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Management options for reducing PM_{10} concentrations in Blenheim – Update 2007

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Executive Summary

This report updates a January 2006 assessment of the effectiveness of management options in reducing PM_{10} concentrations in Blenheim. Key changes introduced in this report include:

- Integration of results of source apportionment work identifying natural and secondary source contributions to PM_{10}.
- Revision to the starting point of the Straight Line Path (SLiP)

Concentrations of PM_{10} measured in Blenheim exceed the ambient air quality guideline and National Environmental Standard (NES) concentration of 50 µg m^{-3} (24-hour average) during the winter months. The main source of PM_{10} in Blenheim during the winter months is solid fuel burning for domestic home heating, which contributes around 85% of the anthropogenic PM_{10}. A previous maximum PM_{10} concentration of 81 µg m^{-3} (24-hour average) recorded at Redwoodtown during 2004 has been disregarded and a new starting point has been established for calculating required reductions. Previously the reduction required in PM_{10} concentrations based was estimated at 37%. The revised reduction in PM_{10} concentrations, based on a maximum of 66 µg m^{-3} is estimated at 25%.

The effectiveness of different options in achieving this reduction were re-evaluated with the inclusion of natural source contributions from soil, sea spray, sulphate and an additional combustion source which may reflect a nearby industry located outside of the inventory area. Management measures focused largely on domestic home heating as the primary source of PM_{10}, although prohibitions on outdoor rubbish burning were also considered. The methodology used the existing PM_{10} emissions for Blenheim as estimated in the 2005 air emission inventory and made predictions of changes that were time based on a number of scenarios. These emissions projections were then compared to existing concentrations assuming a linear relationship between the two variables.

Baseline projections indicate a reduction of just over 10% is likely to occur in the absence of additional controls as older more polluting heating methods are replaced with modern solid fuel burners at the end of their useful life. A number of management options were evaluated including a ban on outdoor rubbish burning and the use of open fires, setting an emission criterion for the installation of new multi fuel burners, a prohibition of the installation of solid fuel burners in new dwellings and existing dwellings using other heating methods and incentives for the replacement of burners with non-solid fuel alternatives. Management options were evaluated based on an assumed wood burner life of 15 years and for an assumed burner life of 20 years.

Consideration could be given to a combination of management options including a ban on outdoor rubbish burning and the use of open fires, prohibiting the installation of new multi fuel burners not meeting the NES design criteria for wood burners and incentives to encourage households replacing solid fuel burners to select non-solid fuel alternatives. It is likely that the implementation of these measures would achieve the NES by 2013. Alternative combinations such as achieving more through the greater use of incentives and less through regulatory options could also be evaluated. An additional regulation requiring households to replace solid fuel burners 15 or 20 years after installation could be considered to improve the likelihood of NES compliance.

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1 Introduction

Air quality monitoring for PM_{10} has been carried out in Blenheim since 2000. Results indicate concentrations in excess of the ambient air quality guidelines (MfE, 2002) and National Environmental Standards (MfE, 2004). The National Environmental Standards (NES) specify a standard for PM_{10} of 50 µg m^{-3} (24-hour average) with one allowable exceedence per year, effective from September 2005.

Monitoring of PM_{10} in other urban areas of the Marlborough District, for example., Picton, has not shown NES breaches to date. However, further monitoring of PM_{10} in the smaller urban areas including Picton is likely to be carried out to provide additional information on NES compliance throughout the Region.

In Blenheim, reductions in PM_{10} concentrations are required if the NES is to be met by 2013. There is significant incentive to do this as the NES indicates that a consent authority must decline an application for a resource consent in an area where PM_{10} concentrations exceed the NES if the PM_{10} discharge is likely to significantly increase the PM_{10} in the airshed and if the discharge to be permitted by the resource consent is likely to cause, at any time, the concentration of PM_{10} in the airshed to be above the straight line path. The straight line path is defined as a line that starts on the y axis of a graph at a point representing the extent to which the concentration of PM_{10} in the airshed breaches its ambient air quality standard at 1 September 2005; and ends on the x axis of the graph at the point representing the ambient air quality standard for PM_{10} in the airshed at 1 September 2013.

The NES also specifies that no resource consent for discharges to air may be granted from 1 September 2013 if the concentrations of PM_{10} in the airshed breach the NES or if the granting of the consent is likely to result in a breach.

An air emissions inventory carried out for Blenheim in 2005 indicates that solid fuel burning for domestic home heating is the main source of PM_{10} during the winter months, when concentrations in excess of the NES have been recorded. Just less than one tonne of PM_{10} per day is estimated to be discharged with domestic home heating contributing around 85% (Wilton, 2005).

This report updates a previous management options report that was prepared in 2006. The main areas updated are:

- Integration of results of source apportionment work identifying natural and secondary source contributions to PM_{10}.
- Revision to the starting point of the Straight Line Path (SLiP)

This report integrates these changes and evaluates the effectiveness of these options in achieving compliance with the NES by 2013.

2 Air quality monitoring in Blenheim

An air quality monitoring site measuring 24-hour average PM_{10} was established at a site in Renwick Road in February 2000. This site is referred to as the "Blenheim" site and has been operated each year since 2000. The method of measurement is gravimetric high volume sampling, which involves the collection and subsequent weighing of PM_{10} on a filter. Monitoring prior to 2002 was carried out based on one sample day in every six. From 2001, the sampling frequency was increased to one day in three during the winter months.

A new air quality monitoring site was established in Redwoodtown during 2002. Monitoring was carried out in this area during the winter months of 2002 and 2003 using a high-volume sampler and a one day in three sampling regime. The location of the monitoring site was the Blenheim Bowling Club for all periods except winter 2004, when the sampler was located at a site in Brooklyn Street. From April 2004, the monitoring period was extended to include sampling during the summer months. Although the Blenheim site provides a long-term record of PM_{10} concentrations in Blenheim, Redwoodtown provides a better indication of worst-case concentrations and records a greater number of NES breaches per year. The latter site is therefore more appropriate as an NES compliant monitoring site and is currently being upgraded to an NES compliant monitoring programme. Based on the urban boundaries and topography of Blenheim it is likely that monitoring in Redwoodtown will be indicative of worst-case ambient PM_{10} concentrations in Blenheim.

2.1 Redwoodtown Monitoring Site

Table 2.1 shows summary statistics for PM_{10} monitoring at Redwoodtown in Blenheim from 2002. The maximum measured PM_{10} concentration in Blenheim was 81 µg m^{-3} (24-hour average) and was measured in 2004 at the Brooklyn Street monitoring site. A recent report (Wilton & Tiernan, 2007) suggests that the 2004 Brooklyn Street results are unlikely to be representative of air quality in Blenheim. The maximum measured PM_{10} concentration, excluding 2004 results, was 63 µg m^{-3} and was measured using gravimetric sampling during 2006 (Figure 2.1). During 2007 the highest measured concentration was 62 µg m^{-3}. The latter concentration was measured using the continuous BAM sampler. A 2007 report suggests this method under reports relative to the gravimetric high volume sampler by around 7%. Thus a maximum PM_{10} concentration of around 66 µg m^{-3} is likely for the Redwoodtown monitoring site.

Excluding 2004, the number of measured guideline exceedences at Redwoodtown ranges from 2 in 2005 to 9 in 2006. If exceedences are statistically extrapolated to non-sample days the number of breaches may have been as high as 34 during 2003.

