

# Transport-Related Air emissions INventory Stocktake (TRAINS)



Prepared for  
NZ Transport Agency

14 June 2018

Authors: Surekha Sridhar, Gerda Kuschel  
Organisation: Emission Impossible Ltd  
Date: 14 June 2018

**Recommended Citation:**

Sridhar S & Kuschel G (2018). *Transport-Related Air emissions INventory Stocktake (TRAINS)*.  
Report for New Zealand Transport Agency prepared by Emission Impossible Ltd, June 2018.

---

# Contents

<b>List of abbreviations.....</b>	<b>ii</b>
<b>1.0 Introduction.....</b>	<b>1</b>
1.1 <i>Background and scope</i>	1
1.2 <i>Report structure</i>	2
1.3 <i>Limitations</i>	2
<b>2.0 Summary tables.....</b>	<b>3</b>
<b>3.0 Source contributions.....</b>	<b>11</b>
3.1 <i>PM<sub>10</sub></i>	12
3.2 <i>PM<sub>2.5</sub></i>	13
3.3 <i>CO</i>	14
3.4 <i>NO<sub>x</sub></i>	15
3.5 <i>SO<sub>x</sub></i>	16
3.6 <i>SO<sub>2</sub></i>	17
3.7 <i>VOCs</i>	18
3.8 <i>CO<sub>2</sub></i>	19
<b>References.....</b>	<b>20</b>
<b>Appendix 1: Inventory metadata .....</b>	<b>25</b>
<i>New Zealand</i>	25
<i>Northland</i>	26
<i>Auckland</i>	27
<i>Bay of Plenty</i>	29
<i>Waikato</i>	31
<i>Gisborne</i>	35
<i>Hawke’s Bay</i>	37
<i>Manawatu-Wanganui</i>	40
<i>Wellington</i>	41
<i>Nelson</i>	42
<i>Tasman</i>	43
<i>Marlborough</i>	44
<i>Canterbury</i>	45
<i>Otago</i>	49
<i>West Coast</i>	50
<i>Southland</i>	51

## List of abbreviations

AADT	Annual average daily traffic
AP42	Emission factor database published by the USEPA
ART	Auckland Regional Transport model
CAU	Census area units
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
DFEPM	Domestic Fire Emissions Prediction Model
EF	Emission factor
LTNZ	Land Transport New Zealand (merged with Transit New Zealand in 2008 to form NZ Transport Agency)
MfE	Ministry for the Environment
MoT	Ministry of Transport
NPI	National Pollutant Inventory (Australia)
NO <sub>x</sub>	Oxides of nitrogen
NZTA	NZ Transport Agency
NZTER	New Zealand Traffic Emission Rates database (MoT)
PM <sub>10</sub>	Particulate matter <10µm in diameter
PM <sub>2.5</sub>	Particulate matter <2.5µm in diameter
RAMM	Road Assessment and Maintenance Management database (NZTA)
SO <sub>x</sub>	Oxides of sulphur
TLA	Territorial local authority
VEPM	Vehicle Emissions Prediction Model (NZTA)
VFEM	Vehicle Fleet Emission Model (MoT)
VKT	Vehicle kilometres travelled
VOC	Volatile organic compounds

## 1.0 Introduction

### 1.1 Background and scope

Air emissions inventories are a critical component of managing air quality and are undertaken by regional councils regularly to gauge how emissions are tracking in the region. The inventories cover key emission sources and pollutants in the region, sometimes covering all major or focussing on one source/pollutant. In New Zealand, 17 local authorities (11 regional councils and six unitary authorities) have the responsibility for managing air quality in their areas.

This report compiles emission inventories prepared in New Zealand at the regional council, unitary council and national level since 2000, for the NZ Transport Agency in order to:

- Understand and catalogue where and how vehicle emissions (greenhouse gases and harmful air pollutants) from land transport have been estimated;
- Allow these estimates of vehicle emissions to be compared against other emission sources at the same geographical scale so as to contextualise the contribution of land transport relative to other sources.

This report includes the following major pollutants:

- Particulate matter <10µm in size (PM<sub>10</sub>)
- Particulate matter <2.5µm in size (PM<sub>2.5</sub>)
- Carbon monoxide (CO)
- Carbon dioxide (CO<sub>2</sub>)
- Oxides of nitrogen (NO<sub>x</sub>)
- Oxides of sulphur (SO<sub>x</sub>) and sulphur dioxide (SO<sub>2</sub>)
- Volatile organic compounds (VOCs)

For the purposes of this report, emission sources are categorised in the following sectors:

- Transport (includes motor vehicles, rail, aviation, shipping, off-road vehicles and re-suspended road dust)
- Domestic (includes home heating, lawn mowing, gardening equipment)
- Industry (includes consented industry, commercial activities)
- Outdoor burning
- Other sources (includes natural sources, agriculture, electricity)

## 1.2 Report structure

This report is structured as follows:

- Section 2 summarises all available emissions inventories that have been undertaken across New Zealand since 2000, indicating key pollutants and sources covered (anthropogenic and natural).
- Section 3 presents summary tables by pollutant for inventories since 2010 which include emissions from transport, domestic, industry, outdoor burning and other sectors for each region/airshed/urban area.
- Appendix 1 provides more detailed metadata for the latest complete inventory for each region/airshed/urban area (ie. inventories that include at least home heating, motor vehicles and consented industry sources, and more than one pollutant).

## 1.3 Limitations

This report collates and presents emission summaries for the most commonly reported sources and pollutants across the country. However, inconsistencies make it difficult to compare inventories, especially between regional and national estimates. The sources and pollutants covered by each inventory vary depending upon the region:

- Most inventories report on the major sources only (motor vehicles, domestic heating and industry) with other sources such as shipping or outdoor burning often excluded.
- Not all pollutants are included in each inventory (as most are PM<sub>10</sub> inventories).
- Oxides of sulphur are reported either as SO<sub>2</sub> or SO<sub>x</sub> which are not interchangeable (ie not the same thing) as it depends on the methodology and emission factors used in the inventory in question.
- Although the general method to calculate emissions is the same, the detailed methodologies for calculating emissions varies depending upon available data.
- There are different reporting requirements and periods (eg. annual emissions/daily winter average)
- The spatial extent and resolution differ between each inventory (region/airshed/urban area).
- Emissions are estimated for different base years and therefore do not reflect the same fuel specifications, emission standards, and regulations in place.

Any comparison made between inventories is indicative only and should be considered with caution.

## 2.0 Summary tables

The following section presents a summary of emissions inventories undertaken across New Zealand at the national and regional level since the year 2000.

The table covers the following information for each inventory:

- Region
- Area or airshed
- Pollutants
- Sources
- Years:
  - Actual base year (indicated as “A”)
  - Backcast year (indicated as “B”)
  - Forecast year (indicated as “F”)

Note: Inventory data presented in section of this report are shaded in grey.

Table 1: Summary table of pollutants and sources in each inventory.

Region	Area/ Airshed	Year A – Actual base year B – Back cast year F – Forecast year	Pollutants								Sources					Reference	
			CO	CO <sub>2</sub>	VOCs	NOx	PM <sub>10</sub>	PM <sub>2.5</sub>	SOx	SO <sub>2</sub>	Transport	Domestic	Industry	Outdoor Burning	Other		
New Zealand	National	2006 <sup>A</sup>					3					3	3	3	3	3	Kuschel <i>et al.</i> 2012
New Zealand	National	2007 <sup>A</sup>									3			3			Wilton <i>et al.</i> 2008
New Zealand	National	2013 <sup>A</sup>	3			3	3	3	3			3	3	3	3		Wilton <i>et al.</i> 2015
New Zealand	National	2013 <sup>A</sup>		3								3	3	3	3	3	MBIE 2014
Northland	Whangarei airshed	2006 <sup>A</sup>	3	3	3	3	3	3	3			3	3	3	3		Wilton 2007
Auckland	Region & Auckland (urban airshed)	2004 <sup>A</sup>	3	3	3	3	3			3		3	3	3	3	3	Metcalfe <i>et al.</i> 2006
Auckland	Region	2006 <sup>A</sup>					3						3				Metcalfe 2010
Auckland	Region	2006 <sup>B</sup> 2010 <sup>A</sup>	3	3	3	3	3			3		3					Peeters 2010
Auckland	Region	2012 <sup>A</sup>					3						3				Metcalfe <i>et al.</i> 2013
Auckland	Region	2001 <sup>B</sup> 2006 <sup>B</sup> 2011 <sup>A</sup>	3	3	3	3	3			3		3					Sridhar <i>et al.</i> 2014a
Auckland	Region & Auckland urban airshed	2001 <sup>B</sup> 2006 <sup>A</sup> 2011 <sup>F</sup>	3	3	3	3	3				3	3	3	3			Xie <i>et al.</i> 2014



Region	Area/ Airshed	Year A – Actual base year B – Back cast year F – Forecast year	Pollutants								Sources					Reference
			CO	CO <sub>2</sub>	VOCs	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	SO <sub>x</sub>	SO <sub>2</sub>	Transport	Domestic	Industry	Outdoor Burning	Other	
Auckland	Region	2011 <sup>A</sup> 2016 <sup>F</sup> 2021 <sup>F</sup> 2031 <sup>F</sup> 2041 <sup>F</sup>	3	3	3	3	3			3						Sridhar <i>et al.</i> 2014b
Auckland	Region	2011 <sup>A</sup>	3	3	3	3	3	3	3				3			Grange & Xie 2015
Auckland	Region	2011 <sup>A</sup>		3							3	3	3	3	3	Xie 2016
Bay of Plenty	Region	2001 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3	3	Ryan 2003
Bay of Plenty	Rotorua	2005 <sup>A</sup>	3		3	3	3		3		3	3	3	3		Iremonger & Graham 2007
Bay of Plenty	Whakatane (urban)	2007 <sup>A</sup>	3		3	3	3		3		3	3	3	3		BOPRC 2008
Waikato	Taupo Huntly Putaruru Matamata	2000 <sup>A</sup>	3	3	3	3	3		3			3				Wilton 2001a
Waikato	Hamilton	1997 <sup>B</sup> 2001 <sup>A</sup> 2021 <sup>F</sup>	3	3	3	3	3		3		3	3	3			Wilton 2002a
Waikato	Hamilton Tokoroa Te Kuiti	2001 <sup>A</sup>	3	3	3	3	3		3			3		3		Wilton 2002b
Waikato	Taupo	2004 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton 2004a

