Environment Committee Meeting

1 September 2022

This Report relates to Item 5 in the Agenda

“Blenheim Air Emission Inventory 2022”

JUNE 2022

PREPARED FOR

Marlborough District Council

PREPARED BY

Emily Wilton, Environet Ltd

www.environet.co.nz

ENVIRONET AIR QUALITY SPECIALISTS

Blenheim Air Emission Inventory - 2022

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

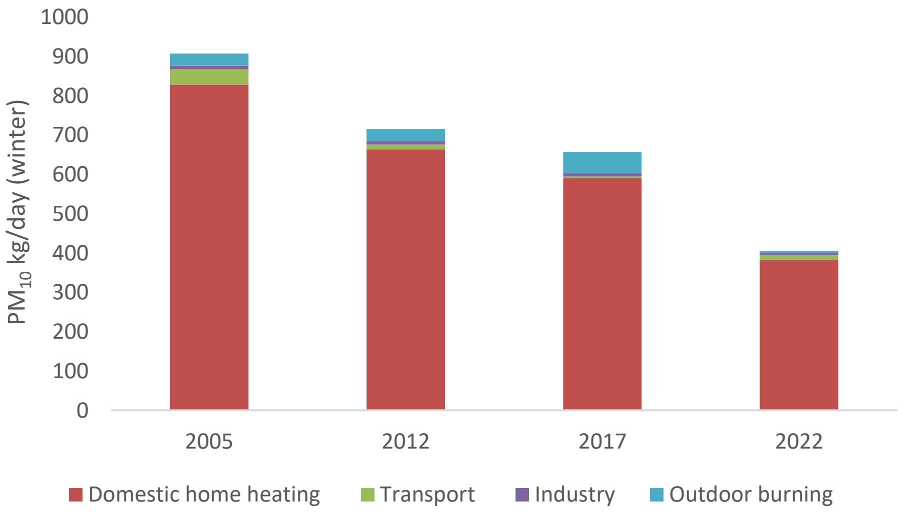
The main air contaminants of concern in Blenheim are PM_{10} (particles in the air less than 10 microns in diameter) and $PM_{2.5}$ (particles in the air less than 2.5 microns in diameter). The National Environmental Standard (NES) for PM_{10} is currently based on a 24-hour average and is set at 50 µg/m^3 with one allowable exceedance per year but is currently under review and a new standard including annual and daily $PM_{2.5}$ limits are proposed.

Blenheim is non-compliant with the current NES for PM_{10} with exceedances of 50 µg/m^3 ranging from 1-11 per year over the past ten years. Blenheim was required to comply with the NES meaning no more than one exceedance of 50 µg/m^3 per year from 2017. In 2017 eleven exceedances of the NESAQ were recorded. Data since 2019 suggests exceedance numbers may have decreased with 2019 recording one exceedance, 2020 recording three and 2021 only recording one exceedance typical of wintertime elevated PM_{10} (Wilton, 2022). Meteorological conditions typically play a major role in year to year variability in the magnitude of the concentrations and the number of exceedances.

The purpose of this assessment is to estimate the contribution of different sources to emissions to air and evaluate changes in PM_{10} emissions to air in Blenheim over time. Previous inventory assessments have been carried out in 2017, 2012 and 2005.

Sources included in the emission inventory are domestic heating, motor vehicle, industrial and commercial activities and outdoor burning. Natural source contributions (for example., sea salt and soil) are not included because the methodology to estimate emissions is less robust. While the evaluation focuses on PM_{10} and $PM_{2.5}$ other contaminants also evaluated include: carbon monoxide, nitrogen oxides, sulphur oxides, volatile organic compounds and carbon dioxide.

Domestic heating was found to be the main source of daily winter PM_{10} emissions, accounting for 94% of the daily winter PM_{10} and 96% of the daily winter $PM_{2.5}$. The main source of annual $PM_{2.5}$ emissions is also domestic heating (91%). On an average winter's night, around 409 kilograms of PM_{10} are discharged from all sources. This compares with around 658 kg/day in Blenheim in 2017 indicating a reduction in PM_{10} emissions of around 38% may have occurred between 2017 and 2022.



1 INTRODUCTION

The main air contaminant of concern in most urban areas of New Zealand is PM_{10}, particles in the air less than 10 microns in diameter. National Environmental Standards (NES) set a limit for PM_{10} of 50 µg/m^3 (24-hour average) with one allowable exceedance per year.

Blenheim is non-compliant with the NES for PM_{10} with exceedances of 50 µg/m^3 ranging from one to 16 per year over the past ten years. From September 2016 Blenheim was required to comply with the NES meaning no more than one exceedance of 50 µg/m^3 per year. During 2017 the number of measured exceedances of the NES was 11, the highest number since the NES was introduced. However, monitoring data since 2019 suggests Blenheim may be close to achievement of the NES for PM_{10} with only one exceedance in 2019, three in 2020 and only one exceedance relating to typical wintertime PM_{10} in 2021 (Wilton, 2022). Meteorological conditions typically play a major role in year to year variability in the magnitude of the concentrations and the number of exceedances. An airshed must record no more than one exceedance per year for a period of five years to revoke its polluted status.

The purpose of this emission inventory is to evaluate changes in emissions to air for Blenheim and the contribution of different sources to these emissions over time to evaluate the extent of any decrease in emissions. Previous assessment of emissions to air for Blenheim were carried out in 2017, 2012 and 2005.

Sources included in the inventory are domestic heating, motor vehicle, industrial and commercial and outdoor burning. Natural source contributions (for example; sea salt and soil) are not included because methodologies are less robust. This report primarily focuses on emissions of particles (PM_{10}) and $PM_{2.5}$ (particles in the air less than 2.5 microns) from these sources. Other contaminants included in this emission inventory are in diameter) carbon monoxide, nitrogen oxides, sulphur oxides volatile organic compounds and carbon dioxide.

2 INVENTORY DESIGN

This emission inventory focuses on particulate (PM_{10}) emissions as this, in conjunction with the finer size fraction has been identified as the main contaminant of concern in urban New Zealand. It is unlikely that concentrations of other contaminants are likely to exceed National Environmental Standards (NES).

2.1 Selection of sources

Estimates of emissions from the domestic heating, motor vehicles, industry and outdoor burning sector are included in the emissions inventory. The report also discusses PM_{10} emissions from a number of other minor sources.

2.2 Selection of contaminants

The inventory included an assessment of emissions of suspended particles (PM_{10}), fine particles ($PM_{2.5}$) carbon monoxide (CO), sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOC), and carbon dioxide (CO_2).

Emissions of PM_{10}, CO, SOx and NOx are included as these contaminants are NES contaminants because of their potential for adverse health impacts. $PM_{2.5}$ has been included in the inventory because this size fraction is known to be the best indicator of health impacts of particulate pollution and was a key focus of the proposed amendments to the NES (Ministry for the Environment, 2020). Carbon dioxide has been typically included in emission inventory investigations in New Zealand to allow for the assessment of regional greenhouse gas CO_2 emissions. However, these data are now generally collected nationally and for a broader range of greenhouse gases. Estimates of CO_2 have been retained in the inventory but readers should be directed to national statistics (e.g., www.climatechange.govt.nz.) should detailed data on this source be required. Volatile organic compounds are typically included in emission inventory investigations because of their potential contribution to the formation of photochemical pollution. It is unlikely that ozone formation from emissions within Blenheim would cause ozone problems. In this report, VOC emissions have been estimated for existing sources but data on emissions from VOC specific sources (e.g., spray painting) has not been included. It is likely that the inventory does not capture a number of sources of VOCs.

2.3 Selection of areas

The Blenheim inventory study area for 2022 is the inventory area defined by Statistical Area units. Figure 2.1 shows that it is closely aligned to the airshed area that is gazetted by the Ministry for the Environment. This is the same area as used for the 2017, 2012 and 2005 emission inventories.

