

# Air Emissions Inventory for the Greater Metropolitan Region in New South Wales

2013 Calendar Year

Consolidated Natural and Human-Made Emissions: Results

© 2019 State of NSW and the NSW Environment Protection Authority

The State of NSW and the NSW Environment Protection Authority (EPA) are pleased to allow this material to be reproduced in whole or in part for educational and non-commercial use, provided the meaning is unchanged and its source, publisher and authorship are acknowledged.

The EPA has compiled this technical report in good faith, exercising all due care and attention. No representation is made about the accuracy, completeness or suitability of the information in this publication for any particular purpose. The EPA shall not be liable for any damage which may occur to any person or organisation taking action or not on the basis of this publication. Readers should seek appropriate advice when applying the information to their specific needs.

All content in this publication is owned by the EPA and is protected by Crown Copyright, unless credited otherwise. It is licensed under the [Creative Commons Attribution 4.0 International \(CC BY 4.0\)](#), subject to the exemptions contained in the licence. The legal code for the licence is available at [Creative Commons](#).

The EPA asserts the right to be attributed as author of the original material in the following manner: © State of New South Wales and the NSW Environment Protection Authority 2019.

Published by:

NSW Environment Protection Authority  
59 Goulburn Street, Sydney NSW 2000  
PO Box A290, Sydney South NSW 1232  
Phone: +61 2 9995 5000 (switchboard)  
Phone: 131 555 (NSW only – environment information and publications requests)  
Fax: +61 2 9995 5999  
TTY users: phone 133 677, then ask for 131 555  
Speak and listen users: phone 1300 555 727, then ask for 131 555  
Email: [info@epa.nsw.gov.au](mailto:info@epa.nsw.gov.au)  
Website: [www.epa.nsw.gov.au](http://www.epa.nsw.gov.au)

Report pollution and environmental incidents  
Environment Line: 131 555 (NSW only) or [info@epa.nsw.gov.au](mailto:info@epa.nsw.gov.au)  
See also [www.epa.nsw.gov.au](http://www.epa.nsw.gov.au)

ISBN 978 1 925987 27 0  
EPA 2019P1917  
October 2019

# Acknowledgements

This study was performed with the help of organisations and individuals who should be recognised for their efforts.

We gratefully acknowledge the 3,533 residential households and 1,117 EPA-licensed premises that participated in the domestic and industrial surveys conducted by Taverner Research and Umwelt Pty Ltd, respectively, in conjunction with the NSW Environment Protection Authority. Their input has enabled a thorough evaluation of domestic and industrial sources of air emissions.

Essential to completion of this study were the data provided by other government departments and service providers, including Airservices Australia; Australian Asphalt Pavement Association; Australian Bureau of Agricultural and Resource Economics and Sciences; Australian Bureau of Statistics; Australian Energy Market Operator; Australian Paint Manufacturers Federation Inc.; Australian Rail Track Corporation; Bureau of Infrastructure, Transport and Regional Economics; Bureau of Resources and Energy Economics; Bureau of Transport Statistics; Commonwealth Scientific and Industrial Research Organisation; Department of Resources, Energy and Tourism; Duskhail Pty Ltd; GfK; IBISWorld; IHS Global Pte Ltd; Informark; International Fertilizer Industry Association; Jemena Gas Networks (NSW) Ltd; Lloyds Register Group Ltd; NSW Department of Health; NSW Maritime; NSW Registry of Births, Deaths and Marriages; NSW Roads and Maritime Services; NSW Rural Fire Service; NSW Trade and Investment; Newcastle Buses and Ferries; Newcastle Port Corporation; Office of Environment and Heritage; Outboard Engine Distributors Association; Pacific National; Port Kembla Port Corporation; Primary Industries Division of the Department of Trade and Investment; RailCorp; Regional Infrastructure and Services; Sydney Ports Corporation; Transport for NSW; United States Department of Agriculture; Winemakers' Federation of Australia and Winetitles Pty Ltd.

The work of a number of individuals is acknowledged – including the late Nick Agapides, Manager Major Air Projects; Gareth Jones, Principal Policy and Programs Officer; Daniel Helm, Technical Policy Advisor; and Greg Cooper, Senior Technical Policy Advisor – for their efforts in project scoping and management, developing emission estimation methodologies, collecting activity data, developing databases, estimating emissions and preparing this report.

# Contents

List of tables	1
List of figures	3
Executive summary	8
<b>1. Introduction</b>	<b>52</b>
<b>2. Inventory specifications</b>	<b>54</b>
<b>2.1. The inventory year</b>	<b>54</b>
<b>2.2. The inventory region</b>	<b>54</b>
<b>2.3. Grid coordinate system</b>	<b>54</b>
<b>2.4. Emission sources considered</b>	<b>56</b>
<b>2.5. Pollutants evaluated</b>	<b>56</b>
<b>2.6. Methodology overview</b>	<b>57</b>
2.6.1. Identify sources	57
2.6.2. Select emission estimation methodologies	58
2.6.3. Acquire activity, spatial and temporal data	58
2.6.4. Design and implement emission estimation techniques	58
<b>2.7. Emission estimation techniques relative to the 2008 inventory</b>	<b>58</b>
2.7.1. Natural (biogenic-geogenic)	58
2.7.2. Commercial	59
2.7.3. Domestic-Commercial	59
2.7.4. Industrial	59
2.7.5. Off-Road Mobile	59
2.7.6. On-Road Mobile	60
<b>3. Emission results</b>	<b>61</b>
<b>3.1. Carbon monoxide</b>	<b>62</b>
3.1.1. Natural and human-made emissions	62
3.1.2. Priority natural and human-made emissions	65
<b>3.2. Oxides of nitrogen</b>	<b>81</b>
3.2.1. Natural and human-made emissions	81
3.2.2. Priority natural and human-made emissions	84
<b>3.3. Particulate matter <math>\leq 10\mu\text{m}</math></b>	<b>100</b>
3.3.1. Natural and human-made emissions	100
3.3.2. Priority natural and human-made emissions	104
<b>3.4. Particulate matter <math>\leq 2.5\mu\text{m}</math></b>	<b>123</b>
3.4.1. Natural and human-made emissions	123
3.4.2. Priority natural and human-made emissions	127
<b>3.5. Sulfur dioxide</b>	<b>147</b>
3.5.1. Natural and human-made emissions	147
3.5.2. Priority natural and human-made emissions	150

<b>3.6. Total volatile organic compounds</b>	<b>166</b>
3.6.1. Natural and human-made emissions	166
3.6.2. Priority natural and human-made emissions	170
<b>4. Emissions summary</b>	<b>193</b>
<b>5. References</b>	<b>235</b>

# List of tables

Table ES-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions	8
Table ES-2: Total estimated annual emissions from natural and human-made sources in each region	11
Table ES-3: Proportions of total estimated annual emissions from natural and human-made sources in each region	12
Table ES-4: Total estimated annual emissions by human-made source type in each region	18
Table ES-5: Proportions of total estimated annual emissions by human-made source type in each region	19
Table ES-6: Top 10 human-made sources of carbon monoxide in each region	25
Table ES-7: Top 10 human-made sources of oxides of nitrogen in each region	29
Table ES-8: Top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$ in each region	34
Table ES-9: Top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$ in each region	38
Table ES-10: Top 10 human-made sources of sulfur dioxide in each region	43
Table ES-11: Top 10 human-made sources of VOC in each region	47
Table 2-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions	54
Table 3-1: Total estimated annual emissions of carbon monoxide by natural and human-made source type in each region	62
Table 3-2: Proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type in each region	62
Table 3-3: Natural and human-made sources of carbon monoxide in each region	65
Table 3-4: Total estimated annual emissions of oxides of nitrogen by natural and human-made source type in each region	81
Table 3-5: Proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type in each region	81
Table 3-6: Natural and human-made sources of oxides of nitrogen in each region	84
Table 3-7: Total estimated annual emissions of particulate matter $\leq 10\mu\text{m}$ by natural and human-made source type in each region	100
Table 3-8: Proportions of total estimated annual emissions of particulate matter $\leq 10\mu\text{m}$ by natural and human-made source type in each region	101
Table 3-9: Natural and human-made sources of particulate matter $\leq 10\mu\text{m}$ in each region	104
Table 3-10: Total estimated annual emissions of particulate matter $\leq 2.5\mu\text{m}$ by natural and human-made source type in each region	123
Table 3-11: Proportions of total estimated annual emissions of particulate matter $\leq 2.5\mu\text{m}$ by natural and human-made source type in each region	124
Table 3-12: Natural and human-made sources of particulate matter $\leq 2.5\mu\text{m}$ in each region	127
Table 3-13: Total estimated annual emissions of sulfur dioxide by natural and human-made source type in each region	147
Table 3-14: Proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type in each region	147
Table 3-15: Natural and human-made sources of sulfur dioxide in each region	150
Table 3-16: Total estimated annual emissions of VOC by natural and human-made source type in each region	166

Table 3-17: Proportions of total estimated annual emissions of VOC by natural and human-made source type in each region	167
Table 3-18: Natural and human-made sources of VOC in each region	170
Table 4-1: Total estimated annual emissions from natural and human-made sources in each region	194
Table 4-2: Proportions of total estimated annual emissions from natural and human-made sources in each region	195
Table 4-3: Total estimated annual emissions by human-made source type in each region	201
Table 4-4: Proportions of total estimated annual emissions by human-made source type in each region	202
Table 4-5: Top 10 human-made sources of carbon monoxide in each region	208
Table 4-6: Top 10 human-made sources of oxides of nitrogen in each region	212
Table 4-7: Top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$ in each region	217
Table 4-8: Top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$ in each region	221
Table 4-9: Top 10 human-made sources of sulfur dioxide in each region	226
Table 4-10: Top 10 human-made sources of VOC in each region	230

# List of figures

Figure ES-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions	9
Figure ES-2: GMR: proportion of total estimated annual emissions from natural and human-made sources	13
Figure ES-3: Sydney region: proportions of total estimated annual emissions from natural and human-made sources	14
Figure ES-4: Newcastle region: proportions of total estimated annual emissions from natural and human-made sources	15
Figure ES-5: Wollongong region: proportions of total estimated annual emissions from natural and human-made sources	16
Figure ES-6: Non-urban region: proportions of total estimated annual emissions from natural and human-made sources	17
Figure ES-7: GMR: proportions of total estimated annual emissions by human-made source type	20
Figure ES-8: Sydney region: proportions of total estimated annual emissions by human-made source type	21
Figure ES-9: Newcastle region: proportions of total estimated annual emissions by human-made source type	22
Figure ES-10: Wollongong region: proportions of total estimated annual emissions by human-made source type	23
Figure ES-11: Non-urban region: proportions of total estimated annual emissions by human-made source type	24
Figure ES-12: GMR: top 10 human-made sources of carbon monoxide	27
Figure ES-13: Sydney region: top 10 human-made sources of carbon monoxide	27
Figure ES-14: Newcastle region: top 10 human-made sources of carbon monoxide	28
Figure ES-15: Wollongong region: top 10 human-made sources of carbon monoxide	28
Figure ES-16: Non-urban region: top 10 human-made sources of carbon monoxide	29
Figure ES-17: GMR: top 10 human-made sources of oxides of nitrogen	31
Figure ES-18: Sydney region: top 10 human-made sources of oxides of nitrogen	32
Figure ES-19: Newcastle region: top 10 human-made sources of oxides of nitrogen	32
Figure ES-20: Wollongong region: top 10 human-made sources of oxides of nitrogen	33
Figure ES-21: Non-urban region: top 10 human-made sources of oxides of nitrogen	33
Figure ES-22: GMR: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	36
Figure ES-23: Sydney region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	36
Figure ES-24: Newcastle region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	37
Figure ES-25: Wollongong region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	37
Figure ES-26: Non-urban region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	38
Figure ES-27: GMR: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	40
Figure ES-28: Sydney region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	41
Figure ES-29: Newcastle region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	41
Figure ES-30: Wollongong region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	42
Figure ES-31: Non-urban region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	42



Figure ES-32: GMR: top 10 human-made sources of sulfur dioxide	45
Figure ES-33: Sydney region: top 10 human-made sources of sulfur dioxide	45
Figure ES-34: Newcastle region: top 10 human-made sources of sulfur dioxide	46
Figure ES-35: Wollongong region: top 10 human-made sources of sulfur dioxide	46
Figure ES-36: Non-urban region: top 10 human-made sources of sulfur dioxide	47
Figure ES-37: GMR: top 10 human-made sources of VOC	49
Figure ES-38: Sydney region: top 10 human-made sources of VOC	50
Figure ES-39: Newcastle region: top 10 human-made sources of VOC	50
Figure ES-40: Wollongong region: top 10 human-made sources of VOC	51
Figure ES-41: Non-urban region: top 10 human-made sources of VOC	51
Figure 2-2: Grid coordinate system	54
Figure 2-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions	55
Figure 3-1: GMR: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type	63
Figure 3-2: Sydney region: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type	63
Figure 3-3: Newcastle region: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type	64
Figure 3-4: Wollongong region: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type	64
Figure 3-5: Non-urban region: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type	65
Figure 3-6: GMR: top 15 natural and human-made sources of carbon monoxide	78
Figure 3-7: Sydney region: top 15 natural and human-made sources of carbon monoxide	79
Figure 3-8: Newcastle region: top 15 natural and human-made sources of carbon monoxide	79
Figure 3-9: Wollongong region: top 15 natural and human-made sources of carbon monoxide	80
Figure 3-10: Non-urban region: top 15 natural and human-made sources of carbon monoxide	80
Figure 3-11: GMR: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type	82
Figure 3-12: Sydney region: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type	82
Figure 3-13: Newcastle region: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type	83
Figure 3-14: Wollongong region: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type	83
Figure 3-15: Non-urban region: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type	84
Figure 3-16: GMR: top 15 natural and human-made sources of oxides of nitrogen	98
Figure 3-17: Sydney region: top 15 natural and human-made sources of oxides of nitrogen	98
Figure 3-18: Newcastle region: top 15 natural and human-made sources of oxides of nitrogen	99
Figure 3-19: Wollongong region: top 15 natural and human-made sources of oxides of nitrogen	99
Figure 3-20: Non-urban region: top 15 natural and human-made sources of oxides of nitrogen	100

