Ministry for the
Environment
Manatū Mō Te Taiao

Review of the Ambient Air Quality Guidelines

Recommended Amendments to the *Ambient Air Quality Guidelines 1994*

Prepared by Kevin Rolfe & Associates for the Ministry for the Environment's Review of the *Ambient Air Quality Guidelines*

October 2000

Air Quality Technical Report No. 23

Foreword by the Ministry for the Environment

Kevin Rolfe and Associates have prepared this report for the Ministry for the Environment's review of the *Ambient Air Quality Guidelines* (1994). The Ministry commissioned Kevin Rolfe and Associates to recommend changes and additions to the Ministry's 1994 Guidelines based on their reviews in Air Quality Technical Reports 12, 13 and 14.

Following discussions with reviewers, the Ministry has accepted the majority of Kevin Rolfe and Associate's recommendations and these are contained within the Ministry's discussion document – *Proposals for Revised and New Ambient Air Quality Guidelines for New Zealand*. The Ministry is now seeking public submissions and feedback on the proposals.

In this report, Kevin Rolfe and Associates also discuss management of offensive odours, dust nuisance and degraded visibility (smogs and hazes etc). These issues and the background work undertaken to develop the recommendations now form part of separate projects under the Ministry's Air Quality Management Programme. These projects include: reviewing the *Guide to Odour Management under the RMA* (MfE, 1995), developing guidance for monitoring and managing atmospheric visibility in New Zealand and preparing a *Good-practice Guide to Assessing and Managing the Environmental Effects of Dust Emissions*. More information about these projects and the relevant reports can be viewed on the Ministry's website http://www.mfe.govt.nz.

This is a technical report prepared to assist the Ministry for the Environment and it is not government policy. Comments on any aspect of this report should be made within your submission on the Ministry's discussion document *Proposals for Revised and New Ambient Air Quality Guidelines for New Zealand*.

Further copies of this report can be obtained from the Ministry for the Environment or downloaded from http://www.mfe.govt.nz/monitoring/epi/airqualtech.htm

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1 Summary and Recommendations

1.1 Summary

The New Zealand *Ambient Air Quality Guidelines* were published in 1994 and are in need of revision, and they should be reviewed again at least every five years.

A review of the health effects data (Air Quality Technical Report 12) for the contaminants covered in the 1994 Guidelines finds there is a need to revise downwards both the 1-hour average guideline for nitrogen dioxide and the 24-hour average PM_{10} guideline, and to reconsider in the near future the guidelines for carbon monoxide. The review introduces $PM_{2.5}$, revises slightly the guidelines for lead and hydrogen sulphide, but leaves unchanged the guidelines for fluoride (pending completion of work on the effects of air pollutants on New Zealand ecosystems).

The recommended methods for ambient air monitoring are reviewed in Air Quality Technical Reports 12 and 13. Consideration should be given to adopting national ambient air quality standards – for PM_{10}, sulphur dioxide, carbon monoxide, ozone, nitrogen dioxide, and (later) $PM_{2.5}$. Guidelines for new hazardous air pollutants are given, both for assessing the results of ambient air monitoring and criteria against which the results of atmospheric dispersion modelling can be evaluated. The important air quality issues of odour, dust nuisance, and visibility are now covered in separate, but linked, Ministry projects under the Air Quality Management Programme.

A review of strategies for managing air quality and a preliminary assessment of the costs and benefits of the new guidelines/standards have also been prepared – Air Quality Technical Report 14.

Specific recommendations are as follows, with all concentrations expressed at $0^{o}C$ and rounded to a maximum of two significant figures:

1.2 Recommendations

1. The ambient air quality guidelines for carbon monoxide remain unchanged, at 30 mg/m^3, 1-hour average, and 10 mg/m^3, 8-hour average, and measurement be in accordance with standard method AS3580.7.1-1992.

2. Consideration be given to adopting the carbon monoxide ambient air quality guidelines as national ambient air quality standards.

3. In view of the emerging research on adverse health effects at lower than expected carboxyhaemoglobin levels in blood, the ambient air quality guidelines/standards for carbon monoxide be reviewed no later than 2002.

4. The 1-hour average ambient air quality guideline for nitrogen dioxide be reduced to 200 $\mu g/m^3$, the 24-hour average guideline remain unchanged, at

100 μg/m^3, and measurement be in accordance with standard method AS3580.5.1-1993.

5. Consideration be given to adopting the revised nitrogen dioxide ambient air quality guidelines as national ambient air quality standards.

6. The ambient air quality guidelines for ozone remain unchanged, at 150 μg/m^3, 1-hour average, and 100 μg/m^3, 8-hour average, and measurement be in accordance with standard method AS3580.6.1-1990.

7. Consideration be given to adopting the ozone ambient air quality guidelines as national ambient air quality standards.

8. The 24-hour average ambient air quality guideline for PM_{10} be reduced to 50 μg/m^3, the annual average guideline be deleted, and measurement be in accordance with the standard method specified in US 40 CFR Part 50, Appendix J, or an equivalent method.

9. Consideration be given to adopting the revised PM_{10} ambient air quality guideline as a national ambient air quality standard.

10. Monitoring of $PM_{2.5}$ be encouraged, with measurement in accordance with the standard method specified in US 40 CFR Part 50, Appendix L, and the results compared with an ambient air quality guideline of 25 μg/m^3, 24-hour average.

11. In view of the emerging research on the relationship between $PM_{2.5}$ and mortality, the $PM_{2.5}$ guideline be reviewed no later than 2004, including consideration of adopting it as a national ambient air quality standard.

12. The 1-hour and 24-hour average ambient air quality guidelines for sulphur dioxide remain essentially unchanged at, respectively, 350 μg/m^3 and 120 μg/m^3 (when expressed to a maximum of two significant figures), the 10-minute and annual average guidelines be deleted, and measurement be in accordance with standard method AS3580.4.1-1990.

13. Consideration be given to adopting the revised sulphur dioxide ambient air quality guidelines as national ambient air quality standards.

14. The ambient air quality guidelines/standards be reviewed at least every five years.

15. The ambient air quality guideline for the lead content of PM_{10} be 0.5 μg/m^3, 3-month moving average, calculated monthly, with sampling in accordance with the standard method specified in US 40 CFR Part 50, Appendix J, and analysis in accordance with the standard method specified in 40 CFR Part 50, Appendix G, or an equivalent analytical method, and that consideration be given to reducing the concentration to 0.2 μg/m^3.

16. Pending completion of the work on the effects of air pollutants on New Zealand ecosystems, the ambient air quality guidelines for fluoride remain unchanged, with monitoring in accordance with standard method AS3580.13.1-1993.