Table 2.1: Summary statistics for air quality monitoring in Redwoodtown from 2002 to 2006

	2002	2003	2004	2005	2006
"Good" 0-33% of guideline	18%	22%	46%	63%	66%
"Acceptable" 33-66% of guideline	62%	30%	22%	17%	21%
"Alert" 66-100% of guideline	10%	26%	20%	17%	10%
"Action" >Guideline	10%	22%	12%	3%	3%
Percentage of valid data	14%	7%	22%	32%	68%
Annual average (µg m-3)	-	-	22	18	17
Measured exceedences	5	6	10	3	6
Guideline exceedences (extrapolated for missing data)	16	34	31	9	10
Annual maximum (µg m-3)	58	60	81	58	63

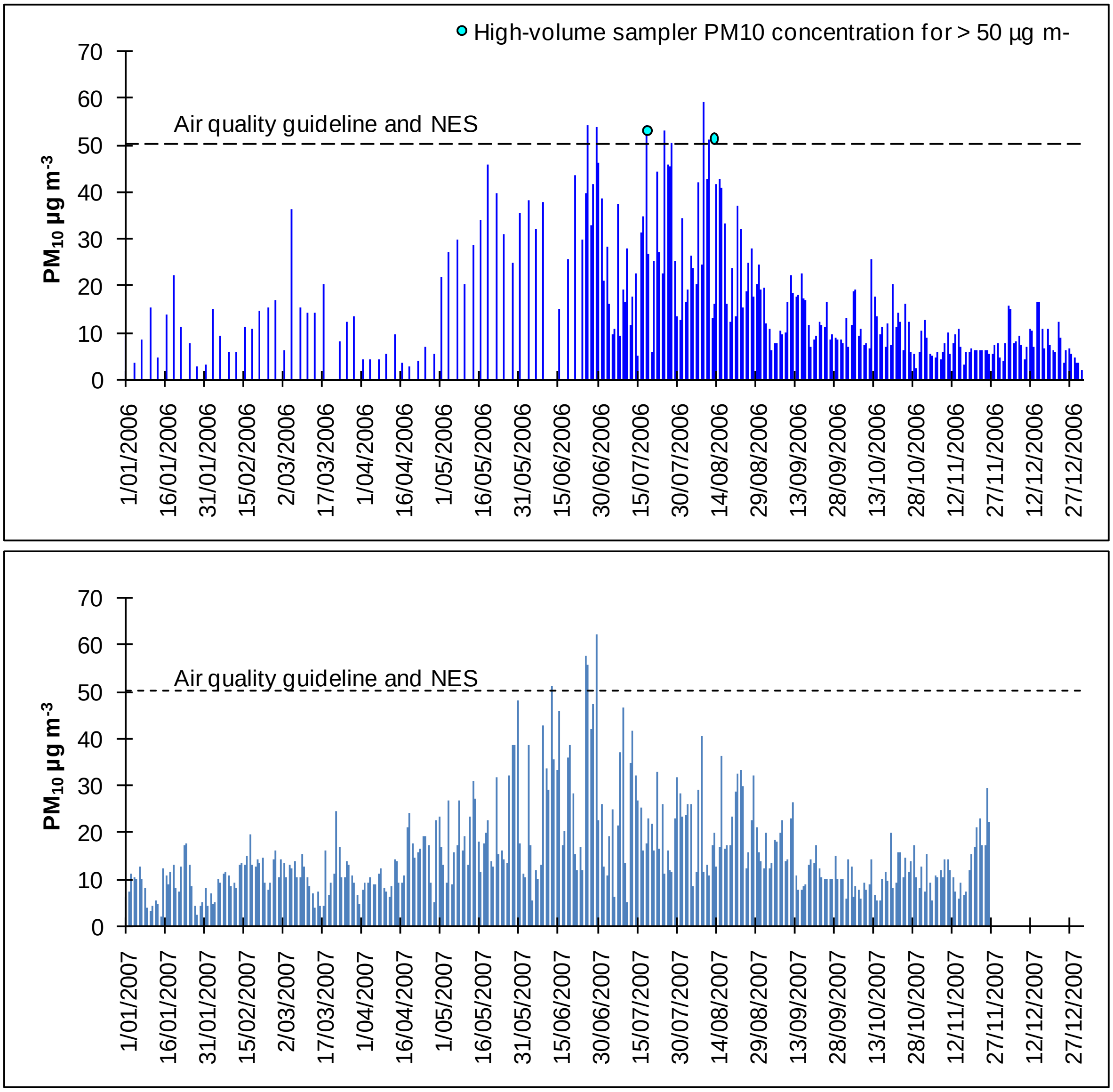

Figure 2.1: Concentrations of PM_{10} measured at Redwoodtown during 2006 and 2007

2.2 Reductions required in PM_{10} concentrations

A number of methods have been proposed for determining the reductions required in PM_{10} concentrations to meet the NES and for determining compliance with the "straight line paths" (SliP) in managing air quality. The reductions required in PM_{10} concentrations to meet the NES could be estimated based on existing monitoring data. This is the most robust method, particularly in locations where there are many years of monitoring results available. The more data available the higher the probability that the data captures the worst-case meteorological conditions that give rise to elevated PM_{10} concentrations.

The maximum PM_{10} concentration measured in Blenheim from 2000 to 2004 was 81 µg m^{-3} (24-hour average), measured at the Redwoodtown (Brooklyn Street) monitoring site in July 2004. In 2007 additional monitoring was undertaken in Brooklyn Street to confirm the validity of the maximum measured concentration. The main reasons for undertaking the monitoring were:

- Concentrations of this magnitude have not been measured at the Bowling Club site in Redwoodtown.
- The monitoring equipment was located in the backyard of a residential dwelling and may have been impacted on by localised sources e.g., neighbouring chimneys.

Monitoring of PM_{10} near Brooklyn Street in 2007 showed PM_{10} concentrations similar to Redwoodtown and suggest that the area is not prone to high PM_{10} concentrations. The possibility of the high pollution during 2004 occurring because of worst case emissions or meteorological conditions was considered unlikely based on an evaluation of the meteorological data.

Excluding the 2004 Brooklyn Street results, the maximum 24-hour PM_{10} concentration for Blenheim is 66 µg m^{-3}. This was based on a concentration of 62 µg m^{-3} measured using the BAM during 2007 and extrapolated upwards by 7% to account for differences in the BAM versus gravimetric methods.

The reduction required in PM_{10} concentrations to meet an air quality target of 50 μgm^{-3} (24-hour average), can be calculated using Equation 2.1:

$$R = 100(1 - \frac{t}{c})$$

where

R = the percentage reduction

t = the air quality target (e.g., 50 μgm^{-3})

c = the percentile concentration (e.g., 99.7 percentile concentrations for one allowable breach)

Based on Equation 2.1 the required reduction if the air quality target of 50 μgm^{-3} is to be met is 25% in Blenheim.

Equation 2.1 could also be used to meet an alternative air quality target. Air quality targets lower than the NES of 50 µg m^{-3} may be considered by Councils wanting to minimise health impacts of PM_{10} concentrations. Prior to the introduction of the NES, a number of councils had adopted an air quality target of 33 µg m^{-3} as the lower limit value for the MfE "acceptable" air quality indicators classification (MfE, 1998). The reduction required to meet an air quality target of 33 µg m^{-3} based on a maximum PM_{10} concentration of 66 µg m^{-3} is 50%.

An alternative to evaluating the reduction required in PM_{10} concentrations based on the maximum and 99.7 percentile concentrations is to use modelling to determine whether worst-case meteorological conditions may have occurred either on a non-sample day or during a non-sample year. The modelling can then be used to estimate the maximum 24-hour average PM_{10} concentration on the day when worst-case meteorological conditions are estimated. The reduction required could then be based on this modelled concentration rather than a measured concentration. The main limitation with this approach is the uncertainty surrounding the modelled estimate of the maximum PM_{10} concentration.

3 Sources of PM_{10} in Blenheim

3.1 Air emission inventory

An air emissions inventory was carried out for the urban area of Blenheim during 2005 to estimate the amount of PM_{10} and other contaminants from different sources.

Sources included in the inventory were domestic home heating, motor vehicles, industrial and commercial emissions (including fuel burning for heating in schools) and domestic outdoor rubbish and green waste burning. Other sources such as railway emissions, dusts and small power tools were also considered.

The main source of PM_{10} was solid fuel burning for domestic home heating, which contributed around 85% of the daily wintertime PM_{10} emissions. Industry, motor vehicles and outdoor burning contributed 2%, 7% and 6% respectively.