Region	Area/ Airshed	Year A – Actual base year B – Back cast year F – Forecast year	Pollutants								Sources					Reference
			CO	CO <sub>2</sub>	VOCs	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	SO <sub>x</sub>	SO <sub>2</sub>	Transport	Domestic	Industry	Outdoor Burning	Other	
Waikato	Tokoroa	2004 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton 2004b
Waikato	Hamilton	2005 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton 2006a
Waikato	Te Awamutu Turangi Ngaruawahia	2006 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton 2006b
Waikato	Matamata Putaruru Waihi	2006 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Smith & Wilton 2007
Waikato	Tokoroa Te Kuiti	2007 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton & Baynes 2007
Waikato	Taupo Thames Huntly	2009 <sup>A</sup>	3	3	3	3	3		3		3	3	3	3		Wilton & Baynes 2010a
Waikato	Hamilton airshed	2012 <sup>A</sup>	3	3	3	3	3		3		3	3	3	3		Wilton 2012a
	Tokoroa airshed															
Waikato	Taupo airshed	2014 <sup>A</sup>	3	3	3	3	3		3		3	3	3	3		Wilton 2015a
Waikato	Te Kuiti airshed Putaruru airshed	2015 <sup>A</sup>	3	3	3	3	3		3		3	3	3	3		Wilton 2015b
Waikato	Tokoroa airshed Morrinsville airshed	2016 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton 2016a
Gisborne	Region	2005 <sup>A</sup>	3	3	3	3	3		3		3	3	3	3	3	Sherman & Fisher 2005

Region	Area/ Airshed	Year A – Actual base year B – Back cast year F – Forecast year	Pollutants								Sources					Reference
			CO	CO <sub>2</sub>	VOCs	NOx	PM <sub>10</sub>	PM <sub>2.5</sub>	SO <sub>x</sub>	SO <sub>2</sub>	Transport	Domestic	Industry	Outdoor Burning	Other	
Hawke's Bay	Region	2005 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton 2005b
Hawke's Bay	Hastings Napier Havelock North	2010 <sup>A</sup>	3	3	3	3	3		3		3	3	3			Wilton & Baynes 2010b
Hawke's Bay	Napier	2015 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3			Wilton 2015c
	Hastings															
	Havelock North															
Hawke's Bay	Awatoto airshed	2016 <sup>A</sup>	3			3	3			3	3	3				Wilton 2016b
Manawatu- Wanganui	Taumarunui airshed Taihape airshed	2010 <sup>A</sup>	3	3	3	3	3		3		3	3	3	3		Wilton & Baynes 2010c
Wellington	Wainuiomata airshed Upper Hutt airshed	2006 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton 2006c
Wellington	Masterton (urban) Carterton (urban)	2013 <sup>A</sup>					3					3				Sridhar & Wickham 2013
Wellington	Region Wellington (urban)	2000 - 2013		3	3						3	3	3	3	3	Marquardt 2014
Wellington	Region Wellington (urban)	2000 - 2015		3	3						3	3	3	3	3	Marquardt 2016
Nelson	Region	2001 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton & Simpson 2001

Region	Area/ Airshed	Year A – Actual base year B – Back cast year F – Forecast year	Pollutants								Sources					Reference
			CO	CO <sub>2</sub>	VOCs	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	SO <sub>x</sub>	SO <sub>2</sub>	Transport	Domestic	Industry	Outdoor Burning	Other	
Nelson	Airshed A Airshed B1 Airshed B2 Airshed C	2006 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3			Wilton 2006d
Nelson	Airshed A Airshed B1 Airshed B2 Airshed C	2014 <sup>A</sup>	3	3	3	3	3			3	3	3	3			Wilton 2014
Tasman	Richmond (urban)	2010 <sup>A</sup>	3	3	3	3	3		3		3	3	3			Wilton & Baynes 2010d
Tasman	Richmond (urban)	2013 <sup>A</sup>					3				3	3	3			Wilton 2015d
Marlborough	Blenheim	2005 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3	3	Wilton 2005d
Marlborough	Blenheim	2012 <sup>A</sup>	3	3	3	3	3			3	3	3	3			Wilton 2012b
Canterbury	Timaru	2001 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3		3	Wilton 2001b
Canterbury	Christchurch (urban)	2002 <sup>A</sup>	3	3		3	3	3	3		3	3	3			Scott & Gunatilaka 2004
Canterbury	Waimate (urban) Ashburton (urban) Kaiapoi (urban) Rangiora (urban)	1997 <sup>B</sup> 2004 <sup>A</sup>	3	3		3	3	3	3		3	3	3	3		McCauley & Scott 2006

Region	Area/ Airshed	Year A – Actual base year B – Back cast year F – Forecast year	Pollutants								Sources					Reference
			CO	CO <sub>2</sub>	VOCs	NOx	PM <sub>10</sub>	PM <sub>2.5</sub>	SO <sub>x</sub>	SO <sub>2</sub>	Transport	Domestic	Industry	Outdoor Burning	Other	
Canterbury	Timaru airshed	1996 <sup>B</sup> 2001 <sup>B</sup> 2005 <sup>A</sup>	3		3	3	3	3	3		3	3	3			Smithson <i>et al.</i> 2006
Canterbury	Christchurch (urban)	2006 <sup>A</sup>	3		3	3	3	3	3		3	3	3			Smithson 2008
Canterbury	Christchurch (urban)	1999 <sup>B</sup> 2002 <sup>B</sup> 2006 <sup>B</sup> 2009 <sup>A</sup>	3		3	3	3	3	3		3	3	3			Smithson 2011
Canterbury	Christchurch airshed Kaiapoi airshed Rangiora airshed	2014 <sup>A</sup>			3	3	3				3					Sridhar & Metcalfe 2014
Canterbury	Ashburton Christchurch Geraldine Kaiapoi Rangiora Timaru Waimate	2014 <sup>A</sup>					3						3			Salomon & Smithson 2015
Otago	Dunedin Mosgiel Alexandra	2005 <sup>A</sup>	3	3	3	3	3	3	3			3	3			Wilton 2005c
Otago	Alexandra Arrowtown Mosgiel Milton	2016 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3			Wilton 2016c
West Coast	Reefton airshed	2012 <sup>A</sup>	3	3	3	3	3			3	3	3	3			Wilton 2013

Region	Area/ Airshed	Year A – Actual base year B – Back cast year F – Forecast year	Pollutants								Sources					Reference
			CO	CO <sub>2</sub>	VOCs	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	SO <sub>x</sub>	SO <sub>2</sub>	Transport	Domestic	Industry	Outdoor Burning	Other	
Southland	Invercargill (urban) Gore (urban)	2004 <sup>A</sup>	3	3	3	3	3	3	3		3	3	3	3		Wilton 2005a
Southland	Invercargill (urban) Gore (urban)	2011 <sup>A</sup>	3	3	3	3	3			3	3	3	3		Wilton 2015e	

### 3.0 Source contributions

This section presents summary data from recent complete inventories in New Zealand since 2010.

Emission summaries are shown for the following pollutants:

- PM<sub>10</sub>
- PM<sub>2.5</sub>
- CO
- NO<sub>x</sub>
- SO<sub>x</sub>
- SO<sub>2</sub>
- VOC
- CO<sub>2</sub>

The sources and pollutants presented are the most common categories reported across the country in almost all inventories. Many inventories report on a broader range of sources and pollutants but, as mentioned earlier, the lack of consistency across the country makes comparing results between inventories difficult.

Similarly, only inventories with base years 2010 onwards are presented here. Inventories for base years prior to 2010 do not reflect the significant changes to various transport fuel specifications, vehicle emission standards, and other regulations that have taken effect since then.

As a result, not all regions in New Zealand have valid data that are able to be compared in this section.<sup>1</sup>

**Note:**

- Emissions reported in this section are based on daily winter averages.
- All values have been rounded to the nearest whole number (in some cases, the value is rounded down to zero).
- Some values are reported in their respective inventory as “zero”. These are reported as is in this report.
- Footnotes are used to indicate important differences between the inventories.

---

<sup>1</sup> Results for Auckland, Wellington and Canterbury region/airsheds are not presented here as the most recent published inventories were produced for base years prior to 2010.

### 3.1 PM<sub>10</sub>

 Table 2: Summary of emissions for PM<sub>10</sub> from inventories produced since 2010.

Region	Area/ Airshed	Year	Sources (kg/day)				Reference
			Transport	Domestic	Industry	Outdoor Burning	
New Zealand	National	2013	5,226	103,401	16,797		Wilton <i>et al.</i> 2015
Waikato	Hamilton	2012	96	1,177	29	47	Wilton 2012a
Waikato	Taupo	2014	10	542	0.1	9	Wilton 2015a
Waikato	Te Kuiti	2015	1	165	34	0	Wilton 2015b
Waikato	Putaruru	2015	2	124	0	6	Wilton 2015b
Waikato	Tokoroa	2016	3	334	6	40	Wilton 2016a
Waikato	Morrinsville	2016	2	137	110	12	Wilton 2016a
Hawke's Bay	Hastings	2015	18	541	3		Wilton 2015c
Hawke's Bay	Napier	2015	68 <sup>A</sup>	587	29		Wilton 2015c
Hawke's Bay	Awatoto	2016	2	0	19		Wilton 2016b
Manawatu-Wanganui	Taumarunui	2010	6	259	1	43	Wilton & Baynes 2010c
Manawatu-Wanganui	Taihape	2010	2	133	12	15	Wilton & Baynes 2010c
Nelson	Nelson A	2014	7	149	8		Wilton 2014
Nelson	Nelson B1	2014	8 <sup>B</sup>	87	65		Wilton 2014
Nelson	Nelson B2	2014	10	223	8		Wilton 2014
Nelson	Nelson C	2014	8	174	5		Wilton 2014
Tasman	Richmond	2010	28	292	8		Wilton & Baynes 2010d
Marlborough	Blenheim	2012	12	627	9	31	Wilton 2012b
Otago	Alexandra	2016	2	169	0		Wilton 2016c
Otago	Arrowtown	2016	0	94	0		Wilton 2016c
Otago	Milton	2016	1	99	20		Wilton 2016c
Otago	Mosgiel	2016	1	267	2		Wilton 2016c
West Coast	Reefton	2012	0	117	3	1	Wilton 2013
Southland	Invercargill	2011	51	3,792	154	12	Wilton 2015e
Southland	Gore	2011	9	961	11	11	Wilton 2015e

<sup>A</sup> Includes road dust, shipping and aviation emissions

<sup>B</sup> Includes aviation emissions



## 3.2 PM<sub>2.5</sub>

Table 3: Summary of emissions for PM<sub>2.5</sub> from inventories produced since 2010.