17. The ambient air quality guideline for hydrogen sulphide be 7 μg/m^3, 1-hour average, and measurement be in accordance with standard method AS3580.4.1-1990, coupled with a hydrogen sulphide to sulphur dioxide converter.

18. Monitoring programmes for priority hazardous air pollutants be encouraged, with monitoring in accordance with the recommended methods of the United States Environmental Protection Agency, and the results compared with the following guidelines (annual average):

Benzene	year 2000	10 $\mu g/m^3$
	year 2010	3.6 $\mu g/m^3$
Toluene		190 $\mu g/m^3$
Xylene		950 $\mu g/m^3$
1,3-Butadiene		2.4 $\mu g/m^3$
Formaldehyde		15 $\mu g/m^3$
Acetaldehyde		30 $\mu g/m^3$
Benzo(a)pyrene		0.0003 $\mu g/m^3$
Mercury	inorganic	0.33 $\mu g/m^3$
	organic	0.13 $\mu g/m^3$
Chromium	chromium VI	0.0011 $\mu g/m^3$
	other forms	0.11 $\mu g/m^3$
Arsenic	inorganic	0.0055 $\mu g/m^3$
	arsine	0.055 $\mu g/m^3$

19. The air quality issue of odour be addressed by a review and update of the Ministry for the Environment's guidance document on odour management (with the revised subtitle "A Good Practice Guide"), covering recent case law and best practice toward odour management, specific criteria for assessing atmospheric dispersion modelling for odour, the relationship between odour management and land use, the role of performance standards for odour, methods for surveying community response, and standard methods for sampling and measurement of odour.

20. The air quality issue of dust nuisance be addressed by the preparation of a guidance document on the management of dust nuisance (with the subtitle "A Good Practice Guide"), and the document include levels of 4 g/m^2/30 days for dust deposition, as an increase above existing background, measured in accordance with standard method ISO DIS4222.2, and 150 $\mu g/m^3$ (24-hour average) or 250 $\mu g/m^3$ (1-hour average) for total suspended particulate, measured in accordance with standard method AS2724.3-1984.

21. Pending completion of studies on the development of criteria and reference methods for measurement of visibility, a national ambient air quality guideline (but not a standard) for visibility be developed, and the guideline be adopted when visibility becomes an air quality indicator in the Environmental Performance Indicators Programme.

22. Application of the revised ambient air quality guidelines/standards for PM_{10}, sulphur dioxide, carbon monoxide, ozone, and nitrogen dioxide to State of the Environment Reporting continue, recording the maximum result, the number of exceedances of the guidelines/standards (in the form 'x number of exceedances occurred on y number of days during the sampling period'), and 99.9 percentile values for 1-hour and 8-hour averages and 99.5 percentile values for 24-hour

averages, and using the categories of air quality approach of the Environmental Performance Indicators Programme.

23. Application of the revised ambient air quality guidelines/standards to regional plans continue, including use of the categories of air quality approach of the Environmental Performance Indicators Programme, to provide greater enhancement of air quality or prevent significant deterioration of existing air quality.

24. Application of the revised ambient air quality guidelines/standards to background air quality monitoring, as part of an application for a resource consent, continue, and for those situations (usually involving large, isolated industry) where ambient monitoring programmes, in conjunction with emission testing, are appropriate for assessing environmental effects and compliance monitoring.

25. The air quality issue of atmospheric dispersion modelling be addressed by the preparation of a guidance document (with the subtitle "A Good Practice Guide"), covering approved procedures for atmospheric modelling and providing specific evaluation criteria against which the results of atmospheric dispersion modelling can be assessed, for a wide range of air pollutants, such as the following for priority hazardous air pollutants (1-hour average):

Benzene		22 $\mu g/m^3$
Toluene		500 $\mu g/m^3$
Xylene		1000 $\mu g/m^3$
1,3-Butadiene		15 $\mu g/m^3$
Formaldehyde		20 $\mu g/m^3$
Acetaldehyde		45 $\mu g/m^3$
Mercury	inorganic	2.0 $\mu g/m^3$
	Organic	0.80 $\mu g/m^3$
Chromium	chromium VI	0.0067 $\mu g/m^3$
	other forms	0.67 $\mu g/m^3$
Arsenic	inorganic	0.033 $\mu g/m^3$
	Arsine	0.33 $\mu g/m^3$

Table 1.1 gives the recommended ambient air quality guidelines/standards and monitoring methods. Differences between these recommendations and the existing guidelines are shown in bold. Those guidelines which could be adopted as standards are underlined.

Table 1.1: Recommended ambient air quality guidelines/standards*

CONTAMINANT	CONCENTRATION**	AVERAGING PERIOD	MONITORING METHODS
Particles (PM_{10}) **($PM_{2.5}$)**†	**50 µg/m^3** **25 µg/m^3**	24-hour **24-hour**	**US 40 CFR Part 50, Appendix J** **US 40 CFR Part 50, Appendix L**
Sulphur dioxide	350 µg/m^3 **120 µg/m^3**	1-hour 24-hour	AS3580.4.1-1990
Carbon monoxide††	30 mg/m^3 10 mg/m^3	1-hour 8-hour	**AS3580.7.1-1992**
Ozone	150 µg/m^3 100 µg/m^3	1-hour 8-hour	AS3580.6.1-1990
Nitrogen dioxide	**200 µg/m^3** 100 µg/m^3	1-hour 24-hour	AS3580.5.1-1993
Lead **content of PM_{10}**	**0.5 µg/m^{3‡}**	3-month **moving, calculated monthly**	**US 40 CFR Part 50, Appendix J** **US 40 CFR Part 50, Appendix G**
Fluoride – Special land use – General land use – Conservation areas	 1.8 µg/m^3 1.5 µg/m^3 0.8 µg/m^3 0.4 µg/m^3 0.25 µg/m^3 3.7 µg/m^3 2.9 µg/m^3 1.7 µg/m^3 0.84 µg/m^3 0.5 µg/m^3 0.1 µg/m^3	 12-hour 24-hour 7-day 30-day 90-day 12-hour 24-hour 7-day 30-day 90-day 90-day	AS3580.13.1-1993
Hydrogen sulphide	7 µg/m^3	**1-hour**	**AS3580.4.1-1990**

NB. Differences between these and the existing guidelines are shown in bold; candidates for possible adoption as national ambient air quality standards are underlined.

* The air quality guidelines/standards should be reviewed at least every five years.

** µg/m^3 is micrograms per cubic metre; mg/m^3 is milligrams per cubic metre, both at 0^{o}C.

† Consideration of adopting the $PM_{2.5}$ guideline as a national ambient air quality standard should await the results of ambient air monitoring, but should be done no later than 2004.