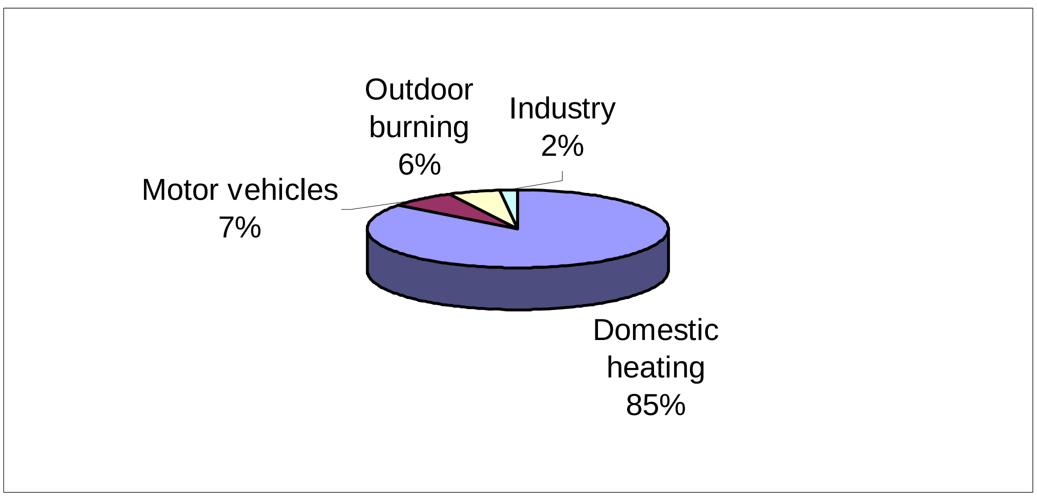

Figure 3.1: Relative contribution of different sources to average daily PM_{10} emissions in Blenheim

Domestic home heating emissions were further broken down into appliance and fuel types. Figure 3.2 shows the main source of PM_{10} from domestic heating is from older wood burners. Multi fuel burners contribute 19% and open fires contribute 11% of the daily winter PM_{10} from domestic heating.

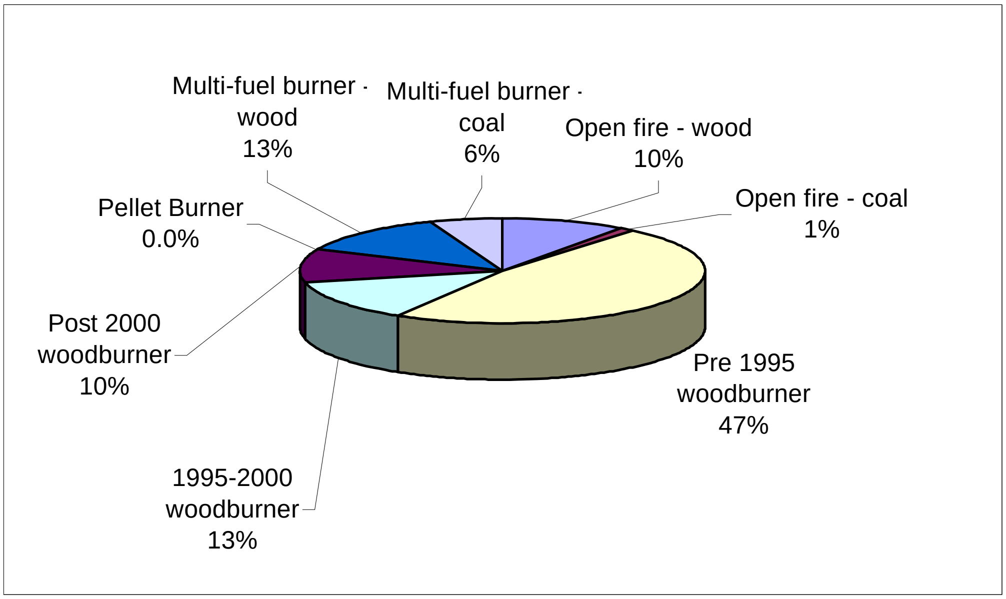

Figure 3.2: Relative contribution of different heating methods to average daily PM_{10} from domestic heating in Blenheim

3.2 Source apportionment (receptor modelling)

A source apportionment receptor modelling study was carried out for Blenheim during 2006 and 2007. The method involves measuring concentrations of chemical elements in particulate matter collected on a filter and the application of statistics to determine the contributions of different sources.

In Blenheim, the receptor modelling identified five sources of PM_{10} concentrations. These were identified as domestic heating, sea spray, sulphate, and two soil profiles, one of which was mixed with combustion and had high concentrations of potassium (K) and Calcium (Ca). In the source apportionment study, domestic heating sources also include outdoor burning of domestic waste biomass. The main contributor to PM_{10} concentrations in Blenheim was found to be domestic heating, which was responsible for 71% of the daily winter concentrations.

The main objective of the study was to assess the natural sources contributions to PM_{10} particularly on days when PM_{10} concentrations exceeded the NES. Results showed that during winter around 5% of the PM_{10} on average was from sea spray and 10% from soil. The average natural source contribution on days when PM_{10} concentrations breached the NES during the study period was 11%. This suggests that around 6 $\mu g\ m^{-3}$ of PM_{10} may come from these sources on days when PM_{10} concentrations are around 50 $\mu g\ m^{-3}$.

4 Emissions projections

4.1 Projections in motor vehicle emissions

The inventory estimates the amount of PM_{10} from motor vehicles based on an assessment of vehicle kilometres travelled for Blenheim, the application of the Ministry of Transport's (MOT) "New Zealand Transport Emission Rates" (NZTER) database and overseas data on likely emissions from non-tailpipe sources including brake and tyre wear. The NZTER database includes estimates of changes in tailpipe emissions and estimates significant decreases in tailpipe emissions of PM_{10} between 2005 and 2021. Table 4.1 compares NZTER PM_{10} emission rates under different levels of congestion for 2005 and 2021 based on the 2005 vehicle fleet composition. This suggests a 66% reduction in tailpipe PM_{10} emissions per vehicle kilometre travelled for free flowing traffic conditions.

Table 4.1: Comparison of 2005 and 2021 tailpipe PM_{10} emissions (from NZTER)

LOS	2005 PM_{10}	2005 PM_{10}
Congested	0.19	0.07
Interrupted	0.13	0.05
Free flow	0.12	0.04

In contrast, VKTs in Blenheim are most likely to increase from 2005 to 2021 as the population residing in the area is predicted to increase. Congestion may also increase during this time. Predicting the extent of increase in VKTs and congestion is difficult without the use of a road network model. In areas where road network models have been used in conjunction with the NZTER database to predict future PM_{10} estimates, increases in VKTs have been offset by the predicted reductions in VKTs. For example, in Napier and Hastings, VKTs are estimated to increase by 19% and 17% respectively between 2005 and 2021 but PM_{10} emissions from motor vehicles are predicted to decrease by around 50% in both areas.

Estimates of likely worst-case motor vehicle PM_{10} emissions for 2021 could be made based on the assumption of a 70% increase in VKTs in Blenheim and the use of the NZTER database for 2021 PM_{10} emission factors. Figure 4.1 shows estimates of PM_{10} emissions from motor vehicles for this scenario, assuming a 70% increase in VKTs resulted in 5% of VKTs occurring under "congested" conditions and 10% under "interrupted" conditions. A reduction in 2005 PM_{10} emissions of around 24% is predicted for this scenario.

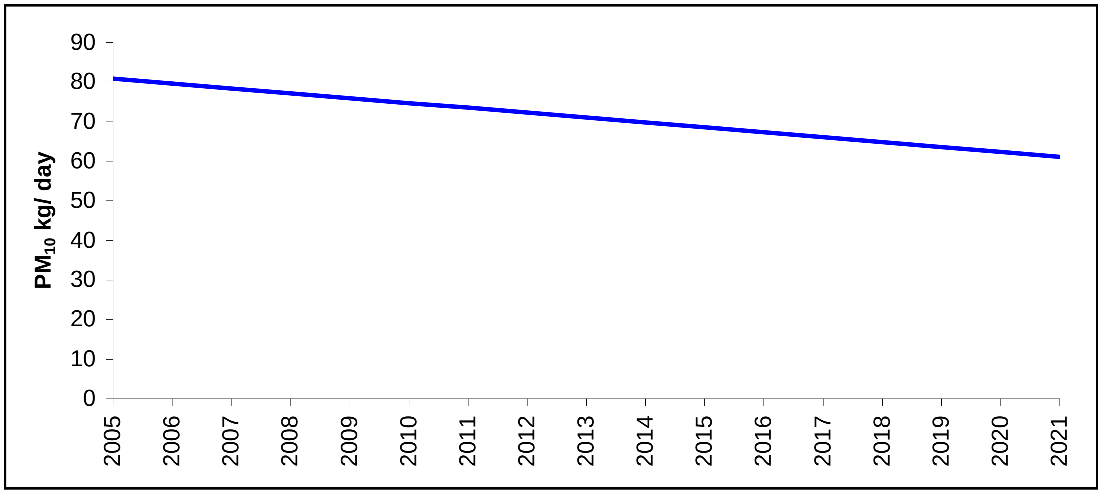

Figure 4.1: Daily motor vehicle emissions in Blenheim from 2005 to 2021 based on a likely worst-case estimate of a 70% increase in VKT with 10% occurring under 'interrupted' and 5% under 'congested' conditions

