Ministry for the Environment
Manatū Mō Te Taiao

Proposed National Environmental Standards for Air Quality

Resource Management Act Section 32

Analysis of the costs and benefits

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Contents

Executive Summary vi

1 Introduction 1
1.1 Overview 1
1.2 The section 32 evaluation and report 2

2 Statement of the Issue 3
2.1 Objectives for ambient air quality 3
2.2 Improving our air quality 3
2.3 Greater protection and certainty 4
2.4 Air pollution 5
2.4.1 Overview 5
2.4.2 Fine particles (PM_{10}) 5
2.5 Other pollutants 9
2.5.1 Sulphur dioxide (SO_2) 10
2.5.2 Nitrogen dioxide (NO_2) 10
2.5.3 Carbon monoxide (CO) 11
2.5.4 Ozone (O_3) 11
2.6 Dioxins and other toxic substances 11

3 What are the Options? 14
3.1 Introduction 14
3.2 Determining the most appropriate option 14
3.2.1 Status quo (continued guidelines and guidance) 16
3.2.2 Increased monitoring and analysis 16
3.2.3 Information and education schemes 16
3.2.4 Voluntary agreements 17
3.2.5 Economic instruments 17
3.2.6 Command and control (national standards) 17
3.2.7 Findings of the appropriateness test 18
3.2.8 The call for national environmental standards 19
3.2.9 Moving to the next stage in the analysis 19

4 The Proposed Air Quality Standards 20
4.1 Ambient air quality 20
4.1.1 Particles (PM_{10}) 20
4.1.2 Nitrogen dioxide (NO_2) 21
4.1.3 Ozone (O_3) 22
4.1.4 Sulphur dioxide (SO_2) 22
4.1.5 Carbon monoxide (CO) 23
4.1.6 International comparison 24

4.2 Dioxins and other toxic substances 24
4.2.1 Open burning of tyres 24
4.2.2 Road-seal burning 25
4.2.3 Coated-wire burning 26
4.2.4 Burning of oil in the open 26
4.2.5 Landfill fires 27
4.2.6 Waste incineration in schools and hospitals 28
4.2.7 High-temperature hazardous waste incineration 30
4.3 Design standard for wood burners 31

5 Efficiency and Effectiveness of the National Environmental Standards for Air Quality Package 33
5.1 Overview 33
5.2 Summary of methodology 34
5.3 Defining the baseline 34
5.4 Assessment of benefits 36
5.4.1 Overview of the approach 36
5.4.2 Modelling the benefits 37
5.4.3 Results of the benefit modelling 38
5.5 Assessment of total costs 42
5.5.1 Sectors affected and sources of cost information 42
5.5.2 Summary of costs 44
5.6 Options appraisal – measuring efficiency 44
5.7 Sensitivity testing 46

References 47

Appendices
Appendix 1: Design Standard for Woodburners – Costs and Benefits 49
Appendix 2: Council Plans and Proposed Activity Bans 55
Appendix 3: Cost Summary Spreadsheet 56

Tables

Table 1:	Estimates of health impacts of particle concentrations in New Zealand	7
Table 2:	Maximum measured concentrations of PM_{10} (24-hour average) in New Zealand compared with the daily guideline	8
Table 3:	Appropriate policy instrument criteria	15
Table 4:	Results of the multi-criteria appropriateness test	18
Table 5:	International comparison of air quality standards	24
Table 6:	Number of North Island schools with incinerators	29
Table 7:	Health effects associated with air pollution: status quo	36
Table 8:	Summary of the benefits of standards	37
Table 10:	Scenarios of differing dates for achieving standards	39
Table 11:	Health benefits from the standards (as compared to the status quo option)	40
Table 12:	Sources of costs for the air quality standards package	43
Table 13:	Summary of total costs and total benefits	45
Table 14:	Summary of sensitivity testing	46
Table A1.1:	Estimated health impacts associated with PM_{10} concentrations in New Zealand – status quo	50
Table A1.2:	Estimated benefits of introducing a standard for wood burners of 4.0 g/kg	50
Table A1.3:	Estimated benefits of introducing a standard for wood burners of 1.5 g/kg	51
Table A1.4:	Estimated benefits of introducing a standard for wood burners of 1.0 g/kg	52
Table A2:	Summary of current regional plans and proposed prohibited activities	55

Figures

Figure 1:	Average daily level of PM_{10} and number of respiratory admissions, Christchurch, 1988–98	6
Figure 2:	Maximum 24-hour average PM_{10} concentrations, New Zealand, measured between 1997 and 2001	9
Figure 3:	Total premature mortality and achievement dates	39
Figure 4:	Cumulative reductions in premature mortality and differing achievement dates	40
Figure 5:	The relationship between age and the willingness to pay for a mortality risk reduction	41

Executive Summary

On the whole, New Zealand has relatively good air quality due to a low population density, close proximity to the sea, and remoteness from other continents and sources of pollution. However, concentrations of fine particles are high in some urban areas and are thought to be creating adverse health impacts that affect both society's quality of life and the economy as a whole. Monitoring results indicate that the existing guideline value for fine particles has been exceeded at 36 locations throughout New Zealand. In many of these areas, the daily guideline is exceeded more than five times a year. It is estimated that five centres (Alexandra, Christchurch, Nelson, Richmond and Timaru) are likely to exceed fine particle guideline values more than 50 times a year.

Although the Resource Management Act was passed more than 12 years ago, no national environmental standards have been developed under the Act. Unlike other countries, New Zealand has no national standards for environmental protection.

National environmental standards have been advocated by industry to give both a 'level playing field' across regions, and to provide certainty in decision making under the Resource Management Act. The benefits in providing consistency and certainty are large, but are difficult to quantify and are not calculated in the subsequent analysis. Instead, the report focuses on the costs and benefits of using national environmental standards to provide an equitable bottom line of health and environmental protection for all New Zealanders.

Section 32 of the Resource Management Act requires the Minister for the Environment to evaluate the objectives and policies of any proposed national environmental standards. A report must be prepared that evaluates whether the proposal is the most appropriate method for achieving the objectives, having regard to their efficiency and effectiveness. Such analysis is included in this report.

The detailed analysis shows that the proposed air quality standards would:

- save 625 lives over the analysis period to 2020
- incur total costs conservatively estimated at $110.8 million
- involve a cost per life saved of $177,000
- have a net present value of $318.4 million
- have a benefit-to-cost ratio of 3.87.

It is, therefore, recommended that the proposed national environmental standards present the most appropriate, effective and efficient means of meeting the Minister for the Environment's objectives for air quality management.

1 Introduction

1.1 Overview

This document presents an analysis of New Zealand's proposed national environmental standards for air quality, as required by section 32 of the Resource Management Act 1991 (RMA). Unlike other countries, New Zealand has no national standards for environmental protection.

The introduction of national environmental standards will provide an equitable bottom line of health protection for all New Zealanders. National environmental standards have been advocated by industry to give both a level playing field across regions and certainty in decision-making under the RMA. Also, the Ministerial Panel on Business Compliance Costs recommended that the Government investigate the use of national planning instruments, such as standards, to improve consistency in decision-making.

The proposed standards are compiled as a package covering:

- **ambient standards** for carbon monoxide (CO), particles (PM_{10}), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and ozone (O_3)
- **emission standards** for small-scale, domestic wood-burning appliances
- **activity standards** that prohibit various activities unless they gain resource consents.

National environmental standards[1] have the force of regulation and will be implemented by agencies and parties with responsibilities under the RMA. The standards are prepared in accordance with sections 43 and 44 of the Act.

In August 2003 the Government agreed that "the Ministry for the Environment undertake an extensive public consultation process on a range of proposed standards, including air quality standards".

1 A separate section 32 document has been prepared for the proposed landfill gas collection and destruction standard.

1.2 The section 32 evaluation and report

The Minister for the Environment has proposed introducing national environmental standards for air quality. Section 32 of the RMA requires the Minister for the Environment to evaluate the objectives and policies of any proposed national environmental standards, and to prepare a report summarising the evaluation. The requirements contained within section 32 of the RMA are:

> *(3) An evaluation must examine:*
>
> *(a) the extent to which each objective is the most appropriate way to achieve the purpose of this Act; and*
>
> *(b) whether, having regard to their efficiency and effectiveness, the policies, rules, or other methods are the most appropriate for achieving the objectives.*
>
> *(4) For the purposes of this examination, an evaluation must take into account:*
>
> *(a) the benefits and costs of policies, rules, or other methods; and*
>
> *(b) the risk of acting or not acting if there is uncertain or insufficient information about the subject matter of the policies, rules, or other methods.*

There are two main aspects to the test of *appropriateness*:

- weighing up alternative objectives to determine which one will provide environmental outcomes that will best meet the purpose of the Act
- being satisfied that the objective chosen can best be achieved through the Act, rather than through some other mechanism.

Getting a measure of *effectiveness* involves assessing how well something might work.

Determining the relative *efficiency* of various alternatives is a more difficult exercise, and involves an examination of costs and benefits. A measure of efficiency is the extent to which the proposed method achieves the purpose of the Act, compared to the magnitude of what is foregone as a result of using this method. Assessing this involves calculating and comparing the net environmental benefits against the net social and economic benefits. Thus the more the net environmental benefits exceed the net social and economic costs, the more efficient the option is. The smaller the net environmental benefits in relation to the net social and economic costs, the less efficient the option is (Ministry for the Environment, 2000b).

In evaluating the efficiency of the proposed national environmental standards, some assumptions have had to be made about how the policies might be put into practice by local government.

2 Statement of the Issue

2.1 Objectives for ambient air quality

The Minister for the Environment has determined five main objectives for national policy development for air quality management in New Zealand:

- to improve consistency in policy and legislation in relation to ambient air quality
- to improve air quality where it is degraded and reduce the health impacts of poor air quality
- to provide a level playing field across New Zealand
- to provide certainty and equal treatment for all New Zealanders
- to ensure certainty for entrant industry.

2.2 Improving our air quality

On the whole, New Zealand has relatively good air quality due to our low population density, close proximity to the sea, and remoteness from other continents and sources of pollution. However, concentrations of fine particles are quite high in some urban areas, especially during low wind conditions where home heating is mainly by open fires or poorly performing wood burners, and where there is high traffic density.

The Ministry for the Environment, in response to this situation and calls from various sectors, wants to introduce a series of national standards to address fine particle pollution, and other priority contaminants such as CO, NO_2, O_3 and SO_2 before they increase to a level that will result in adverse health effects.

In its *Sustainable Development for New Zealand: Programme of Action* announced in January 2003 (Department of Prime Minister and Cabinet, 2003), the Government noted the importance of improving air quality as an element of creating "liveable cities that support social wellbeing, quality of life and cultural identities". A key step in developing liveable cities was identified as:

> *Developing environmental standards (for air quality, water quality, noise and waste) and a timetable for their implementation, in consultation with urban authorities.*

One key aspect of improving our air quality is reducing New Zealanders' exposure to dioxins. Dioxins are highly toxic chemicals that are known to cause serious health effects such as cancer, birth defects, and reproductive and developmental problems. Once in the environment, dioxins accumulate in the fatty tissue of wildlife, livestock and people. They break down only very slowly and can remain in the environment and in the bodies of animals and people for a very long time.

A major portion of the dioxin that enters the body of the typical New Zealander originates as a discharge to air and is eventually ingested in meat and dairy products.

In October 2001 the Minister for the Environment announced New Zealand's action plan for reducing discharges of dioxin to air (Ministry for the Environment, 2001a), which proposed developing a national environmental standard to reduce dioxin discharges to air. The prohibitive activity standards proposed as part of the current package of national environmental standards reflect many of the recommendations made in the *Dioxin Action Plan* and are intended to reduce exposure to dioxins as well as other toxic pollutants.

The existing Ministry for the Environment *Ambient Air Quality Guidelines* (Ministry for the Environment, 2002a) have no legal status. National environmental standards are therefore seen as a more effective way of providing protection for New Zealanders from the health risks of air pollution and dioxins. Parameters selected for the proposed standards will use the existing guideline values as the ambient standard values. Parameters contained in the *Ambient Air Quality Guidelines* that are not included within the standards are still appropriate to use as best-practice guideline levels.

The prohibitive activity standards (bans) are regarded as the most efficient and effective way to provide protection for all New Zealanders from the health and environmental effects of dioxins and other toxic chemicals.

2.3 Greater protection and certainty

Over the past 10 years the Ministry for the Environment has provided guidance to local government on managing air quality through a series of guidelines. While the levels of some contaminants in our air have declined (such as the decrease in air lead levels with the phasing out of leaded petrol), concentrations of other pollutants appear to be increasing. Where measures are already under way to improve air quality in towns and cities, the standards should strengthen or give greater weight to these efforts. Where there is currently limited action under way, new measures may provide the required boost.

The current system of guideline values has created a range of requirements within plans, monitoring programmes and discharge permits where industries and communities may face different rules in different regions. It has also created an environment where litigation of the same issues occurs region by region. This causes an uncertainty that can confuse industries and communities and potentially results in delays in consent processing and plan development.

It therefore makes sense to ensure that all discharges to air meet a certain standard throughout the country and to establish the same regulation and protection for all New Zealanders. There have been calls by industry, councils and others for the government to develop national environmental standards to improve consistency and set the environmental bottom lines for air quality.

The Minister for the Environment considers that action is needed to protect air quality for all New Zealanders and to give greater certainty for planning and resource consents.

2.4 Air pollution

2.4.1 Overview

A number of reports prepared by the Ministry for the Environment deal with the health and environmental effects of air pollutants. While some aspects of our air quality are improving, the concentrations of other pollutants, especially from vehicle emissions, are increasing. There is evidence that air pollution in some towns and cities is causing adverse effects on people's health and wellbeing and needs to be improved.

While many New Zealanders believe that our air quality is good, surveys show that the majority perceive a decline in the last five years. This perceived deterioration is matched by a demand for more expenditure on air quality (Hughey et al, 2003).

The key air pollutant of concern in New Zealand is fine particles (PM_{10} – particles less than 10 microns in diameter). Action is also required to prevent other pollutants such as CO, NO_2, O_3, SO_2 and dioxins from increasing to levels at which they become a concern.