The statistical area (SA2, 2018) units defining the inventory area are: Springlands, Whitney West, Whitney East, Redwoodtown West, Redwoodtown East, Blenheim Central, Witherlea West, Witherlea East, Yelverton and Mayfield.

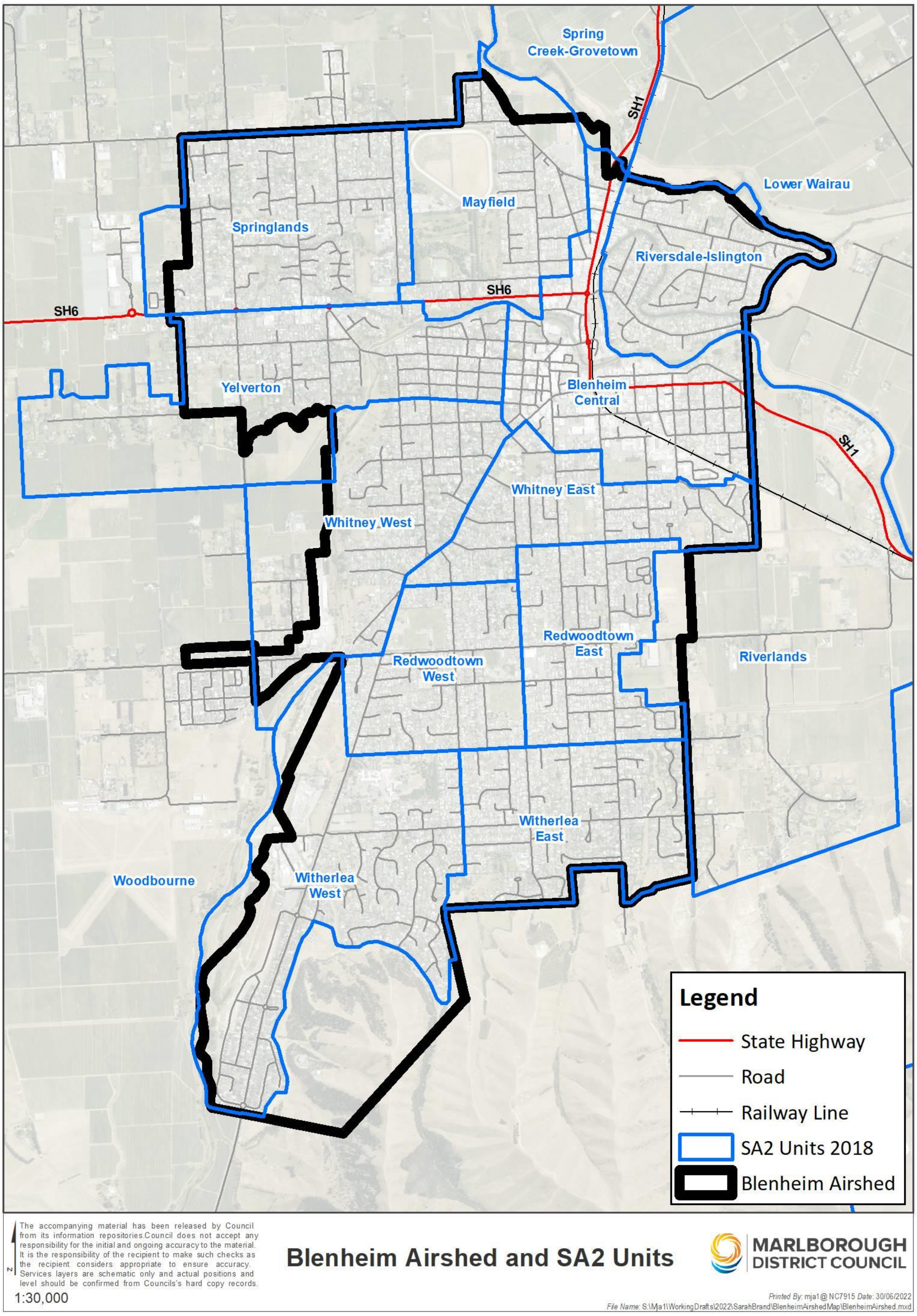


Figure 2.1: Blenheim Airshed and inventory area (source Marlborough District Council).

2.4 Temporal distribution

Data were collected based on daily data with some seasonal variations. Domestic heating data were collected based on average and worst-case wintertime scenarios and by month of the year. Motor vehicle data were collected for an average day as models and data do not contain seasonal variations in vehicle movements. Industrial data were collected by season as was outdoor burning data.

No differentiation was made for weekday and weekend sources. Collection of data for time periods of less than a day were not obtained for most data.

3 DOMESTIC HEATING

3.1 Methodology

Domestic heating methods and fuel used by households in Blenheim was collected using a household survey carried out by Symphony Research during May and June 2022 (Appendix A). Table 3.1 shows the number of households based on 2018 census data and projected population increases for Blenheim, the sample size and study area size.

Table 3.1: Summary household, area and survey data.

	Dwellings in inventory area	Sample size	Area (ha)	Sample error
Blenheim	11,664	331	5%	1,930

Home heating methods were classified as; electricity, open fires, wood burners, pellet fires, multi fuel burners, gas burners and oil burners. Emission factors were applied to these data to provide an estimate of emissions for each study area. The emission factors used to estimate emissions from domestic heating are shown in Table 3.2. The basis for these is detailed in Appendix B.

Table 3.2: Emission factors for domestic heating methods.

	PM_{10} g/kg	$PM_{2.5}$ g/kg	CO g/kg	NOx g/kg	SO_2 g/kg	VOC g/kg	CO_2 g/kg
Open fire - wood	7.5	7.5	55	1.2	0.2	30	1600
Open fire - coal	21	18	70	4	8	15	2600
Pre 2006 burners	10	10	140	0.5	0.2	33	1600
Post 2006 burners	4.5	4.5	45	0.5	0.2	20	1600
Pellet burners	2	2	20	0.5	0.2	20	1600
Multi-fuel[1] - wood	10	10	140	0.5	0.2	20	1600
Multi-fuel[1] – coal	19	17	110	1.6	8	15	2600
Oil	0.3	0.22	0.6	2.2	3.8	0.25	3200
Gas	0.03	0.03	0.18	1.3	7.56E-09		2500

[1] - includes potbelly, incinerator, coal range and any enclosed burner that is used to burn coal

The average weight for a log of wood is one of the assumptions required for this inventory to convert householder's estimates of fuel use in logs per evening to a mass measurement required for estimating emissions. This was converted into average daily fuel consumption based on an average log weight of 1.6 kg per piece of wood and integrating seasonal and weekly usage rates. The value of 1.6 kg/log was selected as the mid-point of the range found from different New Zealand evaluations (Wilton & Bluett, 2012)(Wilton et al., 2006) (Metcalfe et al., 2013). The log weight recommended for this work (1.6 kg/ piece) is the midpoint and average of the range of values.

Emissions for each contaminant and for each time period and season were calculated based on the following equation:

Equation 3.1 CE (g/day) = EF (g/kg) * FB (kg/day)

Where:

CE = contaminant emission

EF = emission factor

FB = fuel burnt

The main assumptions underlying the emissions calculations are as follows:

- The average weight of a log of wood is 1.6 kilograms.

3.2 Home heating methods in Blenheim

The most popular form of heating the main living area of homes in Blenheim is electricity with around 76% of surveyed households using that method. Wood burners are the next most common method (39%) and around 4500 households. Open fires and multi fuel burners are only used by a very small proportion of households and none of the households surveyed reported using coal. Table 3.3 also shows that households rely on more than one method of heating their main living area during the winter months.

Around 70 tonnes of wood is estimated to be burnt per typical winter's night in Blenheim. This is a reduction of around 20% on the 2017 fuel use (86 tonnes).