†† The carbon monoxide guidelines/standards should be reviewed no later than 2002.

‡ Consideration be given to reduce this to 0.2 µg/m^3.

2 Introduction: Existing Guidelines and Regional Variations

2.1 New Zealand Ambient Air Quality Guidelines

In July 1994, the Ministry for the Environment published the *Ambient Air Quality Guidelines*.[1] It was made quite clear that they are guidelines, not standards, but that 'development of such standards will be considered at some later time, after experience is gained in setting up programmes of air quality management'.

The Guidelines are given in Table 2.1.

2.2 Auckland Regional Council

As a first step in the development of the air section (not yet prepared) of its regional plan, the Auckland Regional Council has adopted some air quality guidelines. These guidelines have been used as criteria for assessing the results of ambient air monitoring.[2]

The Guidelines are given in Table 2.2. Where values are different to the national guidelines, these differences are highlighted in bold.

2.3 Waikato Regional Council

As part of the development of the air section of its regional plan (currently proposed), the Waikato Regional Council has adopted some air quality guidelines.[3]

The Guidelines are given in Table 2.3. Where values are different to the national guidelines, these differences are highlighted in bold.

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1 Ministry for the Environment, 1994, *Ambient Air Quality Guidelines,* July 1994.

2 Auckland Regional Council, 1997, *Ambient Air Quality: Monitoring Results for the Auckland Region 1964–1995,* Technical Publication No. 88, October 1997.

3 Pigott, Leif, 1999, personal communication, 8 February 1999.

2.4 Wellington Regional Council

Wellington Regional Council has an operative regional plan. The air section of the plan contains Regional Ambient Air Quality Guidelines. A feature of them is the use of both maximum desirable levels and maximum acceptable levels for certain air pollutants.

The Guidelines are given in Table 2.4. Where values are different to the national guidelines, these differences are highlighted in bold.

2.5 Environment Canterbury

Environment Canterbury has produced a Draft Natural Resources Regional Plan, Part A: Air. As part of the development of that document the Council adopted, in March 1996, a 24-hour 'monitoring and reporting guideline' for PM_{10} of 50 $\mu g/m^3$.

Table 2.1: New Zealand ambient air quality guideline values

CONTAMINANT	CONCENTRATION*	AVERAGING PERIOD	MONITORING METHODS
Particulates (PM_{10})	120 µg/m^3 40 µg/m^3	24-hour annual	AS3580.9.6-1990 AS3580.9.7-1990
Sulphur dioxide	500 µg/m^3 350 µg/m^3 125 µg/m^3 50 µg/m^3	10-minute 1-hour 24-hour annual	AS3580.4.1-1990
Carbon monoxide	30 mg/m^3 10 mg/m^3	1-hour 8-hour	AS2695-1984
Ozone	150 µg/m^3 100 µg/m^3	1-hour 8-hour	AS3580.6.1-1990
Nitrogen dioxide	300 µg/m^3 100 µg/m^3	1-hour 24-hour	AS3580.5.1-1993
Lead	0.5–1.0 µg/m^3	3-month	AS2800-1985
Fluoride – Special land use – General land use – Conservation areas	 1.8 µg/m^3 1.5 µg/m^3 0.8 µg/m^3 0.4 µg/m^3 0.25 µg/m^3 3.7 µg/m^3 2.9 µg/m^3 1.7 µg/m^3 0.84 µg/m^3 0.5 µg/m^3 0.1 µg/m^3	 12-hour 24-hour 7-day 30-day 90-day 12-hour 24-hour 7-day 30-day 90-day 90-day	AS3580.13.1-1993 AS3580.13.2-1991
Hydrogen sulphide	7 µg/m^3	30-minute	AS3580.8.1-1990

* µg/m^3 is micrograms per cubic metre; mg/m^3 is milligrams per cubic metre, both at 0^{o}C.

Table 2.2: Proposed air quality guidelines of the Auckland Regional Council

CONTAMINANT	CONCENTRATION*	AVERAGING PERIOD
Total suspended particulate	**60 µg/m^3**	**7-day**
Particulates (PM_{10})	**50 µg/m^3** 40 µg/m^3	24-hour annual
Smoke	**125 µg/m^3** **50 µg/m^3**	**24-hour** **quarterly**
Lead	**0.5 µg/m^3**	3-month
Sulphur dioxide	125 µg/m^3 50 µg/m^3 **(health)** **30 µg/m^3 (vegetation)**	24-hour annual **annual**
Carbon monoxide	30 mg/m^3** 10 mg/m^3	1-hour 8-hour
Nitrogen dioxide	**200 µg/m^3** 100 µg/m^3 **40 µg/m^3 (health)** **30 µg/m^3 (vegetation)**	1-hour 24-hour **annual** **annual**
Ozone	150 µg/m^3 100 µg/m^3	1-hour 8-hour

NB. Differences between these and the existing national guidelines are shown in bold.

* µg/m^3 is micrograms per cubic metre; mg/m^3 is milligrams per cubic metre, both at 0^{o}C.

** A table in the Auckland Regional Council report of ambient air monitoring for the Auckland Region 1964-1995 incorrectly has, in parenthesis, a concentration value of 25 parts per million (ppm). The graphical presentation of the results of monitoring for CO, for 1991-1995, uses the correct equivalent (at 0^{o}C), 24 ppm.

Table 2.3: Proposed air quality guidelines of the Waikato Regional Council

CONTAMINANT	CONCENTRATION*	AVERAGING PERIOD
Carbon monoxide	30 mg/m^3 10 mg/m^3	1-hour 8-hour
Nitrogen dioxide	**200 µg/m^3** 100 µg/m^3 **30 µg/m^3**	1-hour 24-hour **annual**
Particulates (PM_{10})	**50 µg/m^3**	24-hour
Sulphur dioxide	500 µg/m^3 350 µg/m^3 125 µg/m^3 **30 µg/m^3**	10-minute 1-hour 24-hour annual
Ozone	150 µg/m^3 100 µg/m^3 **80 µg/m^3**	1-hour 8-hour **24-hour**
Fluoride – Special land use – General land use – Conservation areas	 1.8 µg/m^3 1.5 µg/m^3 0.8 µg/m^3 0.4 µg/m^3 0.25 µg/m^3 3.7 µg/m^3 2.9 µg/m^3 1.7 µg/m^3 0.84 µg/m^3 0.5 µg/m^3 0.1 µg/m^3	 12-hour 24-hour 7-day 30-day 90-day 12-hour 24-hour 7-day 30-day 90-day 90-day
Hydrogen sulphide	7 µg/m^3	30-minute
Lead	0.5–1.0 µg/m^3	3-month

NB. Differences between these and the existing national guidelines are shown in bold.