Fine particle pollution in some of New Zealand's urban areas is causing serious adverse effects on people's health, including premature deaths, respiratory diseases, asthma attacks, reduced immunity, and coughs and wheezing. In turn, these health impacts affect people's ability to work and play, hasten their deaths, and burden the health system.

The Ministry now has partnership agreements with all regional councils for monitoring fine particle pollution.

2.4.2 Fine particles (PM_{10})

The science underpinning our understanding of the health impacts of particles is epidemiology.[2] Observational studies on the relationship between concentrations of particles and health effects have been conducted in many countries, and numerous locations throughout the world. The results show that increases in mortality and other health effects are associated with increases in 24-hour average PM_{10} concentrations. The consistency and coherency of the studies have led researchers to conclude that fine particles cause these health effects and that there is no threshold below which effects do not occur.

The impact of PM_{10} concentrations on the health of residents in different areas of New Zealand has been estimated in a number of different studies. The most extensive study was carried out by Fisher et al (2002), and estimates the number of premature deaths associated with PM_{10} concentrations from all sources and from motor vehicles based on relationships described in a study by Kunzli et al (2000). Results are reported for the four major cities (Auckland, Christchurch, Wellington and Dunedin), with other areas being collated for both the North and South Island. The estimated annual premature mortality rates were: 440 for Auckland, 180 for Christchurch, 80 for Wellington, 50 for Dunedin, 40 for Hamilton and 20 for Nelson.

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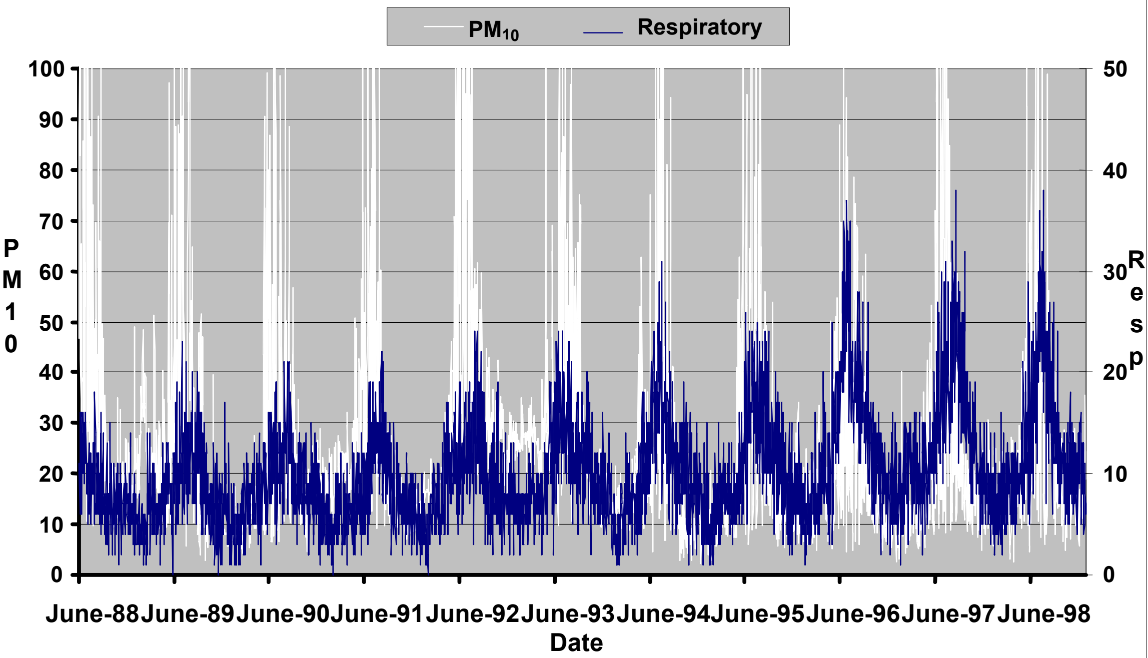
2 The branch of medicine that deals with the study of the causes, distribution, and control of illness in populations.

Figure 1: Average daily level of PM_{10} and number of respiratory admissions, Christchurch, 1988–98



Source: McGowan et al, 2002

Risk assessments of the impact of PM_{10} concentrations in Christchurch and Nelson have been carried out (Hales et al, 1999), as have studies of the health impacts of PM_{10} in Christchurch (McGowan et al, 2002). These studies include mortality estimates as well as hospitalisations and restricted activity days (RADs). The mortality estimates for the latter risk assessments underestimate mortality by around four to five times compared to Fisher et al (2002). This is attributed to the time-series methodology of the Hales et al (1999) study, which associates only those deaths that occur a relatively short time after the pollution episode to PM_{10} concentrations. Thus they are limited to a selection of the acute impacts but do not estimate the reduced life expectancy due to long-term morbidity enhanced by air pollution.

Results from an analysis undertaken for the Ministry for the Environment (2003b) indicate a range of estimated hospitalisations per year in the larger cities, from around 25 in Dunedin to 200 in Auckland. Estimates of RADs in New Zealand cities range from around 90,000 per year in Dunedin to around 750,000 in Auckland. Figure 2 and Table 1 show the extent of the estimated particles problem across New Zealand.

Table 1: Estimates of health impacts of particle concentrations in New Zealand

	Estimated annual premature mortality	Estimated hospitalisations per year	Estimated restricted activity days per year
Auckland	436	200	750,000
Wellington	79	30	100,000
Christchurch	182	80	300,000
Dunedin	48	20	80,000
Nelson	20	14	58,000
Hamilton	40	30	90,000
Timaru	20	10	30,000
Lower Hutt	10	20	60,000
Upper Hutt	20	10	30,000
Alexandra	5	<5	10,000
Tokoroa	10	5	20,000

Source: Ministry for the Environment, 2003b.

The majority of PM_{10} monitoring in New Zealand is carried out on a one-day-in-three or one-day-in-six basis. This means that PM_{10} data are not collected every day of the year. Table 2 summarises the available PM_{10} data in New Zealand. From this we can see that:

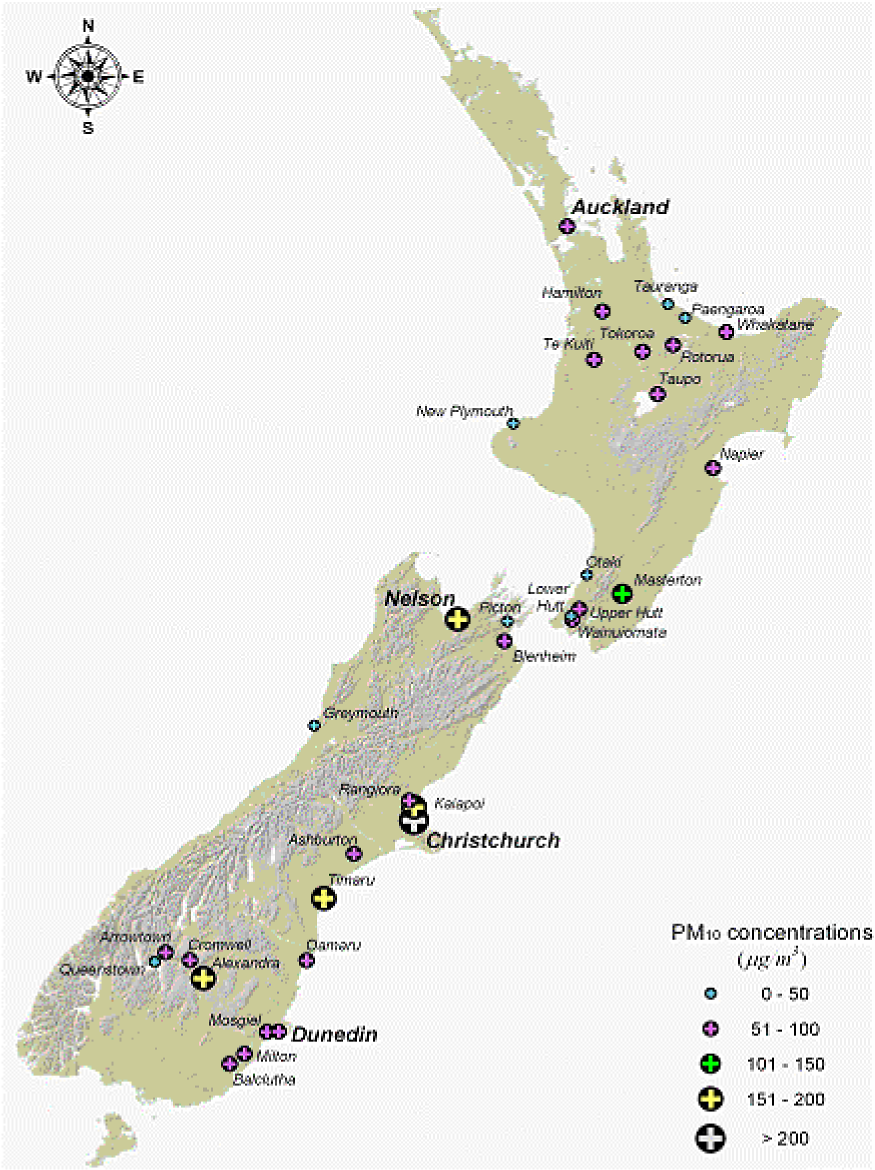
- five locations have measured levels in excess of 120 $\mu g/m^3$
- 36 monitoring stations in 28 urban areas have measured exceedances of the daily guideline
- 11 locations have measured more than five exceedances of the daily guideline.

As mentioned above, monitoring is not carried out every day. For the data presented in Table 2 monitoring was performed on average 39% of the days of the year. If monitoring were to be carried out every day it is estimated that most areas (29 of the 36 monitoring locations) would exceed the proposed daily guideline more than five times per year.

Table 2: Maximum measured concentrations of PM_{10} (24-hour average) in New Zealand compared with the daily guideline

Location	Maximum measured PM_{10}	Measured exceedances (> 50 μg/m^3)
Alexandra	193	**9**
Arrowtown	55	1
Ashburton	72	4
Auckland, Henderson	55	1
Auckland, Khyber Pass	121	2
Auckland, Penrose	101	3
Auckland, Takapuna	50	1
Balclutha	54	1
Blenheim	56	1
Christchurch, St Albans	283	**19**
Christchurch, Beckenham	106	**8**
Christchurch, Hornby	80	**13**
Christchurch, Opawa	196	**21**
Cromwell	73	5
Dunedin	107	2
Gisborne	70	1
Hamilton	67	2
Kaiapoi	97	**25**
Masterton	87	**8**
Milton	57	2
Mosgiel	95	5
Napier	64	2
Nelson	165	**81**
Oamaru	61	1
Otaki	50	1
Rangiora	74	3
Richmond	111	**23**
Rotorua	52	1
Taupo	57	1
Timaru	111	**31**
Tokoroa	75	**13**
Wellington, Upper Hutt	61	4
Wellington, Wainuiomata	57	3
Westport	56	3
Whakatane	53	1
Whangarei	73	1

Figure 2: Maximum 24-hour average PM_{10} concentrations, New Zealand, measured between 1997 and 2001



Source: Ministry for the Environment, 2003d

2.5 Other pollutants

In most areas of New Zealand, concentrations of SO_2, CO, NO_2 and O_3 are below their respective ambient air quality guideline values (Ministry for the Environment, 2002a). Exceptions to this are concentrations of CO in the ambient air in Christchurch, as well as roadside concentrations in Auckland, Christchurch, Wellington and Dunedin and roadside concentrations of NO_2 in Auckland.

The main concern with these pollutants is to maintain or improve the current situation and avoid them increasing to levels that would cause adverse health and environmental impacts.

2.5.1 Sulphur dioxide (SO_2)

Ambient air quality monitoring for SO_2 in New Zealand is largely limited to monitoring carried out in Canterbury, the long-term monitoring site in Penrose (ACI) in Auckland, Hawke's Bay, and around some industrial sources. In addition, survey-type monitoring has been carried out in Taranaki, the Bay of Plenty and Otago. No guideline exceedances for SO_2 were measured at these locations between 1992 and 2002.

Data for Christchurch from 1992 to 2001 shows there have been no exceedances of the proposed national standard of 350 ug/m^3 as a one-hour average (the maximum reading has been 334 ug/m^3). In other areas of Canterbury, concentrations are typically below 100 ug/m^3. In Auckland (Penrose) and around some industrial sites, one-hour average SO_2 concentrations measured up to 165 ug/m^3. The limited amount of SO_2 monitoring that has been carried out in other parts of New Zealand does not indicate concentrations of concern.

Monitoring around a Ravensdown site during 1996/97 showed levels approaching 50% of the proposed standard level, but levels have dropped considerably after the shutdown of the sulphuric acid plant.

2.5.2 Nitrogen dioxide (NO_2)

Concentrations of NO_2 have been monitored in Auckland, Waikato, Hawke's Bay, Wellington, Canterbury and Nelson. In addition, survey-type monitoring has been carried out in Taranaki, the Bay of Plenty and Otago. Most of the time concentrations of NO_2 are 'excellent' or 'good' in these locations.

The main exception is the Khyber Pass Road monitoring site in Auckland, where NO_2 concentrations regularly exceed guideline values. No guideline value exceedances for NO_2 (24-hour average) have been measured at residential air quality monitoring sites.

The guideline values for NO_2 for New Zealand are based on a safety factor of 50% applied to the lowest observable adverse effect level for the protection of sensitive groups, including children and asthmatics and people with chronic respiratory and cardiac disorders (Ministry for the Environment, 2002a).

Because the maximum one-hour average NO_2 concentrations measured at Khyber Pass Road are over twice the guideline value, it is possible that sensitive individuals in this area will suffer health affects as a result of NO_2 exposure. It is also possible that adverse health effects may occur as a result of NO_2 exposure close to other roadsides within Auckland (e.g. Dominion Road). In other areas of New Zealand, ambient air concentrations of NO_2 do not breach the guideline values and are unlikely to be causing adverse health effects.

2.5.3 Carbon monoxide (CO)

Air quality monitoring of CO has been carried out in Auckland, Waikato, Hawke's Bay, Bay of Plenty, Wellington, Canterbury, Otago and Nelson. Most of the time concentrations of CO are 'excellent' or 'good' in most of these locations.

However, the guideline values are regularly exceeded at the Khyber Pass Road traffic site and at residential monitoring sites in Christchurch. Long-term monitoring for CO at Queen Street in Auckland and St Albans in Christchurch indicates concentrations of this contaminant have decreased between 1992 and 2001.