Figure 3-21: GMR: proportions of total estimated annual emissions of particulate matter $\leq 10\mu\text{m}$ by natural and human-made source type	101
Figure 3-22: Sydney region: proportions of total estimated annual emissions of particulate matter $\leq 10\mu\text{m}$ by natural and human-made source type	102
Figure 3-23: Newcastle region: proportions of total estimated annual emissions of particulate matter $\leq 10\mu\text{m}$ by natural and human-made source type	102
Figure 3-24: Wollongong region: proportions of total estimated annual emissions of particulate matter $\leq 10\mu\text{m}$ by natural and human-made source type	103
Figure 3-25: Non-urban region: proportions of total estimated annual emissions of particulate matter $\leq 10\mu\text{m}$ by natural and human-made source type	103
Figure 3-26: GMR: top 15 natural and human-made sources of particulate matter $\leq 10\mu\text{m}$	121
Figure 3-27: Sydney region: top 15 natural and human-made sources of particulate matter $\leq 10\mu\text{m}$	121
Figure 3-28: Newcastle region: top 15 natural and human-made sources of particulate matter $\leq 10\mu\text{m}$	122
Figure 3-29: Wollongong region: top 15 natural and human-made sources of particulate matter $\leq 10\mu\text{m}$	122
Figure 3-30: Non-urban region: top 15 natural and human-made sources of particulate matter $\leq 10\mu\text{m}$	123
Figure 3-31: GMR: proportions of total estimated annual emissions of particulate matter $\leq 2.5\mu\text{m}$ by natural and human-made source type	124
Figure 3-32: Sydney region: proportions of total estimated annual emissions of particulate matter $\leq 2.5\mu\text{m}$ by natural and human-made source type	125
Figure 3-33: Newcastle region: proportions of total estimated annual emissions of particulate matter $\leq 2.5\mu\text{m}$ by natural and human-made source type	125
Figure 3-34: Wollongong region: proportions of total estimated annual emissions of particulate matter $\leq 2.5\mu\text{m}$ by natural and human-made source type	126
Figure 3-35: Non-urban region: proportions of total estimated annual emissions of particulate matter $\leq 2.5\mu\text{m}$ by natural and human-made source type	126
Figure 3-36: GMR: top 15 natural and human-made sources of particulate matter $\leq 2.5\mu\text{m}$	144
Figure 3-37: Sydney region: top 15 natural and human-made sources of particulate matter $\leq 2.5\mu\text{m}$	145
Figure 3-38: Newcastle region: top 15 natural and human-made sources of particulate matter $\leq 2.5\mu\text{m}$	145
Figure 3-39: Wollongong region: top 15 natural and human-made sources of particulate matter $\leq 2.5\mu\text{m}$	146
Figure 3-40: Non-urban region: top 15 natural and human-made sources of particulate matter $\leq 2.5\mu\text{m}$	146
Figure 3-41: GMR: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type	148
Figure 3-42: Sydney region: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type	148
Figure 3-43: Newcastle region: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type	149
Figure 3-44: Wollongong region: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type	149
Figure 3-45: Non-urban region: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type	150

Figure 3-46: GMR: top 15 natural and human-made sources of sulfur dioxide	164
Figure 3-47: Sydney region: top 15 natural and human-made sources of sulfur dioxide	164
Figure 3-48: Newcastle region: top 15 natural and human-made sources of sulfur dioxide	165
Figure 3-49: Wollongong region: top 15 natural and human-made sources of sulfur dioxide	165
Figure 3-50: Non-urban region: top 15 natural and human-made sources of sulfur dioxide	166
Figure 3-51: GMR: proportions of total estimated annual emissions of VOC by natural and human-made source type	167
Figure 3-52: Sydney region: proportions of total estimated annual emissions of VOC by natural and human-made source type	168
Figure 3-53: Newcastle region: proportions of total estimated annual emissions of VOC by natural and human-made source type	168
Figure 3-54: Wollongong region: proportions of total estimated annual emissions of VOC by natural and human-made source type	169
Figure 3-55: Non-urban region: proportions of total estimated annual emissions of VOC by natural and human-made source type	169
Figure 3-56: GMR: top 15 natural and human-made sources of VOC	190
Figure 3-57: Sydney region: top 15 natural and human-made sources of VOC	190
Figure 3-58: Newcastle region: top 15 natural and human-made sources of VOC	191
Figure 3-59: Wollongong region: top 15 natural and human-made sources of VOC	191
Figure 3-60: Non-urban region: top 15 natural and human-made sources of VOC	192
Figure 4-1: GMR: proportions of total estimated annual emissions from natural and human-made sources	196
Figure 4-2: Sydney region: proportions of total estimated annual emissions from natural and human-made sources	197
Figure 4-3: Newcastle region: proportions of total estimated annual emissions from natural and human-made sources	198
Figure 4-4: Wollongong region: proportions of total estimated annual emissions from natural and human-made sources	199
Figure 4-5: Non-urban region: proportions of total estimated annual emissions from natural and human-made sources	200
Figure 4-6: GMR: proportions of total estimated annual emissions by human-made source type	203
Figure 4-7: Sydney region: proportions of total estimated annual emissions by human-made source type	204
Figure 4-8: Newcastle region: proportions of total estimated annual emissions by human-made source type	205
Figure 4-9: Wollongong region: proportions of total estimated annual emissions by human-made source type	206
Figure 4-10: Non-urban region: proportions of total estimated annual emissions by human-made source type	207
Figure 4-11: GMR: top 10 human-made sources of carbon monoxide	210
Figure 4-12: Sydney region: top 10 human-made sources of carbon monoxide	210
Figure 4-13: Newcastle region: top 10 human-made sources of carbon monoxide	211
Figure 4-14: Wollongong region: top 10 human-made sources of carbon monoxide	211
Figure 4-15: Non-urban region: top 10 human-made sources of carbon monoxide	212

Figure 4-16: GMR: top 10 human-made sources of oxides of nitrogen	214
Figure 4-17: Sydney region: top 10 human-made sources of oxides of nitrogen	215
Figure 4-18: Newcastle region: top 10 human-made sources of oxides of nitrogen	215
Figure 4-19: Wollongong region: top 10 human-made sources of oxides of nitrogen	216
Figure 4-20: Non-urban region: top 10 human-made sources of oxides of nitrogen	216
Figure 4-21: GMR: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	219
Figure 4-22: Sydney region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	219
Figure 4-23: Newcastle region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	220
Figure 4-24: Wollongong region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	220
Figure 4-25: Non-urban region: top 10 human-made sources of particulate matter $\leq 10\mu\text{m}$	221
Figure 4-26: GMR: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	223
Figure 4-27: Sydney region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	224
Figure 4-28: Newcastle region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	224
Figure 4-29: Wollongong region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	225
Figure 4-30: Non-urban region: top 10 human-made sources of particulate matter $\leq 2.5\mu\text{m}$	225
Figure 4-31: GMR: top 10 human-made sources of sulfur dioxide	228
Figure 4-32: Sydney region: top 10 human-made sources of sulfur dioxide	228
Figure 4-33: Newcastle region: top 10 human-made sources of sulfur dioxide	229
Figure 4-34: Wollongong region: top 10 human-made sources of sulfur dioxide	229
Figure 4-35: Non-urban region: top 10 human-made sources of sulfur dioxide	230
Figure 4-36: GMR: top 10 human-made sources of VOC	232
Figure 4-37: Sydney region: top 10 human-made sources of VOC	233
Figure 4-38: Newcastle region: top 10 human-made sources of VOC	233
Figure 4-39: Wollongong region: top 10 human-made sources of VOC	234
Figure 4-40: Non-urban region: top 10 human-made sources of VOC	234

# Executive summary

The NSW Environment Protection Authority (EPA) has produced an air emissions inventory (the 'inventory') for natural and human-made sources in NSW. The base year of the inventory represents activities that took place during the 2013 calendar year. The area included in the inventory covers the greater Sydney, Newcastle and Wollongong regions, known collectively as the Greater Metropolitan Region (GMR).

The inventory region defined as the GMR measures 210km (east–west) by 273km (north–south). The GMR and the three urban subregions defined in the inventory are presented in Table ES-1 and shown in Figure ES-1.

**Table ES-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions**

Region	South-west corner MGA <sup>1</sup> coordinates		North-east corner MGA coordinates	
	Easting (km)	Northing (km)	Easting (km)	Northing (km)
Greater Metropolitan	210	6159	420	6432
Sydney	261	6201	360	6300
Newcastle	360	6348	408	6372
Wollongong	279	6174	318	6201

The air emissions inventory includes emissions from biogenic (natural living organisms), geogenic (natural non-living) and anthropogenic (human-made) sources, grouped into six modules as follows:

- **Natural** – biogenic and geogenic (e.g. bushfires, marine aerosol and vegetation)
- **Commercial** – non-EPA licensed<sup>2</sup> premises (e.g. printers, quarries and service stations)
- **Domestic-Commercial** – domestic activities (e.g. residential lawn mowing, wood heaters and portable fuel containers) and non-premises based commercial activities (e.g. public open space lawn mowing)
- **Industrial** – EPA-licensed<sup>3</sup> premises (e.g. coal mines, oil refineries and power stations)
- **Off-Road Mobile** – unregistered non-road vehicles and equipment (e.g. dump trucks, bulldozers, locomotives and marine vessels)
- **On-Road Mobile** – road registered vehicles (e.g. registered cars, trucks and buses).

<sup>1</sup> Map Grid of Australia (MGA) based on the Geocentric Datum of Australia 1994 (GDA94) (ICSM, 2014).

<sup>2</sup> Not a scheduled activity or scheduled development work as defined in the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>3</sup> An activity listed in Schedule 1 of the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).



Figure ES-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions

The pollutants inventoried include criteria pollutants specified in the Ambient Air Quality National Environment Protection Measure (NEPM) (NEPC, 2016), air toxics associated with the National Pollutant Inventory NEPM (NEPC, 2008) and the Air Toxics NEPM (NEPC, 2004), and any other pollutants associated with state-specific programs, i.e. Load Based Licensing (Protection of the Environment Operations (General) Regulation 2009 (PCO, 2010b)) and the Protection of the Environment Operations (Clean Air) Regulation 2010 (PCO, 2011). More than 1,000 pollutants are included in the 2013 inventory.

This report presents emissions of criteria pollutants referred to in the Ambient Air Quality (AAQ) NEPM (NEPC, 2016), including<sup>4</sup>:

- carbon monoxide (CO)
- oxides of nitrogen (NO<sub>x</sub>)
- particulate matter ≤ 10µm (PM<sub>10</sub>)
- particulate matter ≤ 2.5µm (PM<sub>2.5</sub>)
- sulfur dioxide (SO<sub>2</sub>)
- total volatile organic compounds (VOC).

The emission estimation methodologies used for the 2013 inventory are largely consistent with those developed and implemented for the 2008 inventory. Refer to the 2008 inventory reports for further information (EPA, 2012a; EPA, 2012b; EPA, 2012c; EPA, 2012d; EPA, 2012e; and EPA, 2012f). Section 2.7 of this report lists key differences in emission estimation methodologies implemented for this inventory.

Emissions for 17 pollutants, including those listed above, are available to a higher spatial resolution (postcode level) in the [Air Emissions in My Community web tool](#)<sup>5</sup>. Data for the 2003 and 2008 air emissions inventories are also available in the web tool.

---

<sup>4</sup> VOC is not included in the AAQ NEPM but is included in this report due to its importance as a precursor to the formation of secondary pollution in the atmosphere. Lead is an AAQ NEPM pollutant but is not included in this report as monitoring for lead ceased in 2005 with NSW annual average ambient levels having fallen to less than 10% of the NEPM standard (OEH, 2019).

<sup>5</sup> <https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-my-community/air-emissions-in-my-community-tool>.

Table ES-2 presents total estimated annual emissions of criteria pollutants from natural and human-made sources in the Sydney, Newcastle and Wollongong regions, and the whole GMR. Total estimated annual emissions are also presented for the region defined as Non-urban. This region is the area of the GMR minus the combined areas of the Sydney, Newcastle and Wollongong regions.