* µg/m^3 is micrograms per cubic metre; mg/m^3 is milligrams per cubic metre, both at 0^{o}C.

Table 2.4: Air quality guidelines of the Wellington Regional Council

CONTAMINANT	**MAXIMUM DESIRABLE CONCENTRATION***	**MAXIMUM ACCEPTABLE CONCENTRATION**	AVERAGING PERIOD
Particulates	**70 µg/m^3** **40 µg/m^3**	120 µg/m^3 40 µg/m^3	24-hour annual
Carbon Monoxide	**6 mg/m^3**	10 mg/m^3	8-hour
Lead		0.5-1 µg/m^3	3-month
Nitrogen Dioxide	**95 µg/m^3** **30 µg/m^3**	300 µg/m^3 100 µg/m^3	1-hour 24-hour
Fluoride – Special land use		1.8 µg/m^3 1.5 µg/m^3 0.8 µg/m^3 0.4 µg/m^3 0.25 µg/m^3	12-hour 24-hour 7-day 30-day 90-day
– General land use	**1.8 µg/m^3** **1.5 µg/m^3** **0.8 µg/m^3** **0.4 µg/m^3** **0.25 µg/m^3**	3.7 µg/m^3 2.9 µg/m^3 1.7 µg/m^3 0.84 µg/m^3 0.5 µg/m^3	12-hour 24-hour 7-day 30-day 90-day
– Conservation areas		0.1 µg/m^3	90-day
Hydrogen Sulphide	**1 µg/m^3**	7 µg/m^3	30-minute
Ozone	**100 µg/m^3**	150 µg/m^3 100 µg/m^3	1-hour 8-hour
Sulphur Dioxide		500 µg/m^3 350 µg/m^3 125 µg/m^3 50 µg/m^3	10-minute 1-hour 24-hour annual

NB. Differences between these and the existing national guidelines are shown in bold.

* µg/m^3 is micrograms per cubic metre; mg/m^3 is milligrams per cubic metre, both at 0^{o}C.

In May 1997, the Canterbury Regional Council established 50 µg/m^3 as the 'air quality management target' for PM_{10} in Christchurch.[4] For completeness, the Canterbury Regional Council Guidelines are given in Table 2.5, with that one difference to the national guidelines highlighted in bold.

[4] Canterbury Regional Council, 1997, *Taking a Deep Breath – A Discussion Document on Christchurch Air Quality*, Report 97/14, 1997.

Table 2.5: Proposed air quality guidelines of the Environment Canterbury

CONTAMINANT	CONCENTRATION*	AVERAGING PERIOD
Particulates (PM_{10})	**50 µg/m^3** 40 µg/m^3	24-hour annual
Sulphur dioxide	500 µg/m^3 350 µg/m^3 125 µg/m^3 50 µg/m^3	10-minute 1-hour 24-hour annual
Carbon monoxide	30 mg/m^3 10 mg/m^3	1-hour 8-hour
Ozone	150 µg/m^3 100 µg/m^3	1-hour 24-hour
Nitrogen dioxide	300 µg/m^3 100 µg/m^3	1-hour 24-hour
Lead	0.5–1.0 µg/m^3	3-month

NB. The difference between these and the existing national guidelines is shown in bold.

* µg/m^3 is micrograms per cubic metre; mg/m^3 is milligrams per cubic metre, both at 0^{o}C.

2.6 Otago Regional Council

As part of the process to develop its Regional Plan: Air (which is at the 'proposed' stage), the Otago Regional Council has adopted some air quality guidelines. These guidelines have been used as criteria for assessing the results of ambient air monitoring.[5]

The Guidelines are given in Table 2.6. All the concentrations differ from the national guidelines. To provide consistency with the other tables, these differences are highlighted in bold.

[5] Millichamp PE, 1998, *Ambient Air Quality in Otago 1998 Results,* Otago Regional Council, December 1998.

Table 2.6: Proposed air quality guidelines of the Otago Regional Council

CONTAMINANT	CONCENTRATION*	AVERAGING PERIOD
Particulates (PM_{10})	**50 µg/m^3**	24-hour
Sulphur dioxide	**330 µg/m^3** **230 µg/m^3** **80 µg/m^3** **40 µg/m^3 (vegetation)**	10-minute 1-hour 24-hour **annual**
Carbon monoxide	**20 mg/m^3** **6 mg/m^3**	1-hour 8-hour
Nitrogen dioxide	**200 µg/m^3** **60 µg/m^3** **40 µg/m^3 (health)** **30 µg/m^3 (vegetation)**	1-hour 24-hour **annual** **annual**

NB. Differences between these and the existing national guidelines are shown in bold.

* µg/m^3 is micrograms per cubic metre; mg/m^3 is milligrams per cubic metre, both at 0^{o}C.

2.7 Other regional councils and unitary authorities

In addition to the five regional councils referred to above, there are seven other regional councils and four unitary authorities with air quality management responsibilities. Those that have addressed the issue of air quality guidelines have tended to adopt the national guidelines without change.

3 Air Quality Guidelines/ Standards: Criteria Pollutants

3.1 Introduction

The regional variations in air quality guidelines reflect something of what is happening internationally. Guidelines/standards for particles and nitrogen dioxide are now generally lower than they were at the time the New Zealand Ambient Air Quality Guidelines[6] were prepared. There is also increasing interest in $PM_{2.5}$.

3.2 Health effects

Air Quality Technical Report 12 contains a review of up-to-date information on the health effects of what are commonly referred to as 'criteria air pollutants', viz. carbon monoxide, nitrogen dioxide, ozone, particles, and sulphur dioxide. The review uses as its starting point the 1997 report[7] prepared for the Australian National Environment Protection Council, in advance of the promulgation of national ambient air quality standards in Australia. New research findings published since that report are included.

The existing New Zealand ambient air quality guidelines for carbon monoxide are in line with current international requirements. These are established to achieve a carboxyhaemoglobin level in blood less than 2.5%. However, there is emerging research which suggests adverse health effects may occur at lesser concentrations.

Recommendation 1:

The ambient air quality guidelines for carbon monoxide remain unchanged, at 30 mg/m^3, 1-hour average, and 10 mg/m^3, 8-hour average, and measurement be in accordance with standard method AS3580.7.1-1992.

Recommendation 2:

Consideration be given to adopting the carbon monoxide ambient air quality guidelines as national ambient air quality standards.

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6 Ministry for the Environment, 1994, *Ambient Air Quality Guidelines,* July 1994.

7 Streeton JA, 1997, *A Review of Existing Health Data on Six Air Pollutants,* Report to the National Environment Protection Council, Australia, May 1997.