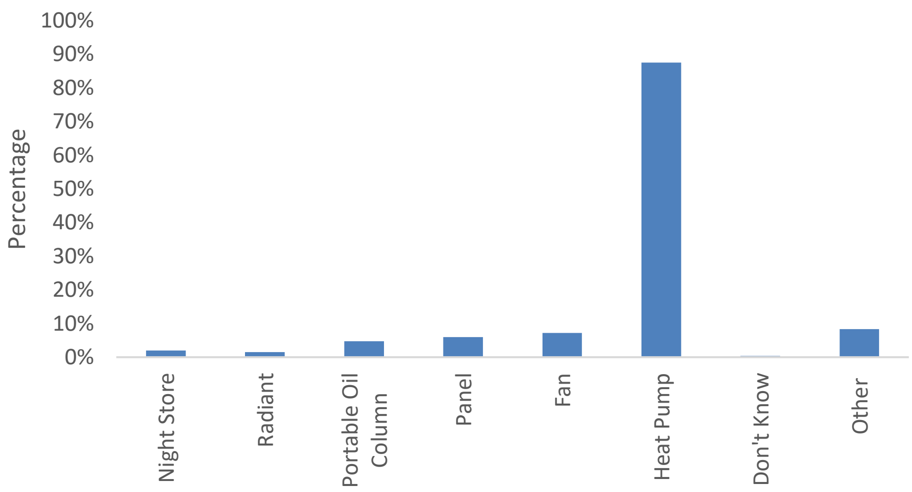


Figure 3.1: Electric heating options for Blenheim households (main living area).

Table 3.3: Home heating methods and fuels.

	Heating methods		Fuel Use	
	%	HH	t/day	%
Electricity	76%	8,810		
Total Gas	5%	599		
Flued gas	4%	423		
Unflued gas	2%	176		
Oil	0%	35		
Open fire	0%	35		
Open fire - wood	0%	35	0.3	0%
Open fire - coal	0%	0	0.0	0%
Total Woodburner	39%	4,511	66	94%
Pre 2006 wood burner	6%	726	11	15%
2006-2016 wood burner	23%	2,676	39	56%
Post-2016 wood burner	10%	1,109	16	23%
Multi-fuel burners	1.5%	176		
Multi-fuel burners-wood	2%	176	2	3%
Multi-fuel burners-coal	0%	0		0%
Pellet burners	2%	247	2	3%
Total wood	40%	4,722	70	100%
Total coal	0%	0	0	0%
Total		11,664	70	100%

3.3 Emissions from domestic heating.

Around 383 kilograms of PM_{10} is discharged on a typical winter's day from domestic home heating in Blenheim. This assumes that all households with burners installed post September 2005 are compliant with models approved as NES compliant burners. This is a 35% reduction in PM_{10} emissions since the 2017 air emission inventory. A similar number of households are using wood burners in 2022 compared to 2017 but the majority of households have converted to NES compliant burners by 2022. Additionally, fuel use data shows the average fuel quantities per household to have decreased from 2017 to 2022.

Whilst in 2017 the majority of the PM_{10} was from pre 2006 wood burners Figure 3.2 shows that burners in the 2006 to 2016 age category now contribute the bulk of the PM_{10}. The NES design criteria for wood burners was mandatory for new installations on properties less than 2 hectares from September 2005. Burners installed prior to this date are being phased out by the Marlborough District Council. It is noted that age estimates of burners by households are likely to be indicative only. Wood burners installed prior to 2006 contribute 28% of domestic heating PM_{10} emissions and burners less than five years old contribute 19%.

Tables 3.4 and 3.5 show the estimates of emissions for different heating methods under average and worst-case scenarios respectively. Days when households may not be using specific home heating methods are accounted for in the daily winter average emissions[1]. Under the worst-case scenario that all households are using a burner on any given night around 446 kilograms of PM_{10} is likely to be emitted.

The seasonal variation in contaminant emissions is shown in Table 3.6. Figure 3.3 indicates that the majority of the annual PM_{10} emissions from domestic home heating occur during June, July and August.

[1] Total fuel use per day is adjusted by the average number of days per week wood burners are used (e.g.,6/7) and the proportion of wood burners that are used during July (e.g.,95%).

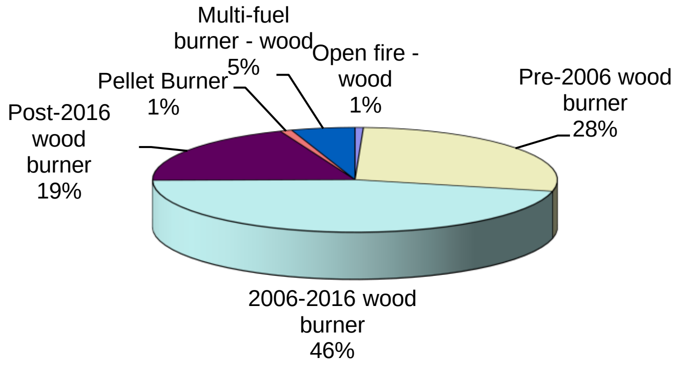


Figure 3.2: Relative contribution of different heating methods to average daily PM_{10} (winter average) from domestic heating.

Table 3.4: Blenheim winter daily domestic heating emissions by appliance type (winter average).

	Fuel Use		PM_{10}			CO			NO_x			SO_x			VOC			CO_2			$PM_{2.5}$		
	t/day	%	kg	g/ha	%	kg	g/ha	%	kg	g/ha	%	kg	g/ha	%	kg	g/ha	%	T	kg/ha	%	kg	g/ha	%
Open fire																							
Open fire - wood	0.3	0%	3	1	1%	19	10	0%	0	0	1%	0	0	0%	10	5	1%	1	0	0%	0.3	0%	3
Open fire - coal	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Wood burner	68.1																				68.1		
Pre 2006 wood burner	10.7	15%	107	55	28%	1495	774	35%	5	3	15%	2	1	15%	352	183	23%	17	9	15%	10.7	15%	107
2006-2016 wood burner	39.3	56%	177	92	46%	1770	917	41%	20	10	55%	8	4	56%	787	408	51%	63	33	56%	39.3	56%	177
Post 2016 wood burner	16.3	23%	73	38	19%	733	380	17%	8	4	23%	3	2	23%	326	169	21%	26	14	23%	16.3	23%	73
Pellet Burner	1.8	3%	3.7	2	1%	37	19	1%	1	0	3%	0	0	3%	37	19	2%	3	2	3%	1.8	3%	3.7
Multi fuel burner																							
Multi fuel– wood	1.9	3%	19	10	5%	272	141	6%	1	1	3%	0	0	3%	39	20	3%	3	2	3%	1.9	3%	19
Multi fuel – coal	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Gas	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Oil	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Total Wood	70.4	100%	383	198	100%	4325	2241	100%	35	18	100%	14	7	100%	1550	803	100%	113	58	100%	70.4	100%	383
Total Coal	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Total	70		383	198		4325	2241		35	18		14	7		1550	803		113	58		70		383

Table 3.5: Blenheim winter daily domestic heating emissions by appliance type (worst case).