There may be some health affects as a result of exposure to CO concentrations in Christchurch and near to roadsides in Auckland and Wellington, including a significant decrease in work capacity in healthy adults, decreased exercise capacity at onset of angina, and increased duration of angina in people with ischaemic heart disease. Similarly prolonged exposure to concentrations measured at these sites and other sites (e.g. Dominion Road and Khyber Pass) could impact on developing foetuses, resulting in reduced birth weight in non-smokers.

2.5.4 Ozone (O_3)

Air quality monitoring for O_3 has been carried out at a number of locations within Auckland and at two sites on the outskirts of Christchurch. Two exceedances of the eight-hour guideline value occurred at Musick Point in Auckland during October 2002. In other locations, guideline values have not been exceeded, although a large proportion of the data were within the 'acceptable' category and in Auckland up to 15% of the data were in the 'alert' air quality category.

An estimate of the impact of O_3 concentrations on mortality in Auckland indicates that over 100 deaths per year may be attributable to exposure to O_3. Concentrations of O_3 in Auckland were in excess of the ambient air quality guideline values at one monitoring site. No estimates were made for Christchurch because of the large uncertainties surrounding exposure.

2.6 Dioxins and other toxic substances

Some activities cause local pollution by toxic materials, including dioxins. Studies carried out by the Ministry for the Environment show that the background levels of dioxins in the New Zealand environment, and in our foods, are generally low compared with many other countries. Nevertheless, even a low level of dioxins in our environment accumulate in people's bodies. An independent report on the health risks of dioxin concluded that the current background exposures to dioxin-like compounds for the New Zealand population has an insufficient margin of safety and steps should be taken to further reduce exposure.

Dioxins are produced as unwanted by-products from combustion processes, including vehicle emissions, coal and wood fires in homes, barbecues, back-yard incinerators, disposal of plastic wrap from hay bales, and crematoria. Overall these are not huge contributors to the total atmospheric load and are beyond sensible control through the application of a standard, so action is not proposed for these sources.

The most recent major survey of dioxin emissions in this country gave by far the biggest source (39%) as fires in landfills. Most local authorities have since put controls on this, and regional councils agree with the proposed standard to ban such fires.

In other countries a major source of dioxin emission is metals refining, but in New Zealand metals refining accounts for less than 10% of national emissions.

Dioxins and a host of other toxic chemicals are associated with the following intermittent burning activities:

- burning of insulated copper wire to recover the copper
- burning tyres in the open (where there is no appropriate pollution control)
- burning road seal (bitumen burn-off), an out-dated practice for road maintenance
- burning oil in the open (where there is no appropriate pollution control)
- low-temperature incinerators in places such as schools and hospitals, which are insidious generators of dioxins in places where people are most vulnerable
- high-temperature incineration of hazardous waste.

The environmental and health effects of these activities, particularly in terms of dioxins emissions, have been discussed in several technical reports prepared by the Ministry for *An Action Plan for Reducing Discharges of Dioxin to Air* (Ministry for the Environment, 2001a). The Ministry considers that these studies justify the need to either completely stop these discharges, or restrict them to ensure they are carried out with appropriate control equipment. Typically, for the activities we are proposing to ban there are alternative, more environmentally friendly options that can be used to achieve the same purpose.

There has been a recent history of work towards a dioxin standard for New Zealand. This work shows that if a numerical standard were to be chosen for dioxins, the most defensible figure for either an emission standard or an ambient level is 0.1 nanograms of toxic equivalent per standardised cubic metre; or 1 part in 10,000,000,000,000 of a kilogram in a cubic metre of atmosphere.

The very low level of 0.1 nanograms per cubic metre could be measured only by special equipment in special circumstances, and it is a significant challenge to measure in most locations where the emissions are an issue. It would not be possible or practicable to take measurements of most point sources of interest. There would also need to be many exemptions (e.g. crematoria, barbecues). The Minister for the Environment proposes that a more effective and direct approach to standards for dioxins is banning those activities that are major or localised sources of dioxins and other toxic chemicals. This will deliver on the Government's policy to reduce dioxin discharges in the most efficient and effective way.

Low-temperature incinerators are significant generators of dioxins and other toxins. It is likely that all existing school incinerators, hospital incinerators, etc. would fail any reasonable test for part or all of their burning cycle. Action is required because of both the level of pollutants and the proximity of the incinerators to vulnerable members of our society. It is pointless to propose a dioxin emission limit or atmospheric standard for such incinerators, because they simply could not meet it. Instead, we offer open encouragement to the potential operators of school and hospital incinerators to avoid installing new ones. If they need to use incinerators, they will be required to obtain a resource consent by 2006. The rubbish burnt at these incinerators can be disposed of by other methods such as landfilling or steam sterilisation.

There is a significant history of concern about large-scale incinerators. Opponents of these incinerators rightly claim that there is no safe level for dioxins, and that even an extremely low atmospheric standard like 0.1 nanograms per cubic metre is not a guarantee of protection. They also claim that there are other issues of public concern with incinerator emissions, and that setting an atmospheric standard could inadvertently act as a proxy for a decision on acceptability. Finally, they claim that incinerators are becoming obsolete technology for hazardous wastes, and more environmentally friendly technology is used elsewhere. It would be very difficult today to justify a resource consent for a new high-temperature hazardous waste incinerator.

There are good reasons for New Zealand's emphasis (through the RMA) on the control of impacts rather than the control of activities. But this is not a case in point. As explained above, an atmospheric dioxin standard would be an ineffective and inefficient way to prevent concerns that could be better managed by direct decision-making. We therefore propose to ban new high-temperature incinerators built for the purpose of destroying hazardous waste.

Further justification for the proposed bans can be found in the section 32 documents prepared for the proposed *Dioxin Action Plan* (with the exception of hazardous waste incineration).

3 What are the Options?

3.1 Introduction

To deal with the air quality problems set out in section 3 and to achieve the stated objectives, a range of national policy options can be implemented, including education programmes, guidelines and guidance, monitoring and analysis, economic instruments, and command and control measures. Alternatively, the current status quo or 'do nothing' scenario can be followed if it will achieve the objectives.

The Ministry regularly reviews and implements tools that are considered to be the most appropriate to improve air quality, and to increase the consistency and quality of decision-making. Since the introduction of the RMA, the Ministry has focused on providing guidance and guideline values. The Ministry has published two sets of guidelines, one in 1994 and an update in 2002. These can be applied by councils through regional plans and decisions on resource consents, and by central government through policy and regulation.

While some improvements are occurring under this framework, there continue to be significant air quality issues and health effects requiring attention, particularly fine particle concentrations in many urban areas during winter months. And while concentrations of CO from vehicles appear to be declining, other contaminants, such as NO_2 and O_3, seem to be increasing or have the potential to increase.

Several regional council plans aim to achieve improvements over the next 10 to 20 years, but in other places limited action has been taken to improve air quality. Central government also has a significant role to play in reducing vehicle emissions, and while policies to address these have been slow in coming they are gaining momentum. The Ministry of Transport has recently announced a series of measures to reduce emissions from vehicles, such as quality assurance for imports and emissions screening/testing. The Ministry for Economic Development has also introduced regulations on fuel specifications (especially sulphur in diesel).

3.2 Determining the most appropriate option

In order to assess the most appropriate option for the air quality issue, the Ministry considered a list of potential options:

- do-nothing (the current status quo of guidance)
- delay, monitor and collate more data
- information and education
- voluntary agreements
- market-based tools (e.g. pollution taxes, tradeable permits)
- command and control tools (e.g. national standards, ban certain activities).

To evaluate these options against each other, an appraisal technique called 'multi-criteria analysis' (MCA) has been used.[3] This appraisal technique enables the decision-maker to assess a range of options using criteria that extend beyond the conventional 'costs' and 'benefits' approach. The conventional appraisal approach relies on quantifying the impacts of a policy in monetary terms, whereas multi-criteria analysis enables a wide variety of criteria to be weighed against each other. In a recent report to the UK's Department for Environment, Food and Rural Affairs (DEFRA) the benefits of using multi-criteria analysis in the context of air quality policy (especially when combined with cost–benefit analysis) were expounded:

> *MCDA [multi-criteria decision analysis] can extend CBA [cost-benefit analysis] by effectively incorporating criteria that are difficult or impossible to monetise using CBA techniques. As applied to air quality policy options, MCDA can be used for appraisal against any set of important criteria ... (DEFRA, 2003)*

For the current study a simplified MCA[4] has been constructed based on a range of policy criteria (Perman et al, 1999). The criteria are shown in Table 3, together with the types of questions to consider in evaluating the specific policy instrument.

Table 3: Appropriate policy instrument criteria

Criterion	Questions to consider
Cost-effectiveness	Does the instrument attain the target at least cost?
Dependability	To what extent can the instrument be relied upon to achieve the target?
Information requirements	How much information does the instrument require? What are the costs of acquiring it?
Enforceability	How much monitoring is required for the instrument to be effective? Can compliance be enforced?
Long-run effects	Does the influence of the instrument strengthen, weaken or remain constant over time?
Dynamic efficiency	Does the instrument create continual incentives to improve?
Flexibility	Is the instrument capable of being adapted quickly and cheaply as new information arises, as conditions change or as targets are altered?
Equity	What implications does the use of an instrument have for the distribution of income or wealth?
Costs of use under uncertainty	How large are the efficiency losses when the instrument is used with incorrect information?

Under the MCA system, a score of 0 to 10 was attributed to the criteria set out above. This score was based on how far the instrument goes towards achieving the required outcomes; for example, if the instrument was deemed to be achieving objectives at least cost, this would score 10. A maximum score for any policy instrument would be 90 (because there are nine criteria under consideration). Given that this system is a very much simplified MCA, no specific weighting was given to the criteria (i.e. equal weighting was used).

3 For a more in-depth discussion of multi-criteria analysis, see *The Multi-criteria Analysis Manual* published by (the then) UK Department of the Environment, Transport and the Regions, http://www.odpm.gov.uk/stellent/groups/odpm_about/documents/page/odpm_about_608524.hcsp.

4 Based on scoring each criterion relevant to its likely success or failure.

The following sections set out the key features of each option and their appropriateness for achieving the required aims and objectives.

3.2.1 Status quo (continued guidelines and guidance)

The Ministry has issued a series of guidance documents on air quality management covering dust, odour, degraded visibility, inventories, monitoring, dispersion modelling and emissions testing. There is limited further national guidance the Ministry could supply to councils, although some of these guides will need to be updated over the next couple of years. Guides and guideline values essentially assist regional instruments, but without the backing of regulatory enforcement.

This situation represents the status quo, and so far the necessary improvements and desirable consistency have not occurred under this approach.

3.2.2 Increased monitoring and analysis

Under this option there would be an increased programme of monitoring and analysis and reporting of data. This approach essentially continues and builds on the current approach in order to develop a much wider suite of data from which to build policy decisions in the future.

As a stand-alone option, therefore, this offers little benefit above the status quo apart from gathering additional information.

3.2.3 Information and education schemes

On their own, and in the absence of regulation, national environmental education schemes are unlikely to bring about the desired environmental outcomes and improvements in consistency in decision-making. Targeted campaigns may be effective, especially if the desirable behavioural change is also required by law, such as the drink-driving and speeding campaigns.

Further options in terms of education schemes could include more formal education and training programmes for air quality specialists and practitioners. However, training is currently available through some universities and the Clean Air Society of Australia and New Zealand. While training of practitioners would be useful for overall air quality management, it may not in itself (as a stand-alone option) bring about desirable air quality improvements without fixed targets. It would also be difficult to gauge its ability to improve consistency in decision-making and air quality improvements.

3.2.4 Voluntary agreements

Voluntary agreements are agreements between organisations, companies or sites, usually to reduce emissions over a preset time period. Voluntary agreements function most efficiently when they are undertaken by industrial sites or industrial groupings. The key focus, therefore, would be on industrial emissions rather than domestic heating and transport. However, current poor air quality in New Zealand is not generally caused by industrial emissions, so the opportunity for voluntary agreements is limited.

Such approaches have also been criticised for not 'setting the bar' high enough, because a low-cost achievable target may actually be less than the level of reductions required to improve air quality.

3.2.5 Economic instruments

Economic instruments cover a wide range of tools, and include taxes and charges, subsidies, and tradeable permits. Tradeable emission rights are better suited for reducing emissions from large industrial discharges, and do not lend themselves easily to addressing numerous small sources such as vehicles and home-heating fires.

Economic incentives, on the other hand, may work well. An example could be schemes to encourage the replacement of open fires and wood burners. There are currently no proposals for such a nationwide scheme, although some regional councils do currently offer incentives to convert to low-emission wood burners.

On their own, economic instruments are unlikely to achieve the desired certainty and consistency. They may, however, prove to be a useful tool used in combination with other methods to improve New Zealand's air quality.

3.2.6 Command and control (national standards)

Command and control approaches are regulatory tools whereby firm targets are set in legislation and there is a duty to meet them. Regulations have been proven to be effective at improving consistency and bringing about desirable outcomes.

National standards for ambient air quality set a base level for the air quality targets that all central and local government agencies responsible for managing air quality must achieve. They provide the targets for all agencies to achieve and thereby reduce inconsistencies. Implementing the standards rests with the regional councils, unitary and territorial authorities, although central government agencies such as the Ministry of Transport would remain responsible for improving vehicle emissions to ensure the standards are capable of being achieved.

The Minister for the Environment proposes a direct approach to standards for dioxins, by banning a range of activities that are major sources of dioxins and other toxics (see section 2.6 of this report). This is an efficient and effective way to deal with dioxin discharges from these sources.

The advantage of this type of approach is that there is certainty about what is to be achieved. Standards being national ensures that the benefits are spread evenly across New Zealand and the same level of protection is afforded to all New Zealanders.

The variety and flexibility of the available implementation tools (open to regional councils, for example) provides this option with opportunities to lower the cost of achieving the required standard. This option can still be used in conjunction with education programmes and economic instruments. In fact, it can be argued that a national standard is a requirement for economic instruments to be successful (in a cap-and-trade regime, for example).

3.2.7 Findings of the appropriateness test

The results of the MCA are shown in Table 4. This table sets out the average score for each option after scoring each criterion. It can be seen that the setting of national standards (a command and control approach) is the most appropriate option to take forward for a more detailed analysis.