**Table ES-2: Total estimated annual emissions from natural and human-made sources in each region**

Substance	Region <sup>6</sup>	Emissions (tonnes/year)		
		Human-made	Natural	Total <sup>6</sup>
Carbon monoxide	Sydney	210,291	42,008	252,299
	Newcastle	60,789	20,261	81,050
	Wollongong	114,170	1,083	115,253
	Non-urban	82,829	810,795	893,625
	GMR	468,079	874,147	1,342,226
Oxides of nitrogen	Sydney	58,676	2,605	61,282
	Newcastle	9,133	739	9,872
	Wollongong	9,863	110	9,973
	Non-urban	191,334	32,466	223,800
	GMR	269,007	35,920	304,927
Particulate matter ≤ 10µm	Sydney	15,415	5,786	21,200
	Newcastle	4,969	2,300	7,269
	Wollongong	1,790	239	2,029
	Non-urban	79,038	95,222	174,260
	GMR	101,211	103,547	204,758
Particulate matter ≤ 2.5µm	Sydney	9,945	3,816	13,761
	Newcastle	2,093	1,769	3,862
	Wollongong	942	111	1,054
	Non-urban	16,248	71,269	87,517
	GMR	29,228	76,965	106,194
Sulfur dioxide	Sydney	10,148	382	10,530
	Newcastle	9,988	184	10,172
	Wollongong	4,840	9.85	4,850
	Non-urban	200,376	7,378	207,754
	GMR	225,351	7,955	233,306
Total volatile organic compounds	Sydney	96,521	31,785	128,306
	Newcastle	7,653	4,376	12,029
	Wollongong	4,300	3,055	7,355
	Non-urban	25,734	165,805	191,539
	GMR	134,209	205,021	339,230

<sup>6</sup> The totals may differ from the sum of the addends due to rounding.



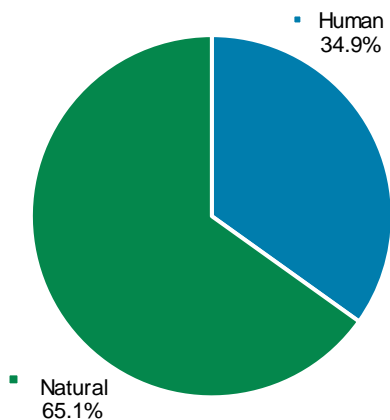
Table ES-3 presents the proportions of total estimated annual emissions of criteria pollutants from natural and human-made sources in the Sydney, Newcastle, Wollongong and Non-urban regions, and the whole GMR.

**Table ES-3: Proportions of total estimated annual emissions from natural and human-made sources in each region**

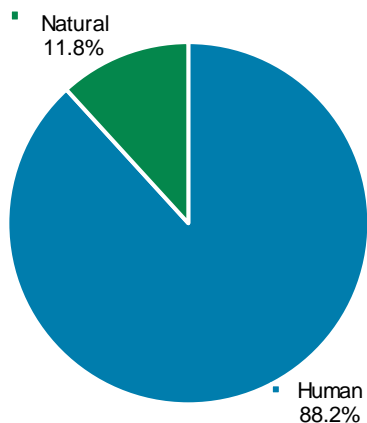
Substance	Region	Proportion (%)	
		Human-made	Natural
Carbon monoxide	Sydney	83.3	16.7
	Newcastle	75.0	25.0
	Wollongong	99.1	0.94
	Non-urban	9.27	90.7
	GMR	34.9	65.1
Oxides of nitrogen	Sydney	95.7	4.25
	Newcastle	92.5	7.49
	Wollongong	98.9	1.11
	Non-urban	85.5	14.5
	GMR	88.2	11.8
Particulate matter $\leq 10\mu\text{m}$	Sydney	72.7	27.3
	Newcastle	68.4	31.6
	Wollongong	88.2	11.8
	Non-urban	45.4	54.6
	GMR	49.4	50.6
Particulate matter $\leq 2.5\mu\text{m}$	Sydney	72.3	27.7
	Newcastle	54.2	45.8
	Wollongong	89.4	10.6
	Non-urban	18.6	81.4
	GMR	27.5	72.5
Sulfur dioxide	Sydney	96.4	3.63
	Newcastle	98.2	1.81
	Wollongong	99.8	0.20
	Non-urban	96.4	3.55
	GMR	96.6	3.41
Total volatile organic compounds	Sydney	75.2	24.8
	Newcastle	63.6	36.4
	Wollongong	58.5	41.5
	Non-urban	13.4	86.6
	GMR	39.6	60.4

Figure ES-2, Figure ES-3, Figure ES-4, Figure ES-5 and Figure ES-6 show the proportions of total estimated annual emissions of criteria pollutants from natural and human-made sources in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

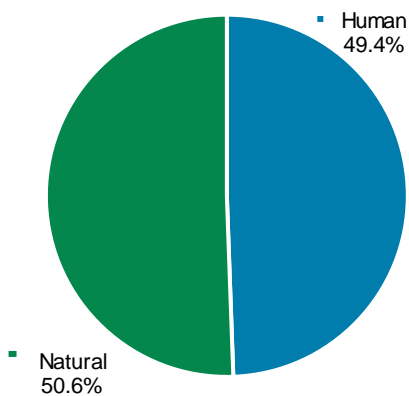
Carbon monoxide



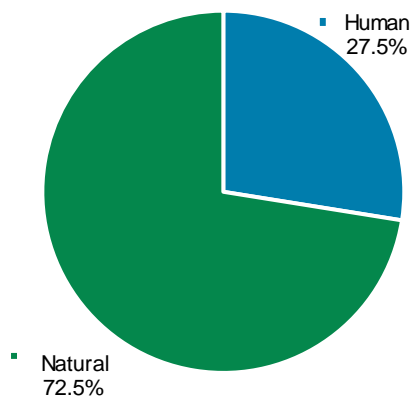
Oxides of nitrogen



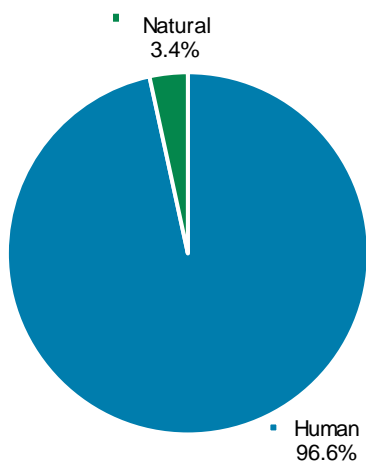
Particulate matter 10µm



Particulate matter 2.5µm



Sulfur dioxide



Total VOC

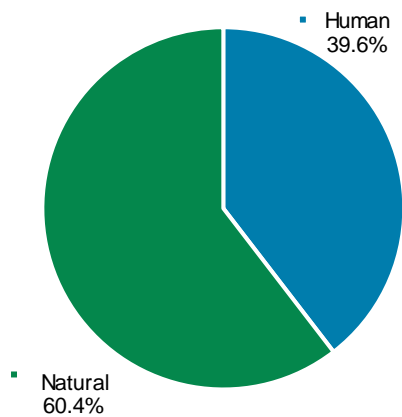


Figure ES-2: GMR: proportion of total estimated annual emissions from natural and human-made sources

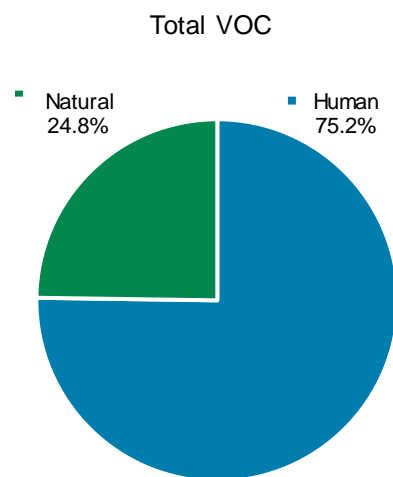
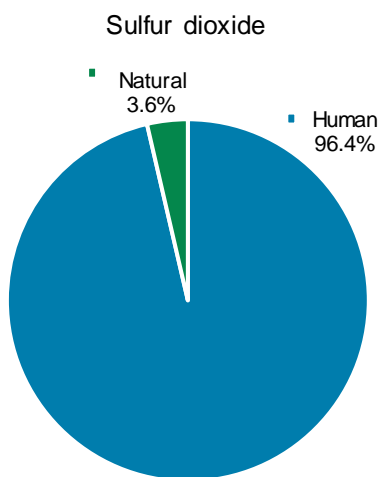
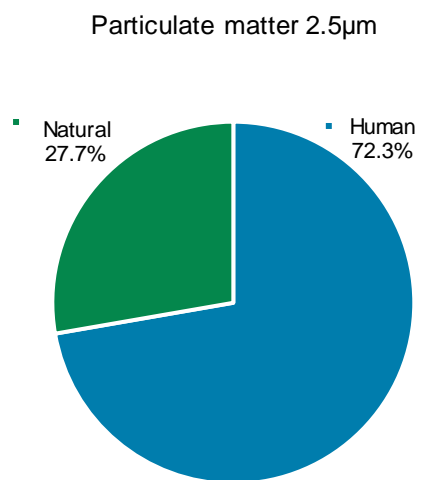
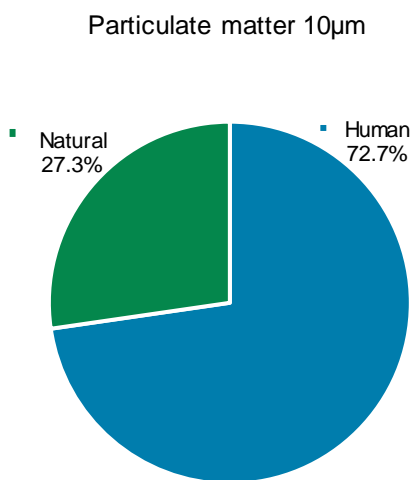
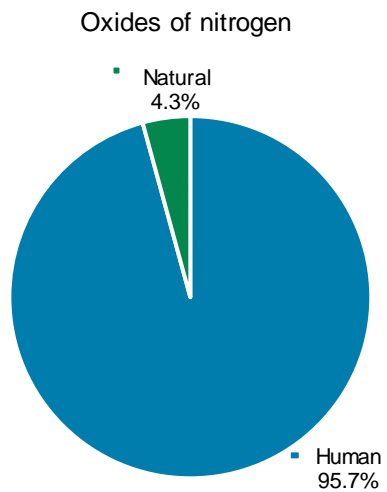
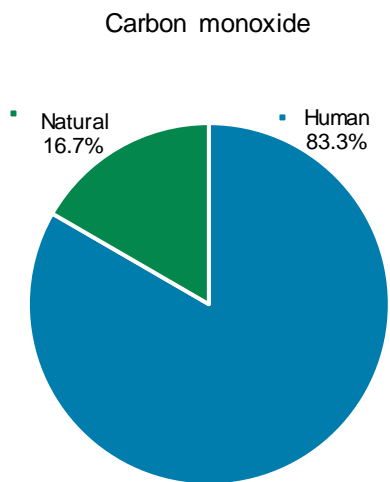


Figure ES-3: Sydney region: proportions of total estimated annual emissions from natural and human-made sources

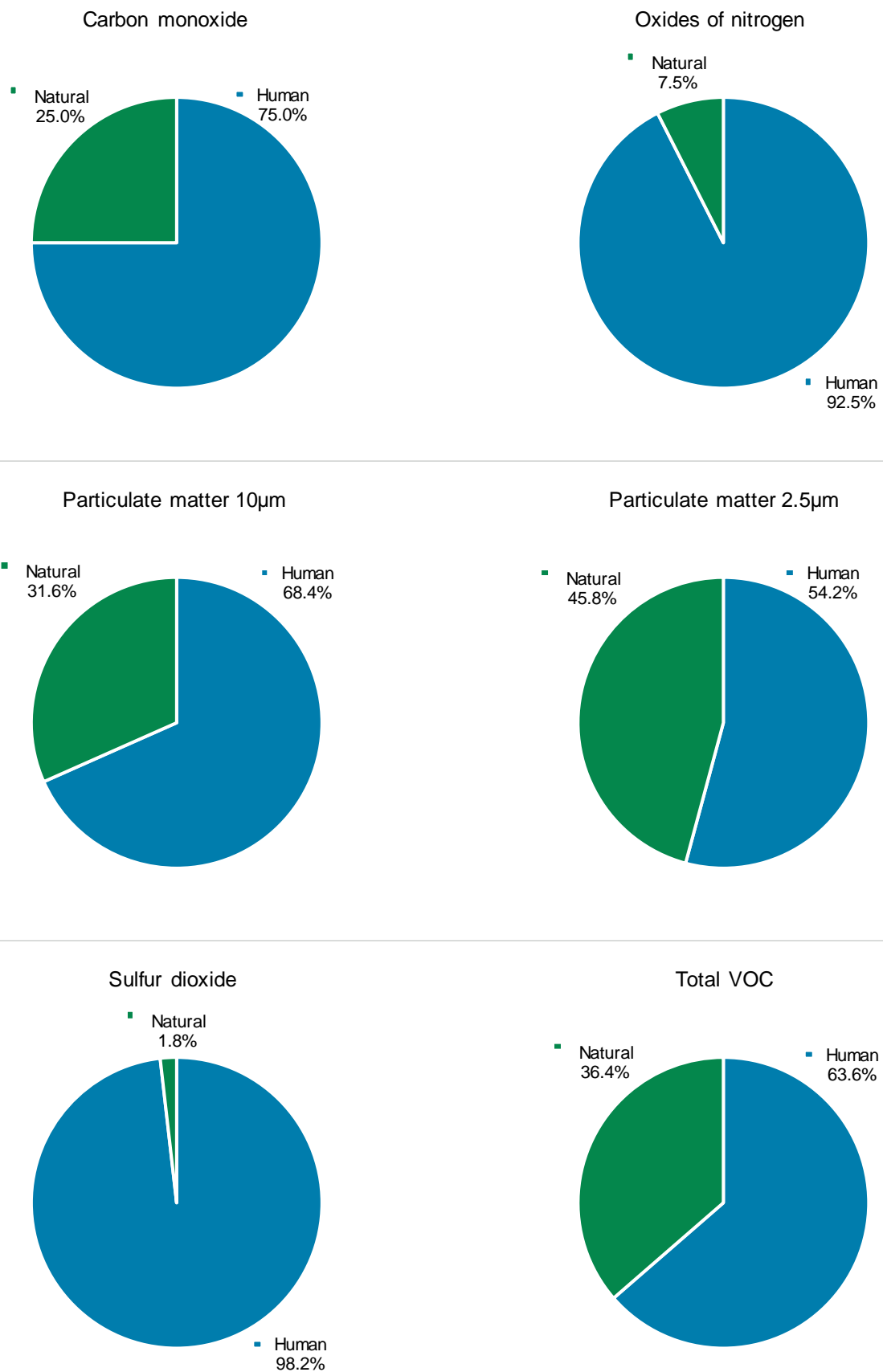


Figure ES-4: Newcastle region: proportions of total estimated annual emissions from natural and human-made sources