	Fuel Use		PM_{10}			CO			NO_x			SO_x			VOC			CO_2			$PM_{2.5}$		
	t/day	%	kg	g/ha	%	kg	g/ha	%	kg	g/ha	%	kg	g/ha	%	kg	g/ha	%	T	kg/ha	%	kg	g/ha	%
Open fire																							
Open fire - wood	0.6	1%	4	2	1%	33	17	1%	1	0	2%	0	0	1%	18	9	1%	1	0	1%	0.6	1%	4
Open fire - coal	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Wood burner	75.7																				75.7		
Pre 2006 wood burner	12.2	15%	122	63	27%	1707	885	34%	6	3	15%	2	1	15%	402	209	22%	20	10	15%	12.2	15%	122
2006-2011wood burner	44.9	55%	202	105	45%	2022	1048	40%	22	12	55%	9	5	55%	899	466	50%	72	37	55%	44.9	55%	202
Post 2011 wood burner	18.6	23%	84	43	19%	838	434	17%	9	5	23%	4	2	23%	372	193	21%	30	15	23%	18.6	23%	84
Pellet Burner	2.0	2%	4	2	1%	39	20	1%	1	1	2%	0	0	2%	39	20	2%	3	2	2%	2.0	2%	4
Multi fuel burner																							
Multi fuel– wood	3.0	4%	30	15	7%	414	215	8%	1	1	4%	1	0	4%	59	31	3%	5	2	4%	3.0	4%	30
Multi fuel – coal	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Gas	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Oil	0.0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0.0	0%	0
Total Wood	81	100%	446	231	100%	5053	2618	100%	41	21	100%	16	8	100%	1790	927	100%	130	67	100%	81	100%	446
Total Coal	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0%	0
Total	81		446	231		5053	2618		41	21		16	8		1790	927		130	67		81		446

Table 3.6: Monthly variations in contaminant emissions from domestic heating in Blenheim.

	PM_{10} kg/day	CO kg/day	NOx kg/day	SOx kg/day	VOC kg/day	CO_2 t/day	$PM_{2.5}$ kg/day
January	2	26	0	0	4	0	2
February	0	0	0	0	0	0	0
March	28	314	3	1	112	8	28
April	64	727	6	2	258	19	64
May	242	2750	22	9	968	70	242
June	366	4126	34	13	1479	107	366
July	383	4325	35	14	1550	113	383
August	338	3830	31	12	1370	100	338
September	84	958	8	3	332	24	84
October	32	368	3	1	120	9	32
November	4	50	0	0	15	1	4
December	0	0	0	0	0	0	0
Total (kg/year)	47313	535851	4350	1729	190361	13832	47313

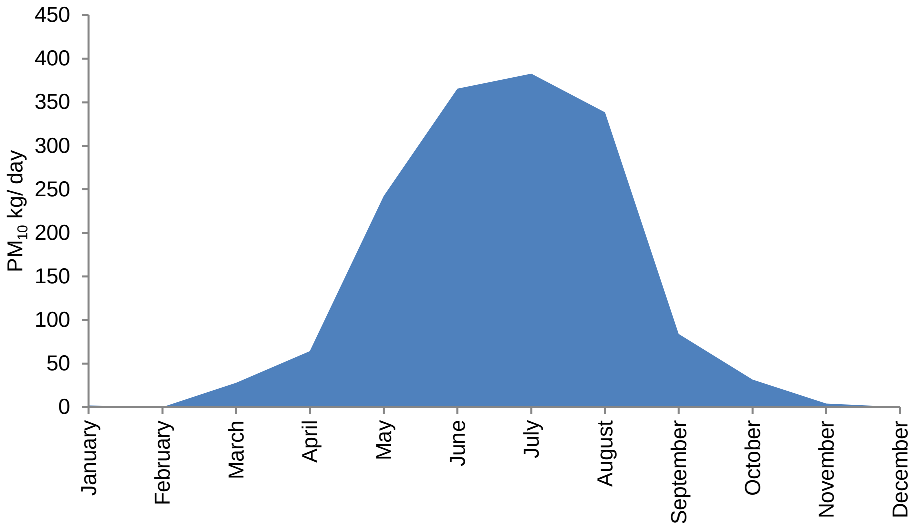


Figure 3.3: Monthly variations in PM_{10} emissions from domestic heating.

4 MOTOR VEHICLES

4.1 Methodology

Motor vehicle emissions to air include tailpipe emissions of a range of contaminants and particulate emissions occurring as a result of the wear of brakes and tyres. Assessing emissions from motor vehicles involves collecting data on vehicle kilometres travelled (VKT) and the application of emission factors to these data.

Emission factors for motor vehicles are determined using the Vehicle Emission Prediction Model (VEPM 6.0) developed by Auckland Council. Emission factors for PM_{10}, $PM_{2.5}$, CO, NOx, VOCs and CO_2 for this study have been based on VEPM 6.0. Default settings were used for all variables except for the temperature data and the vehicle fleet profile which was based on Marlborough vehicle registration data for 2021 (Table 4.1). Temperature data were based on a 2016 winter average temperature for Blenheim of 9 degrees. Resulting emission factors are shown in Table 4.2.

Emission factors for SOx were estimated for diesel vehicles based on the sulphur content of the fuel (0.01%) and the assumption of 100% conversion to SOx. Total VKT for diesel vehicles were estimated based on the proportion of diesels in the vehicle fleet.

In addition to estimates of tailpipe emissions and brake and tyre emissions using VEPM an estimate of re-suspended road dust was made using the emissions factors in the EMEP/EEA air pollutant emission inventory guidebook (Table 4.3). This is a source of vehicle related emissions that wasn't included in previous inventories.

The number of vehicle kilometres travelled (VKT) for the airshed was estimated using the New Zealand Transport Authority VKT data for 2021 for urban roads[2] adjusted downwards based on the proportion of VKT on urban roads in the study area for 2013[3]. This suggests an 18% increase in VKT in Blenheim since 2013. This gives a daily VKT estimate of 239695 for 2022.

Table 4.1: Vehicle registrations (Blenheim) for the year ending December 2021.

Blenheim	Petrol	Diesel	Hybrid	Plug in hybrid	Electric	LPG	Other	Total
Cars	30,110	4,201	420	78	169	3	0	34,981
LCV	2,165	12,442	0	0	3	4	0	14,614
Bus	84	378	0	0	0	0	0	462
HCV		5,516			33			5,549
Miscellaneous	850	2126	1	0	50	18	0	3,045
Motorcycle	2,690							2,690
Total	35899	24663	421	78	255	25	0	61,341

Table 4.2: Emission factors (2022) for Blenheim vehicle fleet.

	CO g/VKT	CO_2 g/VKT	VOC g/VKT	NOx g/VKT	PM_{10} g/VKT	PM_{10} brake & tyre g/VKT	$PM_{2.5}$ (tailpipe and brake and tyre) g/VKT
Blenheim	1.42	241	0.13	0.83	0.027	0.02	0.03

[2] https://www.nzta.govt.nz/planning-and-investment/learning-and-resources/transport-data/data-and-tools/

[3] Most recent year data were available at this spatial resolution

Table 4.3: Road dust TSP emissions (from EMEP/EEA guidebook, EEA, 2016).

	TSP g/VKT
Two wheeled vehicles	0.01
Passenger car	0.02
Light duty trucks	0.02
Heavy duty trucks	0.08
Weighted vehicle fleet factor	0.02
PM_{10} size fraction	0.5
$PM_{2.5}$ size fraction	0.27

Emissions were calculated by multiplying the appropriate average emission factor by the VKT for that time period and level of service.

Emissions (g) = Emission Rate (g/VKT) * VKT

4.2 Motor vehicle emissions

Around 15 kilograms per day of PM_{10} are estimated to be emitted from motor vehicles daily in Blenheim. The analysis found that around 45% of the PM_{10} from motor vehicles is estimated to occur as a result of the tailpipe emissions with 38% from wearing of brakes and tyres and 17% from resuspended road dust. Tables 4.4 and 4.5 shows the daily and annual estimates of motor vehicle emissions in Blenheim.