Table 4: Results of the multi-criteria appropriateness test

Policy option	Average score	Rank
Status quo	43	3
Monitor and analyse	39	5
Voluntary agreements	42	4
Education	37	6
Market-based instruments	45	2
National standards	49	1

Given the nature of the air quality problem (with emissions from a range of sources), it is unlikely that voluntary agreements will be effective. Education may go some way to reducing levels, but some form of legislation will be required to back this up (and education is needed to back up legislation). Market-based tools on their own may not achieve the necessary reductions, and should be viewed as a tool for achieving a pre-set reduction target (i.e. they may be best used as an implementation aid). The setting of national standards, therefore, offers a useful baseline to utilise other policy instruments (such as education and market-based tools). These other tools may also help to lower the costs of compliance with the national standards.

3.2.8 The call for national environmental standards

As further background to the national environmental standards option, a number of events have led to calls from stakeholders for the Ministry to consider the introduction of standards for air quality.

- At a series of public meetings held in mid-2002, business, councils and community groups called on the Ministry to get on with developing a national policy approach for air standards.
- A consultative process was held with regional councils to scope the policy programme needed to support a national approach.
- In May 2003 the Ministry for the Environment presented the concept of national environmental standards to regional council representatives. Feedback was positive.
- In November 2003 the Ministry for the Environment hosted a national roadshow to obtain further input from the community and key interest groups. Feedback at the roadshow meetings was largely supportive of the proposed national air standards.

3.2.9 Moving to the next stage in the analysis

Given the above tests, and taking into account calls from stakeholders, the national environmental standards option will now be taken forward for more detailed analysis. This is not to suggest that this is the only viable option, but it is the only option that meets the current stated objectives. There is still scope for the use of options such as economic instruments and education schemes to help in the implementation of the standards. As stated above, these alternative options require setting a baseline (i.e. a standard) in order to focus and measure their effectiveness.

Section 4 sets out the proposals (further detail can be found in the Ministry for the Environment's proposals document *Proposed National Environmental Standards for Air Quality – Air Quality Report No. 46* (Ministry for the Environment 2003c)), while Section 5 analyses the costs and benefits of the standards package.

4 The Proposed Air Quality Standards

4.1 Ambient air quality

4.1.1 Particles (PM_{10})

The proposed standard for fine particles (less than 10 microns in diameter – PM_{10}) is 50 μg/m^3 averaged over one day. The standard envisages that 'clean air' will be achieved if 50 μg/m^3 is not exceeded more than five days in a year, or that no one-day exceedance is above a limit of 120 μg/m^3.

These values are based on reviews of research into the health effects of PM_{10} and current concentrations in New Zealand (Ministry for the Environment, 2003b, 2003c, 2003d). It reflects a risk-based approach to setting a standard for health protection, given the absence of any threshold below which no adverse effects are observed, and may be referred to as an 'interim' standard. The concentration limit is consistent with several international standards, including the Australian national environmental protection measures (which New Zealand contributed to developing), United Kingdom objectives, and Californian standards. The maximum limit is based on the former World Health Organisation standard for PM_{10}.

Where the standard is not met, regional councils must make that non-compliance public. In air sheds where the standard is not achieved, regional councils can only grant resource consents if they are confident that the net result of all activities in their air shed results in an improvement in air quality.

The proposed monitoring method is US 40 CFR Part 50, Appendix J, or an equivalent method. Where a tapered elemental oscillating microbalance (TEOM®) is used, it should be co-located with another sampling method, such as a high-volume sampler, to determine an appropriate conversion factor.

When inhaled into people's lungs, fine particles, especially those smaller than 10 microns in diameter (PM_{10}), can cause premature death, respiratory diseases, and asthma attacks in asthmatics. These health effects, in turn, can increase hospital admissions, use of medication, days off school, and lost productive days (as people recover from symptoms). A recent report estimated that there are around 970 premature deaths each year in New Zealand from PM_{10} inhalation (Fisher et al, 2002). Such health impacts can also have impacts on local health services.

Response to submissions

In response to the submissions made, our advice to the Minister for the Environment will be to inform Cabinet that the emphasis of the proposed standard is improved regional air quality management. Regional councils will be required to decide whether to monitor for PM_{10}, to publicly report any exceedances, and to use the standard as the basis for regional air shed planning. Regional councils will be required to comply with a 'proxy air plan' of no more than 1 exceedance of 50 ug/m^3 by 2013. Councils can choose to implement an air quality plan that is stricter than the proxy air plan. The proposed upper limit of 120 ug/m^3 will be removed, and the number of allowable exceedances will be reduced from 5 to 1.

No resource consent application will be granted where that consent is the primary source of exceedances. In a polluted airshed, an application may be granted if it will not adversely affect air quality improvement as accounted for in the regional air quality plan.

4.1.2 Nitrogen dioxide (NO_2)

The proposed standard for NO_2 is 200 µg/m^3 averaged over one hour. The standard will be achieved if 200 µg/m^3 is not exceeded more than nine hours per year (99.9 percentile of one year's monitoring data), and no one of these exceedances is above 300 µg/m^3 averaged over one hour.

Regional councils will be required to make a decision whether to monitor for NO_2 in their airshed. This decision will be based on whether they consider NO_2 will be at levels of concern. Any non-compliance with the standard will be made public.

The concentration limit for NO_2 is designed to protect the more vulnerable sub-groups in the population, including children, asthmatics of all ages (but especially child asthmatics), and compromised adults with chronic respiratory and cardiac disorders.

The concentration limit is consistent with the World Health Organisation (WHO) guideline value and the 2002 New Zealand guideline value, and is more stringent than the Australian national environmental protection measure (250 µg/m3, one-hour average). The maximum upper limit of 300 µg/m^3 is consistent with the former WHO guideline value and the 1994 New Zealand guideline value.

Exceedances will be calculated on a fixed one-hour average basis and could potentially all occur on one day.

Response to submissions

In response to submissions, it will be emphasised that the standard is to be used as the basis for airshed planning. Regional councils will be required to decide whether NO_2 is an issue, to monitor where relevant, and to publicly report any exceedances. No consent application will be granted where that application is the primary source of exceedances. Compliance with the standard will be used as the basis for any new resource consent conditions for activities that discharge significant amounts of NO_2. The proposed upper limit of 300 ug/m^3 will be removed.

4.1.3 Ozone (O_3)

The proposed standard for O_3 is 150 μg/m^3 (one-hour average) with no allowable exceedances. Ambient O_3 should be monitored using AS3580.6.1 – 1990.

Regional councils will be required to make a decision whether to monitor for O_3 in their airshed. This decision will be based on whether they consider O_3 will be at levels of concern. Any non-compliance with the standard will be made public.

Although there is no apparent health-effects threshold for O_3, the proposed concentration limit standard aims to provide a reasonable level of protection for human health. As with particles, this represents a risk-based approach and may be referred to as an 'interim' standard. It aims to prevent effects on respiratory function in vulnerable sub-groups of the population, including those with asthma, those with chronic lung disease, healthy young adults undertaking active outdoor exercise over extended periods, and the elderly, especially those with cardiovascular disease.

The concentration limit is consistent with the 2002 New Zealand guideline value and is reasonably consistent with the European Directive value of 170μg/m^3 (one-hour average).

Response to submissions

In response to submissions, it will be emphasised that the standard is to be used as the basis for airshed planning. Regional councils will be required to decide whether O_3 is an issue, to monitor where relevant, and to publicly report any exceedances. No consent application will be granted where that application is the primary source of exceedances. Compliance with the standard will be used as the basis for any new resource consent conditions for activities that discharge significant amounts of O_3.

4.1.4 Sulphur dioxide (SO_2)

The proposed standard for SO_2 is 350 μg/m^3 averaged over one hour. The standard will be achieved if 350 μg/m^3 is not exceeded more than nine hours per year (99.9 percentile of one year's monitoring data), and no one of these exceedances is above 570 μg/m^3 (one-hour average).

Regional councils will be required to make a decision whether to monitor for SO_2 in their airshed. This decision will be based on whether they consider SO_2 will be at levels of concern. Any non-compliance with the standard shall be made public.

The proposed standard for SO_2 is set to prevent adverse impacts on lung function and other respiratory symptoms of vulnerable sub-groups, including asthmatics and those with chronic obstructive lung disease. The value is consistent with the 2002 New Zealand guideline value. Further information on why it was chosen can be found in *Recommended Amendments to the Ambient Air Quality Guidelines 1994* (Ministry for the Environment, 2000c).

The maximum nine allowable exceedances refers to nine hours on which the one-hour average can exceed 350 µg/m^3, up to a maximum limit of 570 µg/m^3 (one-hour average). This latter value is the same as the Australian national environmental protection measure for SO_2 (NEPC, 1998).

Response to submissions

In response to submissions, it will be emphasised that the purpose of the SO_2 standard will be to manage point source SO_2 emissions. The proposed upper limit of 570 ug/m^3 will remain. For new and renewed consent applications, consent conditions will limit emissions, to be calculated to meet ambient levels. Coercive action should follow breaches of consent conditions and ambient levels. Regional councils must consider cumulative SO_2 sources.

4.1.5 Carbon monoxide (CO)

The proposed standard for CO is 10 mg/m^3 averaged over an eight-hour period. The standard will be achieved if there are no more than nine exceedances per year. There is no upper maximum limit.

Regional councils will be required to make a decision whether to monitor for CO in their air shed. This decision will be based on whether they consider CO will be at levels of concern. Any non-compliance with the standard will be made public.

The proposed standard is designed to ensure that people are not exposed to concentrations of ambient CO that would result in a blood carboxyhaemoglobin level greater than 2.5% at any level of physical activity. It is set to protect the more susceptible sub-groups, including those with existing heart disease, children and developing foetuses. The standard value is based on reasonably comprehensive research indicating that CO has a threshold below which adverse health effects are very unlikely to occur.

The proposed standard concentration limit is consistent with the existing New Zealand 2002 guideline value. The proposed monitoring method is AS3580.7.1 – 1992.

Response to submissions

In response to submissions, it will be emphasised that the CO standard is to be used as the basis for airshed planning. Regional councils will be required to decide whether CO is an issue, to monitor where relevant, and to publicly report any exceedances. No consent application will be granted where that application is the primary source of exceedances. Compliance with the standard will be used as the basis for any new resource consent conditions for activities that discharge significant amounts of CO. The number of allowable exceedances per year will drop from 9 to 1, as the initial proposal contained a mathematical error.

4.1.6 International comparison

Table 5 provides an international comparison of the proposals discussed above.

Table 5: International comparison of air quality standards

Pollutant (averaging period)	New Zealand proposed	Australia	UK	EU	WHO
PM_{10} (24-hour)	50 µg/m^3	50 µg/m^3	50 µg/m^3	50 µg/m^3	No safe level
NO_2 (1-hour)	200 µg/m^3	256 µg/m^3	200 µg/m^3	200 µg/m^3	200 µg/m^3
Ozone (1-hour)	150 µg/m^3	210 µg/m^3	–	170 µg/m^3	–
SO_2 (1-hour)	350 µg/m^3	570 µg/m^3	350 µg/m^3	350 µg/m^3	–
CO (8-hour)	10 mg/m^3	–	–	–	10 mg/m^3

As can be seen from the above, the proposed national environmental standards for air quality are consistent with standards set internationally.

4.2 Dioxins and other toxic substances

4.2.1 Open burning of tyres

The burning of tyres in the open or in open containers is a prohibited activity

Burning tyres in the open emits significant quantities of hazardous air pollutants, including particles, dioxins, CO, polyaromatic hydrocarbons, and volatile organic compounds. Although a one-off tyre fire is temporary, the quantity of contaminants released and their concentrations can be significant. Some, such as dioxins, may bioaccumulate and cause contamination problems over time. The remaining ash residue also contains hazardous contaminants, potentially creating a contaminated site that requires remediation.

Smoke from tyre fires can be particularly dark and dense. It has the potential to cause short-term, acute health effects if inhaled (eye, nose and throat irritation, asthma attacks, respiratory difficulties) and significant odour nuisance. Smoke plumes can also reduce visibility on roads, leading to unsafe conditions. Its visual appearance may adversely effect people's perception of New Zealand's environment, which has a reputation for being clean and green.

In New Zealand, unwanted tyres are typically disposed of into landfills or shredded for reuse. Significant quantities are also stockpiled in the hope that an alternative disposal or reuse option will be found. In some parts of the country, farmers use tyres for holding down the plastic covers over silage, although this is decreasing with the increased use of silage wrap.

The burning of waste materials such as tyres in the open is typically a prohibited or non-complying activity within regional air quality plans. Consequently, it is unlikely to occur on a regular basis in New Zealand and may generally be the result of an illegal or accidental ignition of a tyre stockpile.

Under this national standard for dioxins and other toxic substances all burning of tyres in the open air or in open containers will be banned. The burning of tyres as a fuel source under appropriate conditions, such as in a cement kiln, would not be prevented by the standard. Councils would still be able to consider whether to grant consents for discharges to air from tyres burned in appropriately designed equipment with emission controls.

Response to submissions

In response to submissions, the standard will state that the ban does not apply to the burning of tyres as a fuel source at facilities with emission control equipment (e.g. cement kilns). The ban will be effective from 1 September 2004.

4.2.2 Road-seal burning

Road-seal burning is a prohibited activity

Road-seal burning is defined as the process of using flame and heat to burn excess bitumen off road surfaces. Road-seal burners are typically fuelled by diesel, which creates an open flame that comes into contact with the road surface, igniting the bitumen and burning it off (Pickett and Dravitzki, 1996).

Burning bitumen through this process emits large clouds of thick, dark smoke containing hazardous air contaminants, including dioxins, polyaromatic hydrocarbons, volatile organic compounds, particles, NO_2, and CO. Although the discharge is relatively short term, significant quantities of contaminants are emitted in high concentrations. If inhaled by people in the surrounding local environment, these contaminants can cause acute health effects, such as lung, throat and eye irritation, asthma attacks, and coughing. The smoke plume can cause unacceptable environmental nuisance in terms of reducing visibility and producing noxious odours. Reduced visibility across roads may also cause safety concerns for motorists.