Recommendation 3:

In view of the emerging research on adverse health effects at lower than expected carboxyhaemoglobin levels in blood, the ambient air quality guidelines/standards for carbon monoxide be reviewed no later than 2002.

The existing 1-hour average New Zealand ambient air quality guideline for nitrogen dioxide of 300 µg/m^3 is inappropriately high. It should be reduced to the World Health Organization guideline (and also the proposed Auckland, Waikato, and Otago guidelines) of 200 µg/m^3. The existing 24-hour average guideline of 100 µg/m^3 is in line with current international requirements. The guidelines are established to provide protection of respiratory function in vulnerable sub-groups in the population – the young, asthmatics of all ages but especially children, and adults with chronic cardiac and respiratory disorders. A 50% safety factor is applied to the current lowest observed adverse effect level for short term exposures of 400-600 µg/m^3.

Recommendation 4:

The 1-hour average ambient air quality guideline for nitrogen dioxide be reduced to 200 µg/m^3, the 24-hour average guideline remain unchanged, at 100 µg/m^3, and measurement be in accordance with standard method AS3580.5.1-1993.

Recommendation 5:

Consideration be given to adopting the revised nitrogen dioxide ambient air quality guidelines as national ambient air quality standards.

The existing New Zealand ambient air quality guidelines for ozone are in line with current international requirements. These are established to provide protection of respiratory function in vulnerable sub-groups in the population – those with asthma and chronic lung diseases, healthy young adults undertaking active outdoor exercise over extended periods, and the elderly, especially those with cardiovascular disease. Recent epidemiological studies demonstrate there is no apparent threshold concentration for ozone, below which adverse health effects will not be observed.

Recommendation 6:

The ambient air quality guidelines for ozone remain unchanged, at 150 µg/m^3, 1-hour average, and 100 µg/m^3, 8-hour average, and measurement be in accordance with standard method AS3580.6.1-1990.

Recommendation 7:

Consideration be given to adopting the ozone ambient air quality guidelines as national ambient air quality standards.

The existing ambient air quality guidelines for particles are specified as PM_{10}, and are 120 µg/m^3, 24-hour average, and 40 µg/m^3, annual average. The former is inappropriate, and should be reduced to the international norm (and the proposed Auckland, Waikato, Canterbury, and Otago guidelines) of 50 µg/m^3.

Epidemiological studies demonstrate there is no apparent threshold concentration for particles, below which adverse health effects will not be observed. There is increasing interest in $PM_{2.5}$. Although there is no conclusive evidence regarding the role of particle size, different sizes may be important for different health outcomes. For example, $PM_{2.5}$ may be more important for mortality and PM_{10} more important for asthma. Toxicological studies indicate that crustal particles are just as damaging as combustion particles for a given size range.

There is no useful purpose in annual average guidelines for particles. Even for Christchurch, if a long-term average was appropriate (and it is not), a seasonal averaging time would be more relevant.

Recommendation 8:

The 24-hour average ambient air quality guideline for PM_{10} be reduced to 50 µg/m^3, the annual average guideline be deleted, and measurement be in accordance with the standard method specified in US 40 CFR Part 50, Appendix J, or an equivalent method.

Recommendation 9:

Consideration be given to adopting the revised PM_{10} ambient air quality guideline as a national ambient air quality standard.

Recommendation 10:

Monitoring of $PM_{2.5}$ be encouraged, with measurement in accordance with the standard method specified in US 40 CFR Part 50, Appendix L, and the results compared with an ambient air quality guideline of 25 µg/m^3, 24-hour average.

Recommendation 11:

In view of the emerging research on the relationship between $PM_{2.5}$ and mortality, the $PM_{2.5}$ guideline be reviewed no later than 2004, including consideration of adopting it as a national ambient air quality standard.

The existing ambient air quality guidelines for sulphur dioxide are specified for averaging times of 10 minutes, 1 hour, 24 hours, and annual. There are really no good reasons for the first and last of these. Even for atmospheric dispersion modelling purposes, the 10-minute average guideline does not add much to the 1-hour guideline. If a long-term average was appropriate (and it is not), a seasonal averaging time would be more relevant. The existing guidelines of 350 µg/m^3, 1-hour average, and

120 µg/m^3, 24-hour average (rounded down from 125 µg/m^3, using a maximum of two significant figures), are in line with current international requirements. The guidelines are established to provide protection of lung function and other respiratory symptoms of vulnerable sub-groups in the population – asthmatics and those with chronic obstructive lung disease.

Recommendation 12:

The 1-hour and 24-hour average ambient air quality guidelines for sulphur dioxide remain essentially unchanged at, respectively, 350 µg/m^3 and 120 µg/m^3 (when expressed to a maximum of two significant figures), the 10-minute and annual average guidelines be deleted, and measurement be in accordance with standard method AS3580.4.1-1990.

Recommendation 13:

Consideration be given to adopting the revised sulphur dioxide ambient air quality guidelines as national ambient air quality standards.

3.3 Trends in international guidelines/ standards

A trend in international guidelines/standards is the use of such concepts as lowest observed effect level, lowest observed adverse effect level, no observed effect level, and no observed adverse effect levels, along with the application of uncertainty factors. The World Health Organization (WHO) is now proposing that for those contaminants for which thresholds for the onset of health effects do not appear to exist, a risk based approach be used. Unit risks have long been associated with carcinogenic compounds, but the concept has recently been applied to particles (but not to ozone and lead, two contaminants which similarly do not have apparent threshold concentrations). WHO now provides graphs showing the relationships between PM_{10} and $PM_{2.5}$ concentrations and various types of health effects.

Political and economic considerations are still prevalent in the setting of air quality standards in many countries. Even in Australia, this is evident in some aspects of the recently promulgated national ambient air quality standards, specifically those for ozone and sulphur dioxide. New Zealand, with its relatively clean air environment, has the luxury to take a fairly pure stance, and establish air quality guidelines/ standards based almost solely on health and environmental considerations.

It is important that ambient air quality guidelines/standards be regularly reviewed, at least every five years, to take into account developments internationally and, in particular, the results of any research in New Zealand.

Recommendation 14:

The ambient air quality guidelines/standards be reviewed at least every five years.