Table 4.4: Summary of daily motor vehicle emissions

	PM_{10}		CO		NOx		SOx	
	kg	g/ha	kg	g/ha	kg	g/ha	kg	g/ha
Tailpipe	6.5	3.4	341	177	200	103	0.9	0.5
Brake and tyre	5.5	2.9						
Road dust	2.5	1.3						
Total	15	8	341	177	200	103	1	0
	VOC		CO_2		$PM_{2.5}$			
	kg	g/ha	t	kg/ha	kg	g/ha	kg	g/ha
Tailpipe	31	16	58	30	6	3		
Brake and tyre					1	1		
Road dust					1	1		
Total	31	16	58	30	9	4		

Table 4.5: Summary of annual motor vehicle emissions

PM_{10} tonnes/year	CO tonnes/year	NOx tonnes/year	SOx tonnes/year	VOC tonnes/year	CO_2 tonnes/year	$PM_{2.5}$ tonnes/year
5	125	73	0	11	21112	3

5 INDUSTRIAL AND COMMERCIAL

5.1 Methodology

Information on activities discharging to air in Blenheim were provided by the Marlborough District Council. Emissions from gas and some diesel boilers were not included in the inventory as the PM_{10} emissions from them are negligible for small to medium size boilers. Since the first inventory in 2005 a number of industrial activities with resource consents for air discharges have ceased operations in Blenheim and all of the schools previously using coal fired boilers have now converted to electricity (heat pumps), pellets or diesel boilers.

The selection of industries for inclusion in this inventory was based on potential for PM_{10} emissions. Industrial activities such as spray painting or dry cleaning operations, which discharge primarily VOCs were not included in the assessment.

For most industries included in the assessment, site specific emissions data was available from the resource consent application. Emissions were estimated based on equation 5.1.

Equation 5.1 Emissions (kg/day) = Emission rate (kg/hr) x hrs per day (hrs)

Where site specific emissions data were not available (for example for contaminants other than PM_{10}), emissions were estimated using activity data and emission factor information, as indicated in Equation 5.2. Activity data from industry includes information such as the quantities of fuel used, or in the case of non-combustion activities, materials used or produced. Activity data was collected using data contained on resource consent applications or by direct contact with industry.

Equation 5.2 Emissions (kg) = Emission factor (kg/tonne) x Fuel use (tonnes)

The emission factors used to estimate the quantity of emissions discharged are shown in Table 5.1. The coal fired boiler emission factors for PM_{10} are based on New Zealand specific emission factors as described in Wilton et. al. 2007. Other emission factors are from the USEPA AP42 database[4] with the exception of crematorium which is from EEA, (2016).

Fugitive dust emissions from industrial and commercial activities were not included in the inventory assessment because of difficulties in quantifying the emissions.

Table 5.1: Emission factors for industrial discharges.

	PM_{10} g/kg	CO g/kg	NOx g/kg	SOx g/kg	VOC g/kg	CO_2 g/kg	$PM_{2.5}$ g/kg
Coal underfeed	2	5.5	4.8	18 x S*	0.1	2400	1.2
Diesel boiler	0.3	0.67	3.2	0.1	0.2	3194	0.2
Pellet boiler	0.8	6.8	0.8	0.0	0.1	1069	0.7
Crematorium (kg/body)	0.0347	0.14	0.824	0.113	0.013		0.0347

* where S is the sulphur content of the fuel

[4] http://www.epa.gov/ttn/chief/ap42/index.html

5.2 Industrial and commercial emissions

Tables 5.2 and 5.3 show the estimated emissions to air from industrial and commercial activities in Blenheim. Around six kilograms is estimated to be discharged to air per winter's day. The main source of industrial PM_{10} emissions within the study area is the hospital boiler. Emissions from this source have decreased slightly since 2012 owing to a decrease in coal consumption at the hospital.

Emissions from Timberlink Limited, previously Flight Timbers was not included in previous inventories as they were located outside of the inventory area. We note the closure of this source of industrial PM_{10} near to the airshed in 2020.

Table 5.2: Summary of industrial emissions (daily winter).

PM_{10}		CO		NOx		SOx	
kg	g/ha	kg	g/ha	kg	g/ha	kg	g/ha
6	3	17	9	17	9	22	11
VOC		CO_2		$PM_{2.5}$			
kg	g/ha	t	kg/ha	kg	g/ha		
0	0	9	5	4	2		

Table 5.3: Summary of annual industrial emissions

PM_{10}	CO	NOx	SOx	VOC	CO_2	$PM_{2.5}$
tonnes/year	tonnes/year	tonnes/year	tonnes/year	tonnes/year	tonnes/year	tonnes/year
1	3	4	4	0	1386	1

6 OUTDOOR BURNING

Outdoor burning of green wastes or household material can contribute to PM_{10} concentrations and also discharge other contaminants to air. In some urban areas of New Zealand outdoor burning is prohibited because of the adverse health and nuisance effects associated with these emissions. Outdoor burning includes any burning in a drum, incinerator or open air on residential properties in the study area.

The notified Marlborough Plan prohibits outdoor burning in Blenheim during the winter months. The plan is not yet operative. However, because outdoor burning is prohibited in a notified plan a resource consent would be required for outdoor rubbish burning until such time as the plan became operative.

6.1 Methodology

Outdoor burning emissions for Blenheim were estimated for the winter months based on data collected during the 2022 domestic home heating survey. The survey showed 3% of households in Blenheim burnt garden waste in the outdoors during the winter.

Emissions were calculated based on the assumption of an average weight of material per burn of 159 kilograms per cubic metre of material[5] and using the emission factors in Table 6.1 with an average fire size of 1.0 m3 (size based on survey responses). The size of the fire has reduced since the 2017 survey along with the proportion of households that carry out burning in Blenheim.

Table 6.1: Outdoor burning emission factors (AP42, 2002).

	PM_{10}	CO	NOx	SOx	VOC	CO_2	Benzene
	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg
Outdoor burning	8	42	3	0.5	4	1470	0.97

5 Based on the average of low and medium densities for garden vegetation from (Victorian EPA, 2016)

6.2 Outdoor burning emissions

Table 6.2 shows that around five kilograms of PM_{10} from outdoor burning could be expected per day during the winter months on average in Blenheim. This is a significant reduction on the 2017 emissions which were estimated at around 54 kilograms per day during the winter months.

It should be noted, however, that there are a number of uncertainties relating to the calculations. In particular it is assumed that burning is carried out evenly throughout the winter, whereas in reality it is highly probable that a disproportionate amount of burning is carried out on days more suitable for burning. Thus, on some days no PM_{10} from outdoor burning may occur and on other days it might be many times the amount estimated in this assessment. Outdoor burning emissions include a higher degree of uncertainty relative to domestic heating, motor vehicles and industry owing to uncertainties in the distribution of burning and potential variabilities in material density.

The estimated annual average emissions from outdoor burning are shown in Table 6.3. The major uncertainties surrounding the daily emission estimates do not apply to annual estimates as no assumptions about when the stated burning occurs throughout a week is needed.

Table 6.2: Outdoor burning emission estimates.

	PM_{10} kg/ day	CO kg/ day	NOx kg/ day	SOx kg/ day	VOC kg/ day	CO_2 t/ day	$PM_{2.5}$ kg/day
Summer (Dec-Feb)	1	2	0	0	0	0	1
Autumn (Mar-May)	1	2	0	0	0	0	1
Winter (June-Aug)	5	17	1	0	2	1	5
Spring (Sept-Nov)	2	6	0	0	1	0	2

Table 6.3: Outdoor burning emission estimates (annual).

PM_{10} tonnes/year	CO tonnes/year	NOx tonnes/year	SOx tonnes/year	VOC tonnes/year	CO_2 tonnes/year	$PM_{2.5}$ tonnes/year
0.7	2.5	0.2	0.0	0.3	87	0.7

7 OTHER SOURCES OF EMISSIONS

This inventory includes all likely major sources of PM_{10} that can be adequately estimated using inventory techniques. Other sources of emissions not included in the inventory that may contribute to measured PM_{10} concentrations at some times of the year include dusts (a portion of which occur in the PM_{10} size fraction) and sea spray. These sources are not typically included because the methodology used to estimate the emissions is less robust.