Region	Area/ Airshed	Year	Sources (kg/day)				Reference
			Transport	Domestic	Industry	Outdoor Burning	
New Zealand	National	2013	4,908	101,377	11,218		Wilton <i>et al.</i> 2015
Waikato	Tokoroa	2016	3	334	1	37	Wilton 2016a
Waikato	Morrinsville	2016	2	136	0	11	Wilton 2016a
Hawke's Bay	Hastings	2015	13	541	3		Wilton 2015c
Hawke's Bay	Napier	2015	56 <sup>A</sup>	587	25		Wilton 2015c
Hawke's Bay	Awatoto	2016	2	0	12		Wilton 2016b
Otago	Alexandra	2016	2	169	0		Wilton 2016c
Otago	Arrowtown	2016	1	93	0		Wilton 2016c
Otago	Milton	2016	1	97	16		Wilton 2016c
Otago	Mosgiel	2016	2	263	2		Wilton 2016c

<sup>A</sup> Includes shipping emissions

### 3.3 CO

Table 4: Summary of emissions for CO from inventories produced since 2010.

Region	Area/ Airshed	Year	Sources (kg/day)				Reference
			Transport	Domestic	Industry	Outdoor Burning	
New Zealand	National	2013	485,345	1,215,575	69,419		Wilton <i>et al.</i> 2015
Waikato	Hamilton	2012	12,338	11,204	10	158	Wilton 2012a
Waikato	Taupo	2014	885	5,787	0	29	Wilton 2015a
Waikato	Te Kuiti	2015	94	1,970	366	0	Wilton 2015b
Waikato	Putaruru	2015	155	1,548	1	20	Wilton 2015b
Waikato	Tokoroa	2016	330	3,829	7	133	Wilton 2016a
Waikato	Morrinsville	2016	179	1,623	25	39	Wilton 2016a
Hawke's Bay	Hastings	2015	1,534	7,080	20		Wilton 2015c
Hawke's Bay	Napier	2015	2,929 <sup>A</sup>	7,806	123		Wilton 2015c
Hawke's Bay	Awatoto	2016	181	2	14		Wilton 2016b
Manawatu-Wanganui	Taumarunui	2010	328	2,535	0	143	Wilton & Baynes 2010c
Manawatu-Wanganui	Taihape	2010	118	1,249	21	52	Wilton & Baynes 2010c
Nelson	Nelson A	2014	835	2,013	51		Wilton 2014
Nelson	Nelson B1	2014	463	1,164	242		Wilton 2014
Nelson	Nelson B2	2014	1198	2,835	11		Wilton 2014
Nelson	Nelson C	2014	885	2,206	0		Wilton 2014
Tasman	Richmond	2010	1,534	2,988	24		Wilton & Baynes 2010d
Marlborough	Blenheim	2012	1,123	6,145	24	104	Wilton 2012b
Otago	Alexandra	2016	150	2,342	0		Wilton 2016c
Otago	Arrowtown	2016	45	1,274	0		Wilton 2016c
Otago	Milton	2016	69	1,238	70		Wilton 2016c
Otago	Mosgiel	2016	176	3,418	18		Wilton 2016c
West Coast	Reefton	2012	38	895	9	3	Wilton 2013
Southland	Invercargill	2011	3,595	25,473	218	40	Wilton 2015e
Southland	Gore	2011	626	5,836	29	36	Wilton 2015e

<sup>A</sup> Includes shipping emissions

### 3.4 NO<sub>x</sub>

Table 5: Summary of emissions for NO<sub>x</sub> from inventories produced since 2010.

Region	Area/ Airshed	Year	Sources (kg/day)				Reference
			Transport	Domestic	Industry	Outdoor Burning	
New Zealand	National	2013	82,262	8,083	25,227		Wilton <i>et al.</i> 2015
Waikato	Hamilton	2012	1,525	85	18	11	Wilton 2012a
Waikato	Taupo	2014	151	40	0	2	Wilton 2015a
Waikato	Te Kuiti	2015	23	13	270	0	Wilton 2015b
Waikato	Putaruru	2015	26	9	1	1	Wilton 2015b
Waikato	Tokoroa	2016	56	29	8	9	Wilton 2016a
Waikato	Morrinsville	2016	33	11	182	3	Wilton 2016a
Hawke's Bay	Hastings	2015	202	52	47		Wilton 2015c
Hawke's Bay	Napier	2015	779 <sup>A</sup>	58	14		Wilton 2015c
Hawke's Bay	Awatoto	2016	30	0	34		Wilton 2016b
Manawatu- Wanganui	Taumarunui	2010	64	16	0	10	Wilton & Baynes 2010c
Manawatu- Wanganui	Taihape	2010	23	8	30	4	Wilton & Baynes 2010c
Nelson	Nelson A	2014	116	15	30		Wilton 2014
Nelson	Nelson B1	2014	64	8	29		Wilton 2014
Nelson	Nelson B2	2014	166	21	27		Wilton 2014
Nelson	Nelson C	2014	123	14	4		Wilton 2014
Tasman	Richmond	2010	296	21	19		Wilton & Baynes 2010d
Marlborough	Blenheim	2012	152	39	22	7	Wilton 2012b
Otago	Alexandra	2016	27	16	0		Wilton 2016c
Otago	Arrowtown	2016	7	9	0		Wilton 2016c
Otago	Milton	2016	13	7	15		Wilton 2016c
Otago	Mosgiel	2016	23	19	16		Wilton 2016c
West Coast	Reefton	2012	5	7	8	0	Wilton 2013
Southland	Invercargill	2011	640	205	155	3	Wilton 2015e
Southland	Gore	2011	112	47	25	3	Wilton 2015e

<sup>A</sup> Includes shipping emissions

### 3.5 SO<sub>x</sub>

Table 6: Summary of emissions for SO<sub>x</sub> from inventories produced since 2010.

Region	Area/ Airshed	Year	Sources (kg/day)				Reference
			Transport	Domestic	Industry	Outdoor Burning	
New Zealand	National	2013	0	8,486	64,599		Wilton <i>et al.</i> 2015
Waikato	Hamilton	2012	4	43	4	2	Wilton 2012a
Waikato	Taupo	2014	1	15	0	0	Wilton 2015a
Waikato	Te Kuiti	2015	0	7	605	0	Wilton 2015b
Waikato	Putaruru	2015	0	4	0	0	Wilton 2015b
Waikato	Tokoroa	2016	0	13	0	2	Wilton 2016a
Waikato	Morrinsville	2016	0	8	0	0	Wilton 2016a
Hawke's Bay	Hastings	2015	1	19	0		Wilton 2015c
Hawke's Bay	Napier	2015	51 <sup>A</sup>	22	1		Wilton 2015c
Manawatu- Wanganui	Taumarunui	2010	0	7	0	2	Wilton & Baynes 2010c
Manawatu- Wanganui	Taihape	2010	0	4	34	1	Wilton & Baynes 2010c
Tasman	Richmond	2010	1	9	46		Wilton & Baynes 2010d
Otago	Alexandra	2016	0	7	0		Wilton 2016c
Otago	Arrowtown	2016	0	5	0		Wilton 2016c
Otago	Milton	2016	0	10	44		Wilton 2016c
Otago	Mosgiel	2016	0	22	0		Wilton 2016c

<sup>A</sup> Includes shipping emissions

### 3.6 SO<sub>2</sub>

Table 7: Summary of emissions for SO<sub>2</sub> from inventories produced since 2010.

Region	Area/ Airshed	Year	Sources (kg/day)				Reference
			Transport	Domestic	Industry	Outdoor Burning	
Hawke's Bay	Awatoto	2016		0	353		Wilton 2016b
Nelson	Nelson A	2014	0	6	136		Wilton 2014
Nelson	Nelson B1	2014	0	3	7		Wilton 2014
Nelson	Nelson B2	2014	24	10	35		Wilton 2014
Nelson	Nelson C	2014	0	6	24		Wilton 2014
Marlborough	Blenheim	2012	1	18	51	1	Wilton 2012b
West Coast	Reefton	2012	0	59	29	0	Wilton 2013
Southland	Invercargill	2011	2	290	759	0	Wilton 2015e
Southland	Gore	2011	0	80	58	0	Wilton 2015e

### 3.7 VOCs

Table 8: Summary of emissions for VOC from inventories produced since 2010.

Region	Area/ Airshed	Year	Sources (kg/day)				Reference
			Transport	Domestic	Industry	Outdoor Burning	
Waikato	Hamilton	2012	732	3,243	1	16	Wilton 2012a
Waikato	Taupo	2014	56	1,371	0	3	Wilton 2015a
Waikato	Te Kuiti	2015	6	592	8	4	Wilton 2015b
Waikato	Putaruru	2015	9	445	0	2	Wilton 2015b
Waikato	Tokoroa	2016	20	1,299	1	14	Wilton 2016a
Waikato	Morrinsville	2016	11	471	4	4	Wilton 2016a
Hawke's Bay	Hastings	2015	96	2,124	4		Wilton 2015c
Hawke's Bay	Napier	2015	181	2,342	3		Wilton 2015c
Manawatu- Wanganui	Taumarunui	2010	26	753	0	15	Wilton & Baynes 2010c
Manawatu- Wanganui	Taihape	2010	9	364	0	5	Wilton & Baynes 2010c
Nelson	Nelson A	2014	51	604	1		Wilton 2014
Nelson	Nelson B1	2014	28	349	5		Wilton 2014
Nelson	Nelson B2	2014	73	839	1		Wilton 2014
Nelson	Nelson C	2014	54	657	0		Wilton 2014
Tasman	Richmond	2010	119	961	0		Wilton & Baynes 2010d
Marlborough	Blenheim	2012	68	1,828	0	11	Wilton 2012b
Otago	Alexandra	2016	9	682	0		Wilton 2016c
Otago	Arrowtown	2016	3	356	0		Wilton 2016c
Otago	Milton	2016	4	300	2		Wilton 2016c
Otago	Mosgiel	2016	10	822	0		Wilton 2016c
West Coast	Reefton	2012	2	195	0	0	Wilton 2013
Southland	Invercargill	2011	267	6,081	3	4	Wilton 2015e
Southland	Gore	2011	47	1,263	0	4	Wilton 2015e

### 3.8 CO<sub>2</sub>

 Table 9: Summary of emissions for CO<sub>2</sub> from inventories produced since 2010.