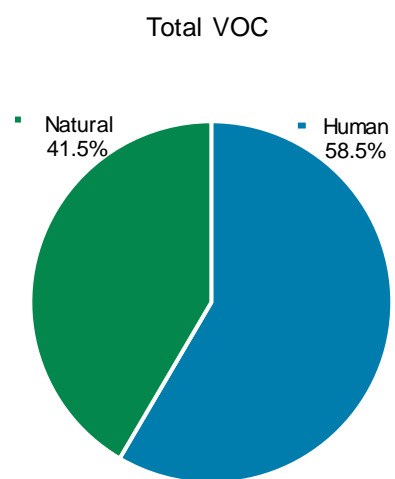
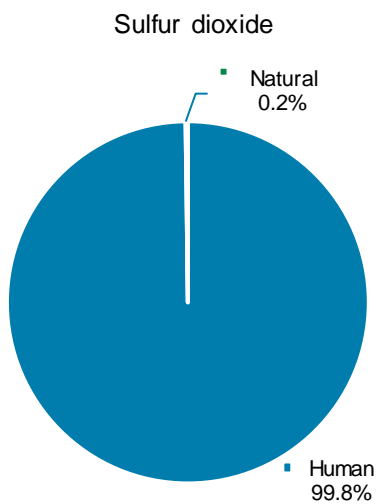
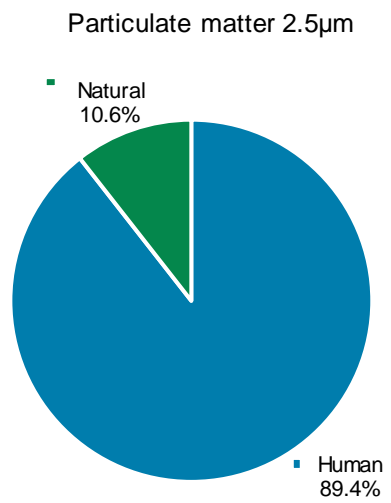
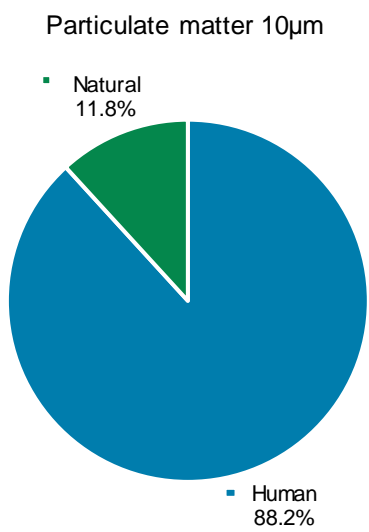
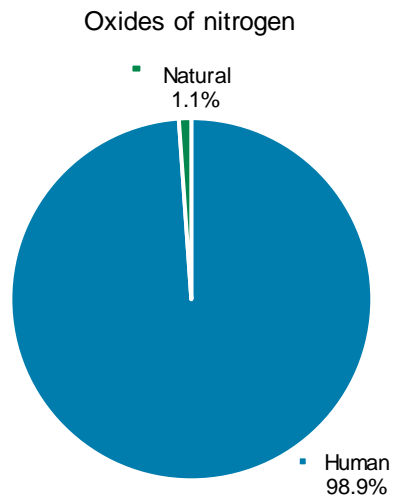
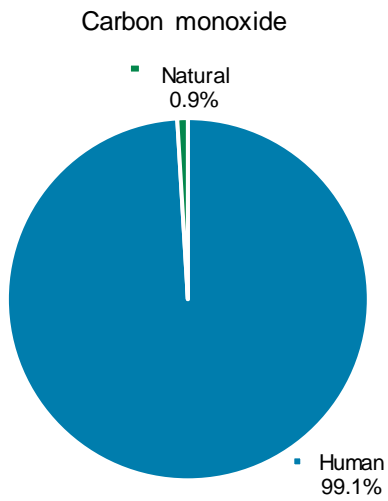
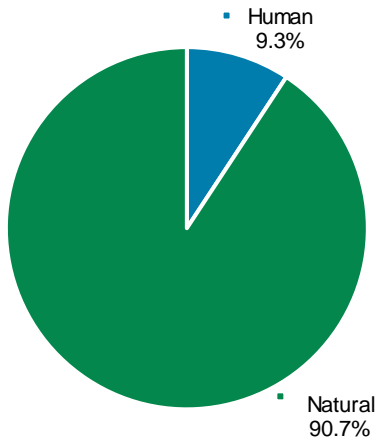
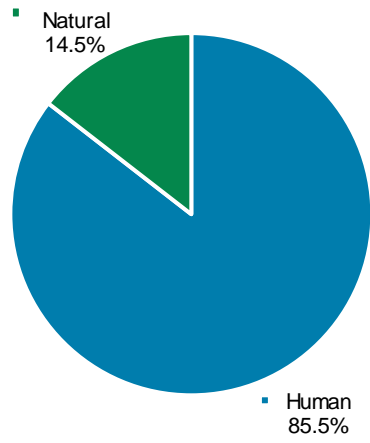


Figure ES-5: Wollongong region: proportions of total estimated annual emissions from natural and human-made sources

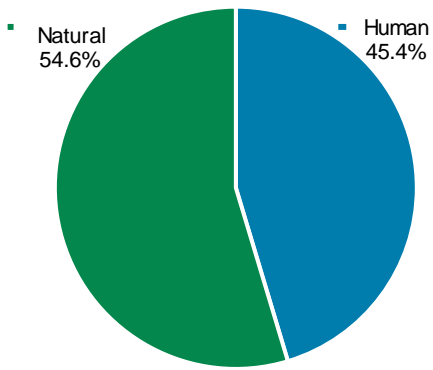
Carbon monoxide



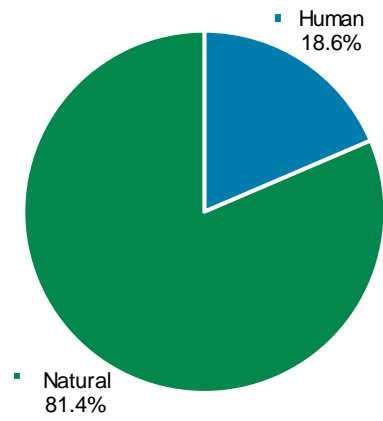
Oxides of nitrogen



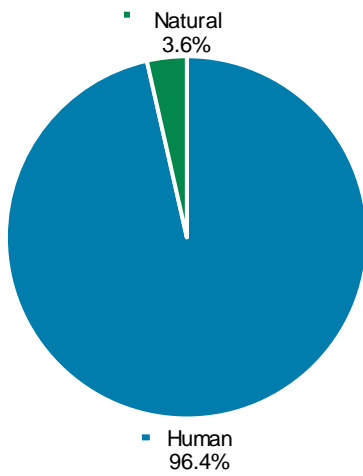
Particulate matter 10µm



Particulate matter 2.5µm



Sulfur dioxide



Total VOC

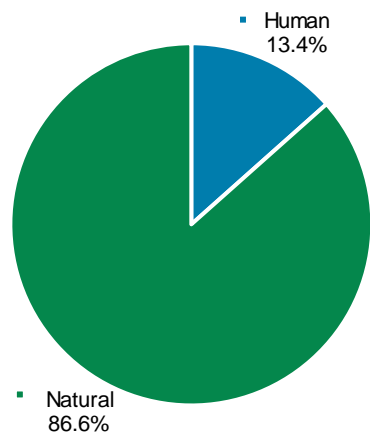


Figure ES-6: Non-urban region: proportions of total estimated annual emissions from natural and human-made sources

Table ES-4 presents total estimated annual emissions of criteria pollutants by human-made source type in the Sydney, Newcastle, Wollongong and Non-urban regions, and the whole GMR.

**Table ES-4: Total estimated annual emissions by human-made source type in each region**

Substance	Region	Emissions (tonnes/year)					Total <sup>7</sup>
		Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Carbon monoxide	Sydney	320	90,299	5,968	22,465	91,239	210,291
	Newcastle	9.68	6,838	43,489	3,802	6,649	60,789
	Wollongong	16.69	4,456	104,510	1,640	3,547	114,170
	Non-urban	31.26	18,072	17,179	33,720	13,827	82,829
	GMR <sup>7</sup>	378	119,664	171,147	61,628	115,262	468,079
Oxides of nitrogen	Sydney	359	2,701	7,387	15,734	32,496	58,676
	Newcastle	38.13	187	2,016	4,104	2,788	9,133
	Wollongong	11.12	129	6,166	1,946	1,610	9,863
	Non-urban	154	457	145,396	37,136	8,191	191,334
	GMR	562	3,473	160,966	58,920	45,085	269,007
Particulate matter ≤ 10µm	Sydney	682	5,744	6,040	1,111	1,838	15,415
	Newcastle	82.44	432	4,016	283	156	4,969
	Wollongong	30.41	262	1,280	133	85.34	1,790
	Non-urban	492	1,296	75,087	1,736	427	79,038
	GMR	1,287	7,734	86,422	3,263	2,505	101,211
Particulate matter ≤ 2.5µm	Sydney	291	5,517	1,824	1,034	1,279	9,945
	Newcastle	19.28	415	1,289	263	107	2,093
	Wollongong	10.03	251	497	125	59.43	942
	Non-urban	112	1,245	12,921	1,665	305	16,248
	GMR	433	7,429	16,530	3,086	1,750	29,228
Sulfur dioxide	Sydney	78.95	124	3,057	6,790	97.36	10,148
	Newcastle	1.76	9.12	8,261	1,709	7.12	9,988
	Wollongong	0.74	5.75	4,190	640	4.06	4,840
	Non-urban	110	25.81	198,604	1,618	17.43	200,376
	GMR	192	165	214,112	10,757	126	225,351
Total volatile organic compounds	Sydney	9,561	57,399	9,369	7,552	12,641	96,521
	Newcastle	108	3,933	1,194	1,466	952	7,653
	Wollongong	79.91	2,750	362	612	497	4,300
	Non-urban	580	9,746	1,703	11,670	2,034	25,734
	GMR	10,330	73,828	12,628	21,300	16,124	134,209

<sup>7</sup> The totals may differ from the sum of the addends due to rounding.

Table ES-5 presents the proportions of total estimated annual emissions of criteria pollutants by human-made source type in the Sydney, Newcastle, Wollongong and Non-urban regions, and the whole GMR.

**Table ES-5: Proportions of total estimated annual emissions by human-made source type in each region**

Substance	Region	Proportion (%) <sup>8</sup>				
		Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Carbon monoxide	Sydney	0.15	42.9	2.84	10.7	43.4
	Newcastle	1.59×10 <sup>-2</sup>	11.2	71.5	6.26	10.9
	Wollongong	1.46×10 <sup>-2</sup>	3.90	91.5	1.44	3.11
	Non-urban	3.77×10 <sup>-2</sup>	21.8	20.7	40.7	16.7
	GMR	8.08×10 <sup>-2</sup>	25.6	36.6	13.2	24.6
Oxides of nitrogen	Sydney	0.61	4.60	12.6	26.8	55.4
	Newcastle	0.42	2.04	22.1	44.9	30.5
	Wollongong	0.11	1.31	62.5	19.7	16.3
	Non-urban	8.06×10 <sup>-2</sup>	0.24	76.0	19.4	4.28
	GMR	0.21	1.29	59.8	21.9	16.8
Particulate matter ≤ 10µm	Sydney	4.43	37.3	39.2	7.21	11.9
	Newcastle	1.66	8.70	80.8	5.70	3.13
	Wollongong	1.70	14.6	71.5	7.44	4.77
	Non-urban	0.62	1.64	95.0	2.20	0.54
	GMR	1.27	7.64	85.4	3.22	2.48
Particulate matter ≤ 2.5µm	Sydney	2.93	55.5	18.3	10.4	12.9
	Newcastle	0.92	19.8	61.6	12.5	5.12
	Wollongong	1.06	26.6	52.7	13.2	6.31
	Non-urban	0.69	7.66	79.5	10.2	1.88
	GMR	1.48	25.4	56.6	10.6	5.99
Sulfur dioxide	Sydney	0.78	1.22	30.1	66.9	0.96
	Newcastle	1.76×10 <sup>-2</sup>	9.13×10 <sup>-2</sup>	82.7	17.1	7.13×10 <sup>-2</sup>
	Wollongong	1.53×10 <sup>-2</sup>	0.12	86.6	13.2	8.38×10 <sup>-2</sup>
	Non-urban	5.50×10 <sup>-2</sup>	1.29×10 <sup>-2</sup>	99.1	0.81	8.70×10 <sup>-3</sup>
	GMR	8.50×10 <sup>-2</sup>	7.31×10 <sup>-2</sup>	95.0	4.77	5.59×10 <sup>-2</sup>
Total volatile organic compounds	Sydney	9.91	59.5	9.71	7.82	13.1
	Newcastle	1.41	51.4	15.6	19.2	12.4
	Wollongong	1.86	63.9	8.41	14.2	11.6
	Non-urban	2.25	37.9	6.62	45.3	7.90
	GMR	7.70	55.0	9.41	15.9	12.0

<sup>8</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10<sup>-2</sup> = 0.0946).