Transit and some local road-controlling authorities occasionally carry out road-seal burning to improve the road surface, usually in rural or remote areas away from major towns and cities. On the whole, agencies are moving away from seal burning to other options, such as high-pressure water blasting. During water blasting the debris and wastewater are collected and disposed of, usually to landfill.

Regional air quality plan rules vary with respect to road-seal burning. Several regional councils specify road-seal burning as a prohibited activity. Others ban it from the date from which the plan becomes operative, and one has a transitional period during which the activity is non-complying and then later is prohibited. This national standard for dioxins and other toxic substances will prevent any consents from being granted for road-seal burning. It will not be allowed anywhere in the country.

Response to submissions

There is no change from the original proposal, though it will be referred to as a ban on "bitumen burning". The ban will be effective from 1 September 2004.

4.2.3 Coated-wire burning

The burning of coated copper wire or any form of coated cable in the open or in an open container is a prohibited activity

Councils will not be able to grant discharge permits to those wishing to burn insulated wire or cable in the open air and it will be illegal without a permit. Councils would still be able to consider whether to grant consents for discharges to air from coated copper wire burnt in appropriately designed equipment with appropriate emission controls.

Depending on the amount and nature of wire being burned and the duration of the burn, the burning can create plumes of smoke containing significant emissions of hazardous air pollutants, including dioxins, particles and volatile organic compounds. If inhaled, these contaminants can cause similar acute health effects to those from road-seal burning and tyre burning, such as lung and eye irritation, asthma attacks and coughing.

Depending on the weather conditions, contaminants may also be deposited on the land near the site, potentially contaminating soils and waterways. The smoke plume can cause unacceptable environmental nuisance in terms of reducing visibility and producing noxious odours.

Most regional councils and unitary authorities specify this activity as a prohibited activity within their regional air quality plans. There are alternative, less-polluting methods of recovering metals from within used cables, such as mechanical stripping.

Response to submissions

There is no change from the original proposal. The ban will be effective from 1 September 2004.

4.2.4 Burning of oil in the open

The burning of any oil (e.g. used oil, re-refined oil, diesel oil, heavy fuel oil, light fuel oil) in the open is prohibited. 'In the open' means that the oil is not being burned in a properly designed appliance.

The burning of oil in an uncontrolled manner in the open can release significant quantities of contaminants into the air. The burning typically involves low burn temperatures and uncontrolled emissions, leading to smoke plumes containing potentially harmful pollutants such as fine particles, sulphur dioxide, polyaromatic hydrocarbons and volatile organics.

There is limited information available on the amount of oil that is burned in the open air in New Zealand and its potential health effects. However, emissions are considered to pose a significant potential health risk in terms of acute health effects from smoke inhalation, and nuisance to neighbouring residents.

Oil may also be burned in the open for fire training and film special effects. These temporary activities are usually undertaken away from populated areas with adequate controls. They will be exempt from this standard for dioxins and other toxic substances. However, they may still be subject to any regional or unitary authority plan requirements.

Response to submissions

In response to submissions, our advice to the Minister for the Environment will be to inform Cabinet that the ban does not apply to the burning of oil as a fuel source at facilities with emission control equipment (e.g. cement kilns). The ban will not apply to oil burned in the open for fire training and film special effects. The burning of oil for frost protection will be a discretionary activity. The ban will be effective from 1 September 2004.

4.2.5 Landfill fires

The known burning of material on a landfill is a prohibited activity

This proposed standard for dioxins and other toxic substances excludes the burning of gaseous waste through purpose-built equipment (landfill gas flaring) or the evaporation of landfill leachate through purpose-built equipment.

Landfill fires can release vast quantities and high concentrations of harmful contaminants into the air. The proposed *Dioxin Action Plan* (Ministry for the Environment, 2001a) estimated that 39% of dioxin discharges are from landfill fires. Fires typically release dense white smoke and products of incomplete combustion. At times, temperatures may get high enough to release contaminants such as arsenic from treated timbers, dioxins, polyaromatic hydrocarbons, particles and volatilised heavy metals. Landfill fires are one of the most significant sources of dioxins in New Zealand.

There is also a risk that landfill gases may be ignited by fires lit on or near a landfill site, so that fires can spread easily and are difficult to extinguish.

Contaminants from landfill fires can cause direct acute health effects (similar to those discussed already) if inhaled by people in the area, and can settle on the land around the site, potentially causing longer-term site contamination. Emissions may also cause longer-term health effects if significant amounts of harmful pollutants such as dioxins are inhaled. The resulting ash from the fire is also likely to contain toxic materials, making it difficult to dispose of.

According to *The 2002 Landfill Review and Audit* (Ministry for the Environment, 2003f), the number of landfill fires, both intentional and accidental, has decreased significantly over the past eight years, so that in 2002 only 17% of landfill sites had experienced a fire, and these were at either small rural sites (where burning was not part of the formal management at the site) or minor incidents on larger landfills. Formally banning deliberate fires on landfills on a national basis will ensure that this figure is further reduced and that harmful emissions of dioxins and effects are prevented.

Accidental fires around landfills can be reduced through improved landfill management. Accidental fires have been caused by sparks from the exhaust systems of site plant or vehicles, smoking on the landfill by staff or users, and uncontrolled dumping of waste materials such as ashes or hazardous substances that can ignite when mixed. Good management procedures are specified in resource consent conditions, and further guidance is available in the *Guide to Landfill Consent Conditions* (Ministry for the Environment, 2001b).

Response to submissions

No change is proposed to the standard as a result of submissions. The standard will make clear that all reasonable actions are taken to extinguish any landfill fire. The ban will be effective from 1 September 2004.

4.2.6 Waste incineration in schools and hospitals

The proposed standard is to prohibit:

- **all new waste incinerators in schools and hospitals that do not have a resource consent**
- **by 2008, all existing waste incinerators in schools and hospitals that do not have a resource consent**

School and hospital incinerators can emit significant quantities and concentrations of contaminants into the air, including dioxins, particles, and volatile organic compounds. The quantity, concentration and toxicity of the contaminants released depends on the amount and type of waste being burnt, the temperatures reached in the firebox, and whether there is sufficient oxygen available for combustion. Chlorinated plastics have the potential to create harmful dioxin emissions.

The potential health effects caused by emissions from low-temperature incineration depend on the amount and nature of the waste being burnt, the likelihood of local residents and children inhaling the contaminants, the dispersion of smoke from the incinerator, and the frequency with which the incinerator is used.

Children and sick people are particularly sensitive to air pollutants. Hospitals and their environs can also be considered to be sensitive receiving environments.

Table 6: Number of North Island schools with incinerators

Region	No. of schools	Regional % not incinerating or open burning	Regional % incinerating or open burning	No. of schools burning waste
Auckland	412	78%	22%	91
Bay of Plenty	140	61%	39%	55
Gisborne	53	58%	42%	22
Hawke's Bay	124	65%	35%	43
Manawatu–Wanganui	179	45%	55%	98
Northland	139	No data	No data	No data
Taranaki	100	41%	59%	59
Waikato	283	46%	54%	153
Wellington	196	88%	12%	24

Note: no data are available for South Island schools. There are no data relating to the difference between urban and rural areas, but it can safely be assumed that rural areas are much more likely to burn waste.

This standard for dioxins and other toxic substances will prohibit any new school and hospital incinerators unless they secure a resource consent through a publicly notified process. Existing school and hospital incinerators will be banned from 2008 unless they secure a resource consent through a publicly notified process.

We are hopeful that the approach proposed in this standard will be effective earlier than 2008. The Ministry of Health accepts this proposed standard provided that hospital incinerators are able to continue if they obtain a resource consent by 2006.

Response to submissions

In response to submissions, our advice to the Minister for the Environment will be to inform Cabinet that all new and existing school and hospital incinerators will be banned, unless they obtain resource consent by 1 September 2005.

4.2.7 High-temperature hazardous waste incineration

New high-temperature hazardous waste incinerators are a prohibited activity

This dioxin standard applies to any new high-temperature incinerators burning wastes that are considered to be hazardous as defined in the Ministry for the Environment's proposed draft definition of hazardous waste (Ministry for the Environment, 2002b). The draft New Zealand hazardous waste definition is similar to that used by Environment Australia to enforce the Basel Convention.[5] 'High temperature' is considered to include incinerators typically operating above 850 degrees Celsius.

Hazardous waste incinerators discharge potentially harmful contaminants into the air. The amount and type of contaminants released depend on the nature and amount of waste burnt, the combustion conditions (such as temperature and residence times), and the effectiveness of emissions control equipment. The health and environmental impacts of these contaminants depend on the sensitivity of the receiving environment (e.g. whether there are places nearby where people gather or live), the frequency of incinerator use, and the dispersion of the pollutants away from the stack.

There is a significant history of public concern associated with emissions from hazardous waste incinerators, mainly centred on emissions of dioxins. Research indicates that there is no safe level of exposure to dioxins and that meeting even extremely low atmospheric standards does not guarantee protection.

Most regional plans specify hazardous waste incineration as a discretionary or non-complying activity, although in some regions it is a prohibited activity. A national environmental standard prohibiting high-temperature hazardous waste incineration would supersede these regional requirements.

The Ministry for the Environment originally proposed an emission limit standard for high-temperature incineration of 0.1 ng/m^3 (Ministry for the Environment, 2001a). However, even this low standard is not a guarantee of protection. The remaining ash residue is also highly toxic and difficult to dispose of. Incineration is an obsolete technology for disposing of hazardous wastes and more environmentally friendly technologies are available. The Ministry considers that a more direct and efficient method of reducing emissions of dioxins is to control the activities that cause them, which is why we have put forward this proposal to ban new high-temperature incineration of hazardous waste.

There are currently only three high-temperature hazardous waste incinerators operating in New Zealand: at Auckland airport, in New Plymouth and near Christchurch airport. The airport facilities burn medical waste, quarantine waste and police-sourced wastes.

This dioxin standard does not apply to metal plants, cement kilns and other industries that burn waste (e.g. tyres, used oil and pot liners from aluminium smelters) at high temperatures as a fuel source.

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5 See Section 3 of Information Paper No. 2, *Distinguishing Wastes from Non-Wastes under Australia's Hazardous Waste Act,* www.deh.gov.au/industry/chemicals/hwa/index.html.

Response to submissions

In response to submissions, our advice to the Minister for the Environment will be to inform Cabinet that the ban will not apply to the three existing hazardous waste incinerators. These existing sites are at Auckland and Christchurch airports, and the Dow facility in New Plymouth. The ban will be effective from 1 September 2004.

4.3 Design standard for wood burners

Any new wood-burning appliance installed into a house in an 'urban area' must be identical (in terms of the features that are likely to affect its emissions) to a unit that has been tested in accordance with AS/NZS 4013:1999 ('Domestic solid-fuel-burning appliances – Method for determination of flue gas emission') or an equivalent

The wood-burning appliance must also meet an emission limit of 1.5 g of particulate matter per kilogram of fuel burned, averaged over high, low and medium burn rates

The costs and benefits of the wood-burner design standard are examined (in summary) in Appendix 1 of this report. This standard aims to improve the consistency and certainty with which new wood-burning appliances are used in New Zealand and, over time, to reduce potential increases in emissions and improve air quality, especially where new lower-emitting burners replace older units.

The emission limit requirement in the proposed standard supersedes the emission limit of 4 g/kg specified in the joint Australian – New Zealand standard. This more stringent limit reflects the serious PM_{10} pollution issues associated with emissions from domestic fires in many New Zealand towns and cities, and the need to bring about significant improvements to reduce adverse health effects.

There are over 50 wood-burner models on the market that meet the proposed emission limit of 1.5 g/kg. A full list of the complying models is available on the Environment Canterbury website (www.ecan.govt.nz). There are currently no coal-fired solid-fuel-burning appliances that would meet the proposed emission limit of 1.5 g/kg.

If appropriate testing shows that any other domestic heating appliance (with or without emissions control equipment) can meet an average emission limit of 1.5 g/kg tested on a range of burn rates, this would also be deemed to meet the standard and manufacturers can market it as such.

The proposed standard will apply to space-heating appliances, including those with water-heating devices. Excluded appliances are listed in the AS/NZ standard. They include open fireplaces, central-heating appliances, cooking appliances, and appliances used solely for water heating. Where appropriate, councils can determine specific regional requirements for these other appliances in regional air quality plans (see section 15(2) of the RMA).

The standard will apply to any new solid-fuel-burning appliance with a maximum heat output of 40 kW used in a dwelling house in an urban area in New Zealand. The definition of 'urban area' has yet to be confirmed, but is likely to be based on district plan zonings or population densities.

This is one part of this package of standards where it is clear that some local areas may require more demanding requirements. New appliances in Christchurch are one example where the councils may impose a stricter requirement. Councils can also implement other programmes, such as public education on how to use burners and incentives schemes to encourage people to convert to cleaner forms of heating.

Response to submissions

After considering submissions, our advice to the Minister for the Environment will be to inform Cabinet that the limit of 1.5 g/kg will apply to all wood burners in New Zealand. We will also advise that an efficiency standard of 65% will apply. The standards will be effective from 1 September 2005. We will clarify that the standard applies only to wood burners, and does not include coal burners.

5 Efficiency and Effectiveness of the National Environmental Standards for Air Quality Package

5.1 Overview

As discussed earlier, effectiveness considers whether the policy option will actually be effective in achieving its aims and objectives. In this case, the setting of national environmental standards provides firm regulation for achieving the stated aims and objectives. It is, therefore, the most direct and effective option – assuming full implementation by local government.

In terms of efficiency, this measure needs to consider the benefits and costs of any policy intervention. If the benefits outweigh the costs over time, then the policy is deemed to be 'efficient'. This, however, assumes that benefits and costs can be quantified in monetary terms. In this case there are a number of 'intangible' benefits such as certainty, consistency and improvements in health.

With this in mind the benefits identified in this section should be viewed as the baseline level of benefits, and the more intangible benefits will be on top of those identified. The main focus of this analysis is the improvement in health brought about by anticipated improvements in ambient air quality. These benefits are more readily quantified than any others, and will be analysed within a cost–benefit analysis framework.

Within this framework, the measure of efficiency will consider the national environmental standards package as a whole rather than breaking it down into its constituent parts. This means that individual components of the package will not be justified on their own, and the national environmental standard package should be viewed as a whole. Costs relating to specific standards are dealt with in the sections below, while benefits are derived only for the whole package.