Lawn mowers, leaf blowers and chainsaws can also contribute small amounts of particulate. These are not typically included in emission inventory studies owing to the relatively small contribution, particularly in areas where solid fuel burning is a common method of home heating. Historically a Pacific Air and Environment (1999) figure of around 0.07 grams of PM_{10} per household per day has been used. This was re-evaluated with more recent information in Wilton (2019). This indicated a range of 0.0012 to 0.05 g/household/day and results in an estimate of less than 0.1 kilograms of PM_{10} per day from these sources.

8 TOTAL EMISSIONS

Around 409 kilograms of PM_{10} is discharged to air in Blenheim on an average winter's day for 2022. This compares with an estimated 658 kilograms per day for 2017 indicating a reduction in emissions of around 38% since 2017. This is significantly more than the 5% estimated for the period from 2012 to 2017 and likely represents the implementation of air plan measures targeting PM_{10} from domestic heating and outdoor burning.

Figure 8.1 shows that domestic home heating is the main source of particulate emissions contributing 94% of the daily wintertime PM_{10} emissions and 96% of the daily wintertime $PM_{2.5}$. Figure 8.2 shows the relative contributions of sources to annual average PM_{10} and $PM_{2.5}$.

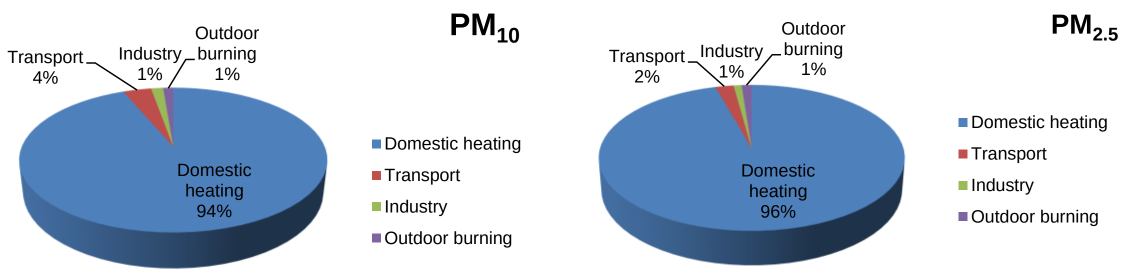


Figure 8.1: Relative contribution of sources to daily winter PM_{10} and $PM_{2.5}$ emissions.

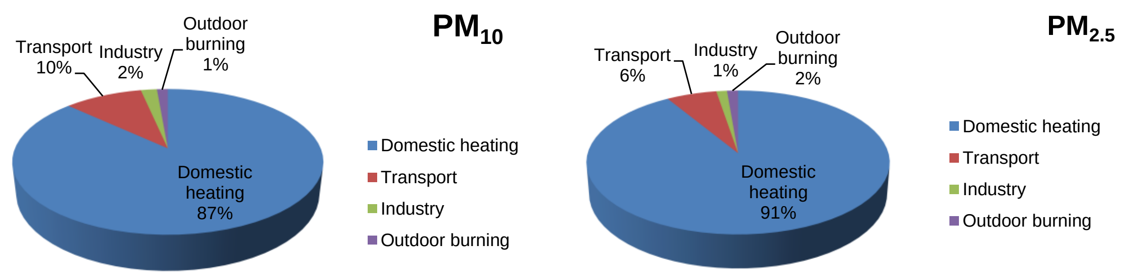


Figure 8.2: Relative contribution of sources to annual PM_{10} and $PM_{2.5}$ emissions.

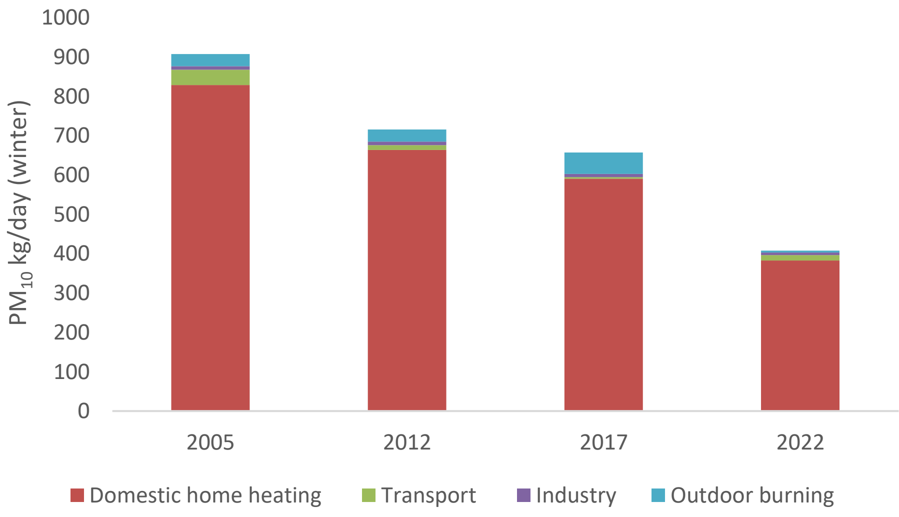


Figure 8.3: Trends in daily winter PM_{10} emissions.

Trends in PM_{10} emissions in Blenheim from 2005 to 2022 are illustrated in Figure 8.3. This shows the estimated emissions have reduced by around 57% from 2005 to 2022, with the greatest reduction occurring from 2017 to 2022.

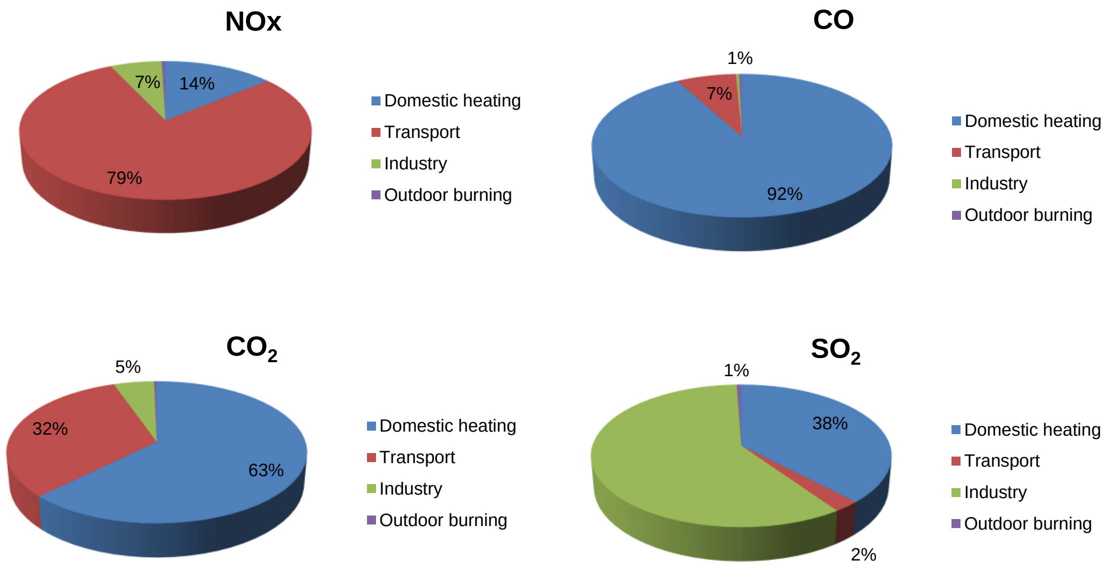


Figure 8.4: Relative contribution of sources to daily winter contaminant emissions.

Domestic home heating is also the main source of daily winter CO, and CO_2. Motor vehicles are the main source of daily winter NOx and industry is the main source of SOx (Figure 8.4).

Table 8.1 shows seasonal variations in PM_{10} and $PM_{2.5}$ emissions. Although domestic home heating is the dominant source of both PM_{10} and $PM_{2.5}$ emissions during the winter months, during the summer, motor vehicles are the main source of PM_{10} and $PM_{2.5}$ emissions. Daily wintertime emissions of PM_{10} and other contaminants (kg/day and g/day/ha) are shown in Table 8.2.