Figure ES-7, Figure ES-8, Figure ES-9, Figure ES-10 and Figure ES-11 show the proportions of total estimated annual emissions of criteria pollutants by human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

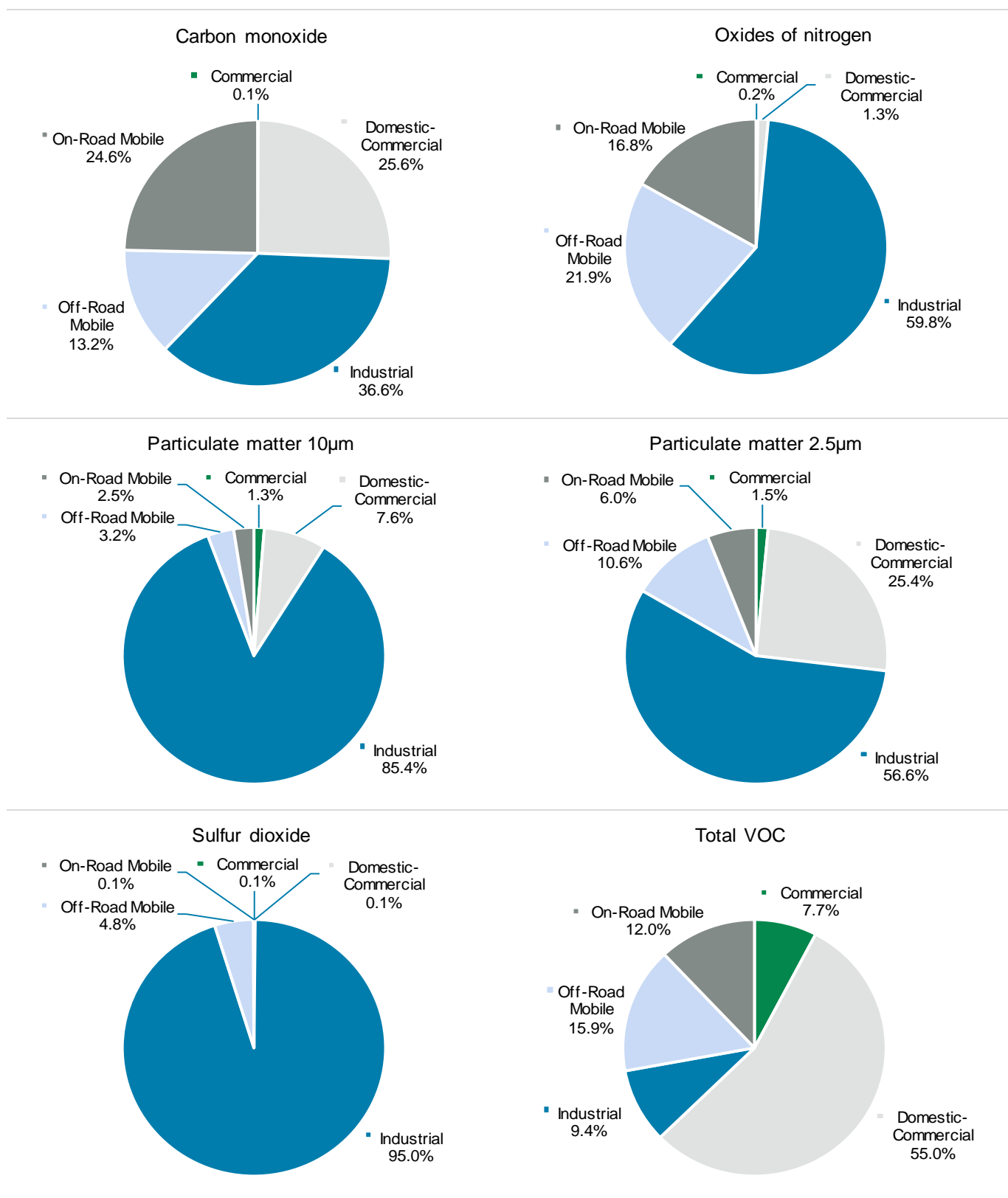


Figure ES-7: GMR: proportions of total estimated annual emissions by human-made source type

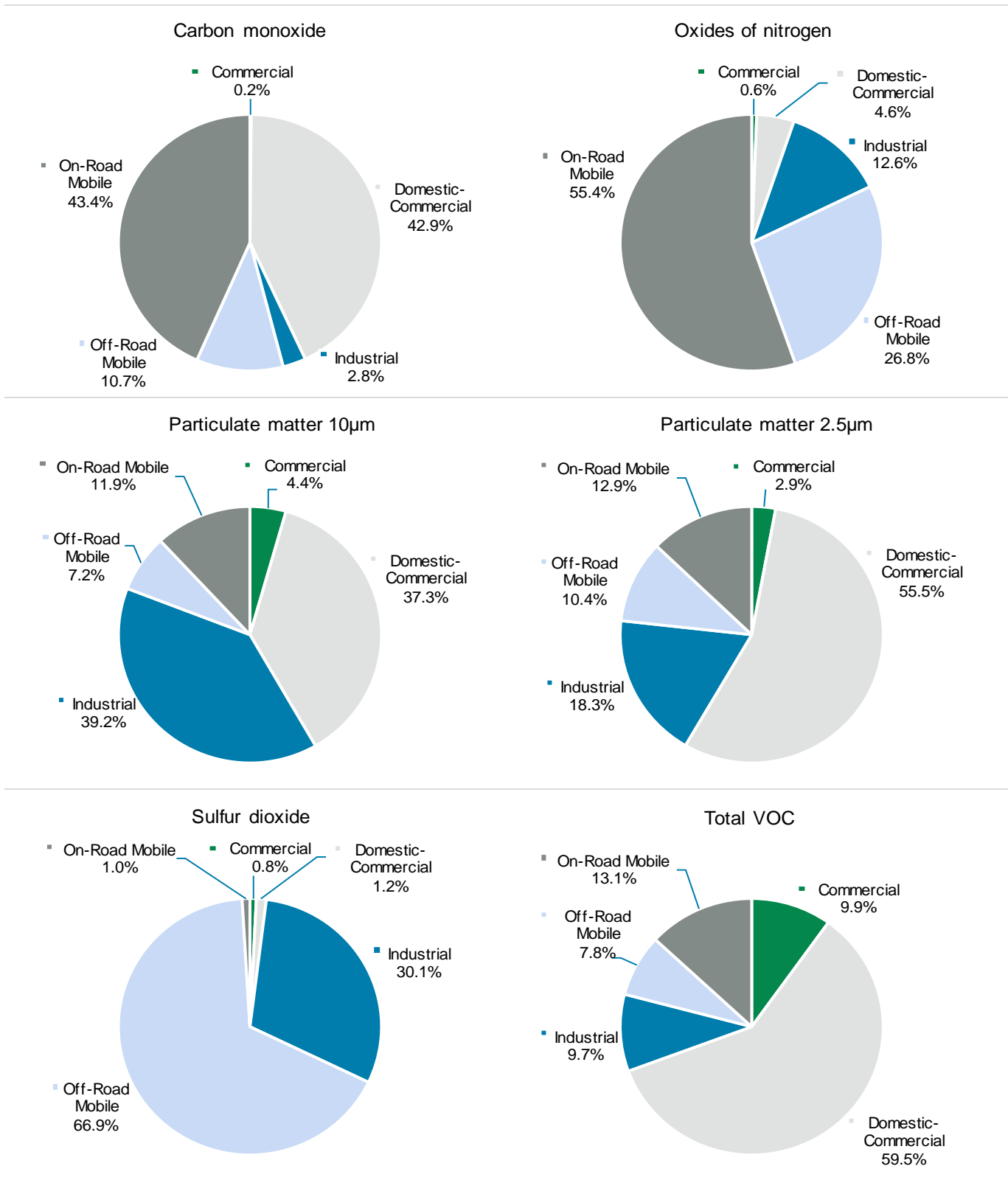


Figure ES-8: Sydney region: proportions of total estimated annual emissions by human-made source type

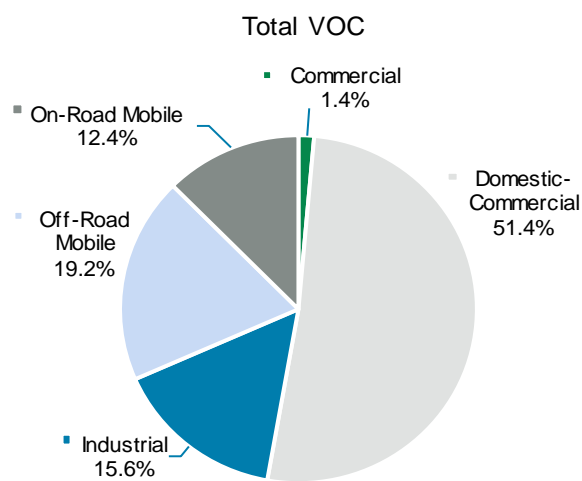
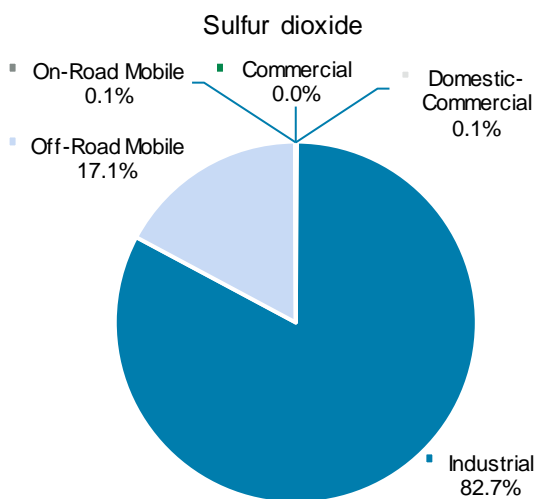
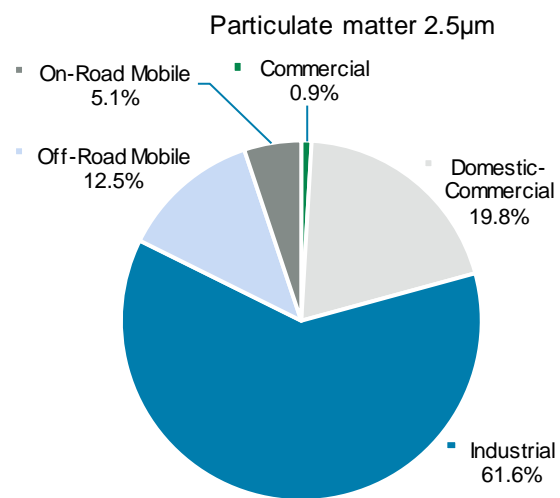
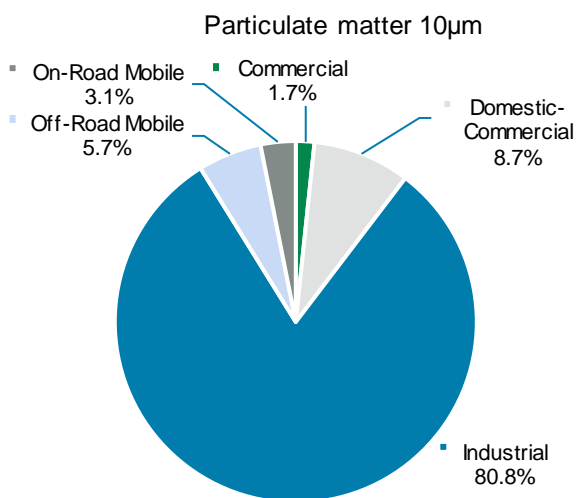
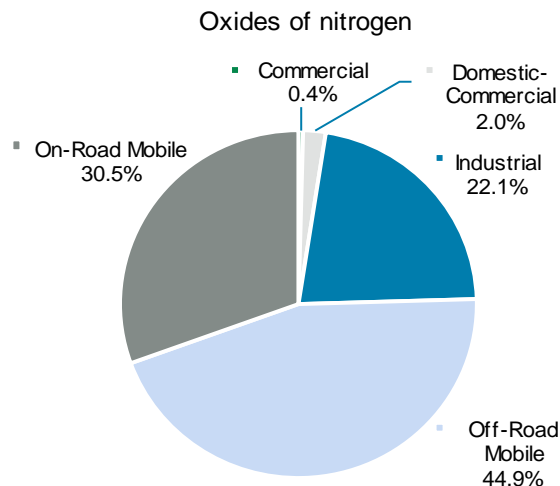
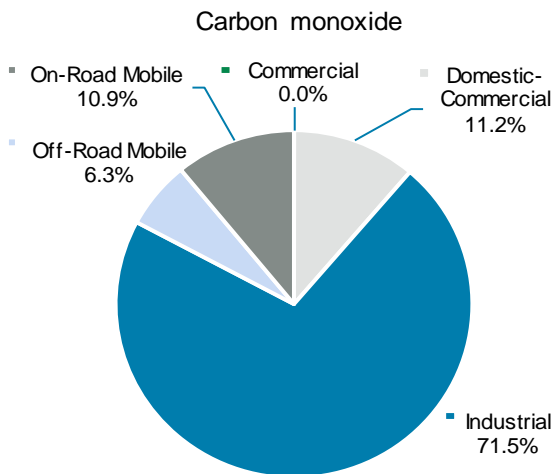