The analysis is, by its nature, national in scope and does not include specific regional or local measures. Nevertheless, local measures – introduced via regional councils and unitary and territorial authorities – are likely to be important in achieving any air quality standard.

In practice there will probably be local measures for achieving reductions in pollutant levels which prove more cost effective than the national measures quantified and costed in this work. We want to emphasise that the whole package of measures – based on national measures – is both illustrative and very much a high-end of cost estimates for the measures that are likely to be implemented (and therefore the reductions in concentrations that are likely to be achieved).

5.2 Summary of methodology

The appraisal in this document has taken a number of steps to reach an overall picture of the impact of the proposed national environmental standards for air quality. This section summarises these steps to help the reader to understand the process undertaken.

The process for calculating benefits can be summarised as follows.

1. Construct a health effects model to determine the current situation and the situation under a regime of standards.
2. Construct an economic model that relates health outcomes to the impact on the economy.
3. Derive an adjusted monetary value for each death brought forward by poor air quality.
4. Merge the health and economy model to provide the economic benefits of reducing premature mortality.
5. Integrate the health model with the monetary value of each death brought forward.
6. Derive the total benefits over the period of the analysis (to 2020).

Cost information was gathered through:

- direct surveys with industry, regional councils and key stakeholders.
- technical working groups, to receive feedback on what the costs of the standards may be
- a literature review and in-house data gathering at the Ministry
- deriving costs over the period of the analysis (to 2020).

The costs and benefits were then brought together to provide the overall impact of the proposed standards.

5.3 Defining the baseline

The baseline option in any policy appraisal is crucial. This is the option with which all other options are compared, so the specification of this option underpins the whole analysis. In this case, the baseline option is represented by the ‘status quo’. This option assumes that current practices continue along the lines of Ministry guidelines and regional council plans.

In order to derive the health effects associated with the status quo option, modelling was conducted for 24 sites in New Zealand. These sites are areas where air quality is considered to be problematic and in some cases results in frequent exceedances over the Ministry’s air quality guideline values.[6]

To evaluate concentrations of contaminants in the absence of air quality standards, estimates of projected emissions and concentrations were made for the years 2001–2021. This took into consideration the impacts of existing legislation and integrated assumptions about trends in heating methods, and motor vehicle and industrial discharges.

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6 These sites include Christchurch, Nelson, Taupo, Tokoroa, Hamilton, Auckland, Alexandra, Dunedin, Lower Hutt and Upper Hutt.

The impact of the proposed standards was then evaluated by comparing these projections and estimates with the required concentrations dictated by the air quality standards. It is the *difference* in projected concentrations that determines the health benefits associated with the introduction of the standards.

A number of general assumptions have been applied to estimate the projected concentrations of contaminants in the absence of more detailed information. These were:

- a 45% decrease in the number of multi-fuel burners from 2001 to 2021 in areas where these are not legislated
- a 10% decrease in open fires from 2001 to 2021 in areas where these are not legislated
- other solid-fuel burners are replaced with new solid-fuel burners 15 years from the date of installation
- a linear relationship between emissions and concentrations for all areas (i.e. any reduction in emission would result in a proportional reduction in concentrations)
- no impact of differences in the time of day of different sources relative to meteorological conditions, except in Christchurch (in Christchurch, a box model was developed by the National Institute of Water and Atmospheric Research to describe this relationship, see Gimson and Fisher, 1997)
- an ageing population, with the proportion of the population over 30 increasing in each area by 20% of the 2001 proportion by 2021 (these estimates are based on limited data provided by Statistics New Zealand)
- a 10% increase in industrial emissions in all areas except those with negative population projections
- a 70% decrease in PM_{10} emissions from motor vehicles from 2001 to 2021 in areas where area-specific modelling and projections have not been carried out. (This is based on New Zealand Transport Emission Rate model (NZTER) emission rate projections, allowing for some increased traffic growth and congestion. Assuming NZTER estimates of emission rates are accurate this should be a conservative (underestimate) of the reductions for most areas.)

Table 7 provides the health outcomes for the status quo option. The health outcomes are measured in terms of:

- anticipated premature deaths brought about by air pollution
- estimated hospitalisations due to the effects of air pollution (e.g. asthma, bronchitis)
- estimated restricted activity days (i.e. RADs − days when an individual's normal activity is restricted due to the effects of air pollution).

Table 7: Health effects associated with air pollution: status quo

Year	Premature deaths	Hospitalisations	Restricted activity days
2004	838	603	2,437,013
2005	804	589	2,383,629
2006	765	573	2,323,476
2007	736	561	2,271,770
2008	711	552	2,229,742
2009	702	550	2,220,958
2010	692	547	2,212,339
2011	688	548	2,212,403
2012	685	549	2,214,841
2013	681	549	2,219,253
2014	677	550	2,222,580
2015	678	553	2,232,999
2016	679	555	2,242,020
2017	680	559	2,252,983
2018	681	561	2,262,999
2019	686	566	2,281,010
2020	689	570	2,296,595
Total	**12,074**	**9,534**	**38,516,609**

5.4 Assessment of benefits

5.4.1 Overview of the approach

There is a range of benefits associated with the introduction of national environmental standards for air quality. These can be split into two main types: tangible and intangible. Intangible benefits are those that are more difficult to quantify and hence are problematic to include in a full consideration of the costs and benefits. The tangible benefits are much more easily quantified and readily fit into an appraisal framework.

Intangible benefits address issues such as certainty, providing a level playing field, and achieving national consistency. National regulations will mean there will be a reduced need to seek legal recourse during the consenting process. There could be major cost savings for both the applicant and consenting authority in this respect. Major consent hearings have been known to stretch to tens of thousands of dollars. Although such avoided costs will be benefits of the standards, they have not been included in the analysis.

During the consultation process the argument was made that national consistency is lost because the RMA allows for local government to introduce stricter controls. The Ministry does not fully agree with this argument. Any council that wishes to be stricter than the national standards will need to present a robust case that such a change is appropriate, effective and efficient. This is likely to be difficult, as the proposed standard values are consistent with internationally accepted standards (see Table 5). Through this process, submitters will be able to be heard and challenge any alteration of the 'level playing field'.

Tangible benefits are those that are more easily quantified and so are more readily fed into an appraisal. In the case of national environmental standards for air quality, the key tangible benefits are improvements in health and the linkages to New Zealand's economy. Further detail on the modelling of these benefits is provided in the next section.

Table 8 presents a summary of the benefits associated with national environmental standards for air quality.

Table 8: Summary of the benefits of standards

Intangible	Tangible
Provides certainty	Improved health
Level playing field across New Zealand	Reduced premature death
Consistency in decision-making	Increased economic productivity

5.4.2 Modelling the benefits

In order to quantify the tangible benefits as far as possible, consultants were commissioned to build two models.

- **Health model:** relating air quality to the health outcomes. This is the same model that was used to develop the baseline option. In this case it was assumed that the air quality standards are achieved within three to four years following implementation.
- **Economic model:** relating health outcomes to the wider impact on the economy. This is a relatively simple general equilibrium model that relates working days lost (due to premature mortality and ill health) to productivity in the economy. This 'cost of illness' approach is well established and has been used worldwide to examine the impact of pollutants on economies.

A number of key assumptions have to be made for the economic model, and these are set out in Box 1.

Box 1: Key assumptions in the economic benefit model

1) Mortality per annum: 40% of people suffering premature mortality are employed.

Approximately 50% of the population is employed, but the health effects of air pollutants are likely to be higher among the elderly.

2) Hospitalisations per annum: 40% of people hospitalised are employed.

40% of people suffering premature mortality and hospitalisations are assumed to be employed. For restricted activity days it is assumed that the higher incidence among the aged is offset by a higher likelihood of absenteeism among workers.

3) Restricted activity days per annum: 50% of these people are employed.

4) Degree of prematurity in premature deaths: 1.5 years.

Premature deaths are assumed to be premature by 18 months (Ministry for the Environment 2003b).

5) Days lost due to hospitalisation:

(a) in hospital 6.8 days

(b) recuperation 5 days.

Length of stay in hospitals is taken to be 6.8 days (the average for asthma, influenza and pulmonary diseases). Five days are assumed for recuperation at home.

6) Proportion of restricted activity days off work: 55%

90% of RADs involve minor restriction and 10% major restriction, with 0.5 and 1.0 working days lost respectively.

7) Discount rate: 5%

8) Growth in real GDP/capita: 1.5% p.a.

9) The model also allows for the possibility of substituting capital, energy and materials in place of the lost labour input. The substitution is imperfect.

This economic model was then linked to the health model, and then two scenarios were modelled:

- the status quo (i.e. continue with current policies and plans)
- with standards in place.

The difference between these two scenarios provides the level of benefits (as measured by cost of illness) of introducing national environmental standards for air quality.

5.4.3 Results of the benefit modelling

In order to fully analyse the impact of the proposed standards, we have modelled three scenarios of when the standards would actually be achieved: 2008, 2013 and 2020. Health improvements are modelled to begin five years before these achievement dates to reflect the council planning process. Table 10 sets out the different health impacts for these scenarios.

Table 10: Scenarios of differing dates for achieving standards

Year	Achieve by 2008			Achieve by 2013			Achieve by 2020		
	Premature deaths	Hospital-isations	RADs	Premature deaths	Hospital-isations	RADs	Premature deaths	Hospital-isations	RADs
2004	838	603	2,437,013	838	603	2,437,013	838	603	2,437,013
2005	804	589	2,383,629	804	589	2,383,629	804	589	2,383,629
2006	739	552	2,273,583	765	573	2,323,476	765	573	2,323,476
2007	674	515	2,163,828	736	561	2,271,770	736	561	2,271,770
2008	609	479	2,054,121	711	552	2,229,742	711	552	2,229,742
2009	612	482	2,069,896	690	539	2,200,356	702	550	2,220,958
2010	611	484	2,076,446	668	525	2,171,072	692	547	2,212,339
2011	609	485	2,079,305	647	512	2,142,271	688	548	2,212,403
2012	609	487	2,088,348	628	501	2,119,935	685	549	2,214,841
2013	611	490	2,100,496	611	490	2,100,496	681	549	2,219,253
2014	613	493	2,112,911	613	493	2,112,911	677	550	2,222,580
2015	615	495	2,125,637	615	495	2,125,637	678	553	2,232,999
2016	617	499	2,138,734	617	499	2,138,734	669	545	2,224,501
2017	620	502	2,152,291	620	502	2,152,325	660	538	2,216,148
2018	623	505	2,166,371	623	505	2,166,352	651	531	2,207,981
2019	629	510	2,188,265	629	510	2,188,265	645	525	2,207,240
2020	635	515	2,207,201	635	515	2,207,139	640	520	2,206,973

Figures 3 and 4 show the difference in total premature mortality brought about by achieving the standards at different points in time.

Figure 3: Total premature mortality and achievement dates

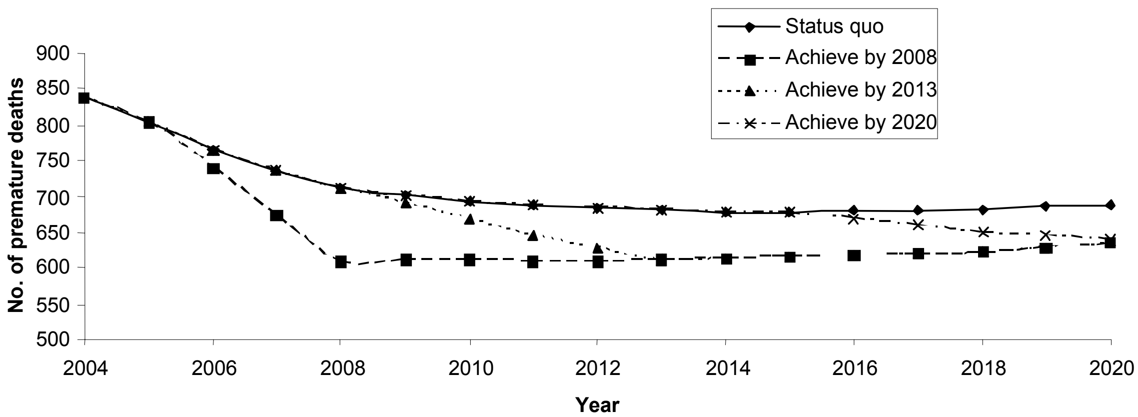
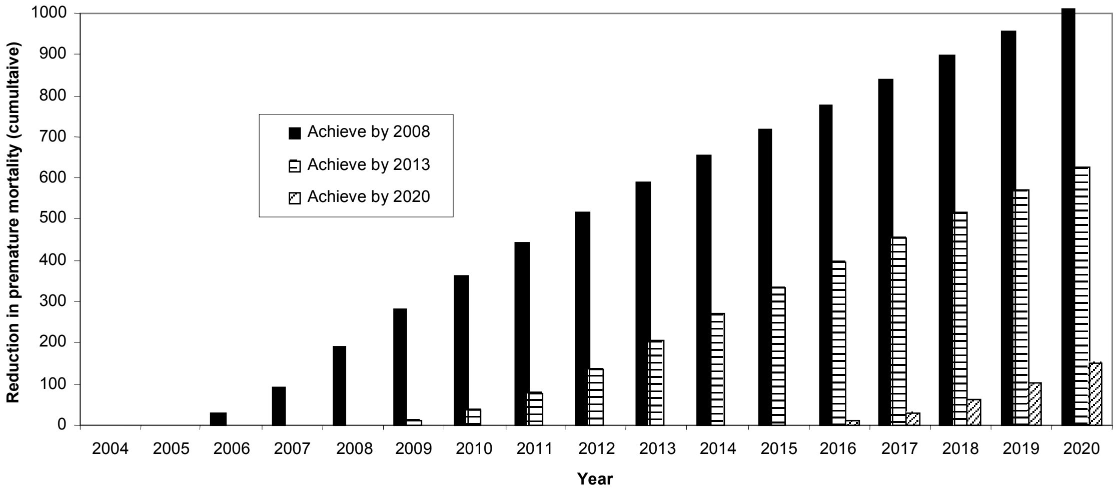


Figure 4: Cumulative reductions in premature mortality and differing achievement dates



These two figures show the impact of delays in meeting the air quality standards. In order to maximise the number of lives saved, the standards need to be achieved as soon as possible.