Region	Area/ Airshed	Year	Sources (t/day)				Reference
			Transport	Domestic	Industry	Outdoor Burning	
Waikato	Hamilton	2012	213	543	25	6	Wilton 2012a
Waikato	Taupo	2014	117	52	0	1	Wilton 2015a
Waikato	Te Kuiti	2015	37	8	187	1	Wilton 2015b
Waikato	Putaruru	2015	27	10	0	1	Wilton 2015b
Waikato	Tokoroa	2016	92	21	12	5	Wilton 2016a
Waikato	Morrinsville	2016	31	13	88	1	Wilton 2016a
Hawke's Bay	Hastings	2015	156	85	72		Wilton 2015c
Hawke's Bay	Napier	2015	175	160	19	0	Wilton 2015c
Manawatu- Wanganui	Taumarunui	2010	48	17	0	5	Wilton & Baynes 2010c
Manawatu- Wanganui	Taihape	2010	23	23	17	2	Wilton & Baynes 2010c
Nelson	Nelson A	2014	48	44	22		Wilton 2014
Nelson	Nelson B1	2014	27 <sup>A</sup>	24	40		Wilton 2014
Nelson	Nelson B2	2014	65	63	15		Wilton 2014
Nelson	Nelson C	2014	44	47	2		Wilton 2014
Tasman	Richmond	2010	61	84	11		Wilton & Baynes 2010d
Marlborough	Blenheim	2012	118	52	12	4	Wilton 2012b
Otago	Alexandra	2016	49	10	0		Wilton 2016c
Otago	Arrowtown	2016	25	3	0		Wilton 2016c
Otago	Milton	2016	22	5	14		Wilton 2016c
Otago	Mosgiel	2016	53	10	16		Wilton 2016c
West Coast	Reefton	2012	16	2	4	0	Wilton 2013
Southland	Invercargill	2011	444	197	121	1	Wilton 2015e
Southland	Gore	2011	107	34	13	1	Wilton 2015e

<sup>A</sup> Includes aviation emissions

## References

- BOPRC (2008). *Whakatane air emissions inventory 2007*. Prepared for Bay of Plenty Regional Council by Bay of Plenty Regional Council. Environmental Publication 2008/07. Available at: [https://www.boprc.govt.nz/media/275618/whakatane\\_air\\_emissions\\_inventory\\_2007.pdf](https://www.boprc.govt.nz/media/275618/whakatane_air_emissions_inventory_2007.pdf)
- Grange & Xie (2015). *Auckland industrial air emission inventory 2011*. Prepared for Auckland Council, TR2015/004. Available at: <http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalreports2015.aspx>
- Iremonger & Graham (2007). *Rotorua air emissions inventory 2005*. Prepared for Bay of Plenty Regional Council. Environmental Publication 2007/02. Available at: [https://www.boprc.govt.nz/media/523535/0702\\_rotorua-air-emissions-inventory-2005\\_final.pdf](https://www.boprc.govt.nz/media/523535/0702_rotorua-air-emissions-inventory-2005_final.pdf)
- Kuschel *et al.* (2012). *Health and air pollution in New Zealand Study update 2012*. Prepared for the Health Research Council of New Zealand, Ministry of Transport, Ministry for the Environment & NZ Transport Agency. Available at: <http://www.hapinz.org.nz>
- Marquardt (2014). *Greenhouse gas inventory for the Wellington region*. Prepared for Greater Wellington Regional Council by URS NZ Ltd. Available at: <http://www.gw.govt.nz/ghg/>
- Marquardt (2016). *Community Greenhouse Gas Inventory for Wellington City and the Greater Wellington Region 2000-2015*. Prepared for Greater Wellington Regional Council by AECOM NZ Ltd
- MBIE (2014). *Energy greenhouse gas emissions, 2013 calendar year edition*. Prepared by Ministry for Business, Innovation & Employment. Available at: <http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-greenhouse-gas-emissions/?searchterm=emissions%20inventory%2A>
- McCauley & Scott (2006). *Inventory of emissions to air in Waimate, Ashburton, Kaiapoi & Rangiora, 2004*. Prepared by Environment Canterbury Regional Council, Report No. R06/24. Available at: <https://ecan.govt.nz/technical-reports/>
- Metcalf (2010). *Estimation of domestic fire emissions in 2006*. Prepared for Auckland Council by Emission Impossible Ltd, TP2010/056.
- Metcalf *et al.* (2006). *Auckland air emissions inventory: 2004*. Prepared for Auckland Council by Endpoint Ltd, TP292. Available at: <http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalpublications251-300.aspx>
- Metcalf *et al.* (2013). *Domestic fire emissions 2012: options for meeting the national environmental standard for PM<sub>10</sub>*. Prepared for Auckland Council by Emission Impossible Ltd, TR2013/022. Available at: <http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalreports2013.aspx>
- Mitchell *et al.* (2016). Heating with biomass in the United Kingdom: Lessons from New Zealand. *Atmospheric Environment*, 152, 431-454. <http://dx.doi.org/10.1016/j.atmosenv.2016.12.042>



- Peeters (2010). *Port-related air emissions for the Auckland region 2006 & 2010*. Prepared for Auckland Council by M&P Consulting Ltd
- Ryan (2003). *Bay of Plenty regional air emission inventory*. Prepared for Bay of Plenty Regional Council by SKM. Available at: <https://www.boprc.govt.nz/.../SKM-090803-BOPAirEmissionInvengory.pdf>
- Salomon & Smithson (2015). *Inventory of emissions to air in the Canterbury airsheds – industrial and commercial emissions – 2014 update*. Prepared by Environment Canterbury Regional Council, Report No. R15/101. Available at: <https://ecan.govt.nz/technical-reports/>
- Scott & Gunatilaka (2004). *2002 Christchurch inventory of emissions to air*. Prepared for Environment Canterbury Regional Council. Report No. R04/03. Available at: <https://ecan.govt.nz/technical-reports/>
- Sherman & Fisher (2005). *Air emissions inventory for the Gisborne region*. Prepared for Gisborne District Council by Endpoint Ltd
- Smith & Wilton (2007). *Air emission inventory - Matamata, Putaruru & Waihi 2006*. Prepared for Waikato Regional Council, Technical Report 2007/13. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Smithson (2008). *Inventory of emissions to air in Christchurch, 2006*. Prepared by Environment Canterbury Regional Council, Report No. R08/70. Available at: <https://ecan.govt.nz/technical-reports/>
- Smithson (2011). *Inventory of emissions to air in Christchurch, 2009*. Prepared by Environment Canterbury Regional Council. Report No. R11/17. Available at: <https://ecan.govt.nz/technical-reports/>
- Smithson *et al.* (2006). *Inventory of emissions to air in Timaru & Washdyke, 2005*. Prepared by Environment Canterbury Regional Council, Report No. R06/42. Available at <https://ecan.govt.nz/technical-reports/>
- Sridhar & Metcalfe (2014). *Motor vehicle emissions inventory for Canterbury airsheds*. Prepared for Environment Canterbury Regional Council by Emission Impossible Ltd. Available at: <https://ecan.govt.nz/technical-reports/>
- Sridhar & Wickham (2013). *Masterton & Carterton domestic fire emissions inventory 2013*. Prepared for Greater Wellington Regional Council by Emission Impossible Ltd
- Sridhar *et al.* (2014a). *Auckland motor vehicle emissions inventory*. Prepared for Auckland Council by Emission Impossible Ltd, TR2014/029. Available at: <http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalreports2014.aspx>
- Sridhar *et al.* (2014b). *Future trends in motor vehicle emissions in Auckland*. Prepared for Auckland Council by Emission Impossible Ltd, TR2014/028. Available at: <http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalreports2014.aspx>
- Wilton (2001a). *Taupo, Huntly, Putaruru & Matamata domestic heating emission inventory*. Prepared for Waikato Regional Council by Environet Ltd Technical Report 2001/17. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>

- Wilton (2001b). *Timaru inventory of air emissions - 2001*. Prepared for Environment Canterbury Regional Council by Environet Ltd, Report No. R01/29. Available at: <https://ecan.govt.nz/technical-reports/>
- Wilton (2002a). *Hamilton emission inventory assessment - 1997 & 2001*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2002/20. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2002b). *Hamilton, Tokoroa & Te Kuiti - Domestic heating emission inventory 2001*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2002/21. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2004a). *Taupo emission inventory 2004*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2004/30. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2004b). *Tokoroa emission inventory 2004*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2005/11. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2005a). *Invercargill & Gore, air emission inventory - 2004*. Prepared for Environment Southland by Environet Ltd
- Wilton (2005b). *Air emission inventory - Hawke's Bay Region - 2005*. Prepared for Hawkes Bay Regional Council by Environet Ltd
- Wilton (2005c). *Air emission inventory Dunedin, Mosgiel & Alexandra 2005*. Prepared for Otago Regional Council by Environet Ltd
- Wilton (2005d). *Blenheim air emission inventory - 2005*. Prepared for Marlborough District Council by Environet Ltd
- Wilton (2006a). *Hamilton emission inventory 2005*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2005/52R. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2006b). *Air emission inventory - Te Awamutu, Turangi & Ngaruawahia 2006*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2006/43. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2006c). *Air emission inventory - Wainuiomata & Upper Hutt*. Prepared for Greater Wellington Regional Council by Environet Ltd
- Wilton (2006d). *Air emission inventory - Nelson 2006*. Prepared for Nelson City Council by Environet Ltd
- Wilton (2007). *Air emission inventory - Whangarei 2006*. Prepared for Northland Regional Council by Environet Ltd
- Wilton (2012a). *Air emission inventory - Hamilton & Tokoroa 2012*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2012/34. Available at: <https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2012b). *Blenheim air emission inventory - 2012*. Prepared for Marlborough District Council by Environet Ltd
-

- Wilton (2013). *Reefton air emission inventory - 2012*. Prepared for West Coast Regional Council by Environet Ltd
- Wilton (2014). *Nelson air emission inventory - 2014*. Prepared for Nelson City Council by Environet Ltd
- Wilton (2015a). *Air emission inventory - Taupo 2014*. Prepared for Waikato Regional Council by Environet Ltd. Technical Report 2015/01. Available at:  
<https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2015b). *Air emission inventory - Te Kuiti & Putaruru 2015*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2015/29. Available at:  
<https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton (2015c). *Napier, Hastings & Havelock North air emission inventory 2015*. Prepared for Hawkes Bay Regional Council by Environet Ltd
- Wilton (2015d). *Assessment of PM<sub>10</sub> Richmond emissions by meshblock 2013 estimate*. Prepared for Tasman District Council by Environet Ltd
- Wilton (2015e). *Invercargill & Gore, air emission inventory - 2011 (2015 update)*. Prepared for Environment Southland by Environet Ltd
- Wilton (2016a). *Air emission inventory - Tokoroa & Morrinsville 2016*. Prepared for Waikato Regional Council by Environet Ltd, Report No. 2016/31. Available at:  
<https://www.waikatoregion.govt.nz/services/publications/technical-reports/>
- Wilton (2016b). *Awatoto air emission inventory - 2016*. Prepared for Hawkes Bay Regional Council by Environet Ltd
- Wilton (2016c). *Alexandra, Arrowtown, Mosgiel & Milton air emission inventory - 2016*. Prepared for Otago Regional Council by Environet Ltd
- Wilton & Baynes (2007). *Air emission inventory - Tokoroa & Te Kuiti 2007*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2008/02. Available at:  
<https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton & Baynes (2010a). *Air emission inventory - Taupo, Thames & Huntly 2009*. Prepared for Waikato Regional Council by Environet Ltd, Technical Report 2010/13. Available at:  
<https://www.waikatoregion.govt.nz/services/publications/air/air-publications/>
- Wilton & Baynes (2010b). *Air emission inventory - Napier, Hastings & Havelock North 2010*. Prepared for Hawkes Bay Regional Council by Environet Ltd
- Wilton & Baynes (2010c). *Air emissions inventory - Taumarunui & Taihape 2010*. Prepared for Horizons Regional Council by Environet Ltd, Report No. 2010/EXT/1129. Available at:  
<https://www.horizons.govt.nz/publications-feedback/publications>
- Wilton & Baynes (2010d). *Air emission inventory - Richmond 2010*. Prepared for Tasman District Council by Environet Ltd
- Wilton & Simpson (2001). *Nelson emission inventory 2001*. Prepared for Nelson City Council by Environet Ltd & Tonkin & Taylor

Wilton *et al.* (2008). *New Zealand sulphur dioxide industrial emission inventory - 2007*. Prepared for the Ministry for the Environment by Environet Ltd and Specialist Environmental Services.