4.2 Domestic heating

The baseline data used for the domestic home heating projections were the home heating methods and subsequent emission estimates from the 2005 air emissions inventory (Wilton, 2005). Future emissions from this source were estimated based on the following assumptions:

- The number of dwellings increases in Blenheim by 70% from 2001 to 2021.
- Emission factors and fuel factors used in the inventory apply across the whole life of the burner.
- Wood burners are replaced 15 and 20 years after installation (note because of uncertainties surrounding this variable both scenarios are modelled).
- The number of open fires decreases by 10% from 2005 to 2021.
- Existing multi fuel burners (at 2005) decrease by 90% by 2021.
- The number of new installations of solid fuel burners per year is equal to 100% of those removing burners plus 16% of new dwellings and 0.25% of the number of households in 2005 that use electricity and gas[1].
- 13% of the new solid fuel burners installed in Blenheim from 2005 are multi fuel burners[2].
- All households with multi fuel burners burn wood with half of these also burning coal.

These assumptions are based on a combination of emission inventory statistics, emissions testing of solid fuel burners in New Zealand, New Zealand Statistics Department data, evaluations of burner installations data in Blenheim, industry advice and in the case of replacement rates, a best guess approach. Because of the lack of information available

[1] This is based on the assumption that less than 5% of existing houses using gas and electricity will convert to wood burning by 2021.
[2] This is based on the proportion of modern multi fuel burners from the 2005 domestic home heating survey.

on the latter, there is a high level of uncertainty surrounding burner replacement rates. Factors that influence householder' choice of heating method include the cost of heating, lifestyle variables, amenity values associated with different heating methods, and household insulation and size. The impact of management options will therefore be shown for a range of assumed household replacement rates.

4.3 Other sources

In the absence of controls on outdoor burning, emission estimates were assumed to increase in proportion to population increases. Population projections for Blenheim were sourced from New Zealand Statistics Department (2005) using the 2003 revised projections of a 70% increase in population from 2001 to 2021 for the Marlborough District.

Changes in emissions from industry are very difficult to predict. Increases can occur as a result of new industry, fuel switching within existing industry or expansion of existing operations. Conversely reductions in industrial emissions are possible as a result of increased efficiencies, process improvements, fuel switching or plant closures. Emissions from industry are assumed to increase by 25% from 2005 to 2021.

5 Managing PM_{10} concentrations in Blenheim

5.1 Methodology

The methodology used to assess the impact of different management options on PM_{10} emissions in Blenheim relies on changing the variables within the projections frameworks for different sources. For example, if a management option aimed to examine the impact of a ban on outdoor rubbish burning from a particular year, the emissions from this source would be removed from the total PM_{10} emissions at the year the ban was assumed to be effective. Estimating the impact of management options for domestic heating is more complex as assumptions regarding replacement heating methods need to be made.

A number of other factors influence the analysis of the effectiveness of management options in reducing PM_{10} concentrations in Blenheim. These include:

1. The relative contribution of different sources to PM_{10} emissions (the emission inventory) and assumptions underpinning this assessment.
2. The potential contribution of sources of PM_{10} not included in the inventory or outside of the study area
3. Estimated projections in sources of emissions in the absence of additional controls.
4. The relationship between emissions and concentrations in Blenheim.

One of the limitations of using the emission inventory source contributions is that this method is unable to adequately estimate emissions from natural sources such as sea spray. Blenheim is located around 5-10 kilometres from the east coast so it is possible that sea spray may contribute to PM_{10} concentrations. In addition, the inventory makes no estimate of the secondary particulate contribution to emissions. If there are baseline contributions from these sources to PM_{10} in Blenheim on high pollution days these should be included in the management options assessment.

The previous assessment of management options (Wilton, 2006) assumed that 6% of the PM_{10} was from natural sources. This compares with around 11% from soil and sea spray as estimated using receptor modelling (as detailed in section 3.2). In addition, it is likely that a large proportion of the sulphate profile is not included in the management options assessment.

Potential sources of PM_{10} from outside of the study area were previously identified as outdoor burning, the burning of vineyard prunings and local industries in the surrounding areas. The inventory estimates that an average 66 kilograms of PM_{10} may be produced per day from outdoor burning. Industries near to the urban areas of Blenheim may also emit more than 100 kilograms of PM_{10} per day during the winter. The receptor modelling study did not identify a separate source appearing to be outdoor burning outside of the study area but suggests a combustion source located to the west of the monitoring site that could represent the contribution of an industry (wood fired boiler) outside of the study area. This source is estimated to contribute around 4% of the PM_{10} on high pollution days.

The contributions from these sources were re-evaluated based on the receptor modelling results. The natural source contribution was increased to 160 kilograms per day and the industry outside of study area was decreased to 57 kilograms per day (4% of daily PM_{10}). Around 100 kilograms per day was allocated to other sources not included in the inventory such as burning outside of the study area and sulphate PM_{10}.

The relationship between PM_{10} emissions and concentrations over a 24-hour period for worst-case meteorological conditions depends primarily on two factors:

- Variations in the impact of meteorological conditions on the dispersion of air pollution over a 24-hour period.
- The relationship between emissions and concentrations in an airshed.

The time of day impact relates to how emissions occurring at different times of the day influence the 24-hour average concentration. For example, emissions that occur when wind speeds are lowest and temperature inversions are present (typically evening and early morning) will have a greater impact on 24-hour average concentrations. A greater proportion of domestic heating emissions occur during this time, relative to other sources, and therefore this source may contribute slightly more to PM_{10} concentrations.

In the absence of modelling of the relationship between emissions and concentrations for Blenheim, the assessment of effects has been based on the assumption of a linear relationship between emissions and concentrations and there is no impact on the time of the day that emissions are occurring relative to meteorological conditions. It is possible that this relationship could be confirmed or revised through the use of airshed dispersion modelling.

As indicated here, there are a number of uncertainties associated with the management options assessment. These include both the uncertainties associated with the emission inventory estimates, non-inventory sources, contributions from areas outside of the inventory area and uncertainties associated with the projections of emissions from different sources. The methodology for assessing the effectiveness of management options in reducing PM_{10} in Blenheim includes an evaluation of the uncertainties associated with a number of aspects of the modelling but can not allow for uncertainties such as the contribution from natural sources, or industry or outdoor burning outside of Blenheim.

5.2 Management options assessed

A number of different management options have been evaluated to reduce PM_{10} concentrations in urban areas of New Zealand. Previous studies (e.g., Wilton 2001, Wilton 2002) have evaluated issues surrounding a wide range of options. These include the methods evaluated in this report (as outlined below) as well as other options such as the introduction of smokeless fuels, district heating options, avoiding the use of solid fuel burners on high pollution nights and the effectiveness of education to improve fuel quality and burner operation. The latter option has significant appeal in many areas. However, there are considerable uncertainties relating to the effectiveness of education in improving air quality (as outlined in Wilton & Millichamp, 2002).

Management options included in this analysis were as follows:

1. Status quo including the NES design standard for new installations of solid fuel burners assuming a 15 year replacement rate for solid fuel burners.
2. Status quo including the NES design standard for new installations of solid fuel burners and a 20 year phase out for existing burners.
3. Status quo plus prohibiting outdoor rubbish burning from 2008 (modelling for both the 15 year and 20 year phase out).
4. Options 1 - 3 plus banning the use of open fires from 2010.

5. Options 1 - 4 plus no new installations of multi fuel burners not meeting the NES design criteria for wood burners (effectively a ban on multi fuel burners as currently there are none that meet the NES design criteria for wood burners).
6. Options 1 – 5 plus economic incentives to replace burners with other heating methods at the end of their useful life.