We realise that achieving the (ambient) air quality standards by 2008 is unrealistic given current constraints and planning time horizons for local government. Achievement by 2013 is a much more realistic prospect – this also matches the requirements in section 4.1.1. The 2013 scenario has been taken forward for the economic modelling and is the scenario used in the cost–benefit analysis. Table 11 show the different health effects if the standards are achieved by 2013.

Table 11: Health benefits from the standards (as compared to the status quo option)

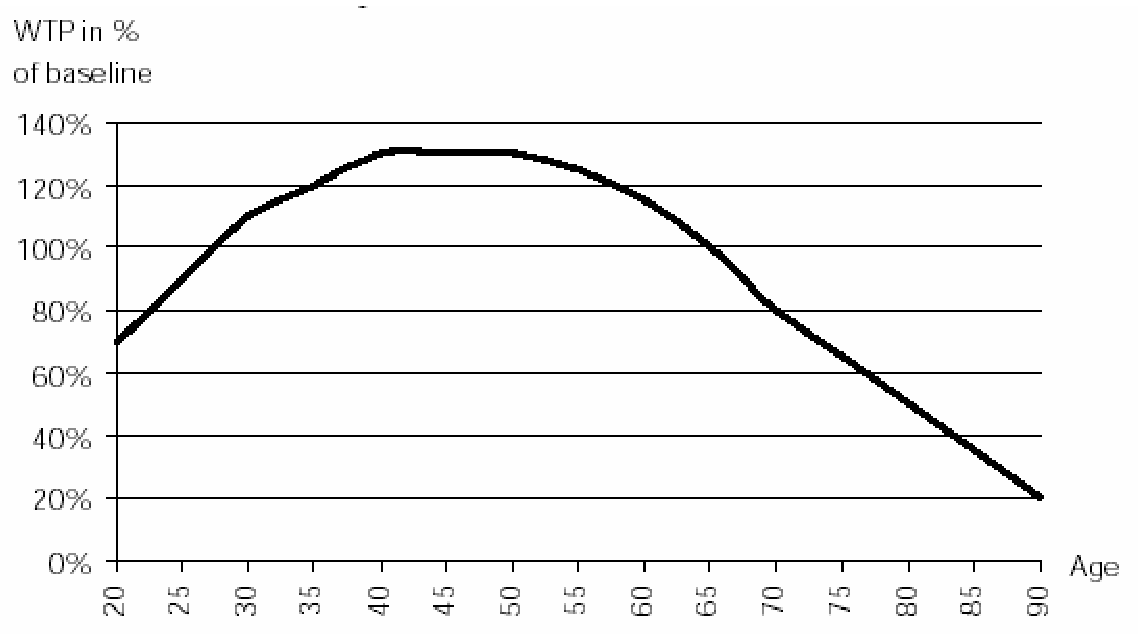
Year	Reduction in premature deaths	Reduction in hospitalisations	Reduction in RADs
2004	0	0	0
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	12	11	20,602
2010	24	22	41,266
2011	42	36	70,132
2012	57	48	94,906
2013	71	60	118,757
2014	65	57	109,669
2015	63	57	107,362
2016	62	57	103,286
2017	61	57	100,658
2018	58	56	96,647
2019	56	56	92,744
2020	54	55	89,457
Total	**625**	**571**	**1,045,487**

As can be seen from the above, over the analysis period premature mortality is reduced by 625, hospitalisations by 571 and RADs by over 1,000,000.

Running the economic model with these figures provides the economic benefits of the proposed standards. The monetary values have been discounted to reflect the fact that economic values in the future are given less weight in the analysis (reflecting a time preference in society). A discount rate of 10% has been used.

The benefits analysis includes a monetary value for premature mortality, based on the value of a statistical life (referred to as VoSL). This uses an adapted value from Transfund (of $2.5 million per fatality) adjusted to reflect age, as shown in Figure 5. In the current model, the 'value of life' figure has been adjusted to 75% to reflect impacts on older members of the at-risk population. This leaves a value per premature death of $1.88 million.

Figure 5: The relationship between age and the willingness to pay for a mortality risk reduction



Source: Based on work by Michael Jones-Lee, as reported in Sommer, 1999.

The economic modelling shows that the benefits of national environmental standards for air quality are large, saving over 625 lives, adding over $9 million to the economy[7] and generating over $420 million in benefits accrued from avoided premature mortality.

7 Derived via the economic model that relates working days lost to GDP.

5.5 Assessment of total costs

5.5.1 Sectors affected and sources of cost information

In broad terms the affected sectors are:

- local government
- central government
- industry
- households.

In order to research the magnitude of these costs, the Ministry undertook three key data-gathering exercises:

- a survey of industry
- five technical workshops with stakeholders, where the cost–benefit process was discussed and data requested
- a survey of local government.

Although able to discuss the concept of standards in general terms, many respondents were concerned that not enough detail was available at the time to make a precise estimate of costs.

Regional council costs, over and above those that currently occur through the implementation of the Ambient Air Quality Guidelines, are unlikely to increase significantly, for the following reasons.

- The standard will not require all regional councils to monitor for every ambient air quality parameter. A judgement will be made by each regional council on what parameters are an issue in their airshed. However, there is likely to be a need to install further ambient monitoring equipment in some regions.
- The national environmental standard automatically supersedes any existing regional plan, so there will be no need for every regional plan to be reviewed upon release of the standard.
- Existing resource consents are not affected – though regional councils may elect to review any existing consents that are a majority emitter of one of the pollutants.
- Resource consent holders will be required to monitor individual point source compliance with the standards, as is the existing situation.

The national environmental standards do not require a regional plan change, but the production of an air quality action plan will incur some costs. With this in mind, respondents to surveys were encouraged to be conservative in their estimates and the Ministry has used these estimates to provide the most likely actions to be undertaken to implement the air quality standards. We must emphasise that it is likely that these estimates are an overstatement of costs, and more cost-effective methods will be utilised during implementation of the standards. All costs, therefore, are Ministry estimates based on primary data and data derived through a umber of assumptions. Table 12 sets out the sources of costs and their magnitude.

Table 12: Sources of costs for the air quality standards package

Source of costs	Amount	Assumptions
Ambient air quality standards		
District / city councils	$50,000 per council per annum	Planning and implementation
Regional / unitary councils	$200,000 per council per annum	Monitoring, plan changes, reporting and enforcement
Central government	$100,000 per annum	Administration and education
Industry	$1,000,000 per annum	Assumes upgrade to 10 different sites each year on an ongoing basis
Strategic costs	Uncertain and unquantifiable	Refers to town planning, urban design, road design and construction
Prohibitive standards		
Schools / hospitals to get consents	$2,000 per school (one-off)	Rural schools only (which is about 860 schools)
Road-seal burning alternatives	$1 m per annum	Source: Transit New Zealand.
Landfill fires	$0	Mostly prohibited in plans
Burning oil	$0	Mostly prohibited in plans
Copper wire recovery	$0	Mostly prohibited in plans
Hazardous waste incineration	$0	Existing facilities remain operational
Wood-burner standard		
Households	$0–$200 per burner	Increased expense of low-emission burners
Government (local and central)	$500–$2,000 per burner	Subsidy and assistance schemes
Industry	Negligible	Some development costs – passed on to consumer

Four specific areas are worth examining in more detail:

- costs to industry
- costs associated with the prohibitive standards
- costs associated with home heating
- ‘strategic’ costs.

In general, *industry* is not a major contributor to air quality problems in New Zealand, so it is highly unlikely that industry will be required to make major upgrades. However, regional councils will need to ensure that appropriate technology is being used in order to ensure that industry does not become a major polluter. A Ministry survey of industry estimated that costs would range from a few thousand dollars to $100 million. However, the ‘best guess’ estimate for any required upgrades was up to but not exceeding $100,000. For the analysis we have assumed an ongoing programme of improvement with 10 (different) sites upgrading each year. This results in total costs to industry of $1 million per annum.

It must be stressed, however, that costs will tend to be minimal given that the levels used in the national environmental standards are entirely consistent with the existing air quality guideline levels. Flexibility for industry is also provided by specifying that the point of compliance with the ambient air quality levels is where people gather or are living. It excludes sites where people are not living or are unlikely to be present.

The *costs associated with the prohibitive activities* reflect the fact the majority of these activities are currently prohibited and deemed unacceptable by regional councils. Appendix 2 provides a summary of current (and immediate) plans. With this in mind, many of the proposed bans will be zero (or minimum) cost. Alternative technologies exist for many of the applications (such as water blasting for roads), and so development costs will be minimal.

The *costs associated with home heating* have been approached in terms of upgrading and replacement costs of open fires and 'dirty' wood burners. It is assumed there will be an assistance scheme operating by central and local government. The feasibility of such a scheme is currently being investigated by the Ministry for the Environment, Energy Efficiency and Conservation Authority and the Climate Change Office. The vision for this funding is $5 million per annum for 10 years to help eliminate the 'worst' polluting open fires and inefficient burners.

'Strategic' costs have been mentioned by some stakeholders with reference to the larger 'big picture' costs. Examples include road design and construction, alteration / new road designations, urban design and town planning. It has been argued that costs may be incurred in order to accommodate design or planning within the air quality standards framework. Re-routing of roads to avoid already polluted airsheds is one example of this. Costs of this nature are wholly uncertain, and environmentally and socially responsible design should be business as usual. These costs are, therefore, excluded from this analysis.

5.5.2 Summary of costs

Given the above assumptions, the total costs of the air quality standards package has been calculated to be $111 million over the appraisal period up to 2020 (in present values discounted at 10%). The spreadsheet of total costs can be found in Appendix 3.

5.6 Options appraisal – measuring efficiency

Efficiency, in the context of economic appraisal, refers in simple terms to an option (be it a policy or project) where the benefits exceed the costs over time. The previous sections have set out the relevant costs and benefits associated with the proposed national environmental standards for air. This section brings together these values to provide a determination of the efficiency of the proposals. Table 13 summarises the findings of the cost and benefit analysis.

Table 13: Summary of total costs and total benefits

Total lives saved	625
Total benefits (value of a statistical life only)	$420.2 m
Total benefits (cost of illness only)	$9.0 m
Total costs	$110.8 m
Cost per life saved	$177,000
Net present value (total benefits)	$318.4 m
Benefit-cost ratio (total benefits)	3.87

The three critical decision-making criteria are shown in the last three rows of the table. These are:

- net present value (NPV, benefits minus costs over time): $318.4 million
- benefit-cost ratio (B/C, benefits divided by costs over time): 3.87
- cost per life saved (costs divided by premature mortality avoided over time): $177,000.

In terms of cost–benefit analysis, a policy is said to be efficient if the benefits outweigh the costs over time. In this case, the proposed standards for air are certainly efficient and economically justified.

With regard to the cost incurred per premature death avoided, given that government (in its road-funding programme) deems $2.5 million as an appropriate investment to avoid a fatality, then the proposed air quality standards are extremely cost-effective.

5.7 Sensitivity testing

Although the findings of the efficiency test have shown that the air quality standards are both efficient and cost-effective, we need to test how sensitive the analysis is to the variation of key parameters. This testing process shows how uncertain and reliable the conclusions of the analysis are. Table 14 presents the findings of this testing procedure.

Table 14: Summary of sensitivity testing

Sensitivity test	Result	Change in decision-making criteria*
Reduce discount rate to 5%	Benefits increase to $699.5m Costs increase to $145.2 m	NPV: $554.3 m B/C: 4.82 Cost per life saved: $232,000
Increase discount rate to 15%	Benefits decrease to $273.9 m Costs decrease to $88.7 m	NPV: $185.2 m B/C: 3.09 Cost per life saved: $142,000
No wood burner costs	Total costs fall to $79.4 m	NPV: $349.8 m B/C: 5.41 Cost per life saved: $127,000
Triple costs to industry	Total costs increase to $128.4 m	NPV: $300.7 m B/C: 3.34 Cost per life saved: $206,000
What would costs need to be for cost per life saved to exceed $2.5m**?	$1.6 billion	Costs need to be over 15 times higher for investment not be ‘worthwhile’

* NPV refers to the net present value and B/C refers to the benefit–cost ratio.

** $2.5 m refers to the Transfund level of ‘acceptable’ investment to avoid a fatality.

From these sensitivity tests it can be concluded that the analysis is robust and no one parameter dominates the analysis. A further conclusion we can draw is that the level of costs would need to be substantially higher compared to the level of avoided premature mortality for the standard not to be economically justified. The already conservative nature of the assumed costs suggests that the proposed standards will be appropriate, effective and efficient.

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Appendix 1: Design Standard for Woodburners – Costs and Benefits

This appendix summarises the Environet Ltd report prepared for the Ministry in 2004 (in press).

A1.1 Current situation

There is currently no mandatory emission level for wood burners installed in most areas of New Zealand, although a large proportion of appliances are tested to NZS 4013 and comply with the 4.0 g/kg emission limit specified in that standard. The New Zealand Home Heating Association website (www.nzhha.co.nz) provides a list of appliances currently tested to NZS 4013.

Estimates of future PM_{10} concentrations and health impacts if national environmental standards or additional controls are not introduced within New Zealand urban areas that currently exceed ambient air quality guidelines are outlined in the Ministry for the Environment's *A National Environmental Standard for Solid Fuel Burners: Assessing the impacts* (2003a). These are approximate estimates only and are based on existing information on home-heating methods and patterns, population projections, existing emission inventory data, Ministry of Transport estimates of variations in tailpipe emissions from motor vehicles, and assumptions relating to changes in industry.

In addition, the home-heating estimates are based on the following assumptions.

- All new wood burners installed within new homes meet the proposed standard option.
- Old existing wood burners are replaced with ones that meet the proposed emission limit approximately 15 years following installation.
- Wood burners operated in a real setting will not achieve the test emission rate.
- The current requirements of the regional councils represent the status quo.
- Some wood burners are not included in the standard and therefore can be installed, unless not allowed through a regional plan.

A summary of the estimates for all areas where PM_{10} concentrations have exceeded ambient air quality guidelines for PM_{10} (Ministry for the Environment, 2002a) is shown in Table A1.1. Subsequent estimates of the impact of introducing national environmental standards of 4.0 g/kg, 1.5 g/kg and 1.0 g/kg are also based on the latter assessment, with modifications to emission factors for new wood-burner installations.