Wilton *et al.* (2015). *Home heating emission inventory and other sources evaluation*. Prepared for Ministry for the Environment and Statistics NZ by Environet Ltd and Golders Associates

Xie (2016). *Auckland's greenhouse gas inventory to 2014*. Prepared by Auckland Council, TR2016/044. Available at:  
<http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalreports2016.aspx>

Xie *et al.* (2014). *Auckland air emissions inventory 2006*. Prepared for Auckland Council, TR2014/015.  
<http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalreports2014.aspx>

## Appendix 1: Inventory metadata

### New Zealand

<b>Region:</b>	New Zealand	<b>Reference:</b>	Wilton <i>et al.</i> 2015
<b>Area/airshed:</b>	National	<b>Population data:</b>	2013 Census
<b>Years:</b>	<b>2013 (actual)</b>	<b>Spatial resolution:</b>	Census area unit Airshed

#### Methodology assumptions

##### Transport sources: Motor vehicles

- VEPM 5.0 default values for 2013
  - Two speeds, more than and less than 80 km/hr (MoT)
- VKT by CAU for 2013 (NZTA)
  - CAU estimate divided by total for NZ for proportion of total emissions within each CAU
- Daily winter average and annual estimate

##### Domestic sources: Home heating

- EFs Varies based on appliance type, year of appliance and pollutant
  - Wood PM<sub>2.5</sub> EFs assumes 100% PM<sub>10</sub> is in PM<sub>2.5</sub> size fraction
  - Coal PM<sub>2.5</sub> proportion assumed to be 88% of PM<sub>10</sub>
- 2013 census home heating methods (wood and coal)
  - Average fuel consumption (from recent inventories)
  - Distribution of wood burning appliances
  - Proportion of coal burnt on appliances
- Additional surveying for other (non-inventory) areas
- Average log weight of 1.6kg (mid-point of average range of values)
- Daily winter average and annual estimate

##### Industry sources: Consented industry

- Based on existing recent inventory data
- Focusses on combustion activities excludes many process emissions and industry-related fugitive dust emissions
- Results differ between summaries and those contained in emission inventories due to:
  - Limited nature of this assessment, and
  - Different spatial coverage (the airshed areas differ to the areas defined in the inventory)
- Daily winter average and annual estimate

##### Outdoor burning

- Emission rates based on existing recent inventory data where available
  - Survey (2014) responses for other areas
- Material burnt based on material density of 75 kg/m<sup>3</sup> and AP42 EFs for burning garden waste
- Daily winter average and annual estimate

## Northland

<b>Region:</b>	Northland	<b>Reference:</b>	Wilton 2007
<b>Area/airshed:</b>	Whangarei airshed	<b>Population data:</b>	2001 Census
<b>Years:</b>	<b>2006 (actual)</b>	<b>Spatial resolution:</b>	Census area unit Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs (fleet weighted) from NZTER database (MoT)
  - Vehicle registration data for Whangarei from July 2006 (MoT).
- SO<sub>2</sub> and CO<sub>2</sub> emission rates derived from national vehicle fleet profile.
- 4 levels of congestion
  - Assumes 30% of VKTs occur under cold running conditions
- VKT estimated using VKT to household ratios (lower range of 28 VKT per household)
- Daily average

#### Domestic sources: Home heating

- EF varies based on appliance type, year of appliance and pollutant
- Home heating survey winter 2006 (heating methods & fuel use)
  - Households extrapolated for 2006 from 2001 Census
  - Based on a 12% increase in population by 2021 (Statistics NZ)
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

#### Industry sources: Consented industry

- Stack testing results used to estimate emissions over emission factors.
  - NZ specific EFs used for PM<sub>10</sub>
  - AP42 database (USEPA) used everywhere else
- Surveyed blasting industries for types of emissions control technology.
- Monthly profile

#### Outdoor burning

- EFs from AP42 database (USEPA)
- Home heating survey
- Monthly profile

## Auckland

<b>Region:</b>	Auckland	<b>Reference:</b>	Xie <i>et al.</i> 2014
<b>Area/airshed:</b>	Auckland (region) Auckland (urban airshed)	<b>Population data:</b>	2006 Census
<b>Years:</b>	<b>2006 (actual)</b> 2001 (backcast) 2011 (forecast)	<b>Spatial resolution:</b>	Census area units Airshed Region

### Methodology assumptions

#### Transport sources: Motor vehicles

- VEPM 4.1
  - Speeds between 10 and 99km/hr
- SO<sub>2</sub> calculated based on methodology in VEPM3.0 user notes
- PM<sub>2.5</sub> assumed 100% PM<sub>10</sub> exhaust emissions and 80% PM<sub>10</sub> for brake and tyre
- VKT from Auckland Regional Transport model (ART) version 3.0
  - 3 time periods (AM, IP and PM) extrapolated for daily profile
  - Light and heavy vehicle proportions
- Daily average and annual estimates

#### Transport sources: Shipping

- AP42 EFS (USEPA)
- Ships, port vessels (tugs and pilot boats), ferries, and commercial fishing boats
  - Includes land based port-related activities (cargo handling, dredging operations)
  - Commercial fishing vessel data from Ministry of Fisheries
- Vessel specific data collected (movements, gross tonnage, engine power, speed) from Ports of Auckland
- Travel speeds from automatic identification system (AIS) transponder data
- Annual estimates

#### Transport sources: Aviation

- EFs per aircraft movement from Auckland air emissions inventory: 2004 (Metcalf *et al.* 2006)
- Annual movements for 2006 from Auckland Airport Ltd
- Annual estimates

#### Transport sources: Rail

- Kilolitre of fuel by type of engine (based on 1998 fleet)
- Fuel consumption for 1998 supplied by the Auckland Regional Council (now Auckland Council)
- Annual estimates

#### Transport sources: Off-road mobile sources

- Unregistered motorbikes, competition vehicles, farm, forestry, and defence vehicles
- Based on vehicle type/equipment specific annual fuel consumption, load and emission factor as per Auckland air emissions inventory: 2004 (Metcalf *et al.* 2006)
- Annual estimates

---

**Domestic sources: Home heating**

- Woodburners EFs from NZ based emissions testing in New Zealand for PM<sub>10</sub>
  - Other burners and contaminants updated based on review of international emission factors, and testing in New Zealand.
- Appliance numbers and emissions estimated from:
  - Home heating survey 2007.
  - Domestic fire emission prediction model (DFEPM)
  - Natural gas and LPG from Auckland regional energy database.
  - Number of households using wood, coal, LPG or natural gas from 2006 Census (Statistics NZ)
- Daily winter average and annual estimate

---

**Domestic sources: Lawn mowing**

- EFs for PM (NPI)
  - For other contaminants, emission factors sourced from Priest et al (2000)
- 1993 domestic survey scaled by population projections for 2006 (Statistics NZ)
- Annual estimate

---

**Industry sources: Consented industry**

- Auckland Council consents database
  - Emissions testing, assessment of environmental effects, consent limits and AP42 USEPA EFs

---

**Industry sources: Commercial sources**

- Per capita emissions calculated based on Auckland air emissions inventory: 2004 (Metcalf *et al.* 2006).
  - Scaled by population for 2006 and 2011

---

**Outdoor burning**

- EFs for municipal refuse (USEPA)
  - CO<sub>2</sub> EFs assumed the same as for wood combustion
- 1993 domestic survey and scaled by population projections for 2006 (Statistics NZ)
- Annual estimate



## Bay of Plenty

**Region:** Bay of Plenty

**Reference:** Iremonger *et al.* 2007

**Area/airshed:** Rotorua (urban)

**Population data:** 2006 Census

**Years:** 2005 (actual)

**Spatial resolution:** Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs (fleet-weighted) from NZTER version 1 (MoT)
  - SO<sub>2</sub> not included in estimates
- Fleet profile for urban roads and state highways
  - Traffic counts from the RAMM traffic database (MoT)
  - Vehicle registration data (MoT)
- 3 levels of congestion

#### Transport sources: Aviation

- EFs from NPI (Environment Australia)
  - General aviation EFs used
- Number of take-offs and landings (Rotorua Regional Airport Limited) for 2005

#### Domestic sources: Home heating

- Rotorua home heating survey 2005
  - Schools included as a subgroup
  - Coal supply figures for 2005 and EFs for overfeed stoker boilers taken from AP42 (USEPA) and Coal Research Ltd
- Heating model developed

#### Industry sources: Consented industry

- Consent limits and hours of operation for PM<sub>10</sub>
  - Fuel consumption from consent application for other contaminants.
  - Maximum consented discharge limits used.