4 Other Existing Guidelines

4.1 Lead

The existing New Zealand ambient air quality guideline for lead is the range 0.5–1.0 µg/m^3, 3-month moving average, calculated monthly. The recommended method of measurement involves the determination of the lead content of PM_{10} (which is unique internationally; other countries use the lead content of total suspended particulate (TSP)). Most jurisdictions are now establishing guidelines/standards for lead in air so as to achieve a blood lead level of less than 10 µg/dL (1dL = 0.1L) in all sub-groups in the population. The sub-groups most vulnerable to lead are young children and developing foetuses. There is now clear epidemiological evidence of a close causal relationship between prenatal exposure to lead and early mental development indices. This effect has been attributed to lead present at blood levels as low as 10 µg/dL, but the absence of an identifiable threshold suggests that a deleterious effect may be produced at blood lead levels lower than 10 µg/dL.

With the removal of lead from petrol in 1996, atmospheric lead is no longer an environmental issue in New Zealand (although lead in old paint is still a significant public health problem). Lead in air concentrations have reduced to about 0.2 µg/m^3, three-month moving average, calculated monthly, and are decreasing. This trend will continue for a while, as residual contamination in petrol distribution systems and environmental contamination, caused by the addition of alkyl lead compounds to petrol for more than 30 years, take on lesser significance.

With no apparent threshold concentration, it is prudent to have the ambient air quality guideline for lead as low as possible. The lower of the current range, 0.5 µg/m^3, is probably appropriate at this time, but consideration should be given to lowering it to 0.2 µg/m^3. (A recent recommendation of the United Kingdom Expert Panel on Air Quality Standards is for 0.25 µg/m^3, annual average.) As with ambient concentrations of particles in New Zealand, there is seasonal variation in lead levels, with highest concentrations during winter months. This is because of the poorer atmospheric dispersion provided by meteorological conditions in winter, especially the increased frequency of temperature inversions. This degree of seasonal variation means that the use of a three month (rather than a one year) averaging period for the ambient air quality guideline is appropriate; a one year average may not adequately show peak concentrations for what are still relatively long term exposure times.

Recommendation 15:

The ambient air quality guideline for the lead content of PM_{10} be 0.5 µg/m^3, 3-month moving average, calculated monthly, with sampling in accordance with the standard method specified in US 40 CFR Part 50, Appendix J, and analysis in accordance with the standard method specified in US 40 CFR Part 50, Appendix G, or an equivalent analytical method, and that consideration be given to reducing the concentration to 0.2 µg/m^3.

4.2 Fluoride

The existing New Zealand ambient air quality guidelines for fluoride are those of the Australian and New Zealand Environment and Conservation Council (ANZECC).[8] They were established to protect sensitive plant species in Australia's natural environment. No New Zealand species were examined as the guidelines were developed. The Ministry for the Environment has commenced work on the impact of air pollutants on New Zealand ecosystems. ANZECC has not reviewed the Goals since 1990.

Recommendation 16:

Pending completion of the work on the effects of air pollutants on New Zealand ecosystems, the ambient air quality guidelines for fluoride remain unchanged, with monitoring in accordance with standard method AS3580.13.1-1993.

4.3 Hydrogen sulphide

The existing New Zealand ambient air quality guideline for hydrogen sulphide is 7 $\mu g/m^3$, 30-minute average. That guideline was originally set by the World Health Organization (WHO) Environmental Health Criteria document,[9] and was based on the prevention of substantial complaints about odour nuisance (the characteristic rotten egg smell). The guideline is above the odour threshold concentration of hydrogen sulphide, which was determined in pristine laboratory conditions.

Although New Zealand played a significant part in the preparation of the WHO criteria document (with its representative both Rapporteur and Chairman of the Sub-Committee on Environmental Impacts at the Task Group Meeting in Geneva, March 1980) our use[10] of a guideline of 7 $\mu g/m^3$, 1-hour average, was in a minority when compared with the Eastern European practice of setting standards with 30-minute averaging times.

A second aspect of the previous New Zealand approach, which is referred to in discussion on page 40 of the existing guidelines document, is that of applying the requirement at areas unaffected by natural sources of hydrogen sulphide (that is, not at natural geothermal areas). For areas affected by natural sources of hydrogen sulphide (for example, Rotorua), a guideline of 70 $\mu g/m^3$, 1-hour average, may be more appropriate, but this is a matter best addressed as a local concern, through regional plans and resource consents. This approach has been applied to most geothermal resource consents. A 10-fold increase in concentration of hydrogen sulphide is approximately equal to a unit increase in odour intensity.

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8 Australian and New Zealand Environment and Conservation Council, 1990, *National Goals for Fluoride in Ambient Air and Forage,* March 1990.

9 World Health Organization, 1981, *Hydrogen Sulfide,* Environmental Health Criteria 19, 1981.

10 Rolfe KA, 1980, *Hydrogen Sulphide from Geothermal Developments: Its Nature and Control,* Proceedings of the New Zealand Geothermal Workshop 1980, pp. 119-125, University of Auckland, November 1980.

Recommendation 17:

The ambient air quality guideline for hydrogen sulphide be 7 µg/m^3, 1-hour average, and measurement be in accordance with standard method AS3580.4.1-1990, coupled with a hydrogen sulphide to sulphur dioxide converter.

5 Hazardous Air Pollutants

An important air quality issue is that of hazardous air pollutants. Public concerns about air toxics have heightened as awareness of such chemicals in the environment has increased, and better information about their potential hazards has become available. The existing Guidelines include an ambient air quality guideline for only one hazardous air pollutant – lead.

There are about 200 substances that can be referred to as hazardous air pollutants, and it is practical to consider them in generic groupings. Air Quality Technical Report 13 contains a review of priority hazardous air pollutants of potential concern in New Zealand, excluding organochlorines and pesticides (which are being addressed in other Ministry for the Environment programmes). Ten priority hazardous air pollutants are considered, in four groupings, viz:

- Volatile Hydrocarbons: **Benzene**, **Toluene**, **Xylene**, and **1,3-Butadiene**
- Carbonyls: **Formaldehyde** and **Acetaldehyde**
- Polycyclic Aromatic Hydrocarbons (PAHs): **Benzo(a)pyrene**
- Metals: **Mercury**, **Chromium**, and **Arsenic**.

Table 5.1 gives guidelines for the 10 priority hazardous air pollutants. They are of two types – annual average concentrations for assessing the results of ambient air monitoring at 'urban residential' sites, and 1-hour average concentrations against which the results of atmospheric dispersion modelling can be evaluated.

