., 2005 was not available in English).[142] Only two of these papers were addressed (by meta-analyses) by the Golder review (Cakmak, Dales & Vidal, 2007 and Tsai *et al*., 2003 were considered in US EPA, 2008).
[143] WHO, 2006 at para 4.2
[144] NB: This study is not in the references

As well as the recommendations of WHO, we considered an evaluation of the effects of SO_2 by the predecessor of the COMEAP Standards Advisory Subgroup, the Expert Panel on Air Quality Standards (EPAQS, 1995b). Like WHO, EPAQS took the view that the majority of people with asthma would not suffer clinically significant effects at ambient concentrations of SO_2 below 200 ppb (parts per billion) (equivalent to 532 µg m^{-3}). Nonetheless, EPAQS recommended a lower standard of 100 ppb (266 µg m^{-3}) averaged over 15 minutes. This recommendation took into account the fact that measurements averaged over 15 minutes would include brief periods of higher concentrations, perhaps as high as double the average. Thus, if the 15-minute average was 200 ppb, there may be periods of higher exposure within those 15 minutes which might affect susceptible individuals. EPAQS also noted the need to ensure an adequate margin of safety for individuals with more severe asthma.

We considered the standard recommended by EPAQS as more appropriate for adoption as the breakpoint between the Low and Moderate bands than the WHO AQG.

We also considered whether an index based on 24-hour average concentrations of SO_2 was desirable. Our deliberations included a review of historical SO_2 concentrations (averaged over both 15 minutes and 24 hours) from the AURN. Our attention focused on exceedances of the current Low to Moderate band breakpoint (15-minute averages) or of a concentration which would equate to the same mortality risk as that posed by particulate matter at the breakpoint between the Low and Moderate bands for particulate matter (24-hour averages). Our conclusion was that an AQI based on 15-minute averages was appropriate and sufficient. Thus, we saw no need to recommend changes to the existing bandings for SO_2.

D.5 The text in bold above was that highlighted by the Golder review. However, this text refers to the **10-minute** WHO ambient air quality guideline – not the 24-hour average guideline inferred in the Golder review.

D.6 The last paragraph reveals that the committee then reviewed exceedances of the 100 ppb (15-minute average) SO_2 level (these only occur in some

locations) and the concentration required to increase short-term mortality by 1.25% (compared with 50 µg/m^3 PM_{10} as a 24-hour average).[145] Based on this (rather high threshold) the committee decided there was no additional protection afforded by introducing the 2006 WHO SO_2 24-hour guideline.

D.7 Despite this, the Golder review states:

> *The UK assessment is consistent with the findings of the present report that the scientific rationale for adoption of the WHO 24-hr guideline of 20 µg/m^3 is not appropriate.*

D.8 In fact, the UK assessment of an Air Quality Index focussing on short-term (15-minute) health protection as compared with a short-term increase in mortality of 1.25% saw no additional protection in adopting a 24-hour guideline. This is a rather different conclusion.

D.9 I note that the 2011 COMEAP review referenced little primary research (only seven papers). It did not consider the 10 papers identified in the 2013 WHO review,[146] or even reference the US EPA integrated science assessment.[147]

Europe

D.10 The Golder review states that no evidence could be found that the EU are actively reviewing their 2008 24-hour average for SO_2 (125 µg/m^3). A lack of any indication to consider adopting a guideline is not proof positive that regulators have decided *against* it.

Canada

D.11 The Golder review states:

> *A review of relevant government authority information did not indicate that Canada are considering adopting the WHO (2006) 24 hour guideline of 20 µg/m^3.*

D.12 The Ontario Ministry of Education health-based air quality standards are provided as supporting evidence (reference not provided):

- 1 hr guideline of 690 µg/m^3

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[145] This being the breakpoint between Low and Moderate bands for particulate matter
[146] WHO, 2013 at para 4.2
[147] US EPA, 2008 at n139

- 24-hr guideline of 275 µg/m^3

D.13 However, the State of Ontario is not representative of the country of Canada. This is equivalent to stating that the Auckland standard is a New Zealand standard. Further, a lack of evidence that a regulator is considering a guideline is not proof positive that a regulator has decided *against* adopting a guideline.

D.14 The Golder review further cited a Fraser Institute report (full reference not provided) as being highly critical of the 2006 WHO SO_2 24-hour guideline is similarly, not representative of the country of Canada.[148]

Australia

D.15 The Golder review states that the current review of the Australian National Environmental Protection Measure is *not* considering adopting the 2006 WHO SO_2 24-hour guideline. However, I understand from my contacts at NSW EPA and EPA Victoria, that no formal discussions have taken place yet about what standards might be considered in the review.[149] In any case, lack of any indication to consider adopting a guideline is not proof positive that regulators have decided *against* it.

United States

D.16 The Golder review notes that the 2010 US EPA revision of the primary SO_2 national ambient air quality standard did **not** use the existing dataset of time-series epidemiology studies for SO_2 to develop an ambient air standard. The reason stated is that most, if not all, of these studies do not provide sufficient evidence to establish a plausible concentration response function over a 1-hour averaging time.

D.17 What the Golder review does not state is that the US EPA review focussed primarily on US only research for standard-setting purposes. The reason for this is as follows:

> *EPA considers all studies - US and around the world in its weight of evidence approach for examining the health effects of an air pollutant such as SO_2. However, for setting the quantitative level of a NAAQS in*

[148] Wikipedia states that the Fraser Institute is a politically conservative and right-libertarian Canadian public policy think tank.
[149] Personal comms. Kerry Lack, NSW EPA, Melanie Middleton, EPA Victoria, Sept 2014.

the U.S., looking at specific air quality levels from U.S. studies is most informative. Reasons for this include differences in monitoring networks and differences in the mixtures of pollutants in the U.S. as opposed to other areas of the world.[150]

D.18 This has a strong influence on the amount of evidence available for standard setting purposes.

[150] Personal comms, Michael Stewart, Environmental Protection Specialist, Health and Environmental Impacts Division, U.S. Environmental Protection Agency, Research Triangle Park, NC. 5 Oct 2011.