#### Industry sources: Small combustion

- Source emission rates allocated based on point source emission data
  - Based on facility type derived from Rotorua District Council database

<b>Region:</b>	Bay of Plenty	<b>Reference:</b>	BOPRC 2008
<b>Area/airshed:</b>	Whakatane (urban)	<b>Population data:</b>	2006 Census
<b>Years:</b>	<b>2007 (actual)</b>	<b>Spatial resolution:</b>	Urban area

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs (fleet-weighted) from NZTER version 1 (MoT)
  - SO<sub>2</sub> not included in estimates
- Fleet profile for urban roads and state highways
  - Traffic counts from the RAMM traffic database (MoT)
  - Vehicle registration data for 2006 (MoT)
- 3 levels of congestion

---

#### Domestic sources: Home heating

- Data gathered from inventories (of similar geographical areas), household energy use studies, Statistics NZ 2006 census datasets
- 2006 census home heating methods
- Ratios of wood burning appliance from the Rotorua domestic heating survey (2005)
- Domestic annual coal volume (Solid Energy)
- Annual average daily wood use of 6.5 kg

---

#### Industry sources: Consented industry

- One consented industry within urban area: CHH Paperboard Limited
  - Total consented emission limit used.

---

#### Industry sources: Small combustion

- Source emission rates allocated based on point source emission data
  - Based on facility type derived from Whakatane District Council database

## Waikato

<b>Region:</b>	Waikato	<b>Reference:</b>	Wilton 2015b
<b>Area/airshed:</b>	Te Kuiti airshed Putaruru airshed	<b>Population data:</b>	2013 Census
<b>Years:</b>	<b>2015 (actual)</b>	<b>Spatial resolution:</b>	Census area unit Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs from VEPM 5.0
- Fleet profile registration data for each area, year ending May 2015
- Annual average temperature of 15°C (Te Kuiti) and 11°C (Putaruru)
- SOx emission factors based on fuel sulphur content (0.01%)
  - Assumed 100% conversion to SOx.
- NZTA VKT data for 2013 by census area unit
  - Distributed by time of day splits from the Taupo transport model
- Daily winter average and annual estimate

#### Domestic sources: Home heating

- EFs vary based on appliance type, year of appliance and pollutant
- Home heating survey (May & June 2015)
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

#### Industry sources: Consented industry

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 EF for all others (USEPA)
- Resource consent application data from council database
- Schools surveyed to determine source of heating
- Fugitive dust emissions not included
- Seasonal profile

#### Outdoor burning

- AP42 EFs (USEPA)
- 2015 home heating survey
- Emissions calculated based on assumption:
  - Average weight of material per burn = 75kg
  - Average fire size = 1m<sup>3</sup>
  - Burning is carried out evenly through winter
- Seasonal profile

<b>Region:</b>	Waikato	<b>Reference:</b>	Wilton 2016a
<b>Area/airshed:</b>	Tokoroa airshed Morrinsville airshed	<b>Population data:</b>	2013 Census
<b>Years:</b>	<b>2016 (actual)</b>	<b>Spatial resolution:</b>	Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- VEPM 5.1
- Fleet profile from registration data for each area, year ending 20 June 2016
- 2015 annual average temperature of 11°C (Tokoroa)
- SO<sub>x</sub> emission factors based on fuel sulphur content of fuel (0.01%)
  - Assumed 100% conversion to SO<sub>x</sub>.
- NZTA VKT data for 2013 by census area unit
  - Distributed by time of day splits from the Taupo transport model
- Daily average

---

#### Domestic sources: Home heating

- EFs vary based on appliance type, year of appliance and pollutant
- Home heating survey (May & June 2016)
- Assumes:
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average
- Monthly profile

---

#### Industry sources: Consented industry

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 emission factors for all others (USEPA)
- Resource consent application data from council database
- Fugitive dust emissions not included
- Seasonal profile

---

#### Outdoor burning

- AP42 EFs (USEPA)
  - Benzene and BaP based on wood burning for domestic heating and are indicative only
- 2016 home heating survey
- Emissions calculated based on assumption:
  - Average weight of material per burn = 159kg
  - Average fire size = 1.9m<sup>3</sup> (Tokoroa) and 0.6m<sup>3</sup> (Morrinsville)
  - Burning is carried out evenly through winter
- Seasonal profile

<b>Region:</b>	Waikato	<b>Reference:</b>	Wilton 2015a
<b>Area/airshed:</b>	Taupo airshed	<b>Population data:</b>	2013 Census
<b>Years:</b>	<b>2014 (actual)</b>	<b>Spatial resolution:</b>	Census area unit Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- VEPM 3.0
- Fleet profile based on Taupo registration data, year ending 31 May 2014
- Annual average temperature for Taupo
- SOx emission factors based on fuel sulphur content of fuel (0.01%)
  - Assumed 100% conversion to SOx.
- NZTA VKT data for 2013 by census area unit
  - Total VKT extrapolated based on additional households in the airshed
  - Time of day splits from Taupo transport model
- Daily average

---

#### Domestic sources: Home heating

- Varies based on appliance type, year of appliance and pollutant
- Home heating survey (June 2014)
- Assumes:
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average
- Monthly profile

---

#### Industry sources: Consented industry

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 emission factors for all others (USEPA)
- Resource consent application data
  - Phone survey or provided by Council staff for missing data
- Schools surveyed by phone/email to determine source of heating
- Fugitive dust emissions not included
- Seasonal profile

---

#### Outdoor burning

- AP42 emission factors (USEPA)
  - Benzene and BaP based on wood burning for domestic heating and are indicative only
- 2014 home heating survey
- Emissions calculated based on assumption:
  - Average weight of material per burn = 75kg
  - Average fire size = 1m<sup>3</sup>
  - Burning is carried out evenly through winter
- Seasonal profile

<b>Region:</b>	Waikato	<b>Reference:</b>	Wilton 2012a
<b>Area/airshed:</b>	Hamilton airshed	<b>Population data:</b>	2006 Census
<b>Years:</b>	<b>2012 (actual)</b>	<b>Spatial resolution:</b>	Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- VEPM 3.0
- Fleet profile based on Hamilton registration data, year ending 30 April 2012
- Annual average temperature for Taupo
- SOx emission factors based on fuel sulphur content (0.01%)
- Assumed 100% conversion to SOx.
- VKT data by census area unit for year ending 2010 (MoT)
  - Total VKT extrapolated based on additional households in the airshed
  - Time of day splits from 2005 Hamilton inventory
- Daily average

---

#### Domestic sources: Home heating

- Varies based on appliance type, year of appliance and pollutant
- Home heating survey (June 2012)
- Assumes:
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average & worst case scenario
- Monthly profile

---

#### Industry sources: Consented industry

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 emission factors for all others (USEPA)
- Resource consent application data
  - Phone survey or provided by Council staff for missing data
- Schools surveyed by phone/email to determine source of heating
- Fugitive dust emissions not included
- Seasonal profile

---

#### Outdoor burning

- AP42 emission factors (USEPA)
  - Benzene and BaP based on wood burning for domestic heating and are indicative only
- 2012 home heating survey
- Emissions calculated based on assumption:
  - Average weight of material per burn = 150kg
  - Average fire size = 1.2m<sup>3</sup> (Hamilton)
  - Burning is carried out evenly through winter
- Seasonal (winter months)

## Gisborne

<b>Region:</b>	Gisborne	<b>Reference:</b>	Sherman & Fisher 2005
<b>Area/airshed:</b>	Gisborne (region)	<b>Population data:</b>	2001 Census
<b>Years:</b>	<b>2005 (actual)</b>	<b>Spatial resolution:</b>	Census area unit

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs (fleet weighted) from NZTER (MoT)
  - Exhaust emissions from on-road motor vehicles only
  - Vehicle fleet profile derived from vehicle registrations for 2002 (MoT)
  - SO<sub>2</sub> and CO<sub>2</sub> emission rates derived from national vehicle fleet profile.
  - Benzene emissions factors based on a weight fraction of motor vehicle VOC emissions from NPI
  - Apportioned using the Gisborne vehicle fleet profile.
  - Average driving speeds 36-70 km/h (suburban) and >71 km/h (rural highway)
- Dynamic On-Road Transport (D.O.T.) Model Fleet Hub (MoT)
- Daily winter average

---

#### Transport sources: Marine

- EFs assumed to apply to all shipping travelling through a 12 NM zone
- Heavy fuel oil (HFO) sulphur content = 1.5%
- Port calls and harbour vessel work hours (Eastland Port Ltd)
- Annual estimates

---

#### Transport sources: Aviation

- Fuel used assumed to apply for all aircraft
  - Aviation fuel (Air BP)
- Percent fuel used for each category assumed same as 1996 taking into account current total fuel used
- Assumes 20% of the fuel loaded is burnt in the Gisborne region
- Annual estimate

---

#### Transport sources: Off-road vehicles

- Off-road vehicle use assumed to be twice that of Auckland

---

#### Domestic sources: Home heating

- EFs vary based on appliance type, year of appliance and pollutant
- Based on the Environment Protection Authority of Victoria's Auckland air emissions inventory upgrade (2005-draft).
  - Emissions scaled according Gisborne's population.
  - 2004 Taupo emissions inventory percentages matched with Gisborne household data to estimate combustion methods for Gisborne.
- Assumes:
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg

- Daily winter average

---

**Industry sources:      Consented industry**

- Resource consent data from council:
  - Amount of fuel used
  - Nature of raw material used
  - Operating hours and capacity
- Additional information obtained from industry.
- Annual estimate

---

**Outdoor burning**

- Rate of domestic waste combustion assumed three times that of Auckland.
- Particulate size distribution assumed same as Auckland
  - 98% of all particulate matter assumed to be PM<sub>10</sub>.
- Annual estimate

---

**Other sources:      Bush fires**

- Assumed biomass density for scrub and forested areas = 50 T/ha
- 75% of biomass was burnt
  - 90% is oxidized to carbon (carbon fraction = 45%)
- Data recorded and estimated by the Rural Fire Authority
  - Includes areas of forest, scrub and grass burned by accident or for clearance purposes.
- Assumed in addition, 50 ha burned each year but unreported.
- Emissions from grass fires assumed negligible.
- Annual estimate

---

**Other sources:      Natural**

- 1996 Natural Emissions Inventory for New Zealand (NIWA).
  - Mostly based on overseas data, adjusted in some cases for New Zealand temperatures.
- 1996 inventory land type classification data.
- Annual estimate



## Hawke's Bay

<b>Region:</b>	Hawke's Bay	<b>Reference:</b>	Wilton 2015c
<b>Area/airshed:</b>	Napier Hastings Havelock North	<b>Population data:</b>	2013 Census
<b>Years:</b>	<b>2015 (actual)</b>	<b>Spatial resolution:</b>	Census area unit

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs from VEPM 5.1
  - Fleet profile based on registration data for each area, year ending March 2015
  - Average winter temperature of 8.5°C
  - Assumed 42km/hr average speed
- SOx emission factors based on fuel sulphur content (0.01%)
  - Assumed 100% conversion to SOx.
- VKT data for 2013 by census area unit (NZTA)
- Daily average

#### Transport sources: Motor vehicles (re-suspended road dust)

- Tracer component method used to separate exhaust and non-exhaust emissions in Auckland.
- Ratios used to estimate non-exhaust PM<sub>10</sub> and PM<sub>2.5</sub> emissions from motor vehicles.