Recommendation 18:

Monitoring programmes for priority hazardous air pollutants be encouraged, with monitoring in accordance with the recommended methods of the United States Environmental Protection Agency, and the results compared with the following guidelines (annual average):

Benzene	year 2000	10 µg/m^3
	year 2010	3.6 µg/m^3
Toluene		190 µg/m^3
Xylene		950 µg/m^3
1,3-Butadiene		2.4 µg/m^3
Formaldehyde		15 µg/m^3
Acetaldehyde		30 µg/m^3
Benzo(a)pyrene		0.0003 µg/m^3
Mercury	inorganic	0.33 µg/m^3
	organic	0.13 µg/m^3
Chromium	chromium VI	0.0011 µg/m^3
	other forms	0.11 µg/m^3
Arsenic	inorganic	0.0055 µg/m^3
	arsine	0.055 µg/m^3

Table 5.1: Recommended guidelines for priority hazardous air pollutants

CONTAMINANT		for AMBIENT AIR MONITORING* (annual average)	for DISPERSION MODELLING* (1-hour average)
Benzene		Year 2000 10 µg/m^3 Year 2010 3.6 µg/m^3	22 µg/m^3
Toluene		190 µg/m^3	500 µg/m^3
Xylene		950 µg/m^3	1,000 µg/m^3
1,3-Butadiene		2.4 µg/m^3	15 µg/m^3
Formaldehyde		15 µg/m^3	20 µg/m^3
Acetaldehyde		30 µg/m^3	45 µg/m^3
Benzo(a)pyrene		0.0003 µg/m^3	n.a.
Mercury	inorganic organic	0.33 µg/m^3 0.13 µg/m^3	2.0 µg/m^3 0.80 µg/m^3
Chromium	chromium VI other forms	0.0011 µg/m^3 0.11 µg/m^3	0.0067 µg/m^3 0.67 µg/m^3
Arsenic	inorganic arsine	0.0055 µg/m^3 0.055 µg/m^3	0.033 µg/m^3 0.33 µg/m^3

* µg/m^3 is micrograms per cubic metre, at 0^{o}C.

6 Other Air Quality Issues: Good Practice Guidance

6.1 Odour

Odour and odour management are common air quality issues. There should be no national ambient air quality guidelines/standards for odour. The Ministry for the Environment has published a guidance document on odour management,[11] and it is suggested the issue of odour is best addressed by a review and update of that guidance document. The style and format of the revised document could follow those of two recent Ministry for the Environment publications,[12,13] including being given the subtitle "A Good Practice Guide". Matters which could be covered in the revised document are:

- recent case law and best practice toward odour management
- specific criteria for assessing atmospheric dispersion modelling for odour
- the relationship between odour management and land use
- the role of performance standards for odour
- methods for surveying community response
- standard methods for sampling and measurement of odour.

Recommendation 19:

The air quality issue of odour be addressed by a review and update of the Ministry for the Environment's guidance document on odour management (with the revised subtitle "A Good Practice Guide"), covering recent case law and best practice toward odour management, specific criteria for assessing atmospheric dispersion modelling for odour, the relationship between odour management and land use, the role of performance standards for odour, methods for surveying community response, and standard methods for sampling and measurement of odour.

[11] Ministry for the Environment, 1995, *Odour Management under the Resource Management Act*, June 1995.

[12] Ministry for the Environment, 1997, *To Notify or Not to Notify Under the Resource Management Act – A Good Practice Guide,* October 1997.

[13] Ministry for the Environment, 1999*, Auditing Assessments of Environmental Effects – A Good Practice Guide,* Ministry for the Environment, June 1995.

6.2 Dust nuisance

Dust nuisance is another perceived air quality issue, especially for regional councils. There should be no national ambient air quality guidelines/standards for dust nuisance. As with odour, it is suggested that the issue of dust nuisance is best addressed in a separate guidance document. The guidance document could be given the subtitle "A Good Practice Guide". Recommended levels for inclusion in the guidance document are:

- Dust deposition: 4 g/m^2/30 days, as an increase above existing background, measured in accordance with standard method ISO DIS4222.2
- Total suspended particulate: 150 $\mu g/m^3$ (24-hour average), or 250 $\mu g/m^3$ (1-hour average), measured in accordance with standard method AS2724.3-1984.

Recommendation 20:

The air quality issue of dust nuisance be addressed by the preparation of a guidance document on the management of dust nuisance (with the subtitle "A Good Practice Guide"), and the document include levels of 4 g/m^2/30 days for dust deposition, as an increase above existing background, measured in accordance with standard method ISO DIS4222.2, and 150 $\mu g/m^3$ (24-hour average) or 250 $\mu g/m^3$ (1-hour average) for total suspended particulate, measured in accordance with standard method AS2724.3-1984.

6.3 Visibility

Visibility has been adopted as a Stage 2 ('further development required') air quality indicator under the Ministry for the Environment's Environmental Performance Indicators Programme.[14] This is quite appropriate, because ultimately the success of air quality programmes will be measured against ensuring New Zealand does not suffer the widespread degradation in visibility that has occurred elsewhere. Both the Ministry for the Environment[15] and NIWA[16] (for the Auckland Regional Council) are carrying out studies related to visibility. Particular foci of those studies are the development of appropriate criteria and reference methods for measurement.

There should be no national ambient air quality standard for visibility, but a national ambient air quality guideline be developed when the criteria and reference methods of measurement are finalised. The guideline should be adopted when visibility is incorporated into the Environmental Performance Indicators Programme. Because

[14] Ministry for the Environment, 1998, *Environmental Performance Indicators – Confirmed Indicators for Air, Fresh Water and Land*, October 1998.

[15] Ministry for the Environment, 1998, *Visibility Protection in New Zealand*, Draft Discussion Document, June 1998.

[16] NIWA, 1998, *Visibility in Auckland*, Report 97024, Commissioned by the Auckland Regional Council, June 1998.

visibility measurements are not directly amenable to the categories of air quality approach, specific criteria for indicators of visibility should be developed.

Recommendation 21:

Pending completion of studies on the development of criteria and reference methods for measurement of visibility, a national ambient air quality guideline (but not a standard) for visibility be developed, and the guideline be adopted when visibility becomes an air quality indicator in the Environmental Performance Indicators Programme.

7 Application of Guidelines/ Standards

7.1 State of the environment reporting

A primary application of ambient air quality guidelines/standards is in ambient air monitoring, or state of the environment reporting. At the time of publication of the existing Guidelines[17] there were only a few air quality monitoring sites in New Zealand, and the assessment of the quality of air and its effects was based on little data. In recent times the number of monitoring sites has increased significantly, and there are attempts[18] to improve the consistency and comparability of monitoring data.

The Ministry for the Environment's Environmental Performance Indicators Programme has provided an impetus for improved state of the environment reporting. Five air contaminants - PM_{10}, sulphur dioxide, carbon monoxide, ozone, and nitrogen dioxide – for which ambient air quality guidelines exist, are Stage 1 ('ready to implement') air quality indicators.[19] The state of air quality is determined by comparing monitoring results with five categories of air quality – excellent being less than 10% of the guideline, good between 10% and 33% of the guideline, acceptable between 33% and 66% of the guideline, alert between 66% and 100% of the guideline, and action being more than 100% of the guideline. A database is being set up along these lines. There seems to be a consensus amongst practitioners[20] that, in addition to maximum results, air quality monitoring data of interest are the 99.9 percentile values for 1-hour and 8-hour averages and 99.5 percentile values for 24-hour averages. The number of exceedances will be reported in the form 'x number of exceedances occurred on y number of days during the sampling period'.