Table 8.1: Monthly variations in daily PM_{10} and $PM_{2.5}$ emissions.

PM_{10}	Domestic Heating		Outdoor Burning		Industry		Motor vehicles		Total
	kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day
January	2	9%	1	3%	3	16%	15	72%	20
February	0	0%	1	3%	4	19%	15	77%	19
March	28	59%	1	1%	4	8%	15	31%	47
April	64	77%	1	1%	4	5%	15	17%	83
May	242	93%	1	0%	4	2%	15	6%	262
June	366	93%	5	1%	6	2%	15	4%	392
July	383	94%	5	1%	6	2%	15	4%	409
August	338	93%	5	1%	6	2%	15	4%	364
September	84	80%	2	2%	4	4%	15	14%	105
October	32	61%	2	3%	4	8%	15	28%	52
November	4	17%	2	7%	4	17%	15	59%	25
December	0	0%	1	3%	3	18%	15	79%	18
Total kg year	47313		737		1650		5298		
$PM_{2.5}$	Domestic Heating		Outdoor Burning		Industry		Motor vehicles		Total
	kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day
January	2	14%	1	4%	2	15%	9	66%	13
February	0	0%	1	5%	2	20%	9	76%	11
March	28	71%	1	1%	2	6%	9	22%	39
April	64	85%	1	1%	3	3%	9	11%	76
May	242	95%	1	0%	3	1%	9	3%	254
June	366	95%	5	1%	4	1%	9	2%	383
July	383	96%	5	1%	4	1%	9	2%	400
August	338	95%	5	1%	4	1%	9	2%	356
September	84	87%	2	2%	3	3%	9	9%	97
October	32	71%	2	4%	3	6%	9	19%	44
November	4	25%	2	9%	3	15%	9	51%	17
December	0	0%	1	5%	2	18%	9	77%	11
Total kg year	47313		690		1012		3151		

Table 8.2: Daily contaminant emissions from all sources (winter average).

	PM_{10}		CO		NOx		SOx	
	kg	g/ha	kg	g/ha	kg	g/ha	kg	g/ha
Domestic home heating	383	198	4325	2241	35	18	14	7
Transport	15	8	341	177	200	103	1	0
Industry	6	3	17	9	17	9	22	11
Outdoor burning	5	3	17	9	1	1	0	0
Total	409	212	4701	2436	253	131	37	19
	VOC		CO_2		$PM_{2.5}$			
	kg	g/ha	tonnes	kg/ha	kg	g/ha		
Domestic home heating	1550	803	113	58	383	198		
Transport	31	16	58	30	9	4		
Industry	0	0	9	5	4	2		
Outdoor burning	2	1	1	0	5	3		
Total	1584	820	180	93	400	207		

REFERENCES

Bluett, J., Smith, J., Wilton, E., & Mallet, T. (2009, September 8). *Real world emission testing of domestic wood burners*. 19th International Clean Air and Environment Conference, Perth.

EEA. (2016). *Air pollutant emission invenotry guidebook—2016*. European Environment Agency Report 21/2016.

Metcalfe, J., Sridhar, S., & Wickham, L. (2013). *Domestic fire emissions 2012: Options for meeting the national environmental standard for PM10.* Auckland Council technical report, TR 2013/022.

Ministry for the Environment. (2020). *Proposed amendments to the National Environmental Standards for Air Quality, particulate matter and mercury emissions*. Ministry for Environment.

Smith, J., Bluett, J., Wilton, E., & Mallet, T. (2009). *In home testing of particulate emissions from NES compliant woodburners: Nelson, Rotorua and Taumaranui 2007*. NIWA report number CHC2008-092.

Smithson, J. (2011). *Inventory of emissions to air in Christchurch 2009*. Environment Canterbury Report R11/17.

Stern, C. H., Jaasma, D. R., Shelton, J. W., & Satterfield, G. (1992). Parametric Study of Fireplace Particulate Matter and Carbon Monoxide Emissions. *Journal of the Air & Waste Management Association*, *42*(6), 777–783. https://doi.org/10.1080/10473289.1992.10467029

Victorian EPA. (2016). *Waste Materials Density Data*. Victorian EPA. http://www.epa.vic.gov.au/business-and-industry/lower-your-impact/~/media/Files/bus/EREP/docs/wastematerials-densities-data.pdf

Wilton, E. (2014). *Nelson Air Emission Inventory—2014*. Nelson City Council Technical Report.

Wilton, E. (2019). *Tauranga Air Emission Inventory—2018*. Bay of Plenty Regional Council. https://www.boprc.govt.nz/environment/air/air-pollution/

Wilton, E. (2022). *Annual Air Quality Monitoring Report – Blenheim 2021*. Marlborough District Council Report.

Wilton, E., & Bluett, J. (2012). *Factors influencing particulate emissions from NES compliant woodburners in Nelson, Rotorua and Taumarunui 2007*. NIWA Client Report 2012- 013.

Wilton, E., Smith, J., Dey, K., & Webley, W. (2006). Real life testing of woodburner emissions. *Clean Air and Environmental Quality*, *40*(4), 43–47.

APPENDIX A: HOME HEATING QUESTIONNAIRE

1. I'm _________from and I am calling from Symphony Research on behalf Marlborough District Council. May I please speak to an adult in your household who knows about your home heating systems? We are currently undertaking a survey in your area on methods of home heating. We wish to know what you use to heat your main living area during a typical year. The survey will take about 5-7 minutes depending on your answers. Is it a good time to talk to you now?

Before we start can I please confirm that you live in Blenheim?

2. (a) Do you use any type of electrical heating in your MAIN living area during a typical year?

(b) What type of electrical heating do you use? Would it be...

- ☐ Night Store
- ☐ Radiant
- ☐ Portable Oil Column
- ☐ Panel
- ☐ Fan
- ☐ Heat Pump
- ☐ Don't Know/Refused
- ☐ Other (specify)

(c). Do you use any other heating system in your main living area in a typical year? *(If yes then question 3 otherwise Q9)*

3. (a) Do you use any type of gas heating in your MAIN living area during a typical year? *(If No then question 4)*

(b) Is it flued or unflued gas heating? If necessary: (A flued gas heating appliance will have an external vent or chimney)

4. (a) Do you use a log burner in your MAIN living area during a typical year? (This is a fully enclosed burner but does not include multi fuel burner i.e., those that burn coal) *(If No then question 5)*

(b) Which months of the year do you use your log burner

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(c) How many days per week would you use your log burner during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How old is your log burner?

e)During the winter, what times of the day do you typically use your log burner

(f) Approximately what time during the evening would you put your last load of wood on the fire?

(g) In a typical year, how many pieces of wood do you use on an average winters day? Interviewers note : winter is defined as May to August inclusive.

(h) ask only If they used their log burner during non winter months How many pieces of wood do you use per day during the other months? Interviewers note : winter is defined as May to August inclusive.

(i) In a typical year, how much wood would you use per year on your log burner? (record wood use in cubic metres - note 1 cord equals 3.6 cubic meters of loosely piled blocks, one trailer equals about 1.65 cubic metres without cage, or 2.2 with cage)

(j) Do you buy wood for your log burner, or do you receive it free of charge?

(k) What proportion would be bought?

l) If you placed your hand on your burner first thing in the morning (e.g., 6am-7am) after having used it the night before would it be?

- ☐ Cold to touch (no feeling of leftover heat)
- ☐ Warm to touch (if you held your hand there for a bit it would warm them up)
- ☐ Hot to touch (too hot to hold a hand on for more than a few seconds)

5. (a) Do you use an enclosed burner which burns coal as well as wood – i.e., a multi fuel burner in your MAIN living area during a typical year? (This includes incinerators, pot belly stoves, McKay space heaters etc but does not include open fires.) *(If No then question 6)*

(b) Which months of the year do you use your multi fuel burner?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(c) How many days per week would you use your multi fuel burner during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How old is your multi fuel burner?