Projections were modelled based on the assumption that solid fuel burners would be replaced 15 years and 20 years following installation. Although 15 years has been quoted by the New Zealand Home Heating Association as the average useful life of a wood burner, some burners may be used for longer periods. In some areas (e.g., Christchurch and proposed for Nelson), the uncertainty associated with burner replacement rates has been reduced by the proposed introduction of regulations requiring the replacement of burners 15 years following installation.

The status quo projections also include the introduction of the NES design criteria for the installation of new wood burners. This specifies new burners must meet an emission criteria of 1.5 grams of particulate per kilogram of fuel burnt when tested to NZS 4013. This criteria does not apply to the installation of new multi fuel burners (burners designed for both wood and coal). The installation rate of new multi fuel versus wood burners was taken from the domestic home heating survey carried out during 2005 for Blenheim. This indicated around 13% of new solid fuel burner installations were multi fuel burners (Wilton, 2005). The domestic home heating survey indicates that of the households with multi fuel burners, only around half actually burn coal.

5.3 Baseline projections by source

Figure 5.1 shows the estimated baseline projections in PM_{10} emissions from each source in the absence of additional management measures. These and subsequent projections are based on the assumptions outlined in Table 5.1. The reductions predicted for domestic home heating emissions are estimated to occur as a result of the phase out of older, more polluting solid fuel burners, with the majority being replaced with modern NES compliant burners. There is currently some uncertainty regarding the emission rates from NES compliant burners, which will influence the extent of reduction likely to occur as a result of natural attrition (as discussed in Smith & Wilton, 2006). While previous management options analyses have assumed an emission rate of 3 grams of particulate per kilogram of fuel burnt (g/kg), a more conservative 6 g/kg has been used in this study.

These projections are based on the assumption that older burners are removed 15 years following installation. Because of the uncertainty surrounding this assumption, air management scenarios have been analysed for both a 15-year and 20-year phase out period.

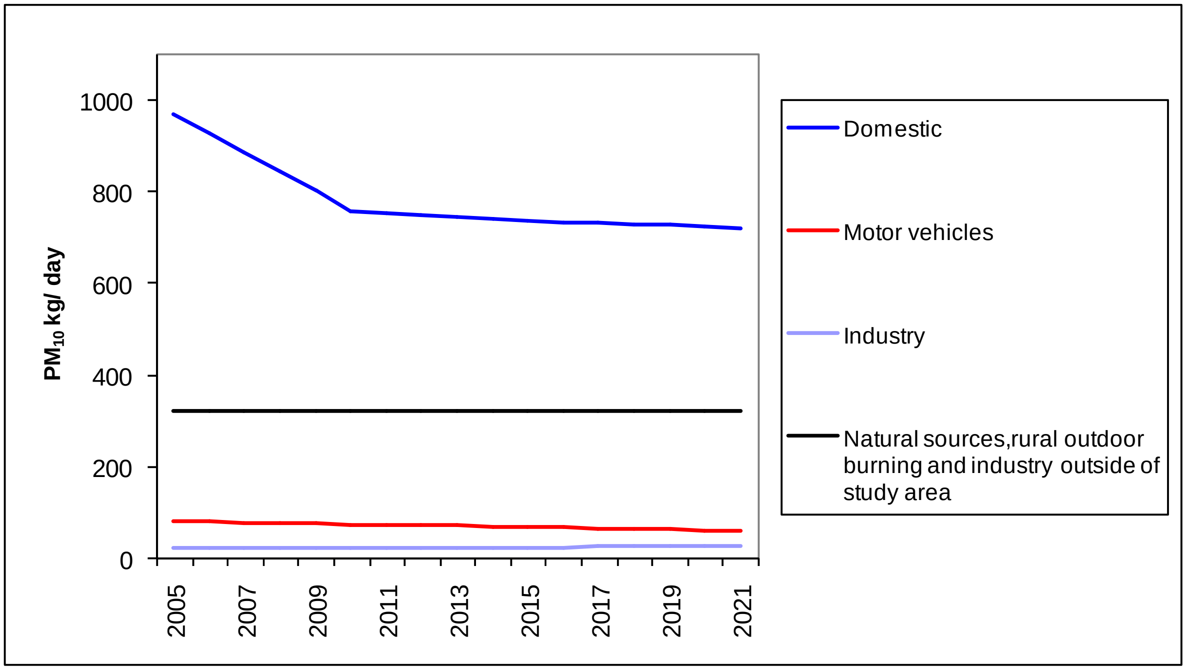

Figure 5.1: Baseline projections in PM_{10} emissions from all sources

Table 5.1: Assumptions underlying the assessment of the effectiveness of management options for reducing PM_{10} emissions

1	A decrease in PM_{10} emissions from motor vehicles of around 20% by 2021. This is based on the assumption of a 70% increase in VKTs with 85% occurring under free flowing conditions, 10% under interrupted flow conditions and 5% occurring under congested conditions. Emission rates are based on the NZTER database emission factors for 2021 for the Blenheim 2005 vehicle fleet profile.
2	The industry contribution to PM_{10} emissions increases by 25% from 2005 to 2021.
3	Current outdoor burning emissions occur throughout the week and weekend.
4	Emission factors for burners as per the 2005 Blenheim emission inventory.
5	Average fuel use for 1.5 g/kg burners of 17 kg per night as per the post 2000 burners in the 2005 emission inventory survey.
6	Average fuel use for other burners as per the 2005 Blenheim air emission inventory survey.
7	A proportional reduction in concentrations for any given reduction in emissions.
8	No variations in the impact of emissions occurring at different times of the day.
10	A 70% increase in the number of households in Blenheim from 2001 to 2021.
11	Unless otherwise stated, 85% of households replacing older solid fuel burners or multi fuel burners will install solid fuel burners.
12	An emission factor for 1.5 g/kg burners of 6 g/kg.

13	All new installations of wood fuel burners from 2005 will meet an emission criterion of 1.5 g/kg when tested to NZS 4013.
14	As per the 2005 air emission inventory, 100% of households with multi fuel burners use wood and 50% use coal.
15	Around 16% of new dwellings install solid fuel burners[3]. Of these around 13% are new multi fuel burners and the remainder are wood burners.
16	Around 90% of the 2005 multi fuel burners are phased out by 2021. Wood burners are phased out 15 years after installation for some scenarios and 20 years after installation for other scenarios.
17	Natural sources contribute around 160 kg/day, industry outside of the study area contributes 57 kg/day and other sources not included in the inventory (e.g., sulphate) contribute 100 kilograms of PM_{10} per day.
18	No significant change in natural source emissions from outdoor rubbish burning in rural areas and industrial emissions from outside of Blenheim from 2005 to 2021.

5.4 Status quo

Figure 5.2 shows the projected PM_{10} emissions assuming wood burners are phased out 15 years following installation. This suggests that the NES for PM_{10} is unlikely to be met in Blenheim in the absence of additional controls for the assumptions outlined in Table 5.1. After 2015, there is little difference between the two options presented for different phase out periods. This is because at this stage it is only post 1999 burners being removed under the 15 year phase out option and these are assumed to have similar emission rates to the NES compliant burner emissions. One point of difference from 2015 is that emissions projections increase for the 15 year phase out option increase despite the assumption that only 85% of households replacing burners choose solid fuel replacements. The main reason for this is that 13% of the new solid fuel burner installations are assumed to be multi fuel burners, which do not meet the NES design criteria for wood burners. Increases in population also offset some of the decreases associated with burner replacements, although this occurs equally for both scenarios.