There are four Stage 2 ('further development required') air quality indicators[18] – benzene, $PM_{2.5}$, lichen diversity/coverage, and visibility. It is difficult to see how measurements of a couple of these indicators can be directly amenable to the categories of air quality approach. Somewhat different criteria will need to be developed for state of the environment reporting for those Stage 2 indicators.

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17 Ministry for the Environment, 1994, *Ambient Air Quality Guidelines*, July 1994.

18 Ministry for the Environment, 1999, *Protocols for Air Quality Monitoring and Data Management*, A draft discussion document, March 1999.

19 Ministry for the Environment, 1998, *Environmental Performance Indicators – Confirmed Indicators for Air, Fresh Water and Land*, October 1998.

20 Ministry for the Environment, 1998, *Environmental Performance Indicators Programme Minimum Reporting Requirements – Air Indicators*, Draft consultation document, November 1998.

Recommendation 22:

Application of the revised ambient air quality guidelines/standards for PM_{10}, sulphur dioxide, carbon monoxide, ozone, and nitrogen dioxide to State of the Environment Reporting continue, recording the maximum result, the number of exceedances of the guidelines/standards (in the form 'x number of exceedances occurred on y number of days during the sampling period'), and 99.9 percentile values for 1-hour and 8-hour averages and 99.5 percentile values for 24-hour averages, and using the categories of air quality approach of the Environmental Performance Indicators Programme.

7.2 Regional plans

Regional plans are an instrument to assist regional councils carry out their functions under the Resource Management Act. They can provide the detailed programmes to achieve specific objectives identified in regional policy statements. It is common to refer to the air section of the plan as the regional air quality plan. Only a few regional air quality plans are currently in place, most are at the 'proposed' stage, and the remainder are at the 'draft' stage. Air quality guidelines are a feature of those plans, as well as being used to assess the results of ambient air monitoring.

The categories of air quality approach developed for the Environmental Performance Indicators Programme is appropriate to regional plans. In fact, it would seem that the Otago Regional Council has adopted this approach with many of its proposed air quality guidelines set at a level of two-thirds the existing national Guidelines. This indicates the Otago Regional Council wants to provide greater enhancement of air quality or prevent significant deterioration of existing air quality. (Using the categories of air quality, the Otago Regional Council want 'acceptable' air quality.)

Recommendation 23:

Application of the revised ambient air quality guidelines/standards to regional plans continue, including use of the categories of air quality approach of the Environmental Performance Indicators Programme, to provide greater enhancement of air quality or prevent significant deterioration of existing air quality.

7.3 Resource consents

Applications for resource consents under the Resource Management Act are required to include an Assessment of Environmental Effects. This may involve background air quality monitoring. The ambient air quality guidelines/standards are appropriate to assess the results of the monitoring. Atmospheric dispersion modelling is also a common feature of resource consent applications. Compliance monitoring is another

resource consent issue,[21] and it is usually best achieved by process monitoring and discharge monitoring. In most circumstances, ambient monitoring should not be used to assess the downwind effects of a specific site emissions, because it is usually difficult to distinguish this source from other sources. It is usually better to impose emission limits as conditions of a resource consent, and use dispersion modelling to assess downwind effects. There may be situations (involving large, isolated industry), however, where ambient monitoring programmes, in conjunction with emission testing, are appropriate for assessing environmental effects and compliance monitoring.

Recommendation 24:

Application of the revised ambient air quality guidelines/standards to background air quality monitoring, as part of an application for a resource consent, continue, and for those situations (usually involving large, isolated industry) where ambient monitoring programmes, in conjunction with emission testing, are appropriate for assessing environmental effects and compliance monitoring.

[21] Ministry for the Environment, 1998, *Compliance Monitoring and Emission Testing of Discharges to Air*, August 1998.

8 Atmospheric Dispersion Modelling

Atmospheric dispersion modelling can be used in one of two ways for resource consents – as part of an Assessment of Environmental Effects at the time of application for a consent, or, in association with emission limits imposed as conditions of a consent (or direct measurement of emissions), to assess downwind effects. For both situations evaluation criteria (usually the same) are required.

Although considerable development has occurred in New Zealand in recent years with atmospheric dispersion modelling, including the production of 'certified' meteorological data sets,[22] there is a need for some general guidance. The Environment Protection Authority of Victoria, for example, has a procedure that is set down in policy[23] for atmospheric dispersion modelling. Although the Victorian approach is currently lacking uniformity, with 1-hour average design ground level concentrations for three air pollutants ('class 1 indicators') and 3-minute average concentrations for more than 100 other air contaminants ('class 2 and class 3 indicators'), it serves as a good model. There is an additional publication[24] which gives information on an approved plume calculation procedure.

Air Quality Technical Report 13 gives evaluation criteria for priority air toxics against which the results of atmospheric dispersion modelling (1-hour average) can be assessed.

[22] NIWA, 1997, *Met. Data a la carte*, Aniwaniwa, No. 6, Spring 1997, page 6.

[23] EPA Victoria, 1981–1999, *State Environment Protection Policy (The Air Environment)*, Victoria Government Gazette, July 1981, and amended in November 1982, June 1988, and February 1999.

[24] EPA Victoria, 1985, *Plume Calculation Procedure – an approved procedure under Schedule E of State Environment Protection Policy (The Air Environment)*, Publication 210, March 1985.

Recommendation 25:

The air quality issue of atmospheric dispersion modelling be addressed by the preparation of a guidance document (with the subtitle “A Good Practice Guide”), covering approved procedures for atmospheric modelling and providing specific evaluation criteria against which the results of atmospheric dispersion modelling can be assessed, for a wide range of air pollutants, such as the following for priority hazardous air pollutants (1-hour average):

Benzene		22 µg/m^3
Toluene		500 µg/m^3
Xylene		1000 µg/m^3
1,3-Butadiene		15 µg/m^3
Formaldehyde		20 µg/m^3
Acetaldehyde		45 µg/m^3
Mercury	inorganic	2.0 µg/m^3
	organic	0.80 µg/m^3
Chromium	chromium VI	0.0067 µg/m^3
	other forms	0.67 µg/m^3
Arsenic	inorganic	0.033 µg/m^3
	arsine	0.33 µg/m^3