#### Transport sources: Marine

- EFs have the following assumptions:
  - Total harbour transit times for each journey in and out of one hour
  - Operating power during harbour transit of 50%
  - SOx emission rate based on average sulphur content of 1%.
  - PM<sub>2.5</sub> to PM<sub>10</sub> ratio of 0.87
- Number and types of vessels entering and leaving Port of Napier
  - Data supplied by the Harbourmaster
- Average kW per ship based on gross tonnage of vessels within each weight category
- Annual estimates

#### Transport sources: Aviation

- EFs from combination of sources
- 2010 annual landing and take-off cycles by time of day for Hawke's Bay airport
- Time of day profile and annual estimates

#### Domestic sources: Home heating

- EFs varies based on appliance type, year of appliance and pollutant
- Home heating survey June 2015 (heating methods & fuel use)
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

---

**Industry sources:    Consented industry**

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 emission factors for all others (USEPA)
- Combination of resource consent database and 2010 air emission inventory industry to identify emitters.
- Phone and email survey
  - Schools surveyed to determine source of heating
- Fugitive dust emissions not included
- Small commercial activities such as spray painting, dry cleaning etc not included in inventory
- Seasonal profile

<b>Region:</b>	Hawke’s Bay	<b>Reference:</b>	Wilton 2016b
<b>Area/airshed:</b>	Awatoto airshed	<b>Population data:</b>	N/A
<b>Years:</b>	<b>2016 (actual)</b>	<b>Spatial resolution:</b>	Census area unit Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- MfE database using national vehicle emissions estimates (NIWA)
  - Distributed to CAUs based on VKT data (Wilton *et al.* 2015)
- Estimates include tail pipe emissions, brake and tyre wear
- Daily average and annual estimate

---

#### Domestic sources: Home heating

- Weighted average solid fuel burner for Napier from (Wilton 2015c)
  - Average daily fuel use during winter = 16.8 kg per night
- Aerial survey of dwellings;
- Proportion of dwellings using solid fuel for home heating by CAU.
- Daily winter average and monthly profile

---

#### Industry sources: Consented industry

- Emission factors/emission rates from industrial testing or consent files.
- Resource consents data
- Historical emissions inventory information obtained through industry surveys.

## Manawatu-Wanganui

<b>Region:</b>	Manawatu-Wanganui	<b>Reference:</b>	Wilton & Baynes 2010c
<b>Area/airshed:</b>	Taumarunui airshed Taihape airshed	<b>Population data:</b>	Census 2006
<b>Years:</b>	<b>2010 (actual)</b>	<b>Spatial resolution:</b>	Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- VEPM 3.0 EFs
  - Fleet profile based on registration data for each area, year ending April 2010
  - Assumed average 50km/hr speeds
  - SOx emission factors based on fuel sulphur content (0.005%) and assumed 100% conversion to SOx.
- Population based estimate derived from relationship between VKT and dwelling numbers
  - VKT estimate based on the average ratio of VKT/households for Timaru and Havelock North
- Daily average estimate

---

#### Domestic sources: Home heating

- Varies based on appliance type, year of appliance and pollutant
- Home heating survey June 2010 (heating methods & fuel use)
- 2010 household estimates made using 2007 Statistics NZ population projections
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

---

#### Industry sources: Consented industry

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 EFs for all others (USEPA)
- Consents data used to identify possible emitters.
- Fugitive dust emissions not included
- Small commercial activities such as spray painting, dry cleaning etc not included in inventory
- Seasonal profile

---

#### Outdoor burning

- AP42 EFs (USEPA)
- 2010 home heating survey
- Emissions calculated based on assumption:
  - Average weight of material per burn = 120kg
  - Average fire size = 1.2m<sup>3</sup> (Hamilton)
  - Burning is carried out evenly through winter
- Seasonal - winter months

## Wellington

<b>Region:</b>	Wellington	<b>Reference:</b>	Wilton 2006c
<b>Area/airshed:</b>	Wainuiomata airshed Upper Hutt airshed	<b>Population data:</b>	2001 Census
<b>Years:</b>	<b>2006 (actual)</b>	<b>Spatial resolution:</b>	Airshed

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs (fleet-weighted) from NZTER (MoT)
  - Vehicle registrations data year ending December 2005 (Land Transport NZ)
  - Distribution light, medium and heavy-duty vehicles based on the 1998 New Zealand fleet profile
  - 3 levels of congestion
  - Brake & tyre emission factors for PM<sub>10</sub> and PM<sub>2.5</sub> from the British Columbia Lower Fraser Valley and adjusted for the Wellington vehicle fleet profile
- Greater Wellington Region road network model
- Assumes 27% VKT in Wainuiomata and 12% of the VKTs in Upper Hutt
- Daily average

---

#### Domestic sources: Home heating

##### Emission factors:

- Varies based on appliance type, year of appliance and pollutant
  - Reviewed to include “in-situ” burner testing
- Phone home heating survey May 2006 (heating methods & fuel use)
  - Number of households extrapolated for 2006 from 2001 census population projections (Statistics NZ)
- Assumes:
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

---

#### Industry sources: Consented industry

- AP42 EFs (USEPA)
- Natural gas factors derived by NIWA for the Christchurch 1996 emission inventory
- List of industries discharging to air from consents information (Greater Wellington Regional Council)
  - Stack testing results used where available
  - Activity data collected from local industrial and commercial activities and local schools
- Monthly profile

---

#### Outdoor burning

- AP42 EFs (USEPA)
  - Domestic home heating survey
  - Emissions calculated based on assumption that average weight of material per burn = 180kg
  - Monthly profile
-

## Nelson

<b>Region:</b>	Nelson	<b>Reference:</b>	Wilton 2014
<b>Area/airshed:</b>	Nelson A airshed Nelson B1 airshed Nelson B2 airshed Nelson C airshed	<b>Population data:</b>	N/A
<b>Years:</b>	<b>2014 (actual)</b>	<b>Spatial resolution:</b>	Census area units Airsheds

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs from VEPM 5.0
  - Vehicle fleet profile based on Nelson vehicle registration data (year ending 31 May 2014)
  - Average temperature for Nelson used
  - 42 km/hr average speed assumed
  - SO<sub>x</sub> emission factors for diesel vehicles based on fuel sulphur content and assumed 100% conversion to SO<sub>x</sub>.
- VKT data for 2013 by CAU (NZTA)
- Daily average

---

#### Transport sources: Aviation

- Assumed 4kg/day of PM<sub>10</sub> emitted

---

#### Domestic sources: Home heating

- Varies with type of appliance, type of fuel, and pollutant.
- July 2014 home heating survey (heating methods & fuel use)
- Daily winter average

---

#### Industry sources: Consented industry

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 EFs for all others (USEPA)
  - Combinaton of consents data, 2006 air emissions inventory and information from Nelson City Council used to identify possible emitters
  - Site specific emissions data used where available
- Schools surveyed for heating method used
- Seasonal profile

## Tasman

<b>Region:</b>	Tasman	<b>Reference:</b>	Wilton & Baynes 2010d
<b>Area/airshed:</b>	Richmond (urban)	<b>Population data:</b>	2006 Census
<b>Years:</b>	<b>2010 (actual)</b>	<b>Spatial resolution:</b>	Census area units

### Methodology assumptions

#### Transport sources: Motor vehicles

- VEPM 3.0 EFs
  - Vehicle fleet profile based on vehicle registration data year ending April 2010
  - Winter average temperature 2006 - 2009 for Richmond of 8.4°C
  - SOx emission factors based on fuel sulphur content (0.005%) and assumed 100% conversion to SOx
- Population based estimate:
  - Relationship between VKT and dwelling numbers
  - Ratio of VKT/households based on road network modelling for Nelson (2006 inventory)
- Daily average

---

#### Domestic sources: Home heating

- Varies with type of appliance, type of fuel, and pollutant.
- Digipol home heating survey June 2010 (heating methods & fuel use)
- 2010 households estimated using 2007 population projections for Tasman (Statistics NZ)
  - Average log weight = 1.6kg
  - Average bucket of coal = 9kg
- Daily winter average and monthly profile

---

#### Industry sources: Consented industry

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 EFs for all others (USEPA)
- Phone survey
  - Additional data provided by Tasman District Council
  - Scvhools surveyed to determine heating methods
- Fugitive dust emissions not included
- Seasonal profile

## Marlborough

<b>Region:</b>	Marlborough	<b>Reference:</b>	Wilton 2012b
<b>Area/airshed:</b>	Blenheim	<b>Population data:</b>	2006 Census
<b>Years:</b>	<b>2012 (actual)</b>	<b>Spatial resolution:</b>	Census area units Airsheds

### Methodology assumptions

#### Transport sources: Motor vehicles

- VEPM 5.0 EFs
  - Vehicle fleet profile based on Marlborough vehicle registration data (year ending 30 April 2012)
  - Average winter temperature for Blenheim (8°C) in 2011
  - 42 km/hr average speed assumed
  - SOx emission factors for diesel vehicles based on fuel sulphur content (0.01%) and assumed 100% conversion
- VKT by CAU for the year ending 2010 (MoT)
  - VKT adjusted down by 8% to align estimates with vehicle registration data
  - Time of day breakdown from Havelock North 2005 (no data available for Blenheim)
- Hourly profile and daily averages

---

#### Domestic sources: Home heating

- EFs vary with type of appliance, type of fuel, and pollutant.
- Home heating survey June 2012 (heating methods & fuel use)
- 2012 estimate based on population projection for Marlborough district (Statistics NZ)
  - Average log weight = 1.6kg
- Daily winter average and monthly profile

---

#### Industry sources: Consented industry

- NZ specific coal fired boiler PM<sub>10</sub> EFs
  - AP42 EFs for all others (USEPA)
- Phone survey and additional data provided by Marlborough District Council staff
- Activities such as spray painting or dry cleaning not included
- Schools with discharge consents surveyed by phone to determine source of heating.
- Fugitive dust emissions not included

---

#### Outdoor burning

- AP42 EFs (USEPA)
- Assumed:
  - Average weight of material per burn = 75kg
  - Burning is carried out evenly through winter
- 2012 domestic home heating survey
- Collected for winter months



## Canterbury

<b>Region:</b>	Canterbury	<b>Reference:</b>	McCauley & Scott 2006
<b>Area/airshed:</b>	Waimate, Ashburton, Kaiapoi & Rangiora	<b>Population data:</b>	2001 Census
<b>Years:</b>	<b>2004 (actual)</b>	<b>Spatial resolution:</b>	Census area units