[3] Based on burner installation data for 2004 and 2005

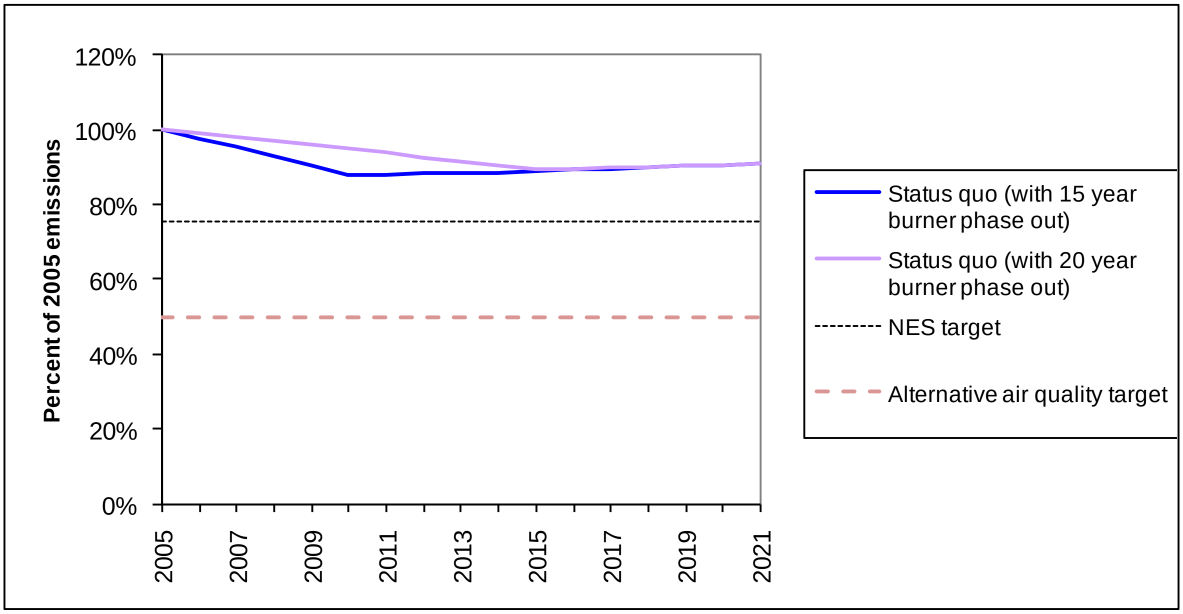

Figure 5.2: Status quo projections for PM_{10}

5.5 Ban on outdoor rubbish burning

Outdoor rubbish burning in the urban area of Blenheim is estimated to contribute around 6% of the daily anthropogenic PM_{10} emissions during the winter. Emissions from this source are predicted to increase with increases in population and in the absence of controls. Figure 5.3 shows the impact of a ban on outdoor rubbish burning during the winter months from 2008 on daily PM_{10} estimates from 2005 to 2021.

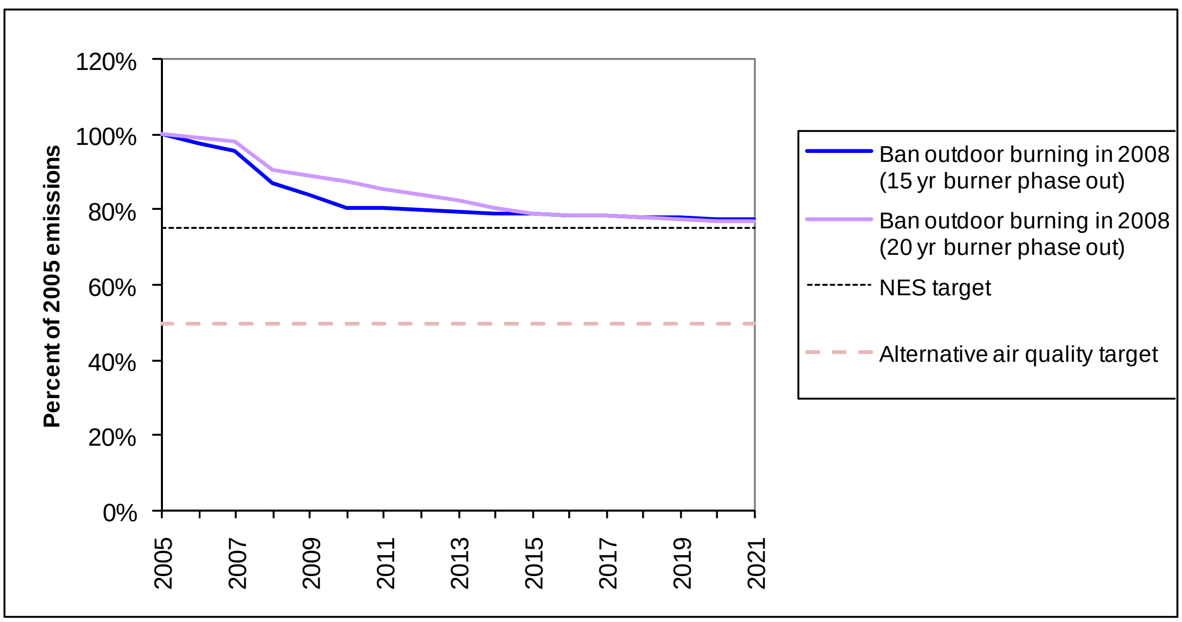

Figure 5.3: Status quo plus a ban on outdoor rubbish burning

5.6 Ban on outdoor rubbish burning and open fires

The addition of a ban on the use of open fires in Blenheim is shown in Figure 5.4. The latter analysis assumes open fires are not used beyond 2010 and that 50% of open fires are replaced with solid fuel burners. The latter assumption may be conservative as the domestic home heating survey carried out for the 2005 air emission inventory indicates that over 80% of the households that used open fires had an alternative heating method, with 50% having wood burners that they used in the main living area.

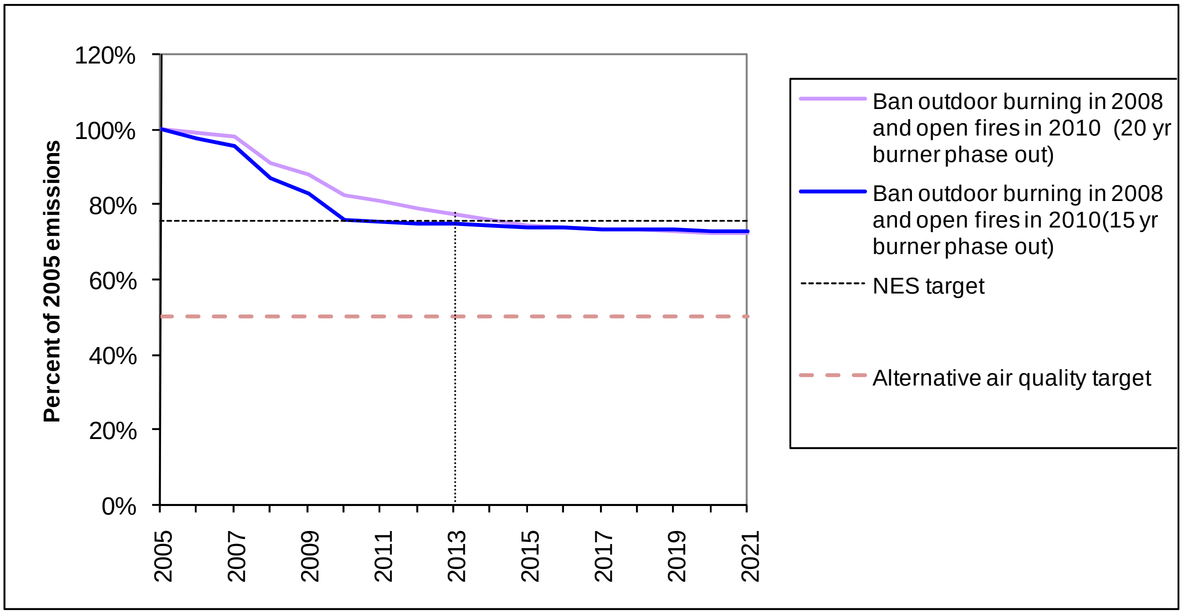

Figure 5.4: Status quo plus a ban on outdoor rubbish burning and the use of open fires

5.7 Ban on outdoor rubbish burning and open fires and no new burner installations except as solid fuel burner replacements

Figure 5.5 shows the impact of prohibiting the installation of solid fuel burners in new houses and existing dwellings currently using other heating methods from 2010 in addition to an outdoor burning ban and a ban on the use of open fires. This indicates an additional reduction of around 3% compared to the previous option.