Figure ES-9: Newcastle region: proportions of total estimated annual emissions by human-made source type

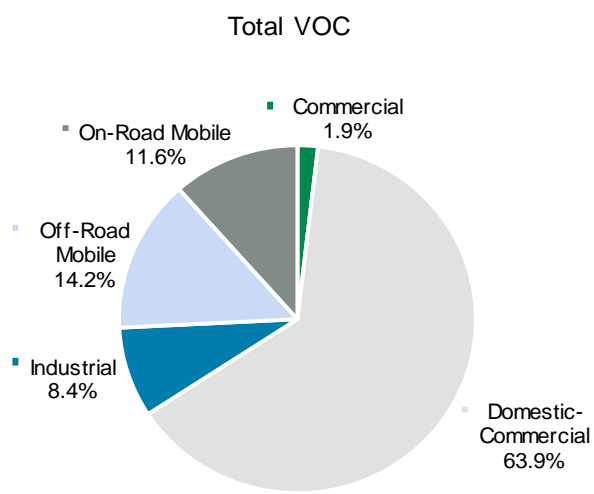
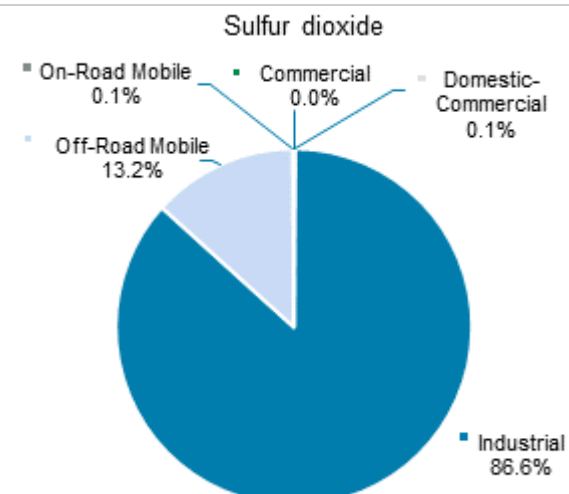
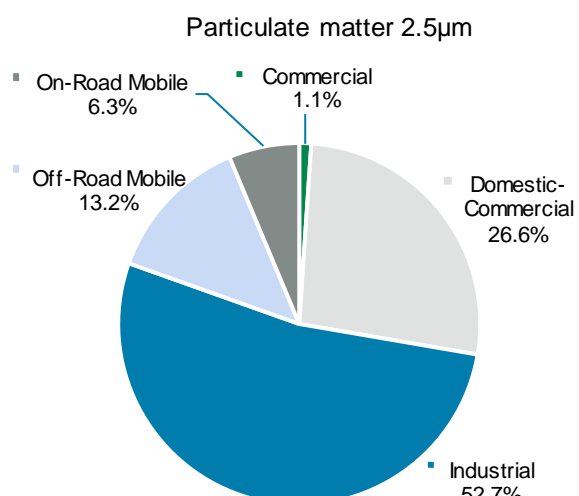
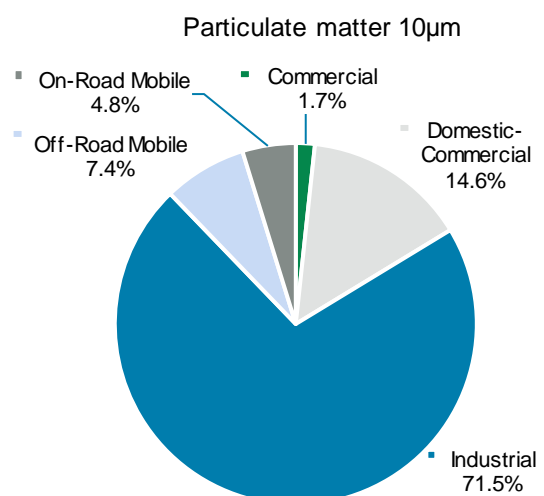
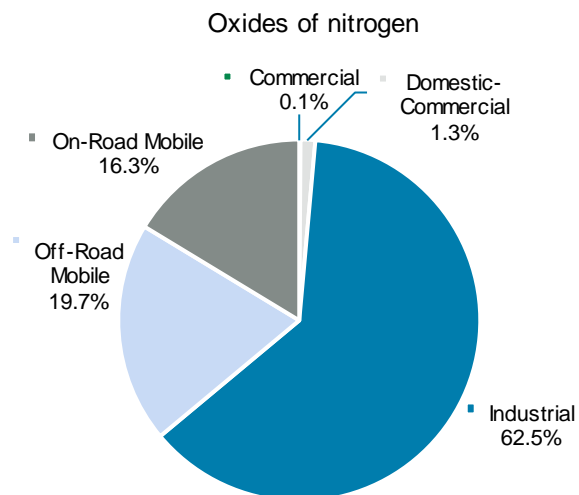
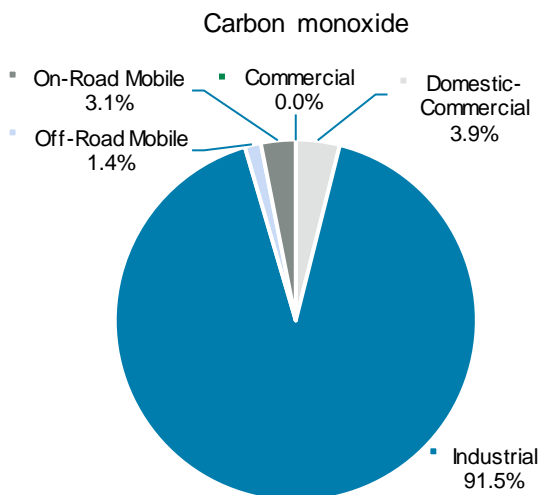


Figure ES-10: Wollongong region: proportions of total estimated annual emissions by human-made source type

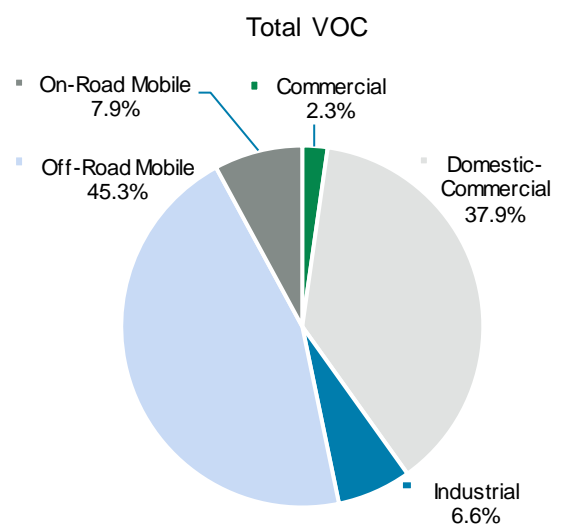
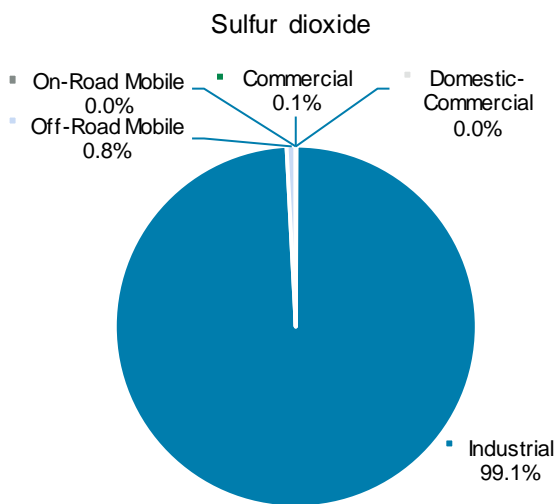
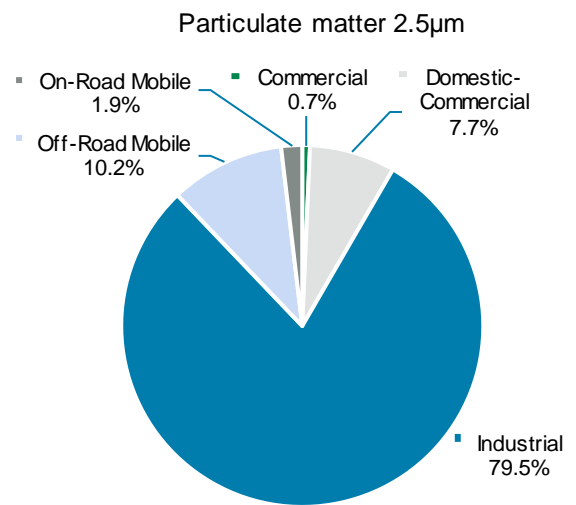
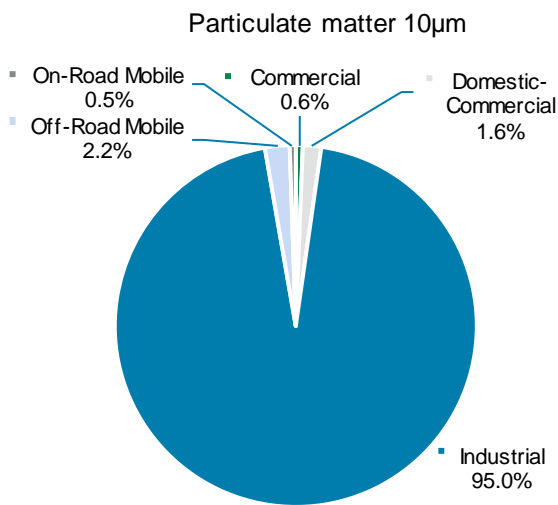
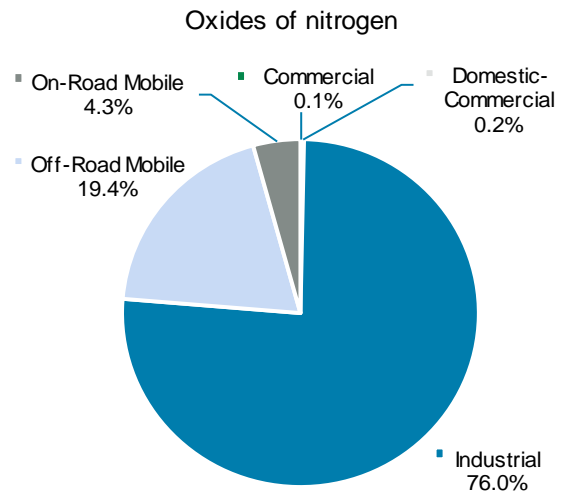
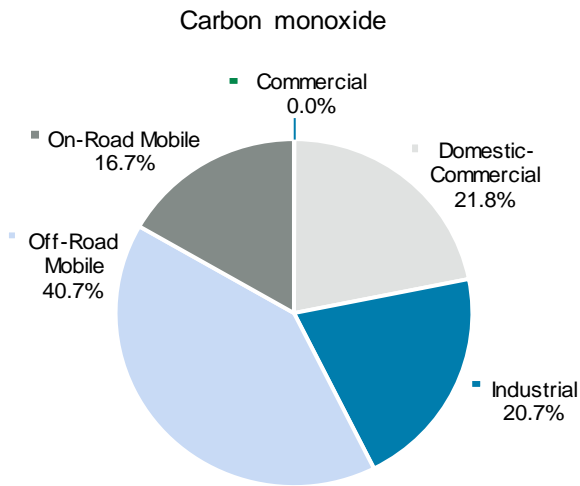


Figure ES-11: Non-urban region: proportions of total estimated annual emissions by human-made source type

Table ES-6 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of carbon monoxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table ES-6: Top 10 human-made sources of carbon monoxide in each region**

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made carbon monoxide sources in the GMR</b>				
Industrial	Iron or steel production (iron ore)	103,354	22.1	22.1
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	79,074	16.9	39.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	50,117	10.7	49.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	45,363	9.69	59.4
Industrial	Aluminium production (alumina)	40,709	8.70	68.1
Off-Road Mobile	Commercial Boats Exhaust	27,225	5.82	73.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	23,995	5.13	79.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	22,657	4.84	83.9
Off-Road Mobile	Recreational Boats Exhaust	16,490	3.52	87.4
Off-Road Mobile	Industrial Vehicles and Equipment	11,822	2.53	89.9
Human-made	Other	47,273	10.1	100.0
<b>Top 10 human-made carbon monoxide sources in the Sydney region</b>				
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	62,708	29.8	29.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	37,063	17.6	47.4
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	33,868	16.1	63.5
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	19,688	9.36	72.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	18,161	8.64	81.5
Off-Road Mobile	Recreational Boats Exhaust	8,411	4.00	85.5
Off-Road Mobile	Commercial Boats Exhaust	7,616	3.62	89.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	3,706	1.76	90.9
Off-Road Mobile	Aircraft (Flight Operations)	2,936	1.40	92.3
On-Road Mobile	Others - Exhaust	2,897	1.38	93.7
Human-made	Other	13,236	6.29	100.0
<b>Top 10 human-made carbon monoxide sources in the Newcastle region</b>				
Industrial	Aluminium production (alumina)	40,709	67.0	67.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	4,776	7.86	74.8
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	2,840	4.67	79.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	2,800	4.61	84.1
Off-Road Mobile	Commercial Boats Exhaust	2,560	4.21	88.3
Industrial	Iron or steel production (scrap metal)	2,038	3.35	91.7
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1,126	1.85	93.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	1,116	1.84	95.4