(e) What type of multi fuel burner is it?

(f) In a typical year, how much wood do you use on your multi fuel burner per day during the winter? (ask them how many pieces of wood (logs) they use on an average winters day) Interviewer: Winter is defined as May to August inclusive

(g) ask only If they used their multi fuel burner during non winter months How much wood do you use per day during the other months?

(h) In a typical year, how much wood would you use per year on your multi fuel burner?_____ (record wood use in cubic metres - note 1 cord equals 3.6 cubic meters of loosely piled blocks one trailer equals about 1.65 cubic metres without cage, or 2.2 with

(i) Do you use coal on your multi fuel burner?

(j) How many buckets of coal do you use per day during the winter? (how many buckets of coal used on an average winters day) Interviewer: Winter is defined as May to August inclusive .

(k) Ask only If they used their multi fuel burner during non winter months How much coal do you use per day during the other months?

(l) Do you buy wood for your multi fuel burner, or do you receive it free of charge?

(m) What proportion would be bought?

6. (a) Do you use an open fire (includes a visor fireplace which is one enclosed on three sides but open to the front) in your MAIN living area during a typical year? *(If No then question 7)*

(b) Which months of the year do you use your open fire

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(c) How many days per week would you use your open fire during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) Do you use wood on your open fire?

(e) On a typical year, how much wood do you use per day during the winter? (ask them how many pieces of wood (logs) they use on an average winters day) Interviewer: Winter is defined as may to August inclusive

(f) Ask only If they used their open fire during non winter months How much wood do you use per day during the other months?

(g) In a typical year, how much wood would you use per year on your open fire? (record wood use in cubic metres - note 1 cord equals 3.6 cubic meters of loosely piled blocks one trailer equals about 1.65 cubic metres without cage, or 2.2 with cage)

(h) Do you use coal on your open fire?

(i) How many buckets of coal do you use per day during the winter? (how many buckets of coal used on an average winters day)____ Interviewer: Winter is defined as may to August inclusive

(j) Ask only If they used their open fire during non winter months How much coal do you use per day during the other months?

(k) Do you buy wood for your open fire, or do you receive it free of charge?

(l) What proportion would be bought?

7. (a) Do you use a pellet burner in your MAIN living area during a typical year? *(If No then question 8)*

(b) Which months of the year do you use your pellet burner

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(c) How many days per week would you use your pellet burner during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June

☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How old is your pellet burner?

(e) What make and model is your pellet burner? First, can you tell me the make?

(e) and what model is your pellet burner?

(f) In a typical year, how many kilograms of pellets do you use on an average winters day? Interviewers note : winter is defined as May to August inclusive.

(g) Ask only If they used their pellet burner during non winter months How many kgs of pellets do you use per day during the other months? Interviewers note : winter is defined as May to August inclusive.

(h) In a typical year, how many kilograms of pellets would you use per year on your pellet burner?

8. (a) Do you use any other heating system in your MAIN living area during a typical year? *(If No then question 9)*

(b) What type of heating system do you use   (if they respond with diesel or oil burner go to question c otherwise go to Q8)

(c) Which months of the year do you use your oil burner

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(d) How many days per week would you use your diesel/oil burner during?

☐ Jan	☐ Feb	☐ March	☐ April	☐ May	☐ June
☐ July	☐ Aug	☐ Sept	☐ Oct	☐ Nov	☐ Dec

(e) How much oil do you use per year ?

9. Does you home have insulation?

- ☐ Ceiling
- ☐ Under floor
- ☐ Wall
- ☐ Cylinder wrap
- ☐ Double glazing
- ☐ None
- ☐ Don't know
- ☐ Other

DEMOGRAPHICS We would like to ask some questions about you now, just to make sure we have a cross-section of people for the survey. We keep this information strictly confidential.

D1. Would you mind telling me in what decade/year you were born ?

D2. Which of the following describes you and your household situation?

- ☐ Single person below 40 living alone

- ☐ Single person 40 or older living alone
- ☐ Young couple without children
- ☐ Family with oldest child who is school age or younger
- ☐ Family with an adult child still at home
- ☐ Couple without children at home
- ☐ Flatting together
- ☐ Boarder

D3 With which ethnic group do you most closely relate?

Interviewer: tick gender.

D4 How many people live at your address?

D5 Do you own your home or rent it?

D6 Approximately how old is your home?

D7 How many bedrooms does your home have?

Thank you for your time today.

APPENDIX B: EMISSION FACTORS FOR DOMESTIC HEATING.

Emission factors were based on the review of New Zealand emission rates carried out by Wilton et al., (2015) for the Ministry for the Environments air quality indicators programme. This review evaluated emission factors used by different agencies in New Zealand and where relevant compared these to overseas emission factors and information. Preference was given to New Zealand based data where available including real life testing of pre 1994 and NES compliant wood burners (Wilton & Smith, 2006; Smith, et. al., 2008) and burners meeting the NES design criteria for wood burners (Bluett et al., 2009; Smith et al., 2009).

The PM_{10} open fire emission factor was reduced in the review relative to previous factors. Some very limited New Zealand testing was done on open fires during the late 1990s. Two tests gave emissions of around 7.2 and 7.6 g/kg which at the time was a lot lower than the proposed AP42 emission factors (http://www.rumford.com/ap42firepl.pdf) for open fires and the factors used in New Zealand at the time (15 g/kg). An evaluation of emission factors for the 1999 Christchurch emission inventory revised the open fire emission factor down from 15 g/kg to 10 g/kg based on the testing of (Stern et al., 1992) in conjunction with the results observed for New Zealand (as reported in Wilton, 2014). The proposed AP42 emission factors (11.1 g/kg dry) now suggest that the open fire emission factor may be lower still and closer to the result of the limited testing carried out in New Zealand. Consequently a factor of 7.5 g/kg for PM_{10} (wet weight) is proposed to be used for open fires in New Zealand based on the likelihood of the Stern et al., (1992) data being dry weight (indicating a lower emission factor), the data supporting a proposed revised AP 42 factor and the results of the New Zealand testing being around this value. It is proposed that other contaminant emissions for open fires be based on the proposed AP42 emission factors adjusted for wet weight.

The emission factor for wood use on a multi fuel burner was also reduced from 13 g/kg (used in down to the same value as the pre 2004 wood burner emission factor (10 g/kg). The basis for this was that there was no evidence to suggest that multi fuel burners burning wood will produce more emissions than an older wood burner burning wood.

Emission factors for coal use on a multi fuel burner are based on limited data, mostly local testing. Smithson, (2011) combines these data with some further local testing to give a lower emission factor for coal use on multi fuel burners. While these additional data have not been viewed, and it uncertain whether bituminous and subbituminous coals are considered, the value used by Smithson has been selected. The Smithson, (2011) values for coal burning on a multi fuel burner have also been used for PM_{10}, CO and NOx as it is our view that many of the more polluting older coal burner (such as the Juno) will have been replaced over time with more modern coal burners.

No revision to the coal open fire particulate emission factor was proposed as two evaluations (Smithson, (2011) and Wilton 2002) resulted in the same emission factor using different studies. Emissions of sulphur oxides will vary depending on the sulphur content of the fuel, which will vary by location. A value of 8 g/kg is proposed for SOx based on an assumed average sulphur content of 0.5 g/kg and relationships described in AP42 for handfed coal fired boilers (15.5 x sulphur content).

An emission factor of 0.5 g/kg was proposed for NOx from wood burners based on the AP42 data because the non-catalytic burner measurements were below the detection limit but the catalytic converter estimates (and conventional burner estimates) weren't. This value is half of the catalytic burner NOx estimate.

A ratio of 14 x PM_{10} values was used for CO emission estimates as per the AP42 emissions table for wood stoves. This is selected without reference to any New Zealand data owing to the latter not being in any publically available form.