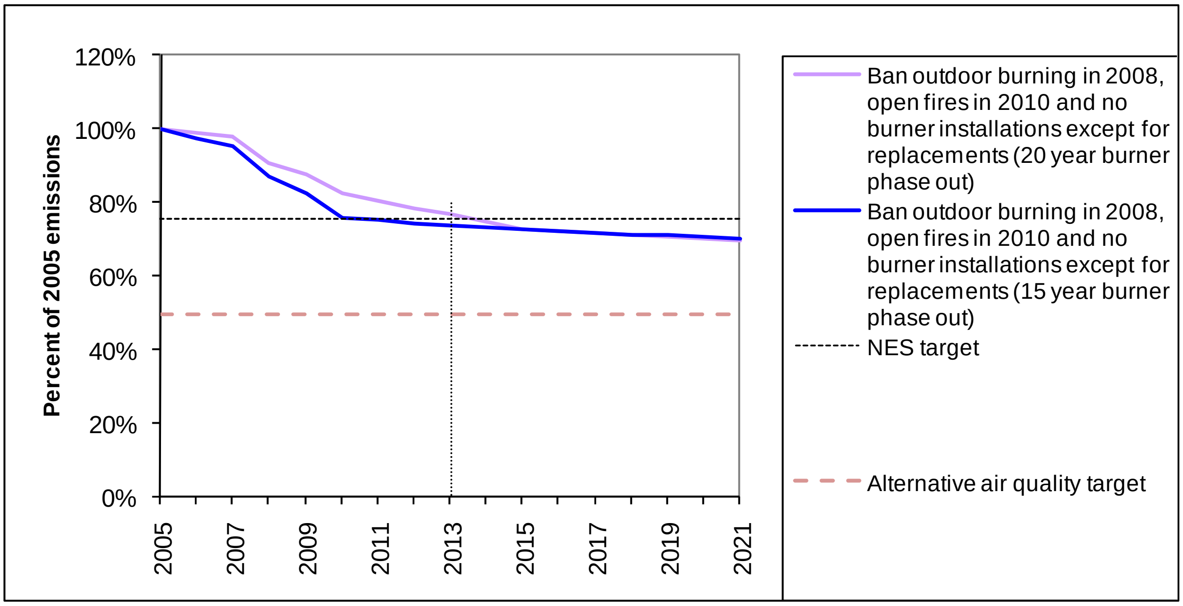

Figure 5.5: Status quo plus a ban on outdoor rubbish burning, a ban on the use of open fires and no new burner installations except to replace existing burners from 2010

5.8 Ban on outdoor rubbish burning, open fires and new multi fuel burners must comply with the emission rate criterion specified in the NES design standard for wood burners

In 2005, the Ministry for the Environment introduced the requirement that all new wood burner installations meet an emission criterion of 1.5 grams of particulate per kilogram of fuel burnt (referred to as the NES design criteria for wood burners). However, there are currently no restrictions on emission rates for new installations of burners designed to burn coal or a combination of wood and coal. The air emission inventory domestic home heating survey suggests that around 13% of households installing new solid fuel burners from 2000 to 2005 in Blenheim installed multi fuel burners.

Additional reductions in PM_{10} are predicted if the emission criterion specified in the NES design standard for wood burners were to apply also to multi fuel burners (Figure 5.6). At present there are no multi fuel burners that meet this criterion so the assumption is made that households that might otherwise have installed a multi fuel burner will instead install a low emission wood burner.

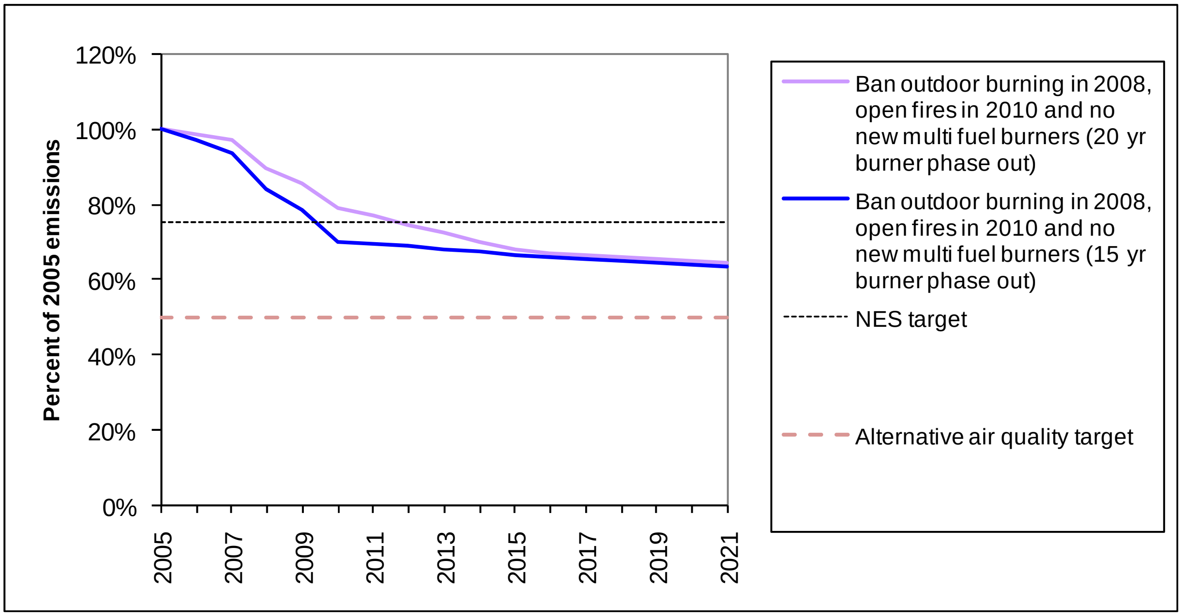

Figure 5.6: Status quo plus a ban on outdoor rubbish burning, the use of open fires and all new solid fuel burners installations in Blenheim must meet the emission criterion specified in the NES design standard for wood burners

Figure 5.6 suggests that the combination of a ban on outdoor rubbish burning, the use of open fires and not allowing new installations of multi fuel burners (unless they meet the NES design criteria for wood burners) could result in PM_{10} concentrations meeting the NES by 2013. As indicated previously, the uncertainty surrounding the projections is high and it is possible that all of these measures may not be required or that this combination may not be sufficient to achieve the NES.

5.9 Ban on outdoor rubbish burning, open fires and new multi fuel burners must comply with the emission rate criterion specified in the NES design standard for wood burners and incentives to encourage households towards non-solid fuel alternatives

Figures 5.7 and 5.8 show the impact of a ban on outdoor rubbish burning, a ban on open fires, the requirement that new multi fuel burners must comply with the emission rate criterion specified in the NES design standard for wood burners and incentives to encourage households to select non-solid fuel alternatives. Figure 5.7 assumes that 30% of households replacing solid fuel burners will choose non-solid fuel alternatives and Figure 5.8 assumes that 50% of households select non-solid fuel alternatives.

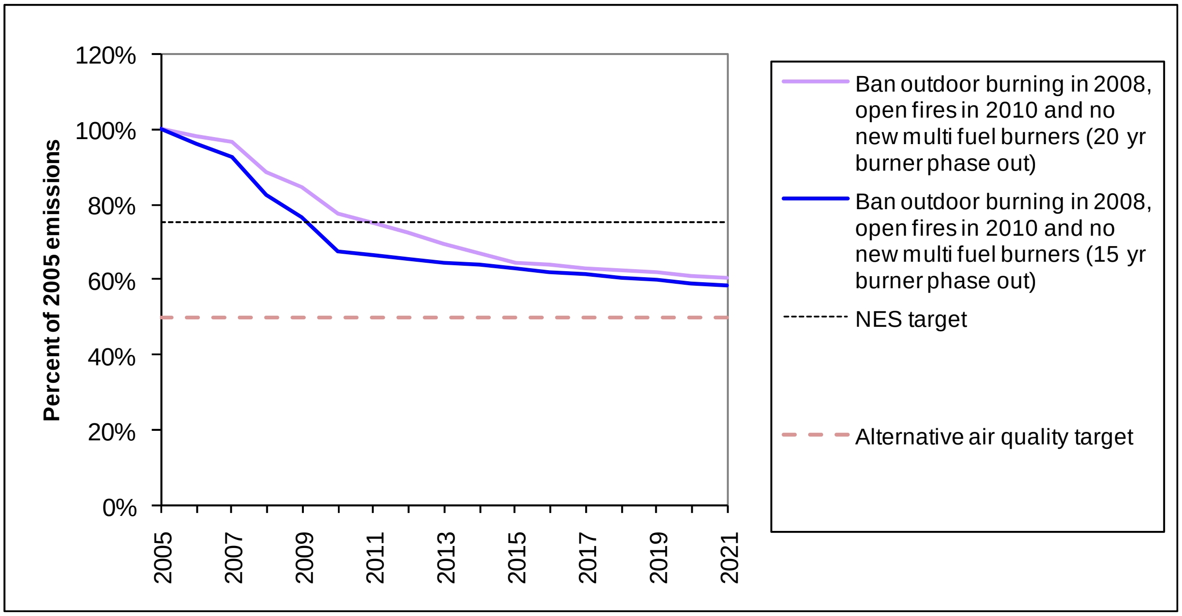

Figure 5.7: Status quo plus a ban on outdoor rubbish burning, the use of open fires and all new solid fuel burners installations in Blenheim must meet the emission criterion specified in the NES design standard for wood burners plus 30% of households choose non-solid fuel replacement heating methods