### Methodology assumptions

#### Transport sources: Motor vehicles

- Non-tailpipe emissions (ie. brake and tyre wear) not included in the inventory
- NZTER version 1.0 (MoT)
  - Base year 2004 for PM<sub>10</sub>, NO<sub>x</sub> and CO
  - PM<sub>2.5</sub> calculated as proportions of PM<sub>10</sub> values using Canadian lower Fraser Valley emissions inventory
  - SO<sub>x</sub> and CO<sub>2</sub> emission factors sourced from 2002 Christchurch emissions inventory
- Single car emission rates calculated for all vehicle types
- AADT traffic count and road link lengths from RAMM database for local roads
  - Transit New Zealand for state highways
- Hourly traffic count used AADT estimate proportion of VKT occurring throughout the day VKT split by vehicle type based on 2004 vehicle registrations to calculate emissions.
- Daily average

#### Transport sources: Rail

- EFs (baseline in service) from MoT
  - SO<sub>x</sub> based on mass balances with the fuel sulphur content of 0.06 wt%
- Data from rail network owner (Toll Rail) for:
  - Train movement data
  - Engine type, time and number per day
- Assumed average train speed = 30km/hr
- Daily average

#### Domestic sources: Home heating

- EFs from 2002 Christchurch emissions inventory
  - PM<sub>10</sub> and PM<sub>2.5</sub> EFs gas fired appliances altered based on emission test results
- Household telephone survey
- Hourly profile and daily average

#### Industry sources: Consented industry

- AP42 EFs (USEPA)
- Resource consent files & site visits to identify potential sources.
  - Industrial survey undertaken
- Seasonal profile

#### Outdoor burning

- Collected for May to September 2004
- No other details (ie mass of material burnt, frequency or duration of burns) collected

<b>Region:</b>	Canterbury	<b>Reference:</b>	Smithson <i>et al.</i> 2006
<b>Area/airshed:</b>	Timaru airshed	<b>Population data:</b>	N/A
<b>Years:</b>	<b>2005 (actual)</b> 1996 (backcast) 2001 (backcast)	<b>Spatial resolution:</b>	Airshed

### Methodology assumptions

Washdyke included within Timaru airshed.

#### Transport sources: Motor vehicles

- EFs from NZTER version 1.0 (MoT)
  - Base year 2005 for PM<sub>10</sub>, NO<sub>x</sub> and CO
  - PM<sub>2.5</sub> based on proportions of PM<sub>10</sub> values
  - Fleet averaged SO<sub>x</sub> EF
  - Timaru fleet profile from vehicle registration data (MoT)
- Assumed 30% of all driving is under cold start conditions
- VKT from Timaru Transportation Model
- 3 level of service categories
- Hourly profile & daily average

#### Transport sources: Rail

- EFs for PM<sub>10</sub>, CO & NO<sub>x</sub> from MoT
  - SO<sub>x</sub> based on mass balances with the fuel containing 0.05% by weight sulphur
- Data from Toll Holdings for:
  - Average monthly fuel use
  - Engine type and capacity
  - Individual train movements
  - Engine power, throttle settings and distance travelled.
- Monthly profile

#### Domestic sources: Home heating

- EFs vary with type of appliance, type of fuel, and pollutant.
  - EFs for open fires from 2002 Christchurch emissions inventory (except for benzene)
- 2005 Timaru home heating survey
- Figures from 2002 Christchurch home heating diary for woodburners used
- Assumes:
  - Coal bucket = 9kg mass
  - Log burnt wood = 1.9kg
- Hourly profile and daily average

#### Industry sources: Consented industry

- EFs AP42 and additional data from Air Chief 12 (USEPA)
  - NZ specific coal fired boiler PM<sub>10</sub> EFs
- Activity data collected based on process rather than industry type
- Questionnaires distributed to air discharge consent holders
- Follow-up phone calls
- Resource consent files
- Hourly profile, daily average and monthly profile

<b>Region:</b>	Canterbury	<b>Reference:</b>	Smithson 2011
<b>Area/airshed:</b>	Christchurch (urban)	<b>Population data:</b>	
<b>Years:</b>	<b>2009 (actual)</b> 1999 (backcast) 2002 (backcast) 2006 (backcast)	<b>Spatial resolution:</b>	TLA 10 sub areas

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs from NZTER v 1.0 (MoT)
  - Base year 2009 for PM<sub>10</sub>, NO<sub>x</sub> and CO
  - PM<sub>2.5</sub> based on proportions of PM<sub>10</sub> values
  - Brake and tyre factors included
- SO<sub>x</sub>, benzene (Environment Australia)
- Assumed 30% of all driving is under cold start conditions
- Christchurch Transport Model (CTM)
  - 4 model periods (AM, IP, PM & overnight)
  - 3 level of service categories
- Traffic count used to disaggregate VKT into hourly values
- 24 vehicle classes using Ministry of Transport registration data from Environment Canterbury.
- Hourly profile and daily average

---

#### Transport sources: Rail

- EFs for PM<sub>10</sub>, CO & NO<sub>x</sub> calculated from MoT
- SO<sub>x</sub> based on mass balances with the fuel containing 50 mg/kg sulphur
- Based solely on fuel use data from KiwiRail
- Monthly diesel tank readings
- Monthly profile

---

#### Transport sources: Aviation

- EFs from 2006 Christchurch inventory
- Landing & take-off cycles for June 2009, Christchurch International Airport Ltd
- Assumed no. arrivals = no. departures
- Annual estimates

---

#### Domestic sources: Home heating

- EFs vary with type of appliance, type of fuel, and pollutant.
- Household telephone survey
- Pellet burn rate data provided by Solid Energy
- Assumes:
  - Coal bucket = 9kg mass
  - Log burnt wood = 1.9kg
- Hourly profile and daily weekday average

---

**Domestic sources: Garden equipment**

- Includes lawn mowing, chain saws and petrol driven equipment
- Methodology and assumptions from 2002 Christchurch inventory
- Number of households in each area
- Assumes equipment used once every 8 weeks for 20 mins in winter

---

**Industry sources: Consented industry**

- EFs from AP42 and additional data from Air Chief 12 (USEPA)
  - NZ specific coal fired boiler PM<sub>10</sub> EFs
- Activity data collected based on process rather than industry type
- Questionnaires distributed to air discharge consent holders
- Follow-up phone calls
- Resource consent files
- Hourly profile and daily average
- Monthly profile

## Otago

<b>Region:</b>	Otago	<b>Reference:</b>	Wilton 2016c
<b>Area/airshed:</b>	Airzone One airsheds: Alexandra Arrowtown Mosgiel Milton	<b>Population data:</b>	2013 Census
<b>Years:</b>	<b>2016 (actual)</b>	<b>Spatial resolution:</b>	Census area units

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs from VEPM 5.1
  - Vehicle fleet profile based on vehicle registration data for year ending 30 June 2016
  - Winter average temperature for each area (Otago Regional Council)
  - SOx emission factors based on fuel sulphur content (0.01%) and assumed 100% conversion to SO<sub>2</sub>
- VKT for 2013 by CAU (NZTA)
- Daily average

#### Domestic sources: Home heating

- EFs vary with type of appliance, type of fuel, and pollutant.
- Home heating survey June and July 2016 (heating methods & fuel use)
- 2016 households estimated using 2013 census data and estimated changes in population for each area (Statistics NZ)
- Log weight of 1.6kg
- Daily winter average & monthly profile

#### Industry sources: Consented industry

- EFs from AP42 (USEPA)
- NZ specific coal fired boiler PM<sub>10</sub> EFs
- Resource consent database (Otago Regional Council) to identify potential emitters
  - Phone and email survey
- Fugitive dust emissions not included
- Seasonal profile

## West Coast

<b>Region:</b>	West Coast	<b>Reference:</b>	Wilton 2013
<b>Area/airshed:</b>	Reefton	<b>Population data:</b>	2006 Census
<b>Years:</b>	<b>2012 (actual)</b>	<b>Spatial resolution:</b>	Census area units

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs from VEPM 5.0
  - Vehicle fleet profile based on vehicle registration data for 2010 (MoT)
  - SOx emission factors for diesel vehicles based on fuel sulphur content (0.01%) and assumed 100% conversion.
- VKT by CAU for the year ending 2010 (MoT)
- Time of day breakdown from Havelock North - 2005 (no data available for Reefton)
- Daily average

---

#### Domestic sources: Home heating

- EFs vary with type of appliance, type of fuel, and pollutant
- Home heating survey November 2012 (heating methods & fuel use)
- 2012 estimated dwellings based on proportional increase in population for Reefton (Buller District Council)
- Assumed average log weight of 1.6kg
- Daily winter average & monthly profile

---

#### Industry sources: Consented industry

- EFs from AP42 (USEPA)
  - NZ specific coal fired boiler PM<sub>10</sub> EFs
- Activity data provided by West Coast Regional Council staff
- Fugitive dust emissions not included
- Seasonal profile

---

#### Outdoor burning

- AP42 EFs (USEPA)
- Assumed burning is carried out evenly through winter
- 2012 home heating survey
- Seasonal - collected for winter months

## Southland

<b>Region:</b>	Southland	<b>Reference:</b>	Wilton 2015e
<b>Area/airshed:</b>	Invercargill (urban) Gore (urban)	<b>Population data:</b>	2006 Census
<b>Years:</b>	<b>2011 (actual)</b>	<b>Spatial resolution:</b>	Census area units

### Methodology assumptions

#### Transport sources: Motor vehicles

- EFs from VEPM (version not indicated)
  - Vehicle fleet profile based on Invercargill vehicle registration data, year ending 31 July 2011
  - Average temperature of 9.5°C
  - Travel speed of 50km/hr
  - 100% conversion of sulphur in fuel
- VKT for year ending 2006 (MoT)
  - Scaled up to 2010 based on national % increase in VKT between 2006 & 2010
- Daily average

---

#### Domestic sources: Home heating

- EFs vary with type of appliance, type of fuel, and pollutant.
- Home heating survey June and July 2011 (heating methods & fuel use)
- Assumed average log weight = 1.6kg
- Daily winter average & monthly profile

---

#### Industry sources: Consented industry

- AP42 EFs (USEPA)
  - NZ specific coal fired boiler PM<sub>10</sub> EFs
- Industry phone survey
- Additional data provided by Environment Southland
- Fugitive dust emissions not included
- Seasonal profile

---

#### Outdoor burning

- AP42 EFs (USEPA)
- Assumed burning is carried out evenly through winter
- 2011 home heating survey
- Seasonal - collected for winter months