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Off-Road Mobile	Recreational Boats Exhaust	736	1.21	96.6
Industrial	Ammonium nitrate production	411	0.68	97.2
Human-made	Other	1,674	2.75	100.0
<b>Top 10 human-made carbon monoxide sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	103,354	90.5	90.5
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2,541	2.23	92.8
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1,899	1.66	94.4
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,668	1.46	95.9
Off-Road Mobile	Recreational Boats Exhaust	1,045	0.92	96.8
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	831	0.73	97.5
Industrial	Generation of electrical power from gas	820	0.72	98.2
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	586	0.51	98.8
Off-Road Mobile	Industrial Vehicles and Equipment	333	0.29	99.0
Industrial	Metal plating or coating	289	0.25	99.3
Human-made	Other	804	0.70	100.0
<b>Top 10 human-made carbon monoxide sources in the Non-urban region</b>				
Off-Road Mobile	Commercial Boats Exhaust	16,871	20.4	20.4
Off-Road Mobile	Industrial Vehicles and Equipment	9,309	11.2	31.6
Industrial	Mining for coal	9,122	11.0	42.6
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	9,050	10.9	53.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	8,586	10.4	63.9
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	6,755	8.16	72.1
Off-Road Mobile	Recreational Boats Exhaust	6,298	7.60	79.7
Industrial	Generation of electrical power from coal	6,093	7.36	87.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	2,594	3.13	90.2
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	2,549	3.08	93.2
Human-made	Other	5,602	6.76	100.0

Figure ES-12, Figure ES-13, Figure ES-14, Figure ES-15 and Figure ES-16 show the proportions of total estimated annual emissions for the top 10 human-made sources of carbon monoxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