Table A1.1: Estimated health impacts associated with PM_{10} concentrations in New Zealand – status quo

	Year										
	0	1	2	3	4	5	6	7	8	9	10
Total no. of guideline breaches in New Zealand*	560	515	482	454	441	426	415	408	398	389	384
Mortality	872	838	804	770	749	713	708	703	687	681	678
Hospitalisations	618	603	589	575	567	552	552	552	547	547	548
RADs (000)	2,492	2,438	2,383	2330	2,295	2,235	2,232	2,230	2,212	2,211	2,217

* Estimate based on the maximum number of breaches for the worst case year from 1992 to 2001 for each location.

Table A1.1 shows a decrease in the number of breaches of the PM_{10} guideline (50 $\mu g/m^3$, 24-hour average) across New Zealand in the absence of further controls. This occurs as a result of existing or proposed air plans (e.g. Christchurch and Nelson), as well as gradual reductions in domestic heating emissions of PM_{10} as older, more polluting solid-fuel burners and open fires are replaced with modern solid-fuel burners. Although the installation of new open fires is permitted in most areas of New Zealand, few households appear to be installing new open fires.

A1.2 Benefits

A1.2.1 Introduce a standard of 4 g/kg

The introduction of a national environmental standard for wood burners of 4 g/kg is likely to result in some improvements in PM_{10} concentrations across the whole of New Zealand. However, the reduction achieved is limited because many existing wood burners available in New Zealand currently meet these emission levels and because a number of high-exposure areas (Christchurch, Nelson, Auckland and Otago) have already implemented a mandatory emission limit of 4 g/kg or less.

The estimates of impact shown in Table A1.2 are based on an emission factor of 4.4 g/kg for the new installations of wood burners. This emission factor was selected after evaluating emission test results for burners complying with the 4.0 g/kg emission limit and emissions results for wood burners under simulated operating conditions, as detailed in section 4 of this report.

Table A1.2: Estimated benefits of introducing a standard for wood burners of 4.0 g/kg

	Year										
	0	1	2	3	4	5	6	7	8	9	10
Total guideline breaches*	560	513	479	447	436	415	407	396	378	364	355
Mortality	873	837	801	767	745	707	699	692	674	666	662
Improvement in PM_{10} breaches over status quo	0.0%	0.4%	0.6%	1.5%	1.1%	2.6%	1.9%	2.9%	5.0%	6.4%	7.6%
Improvement in mortality over status quo	0.0%	0.2%	0.5%	0.7%	0.9%	1.2%	1.6%	1.9%	2.2%	2.6%	2.9%

* Estimate based on the maximum number of breaches for the worst case year from 1992 to 2001 for each location.

A1.2.2 Introduce a standard of 1.5 g/kg

The introduction of a national environmental standard for wood burners of 1.5 g/kg is likely to result in significant reductions in PM_{10} concentrations and associated health impacts in New Zealand. Table A1.3 suggests a significant reduction (29%) in the maximum number of days 50 µg/m^3 (24-hour average) is likely to be breached in urban areas of New Zealand, and a reduction in mortality of around 11% may occur by 2013 as a result of introducing a standard of 1.5 g/kg.

These estimates are based on an average emission factor of 3.0 g/kg for wood-burning appliances meeting a test criterion of 1.5 g/kg. This is based on simulations of real-life emissions and testing carried out by Applied Research Services for Environment Canterbury during 1999 and as a part of a study funded by the Sustainable Management Fund during 2003. Further details on the selection of the emission factor are discussed in section 3.

Table A1.3: Estimated benefits of introducing a standard for wood burners of 1.5 g/kg

	Year										
	0	1	2	3	4	5	6	7	8	9	10
Total guideline breaches*	560	497	458	421	401	358	329	302	281	261	252
Mortality	873	831	789	749	721	675	663	652	630	618	610
Improvement in no. of PM_{10} breaches over 4.0 g/kg	0.0%	3.1%	4.4%	5.8%	8.0%	13.7%	19.2%	23.7%	25.7%	28.3%	29.0%
Improvement in mortality over 4.0 g/kg	0.0%	0.9%	1.9%	2.9%	3.9%	5.4%	6.4%	7.2%	8.3%	9.2%	10.0%

* Estimate based on the maximum number of breaches for the worst case year from 1992 to 2001 for each location.

A1.2.3 Introduce a standard of 1.0 g/kg

Based on the limited test data available, it is unlikely that the introduction of a standard for wood burners of 1.0 g/kg will result in additional reductions in PM_{10} concentrations above what might be achieved with a standard of 1.5 g/kg. Results of emission testing for sub 1.0 g/kg burners under simulated operating conditions are summarised in Ministry for the Environment 2003a. These do not support the assumption that a reduction in the test emission criterion below 1.5 g/kg will result in subsequent reductions in real-life PM_{10} emissions. Consequently, the emission factor of 3 g/kg, as per the 1.5 g/kg wood burners, has been used to estimate the impact of a standard of 1.0 g/kg. Table A1.4 indicates that the introduction of a standard for wood burners of 1.0 g/kg is unlikely to improve PM_{10} concentrations and subsequent health impacts relative to a standard of 1.5 g/kg.

Table A1.4: Estimated benefits of introducing a standard for wood burners of 1.0 g/kg

	Year										
	0	1	2	3	4	5	6	7	8	9	10
Total guideline breaches*	560	497	458	421	401	358	329	302	281	261	252
Mortality	873	831	789	749	721	675	663	652	630	618	610
Improvement in no. of PM_{10} breaches over 1.5 g/kg	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Improvement in mortality over 1.5 g/kg	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Estimate based on the maximum number of breaches for the worst case year from 1992 to 2001 for each location.

A1.3 Likely costs

The costs associated with implementing a national environmental standard for wood burners include:

- getting appliances tested and approved.
- administration and compliance monitoring costs.
- A reduced choice of burners for householders.
- manufacturers being unable to sell appliances not meeting the required emission limit.

A1.3.1 Administration costs

Administration costs include the cost of the approval process, maintaining a database or list of approved appliances, and education relating to the proposed standard.

The approval process involves examining the wood-burner test report, design specifications of both prototype and production model, and labelling. The current cost of approval by a regulatory authority is about $1,000 per application for Environment Canterbury-approved appliances, but it can be double this if there are significant discrepancies between the appliance design specifications for the prototype and the production model.

A list of approved burners could be established on the Ministry for the Environment website. The costs associated with developing the page within the website and updating it with burner approvals would initially be around 20 to 30 hours for establishing the web page and less than 30 minutes per burner.

Education costs include the preparation of an information sheet or pamphlet, printing costs, and time associated with contacting manufacturers and retailers and liaising with territorial authority staff. Most of these would be one-off costs that would occur when the standard was introduced. However, some ongoing maintenance of relationships would be required.

A1.3.2 Compliance monitoring / enforcement costs

Compliance monitoring costs include time and travel expenses associated with checking that wood burners available for installation comply with the design specifications of the approved wood burners.

Enforcement costs include time liaising with burner manufacturers in the case of non-compliance, and the costs of any subsequent enforcement action.

A1.3.3 Manufacturers' costs

Manufacturers currently pay around $8,000 per burner for emissions testing to NZS 4013. This testing is typically carried out at Applied Research Services in Nelson, although Coal Research Limited (CRL) is also likely to offer emission testing to this standard in the near future. As a number of regional councils already have mandatory emission limits for new installations of solid-fuel burners, most manufacturers already carry out emission testing on their appliances, so the introduction of a national environmental standard would not result in significant extra testing costs for most manufacturers.

At present, regional councils can recover the costs associated with the approval process from the manufacturers of solid-fuel burners. This typically results in an addition of around $1,000 to $2,000 to get an appliance approved for use in a particular area (e.g. Christchurch). The cost of compliance monitoring and enforcement may also be recoverable from burner manufacturers. Environment Canterbury has budgeted for compliance monitoring costs of around 100 person hours per year.

A1.3.4 Burner costs

It is likely that manufacturers would pass on additional costs associated with wood-burner production to consumers. However, in most cases the cost of research and design and the costs associated with appliance testing to the NZS 4013 criteria will already be integrated into wood-burner prices.

Currently there do not appear to be significant differences in the cost of burners meeting the 4.0 g/kg emission standard and those currently approved to the 1.5 g/kg level, with retailers in Christchurch quoting burner acquisition and installation costs starting from around $1,800 for the latter and an Auckland dealer quoting from $1,600 installed for a 4.0 g/kg burner. However, the Home Heating Association suggests a real cost difference of about $800 per inbuilt burner for a 1.5 g/kg burner compared to a 4.0 g/kg burner and a similar real cost differential for the freestanding models (personal comment, Ed Hawkes, December 2003). The $1,800 installed cost for a 1.5 g/kg burner compares to around $2,500 for a burner meeting the new Christchurch standard of 1.0 g/kg. At present there are only a small number of solid-fuel appliances approved to the latter standard, limiting the options, including the range in heat output available to consumers.

A1.4 Conclusion

The introduction of a national environmental standard of 4.0 g/kg would have some additional benefits in reducing PM_{10} concentrations, with an estimated 3% decrease in the health impacts of PM_{10} relative to the status quo option. In contrast, the introduction of a 1.5 g/kg emission standard is likely to result in significant improvements in PM_{10} concentrations and the associated health impacts in urban areas of New Zealand. An estimated additional reduction of 10% in existing pollution-related mortality is predicted by 2013 if a standard of 1.5 g/kg for wood burners were introduced. Based on existing information, it is unlikely that there would be additional benefits in reducing the test criterion to below 1.5 g/kg.

Costs associated with the introduction of a national environmental standard for wood burners include potential costs to manufacturers associated with appliance testing (around $8,000 per burner), appliance approval costs (around $1,000 per burner), additional research and design costs, and loss of market share for manufacturers unable to produce appliances meeting the standard. In many cases manufacturers already incur these costs, because a proportion of appliances for sale in New Zealand are already tested to NZS 4013 and administration costs are already incurred by manufacturers submitting appliances for approval for installation in the Clean Air Zones of Christchurch. Other costs associated with the introduction of a standard of 1.5 g/kg for wood burners include a possible increase in the cost of a burner of around $200 to $800 per burner, and costs associated with education, awareness and enforcement, and compliance monitoring.

Appendix 2: Council Plans and Proposed Activity Bans

Table A2: Summary of current regional plans and proposed prohibited activities

Activity	NRC	ARC	EW	EBoP	HBRC	TRC	MW	GW	GDC	TDC	MDC	NCC	ECan	ORC	WCRC	ES
Landfill fires	X		X				NC						X		X	D
Uncontrolled low-temperature burning of oil	D	X	X	X	X	X	X	D	D	X	X	X	X	X	X	D
Burning of insulated copper wire for copper recovery	X	X	X	X	X	X	X	D		X	X	X	X	X	X	D
Open burning of road seal		X	X	P			P	D	D	X	D	X	X	D		
Uncontrolled open burning of tyres	X	X	X	X	X	X		D	D	X	X	X	X	X	X	D

P – permitted activity	Means an activity that is allowed by a plan without a resource consent if it complies in all respects with any conditions (including any conditions in relation to any matter described in s108 or s220 of the RMA) specified in the plan.
D – discretionary activity	Means an activity: a. which is provided for, as a discretionary activity, by a rule in a plan or proposed plan; and b. which is allowed only if a resource consent is obtained in respect of that activity; and c. which may have standards and terms specified in a plan or proposed plan; and d. in respect of which the consent authority may restrict the exercise of its discretion to those matters specified in a plan or proposed plan for that activity.
C – controlled activity	Means an activity which: a. is provided for, as a controlled activity, by a rule in a plan or proposed plan; and b. complies with standards and terms specified in a plan or proposed plan for such activities; and c. is assessed according to matters the consent authority has reserved control over in the plan or proposed plan; and d. is allowed only if a resource consent is obtained in respect of that activity.
X – prohibited activity	Means an activity which a plan expressly prohibits and describes as an activity for which no resource consent shall be granted (and includes any activity prohibited by s105(2)(b) of the Historic Places Act 1993).
NC – non-complying	Means an activity which: a. is provided for, as a non-complying activity, by a rule in a plan or proposed plan; or b. contravenes a rule in a plan or proposed plan; and c. is allowed only if a resource consent is obtained in respect of the activity.
	Unclear in plan

Key:

ARC	Auckland Regional Council	EBoP	Environment Bay of Plenty
ECan	Environment Canterbury	ES	Environment Southland
EW	Environment Waikato	GDC	Gisborne District Council
GW	Greater Wellington	HBRC	Hawke's Bay Regional Council
MDC	Marlborough District Council	MW	Horizons MW
NCC	Nelson City Council	NRC	Northland Regional Council
ORC	Otago Regional Council	TDC	Tasman District Council
TRC	Taranaki Regional Council	WCRC	West Coast Regional Council

Appendix 3: Cost Summary Spreadsheet

Area of cost	Year																	
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Ambient air quality																		
District city councils																		
at $50,000 per council per year		$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000
Regional councils and unitary authorities																		
at $200,000 per council per year		$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000	$3,200,000
Central government																		
at $100,000 per annum		$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
Industry																		
10 sites per annum @ $100,000		$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Prohibitive standards																		
Schools / hospitals to get consents		$1,724,000																
Alternatives to road-seal burning		$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Landfill fires		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternatives to burning oil		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternatives to copper wire burning recovery		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternative disposal for haz waste to landfill		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Wood-burner standard																		
Households		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Wood-burner manufacturers																		
Government / councils		$700,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$0	$0	$0	$0	$0	$0
($500 per h/h)																		
Total		$11,224,000	$13,800,000	$13,800,000	$13,800,000	$13,800,000	$13,800,000	$13,800,000	$13,800,000	$13,800,000	$13,800,000	$13,800,000	$8,800,000	$8,800,000	$8,800,000	$8,800,000	$8,800,000	$8,800,000
Discount rate	**10%**																	
PV Total		$11,224,000	$12,545,455	$11,404,959	$10,368,144	$9,425,586	$8,568,714	$7,789,740	$7,081,582	$6,437,802	$5,852,547	$5,320,497	$3,084,346	$2,803,951	$2,549,047	$2,317,315	$2,106,650	$1,915,136
PV Total over 10 years	**$110,795,472**																	