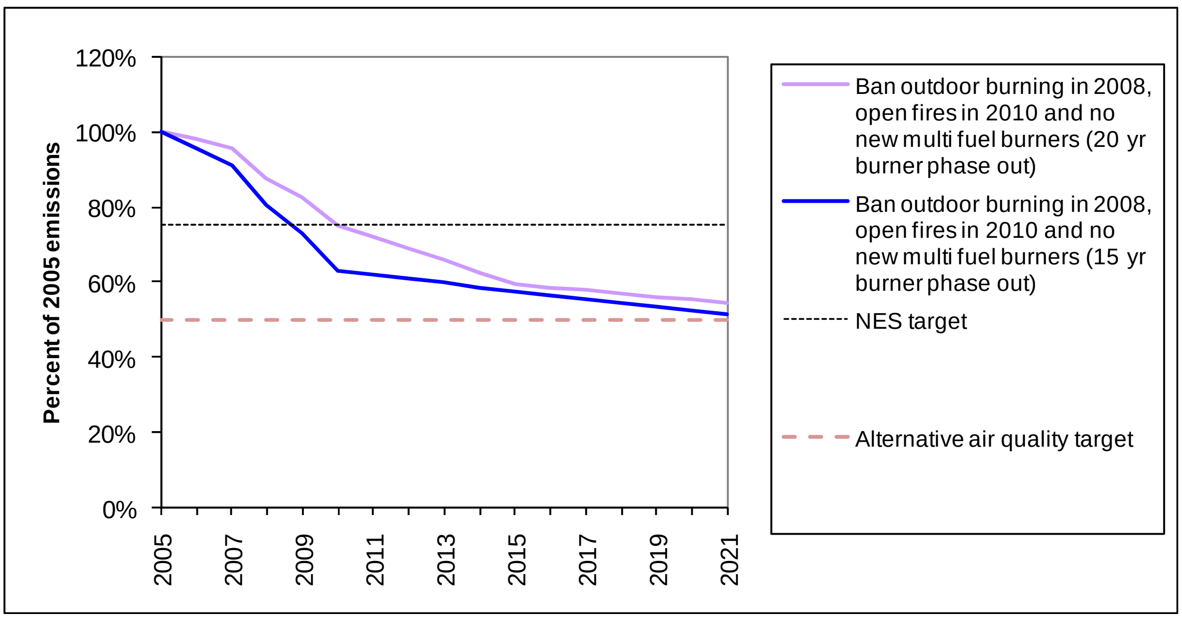

Figure 5.8: Status quo plus a ban on outdoor rubbish burning, the use of open fires and all new solid fuel burners installations in Blenheim must meet the emission criterion specified in the NES design standard for wood burners plus 50% of households choose non-solid fuel replacement heating methods

5.10 Uncertainty estimates

Estimates of projections in PM_{10} are based on assumptions including variables such as emission rates, fuel use rates, population projections and household heating choices. Figure 5.9 shows the estimated upper and lower uncertainty bands if the uncertainty (estimated at 95% CI) surrounding each of these variables is combined statistically[4] for the management options shown previously in Figure 5.7. Factors not included in the uncertainty analysis include the reliability of the air quality monitoring results and the likelihood that they have captured "worst-case" meteorological conditions and variations in the contribution of sources originating outside of the study area.

The uncertainty analysis indicates some chance that the combined management options considered here may not be sufficient to achieve the NES for PM_{10} in Blenheim.

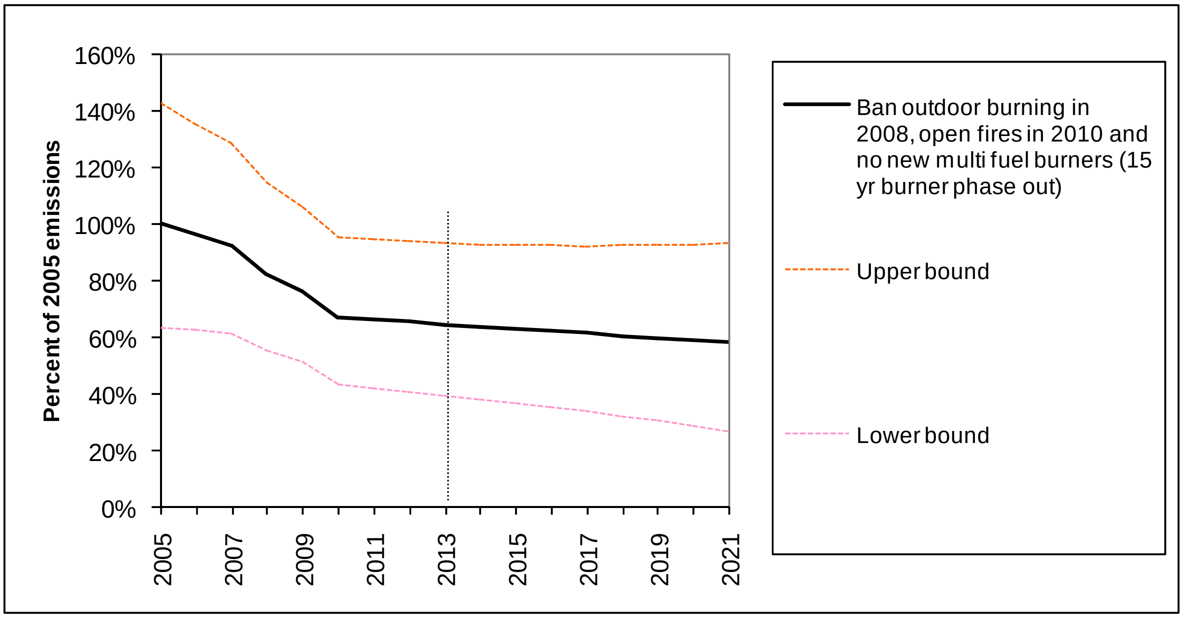

Figure 5.9: Estimated uncertainty bands for a combination of management options assuming 30% of households replacing solid fuel burners choose non-solid fuel alternatives

[4] Statistical formulae are based on Topping (1971)

6 Summary

Air quality monitoring in Blenheim shows PM_{10} concentrations in excess of the NES occur during the winter months at the Redwoodtown monitoring site. Based on monitoring results to date, excluding the 2004 Brooklyn Street results, a reduction of around 25% would be required to meet the NES. The main source of PM_{10} is solid fuel burning for domestic home heating, which contributes around 85% of the daily anthropogenic PM_{10} during the wintertime.

An analysis of the effectiveness of different management options in achieving this reduction suggests that some management intervention is required. The most effective measures examined in this analysis included a combination of a ban on outdoor rubbish burning, the use of open fires and the application of the NES design criteria for wood burners to multi fuel burners. The analysis suggests that this option may be sufficient to achieve the NES by 2013 particularly if existing wood burners are replaced 15 years following installation. The use of financial incentives to encourage households to cleaner heating options should also be considered to improve the likelihood of meeting the NES and/ or to mitigate any socio economic impacts. Consideration could also be given to making the burner replacements mandatory after a specified time (e.g., 15 or 20 years) to ensure burners are replaced as predicted in the model.

This projection analysis has been done based on the best available information and provides a good indication of the likely management options required to improve PM_{10} concentrations to meet the NES in Blenheim.

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