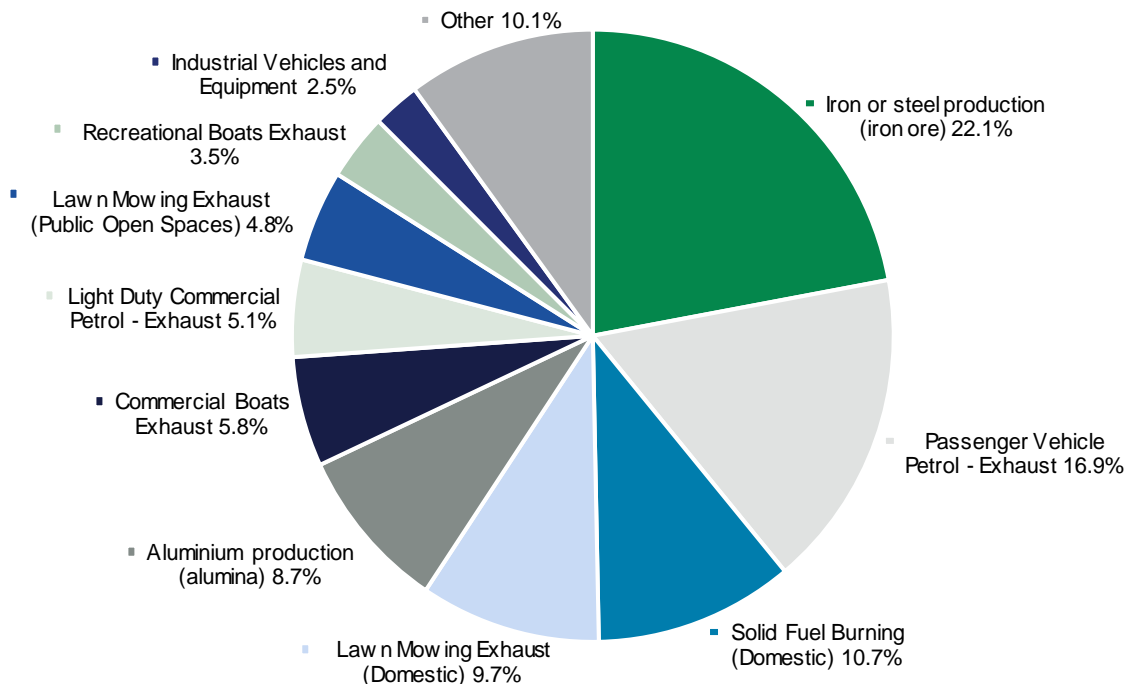


Figure ES-12: GMR: top 10 human-made sources of carbon monoxide

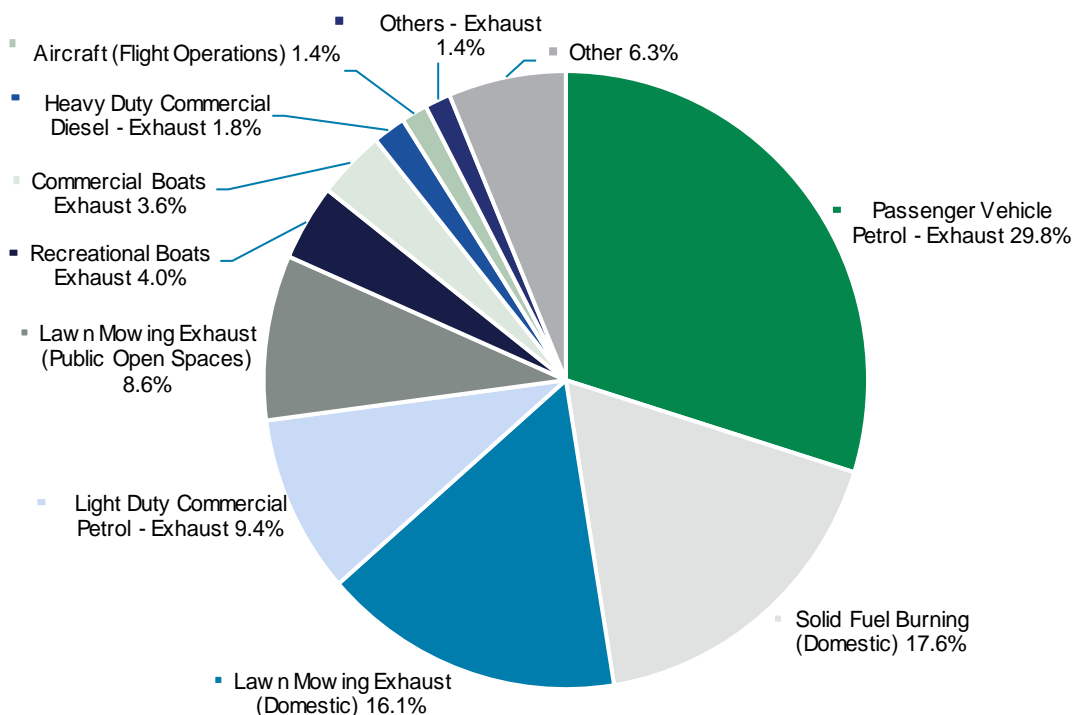


Figure ES-13: Sydney region: top 10 human-made sources of carbon monoxide



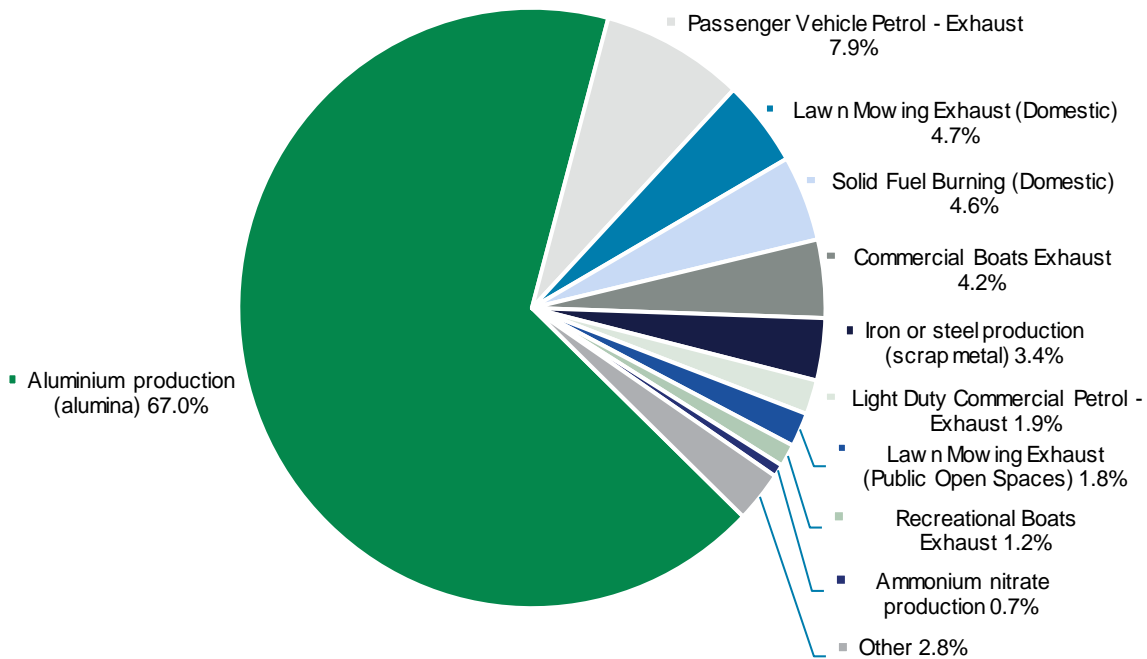


Figure ES-14: Newcastle region: top 10 human-made sources of carbon monoxide

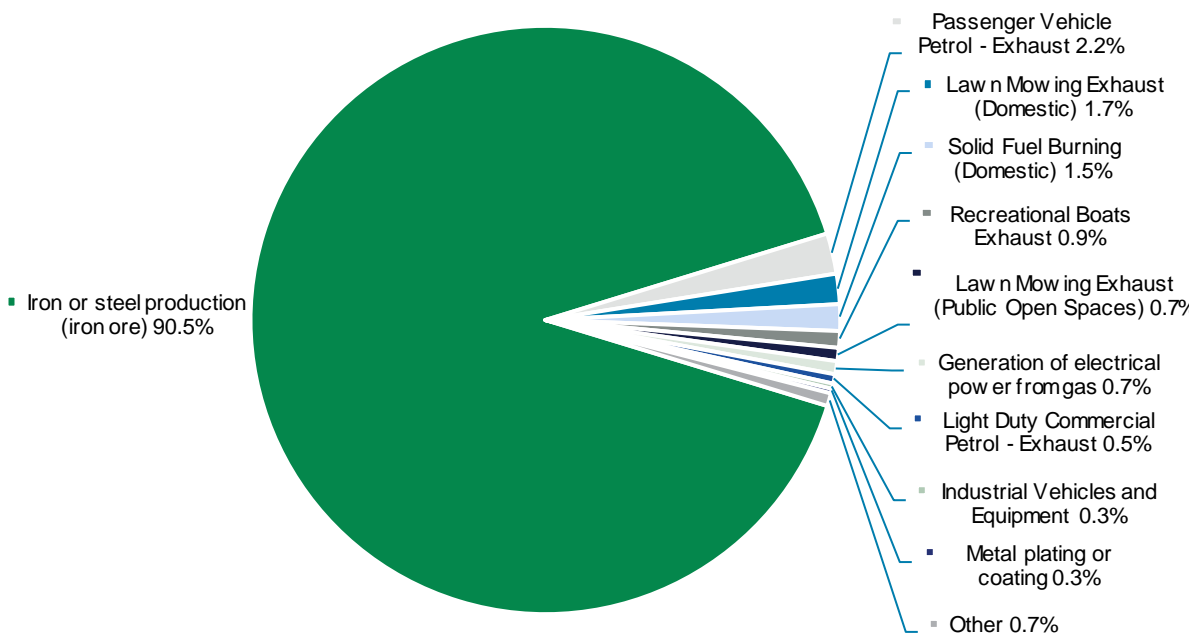


Figure ES-15: Wollongong region: top 10 human-made sources of carbon monoxide

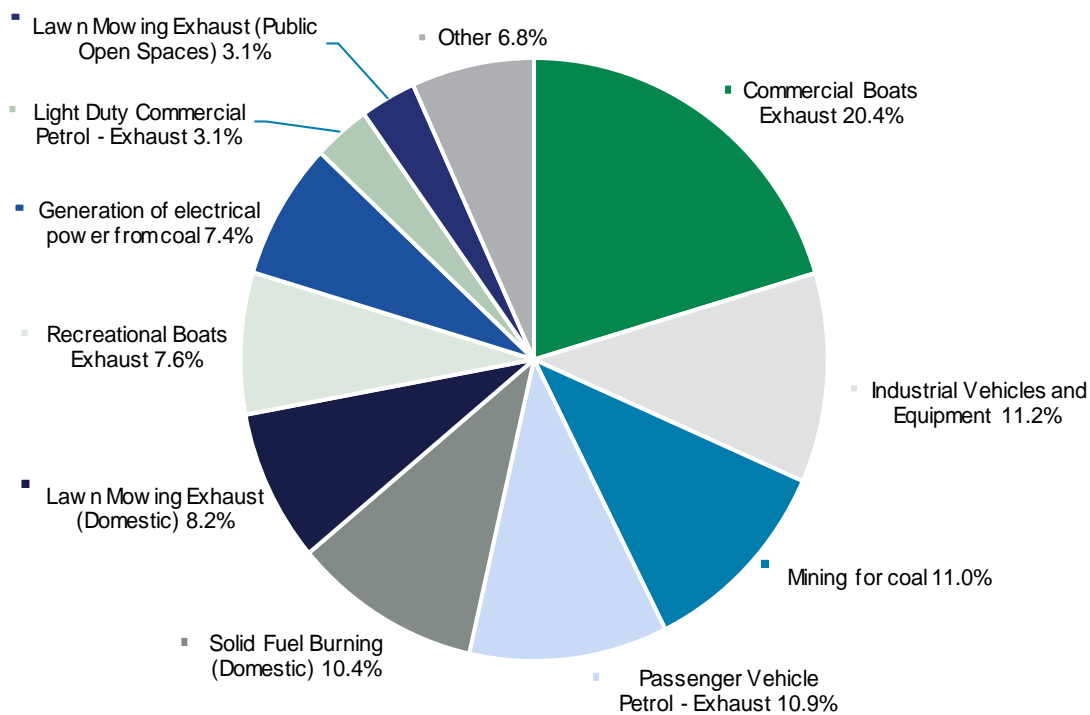


Figure ES-16: Non-urban region: top 10 human-made sources of carbon monoxide

Table ES-7 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of oxides of nitrogen in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-7: Top 10 human-made sources of oxides of nitrogen in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made oxides of nitrogen sources in the GMR</b>				
Industrial	Generation of electrical power from coal	139,246	51.8	51.8
Off-Road Mobile	Industrial Vehicles and Equipment	30,767	11.4	63.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	20,564	7.64	70.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	13,273	4.93	75.8
Off-Road Mobile	Ships	12,373	4.60	80.4
Off-Road Mobile	Locomotives	9,093	3.38	83.8
On-Road Mobile	Light Duty Diesel - Exhaust	6,631	2.47	86.2
Industrial	Iron or steel production (iron ore)	5,772	2.15	88.4
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	4,490	1.67	90.0
Industrial	Cement or lime production	3,985	1.48	91.5
Human-made	Other	22,812	8.48	100.0

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made oxides of nitrogen sources in the Sydney region</b>				
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	13,694	23.3	23.3
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	10,039	17.1	40.4
Off-Road Mobile	Ships	6,874	11.7	52.2
On-Road Mobile	Light Duty Diesel - Exhaust	5,230	8.91	61.1
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	3,443	5.87	66.9
Off-Road Mobile	Industrial Vehicles and Equipment	2,840	4.84	71.8
Off-Road Mobile	Commercial Boats Exhaust	2,154	3.67	75.5
Off-Road Mobile	Aircraft (Flight Operations)	1,966	3.35	78.8
Industrial	Generation of electrical power from gas	1,905	3.25	82.1
Domestic-Commercial	Gaseous Fuel Burning	1,705	2.91	85.0
Human-made	Other	8,827	15.0	100.0
<b>Top 10 human-made oxides of nitrogen sources in the Newcastle region</b>				
Off-Road Mobile	Ships	2,293	25.1	25.1
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	1,339	14.7	39.8
Industrial	Ammonium nitrate production	1,301	14.2	54.0
Off-Road Mobile	Locomotives	1,115	12.2	66.2
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	857	9.38	75.6
Off-Road Mobile	Industrial Vehicles and Equipment	360	3.94	79.5
On-Road Mobile	Light Duty Diesel - Exhaust	344	3.77	83.3
Off-Road Mobile	Commercial Boats Exhaust	251	2.74	86.1
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	240	2.62	88.7
Industrial	Iron or steel production (scrap metal)	186	2.04	90.7
Human-made	Other	848	9.29	100.0
<b>Top 10 human-made oxides of nitrogen sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	5,772	58.5	58.5
Off-Road Mobile	Industrial Vehicles and Equipment	935	9.48	68.0
Off-Road Mobile	Ships	781	7.92	75.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	774	7.85	83.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	504	5.11	88.9
Industrial	Generation of electrical power from gas	328	3.33	92.2
On-Road Mobile	Light Duty Diesel - Exhaust	190	1.93	94.1
Off-Road Mobile	Locomotives	163	1.65	95.8
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	136	1.38	97.2

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Domestic-Commercial	Gaseous Fuel Burning	82.22	0.83	98.0
Human-made	Other	197	1.99	100.0
<b>Top 10 human-made oxides of nitrogen sources in the Non-urban region</b>				
Industrial	Generation of electrical power from coal	139,246	72.8	72.8
Off-Road Mobile	Industrial Vehicles and Equipment	26,632	13.9	86.7
Off-Road Mobile	Locomotives	6,513	3.40	90.1
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	4,757	2.49	92.6
Industrial	Cement or lime production	3,104	1.62	94.2
Industrial	Mining for coal	2,481	1.30	95.5
Off-Road Mobile	Ships	2,425	1.27	96.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	1,874	0.98	97.8
Off-Road Mobile	Commercial Boats Exhaust	1,205	0.63	98.4
On-Road Mobile	Light Duty Diesel - Exhaust	867	0.45	98.8
Human-made	Other	2,231	1.17	100.0

Figure ES-17, Figure ES-18, Figure ES-19, Figure ES-20 and Figure ES-21 show the proportions of total estimated annual emissions for the top 10 human-made sources of oxides of nitrogen in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

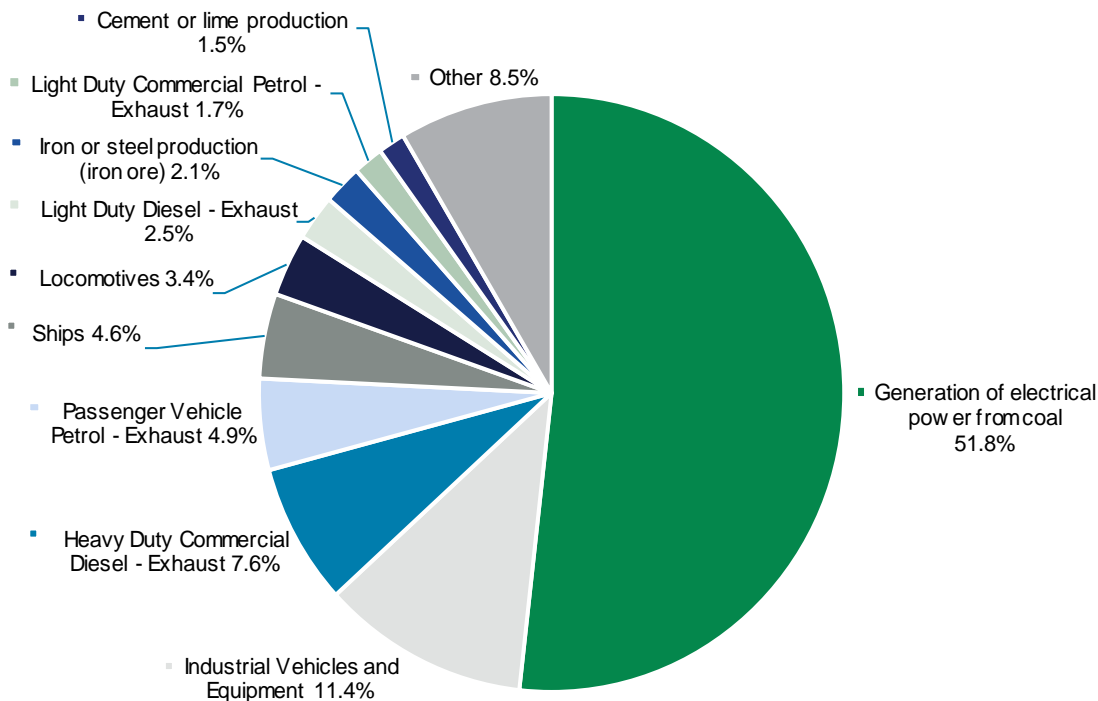


Figure ES-17: GMR: top 10 human-made sources of oxides of nitrogen

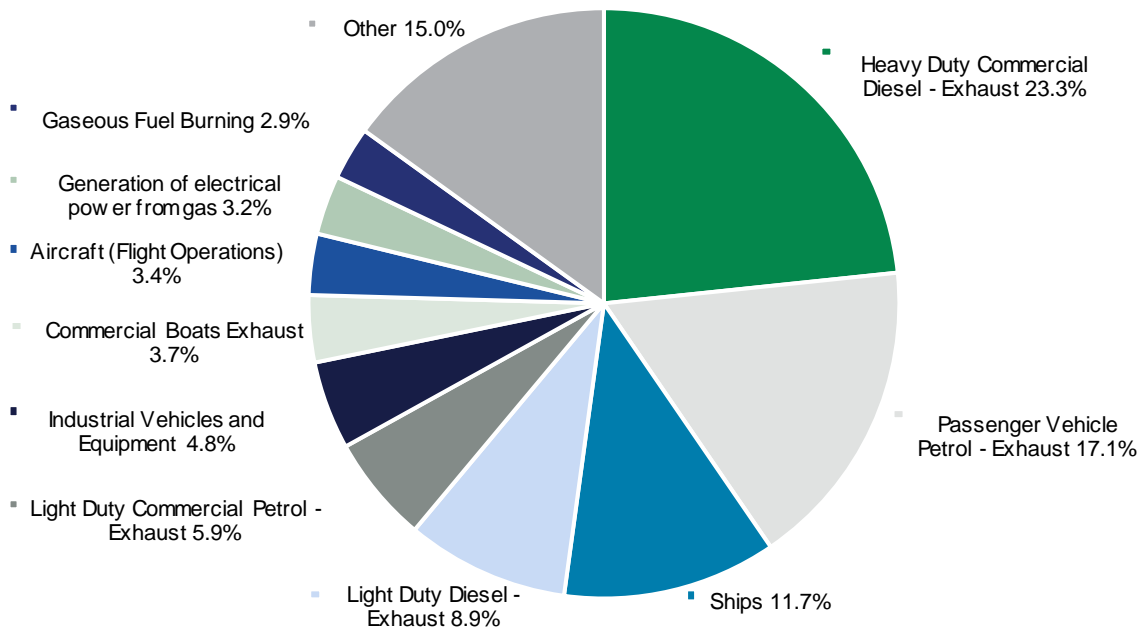


Figure ES-18: Sydney region: top 10 human-made sources of oxides of nitrogen

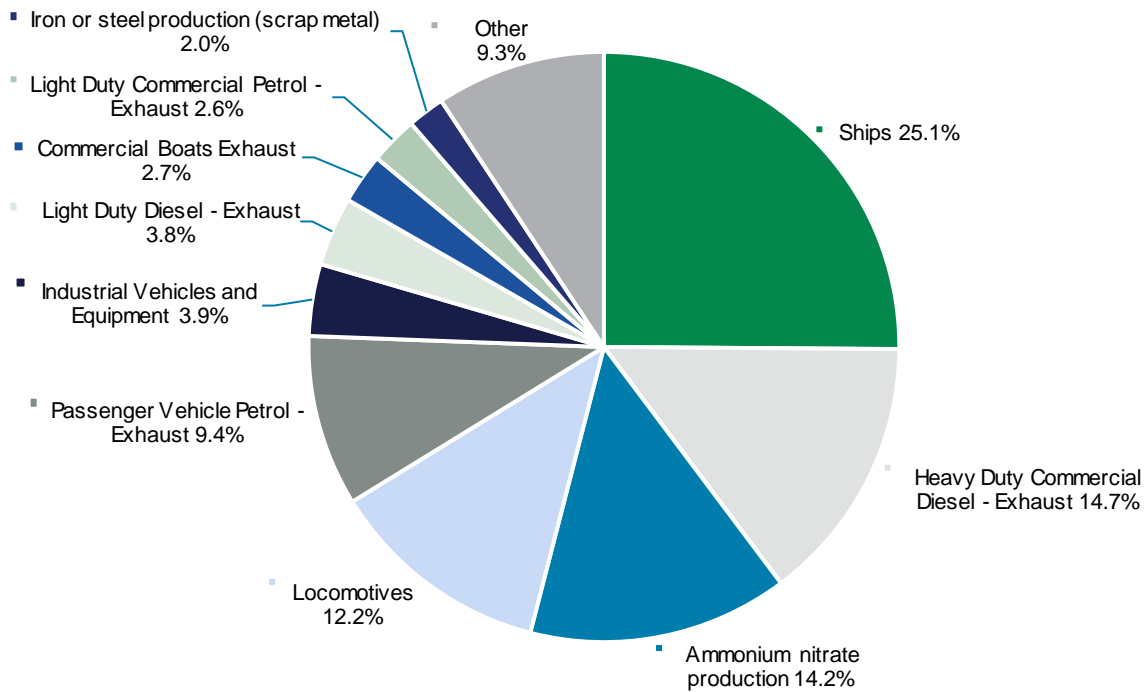


Figure ES-19: Newcastle region: top 10 human-made sources of oxides of nitrogen

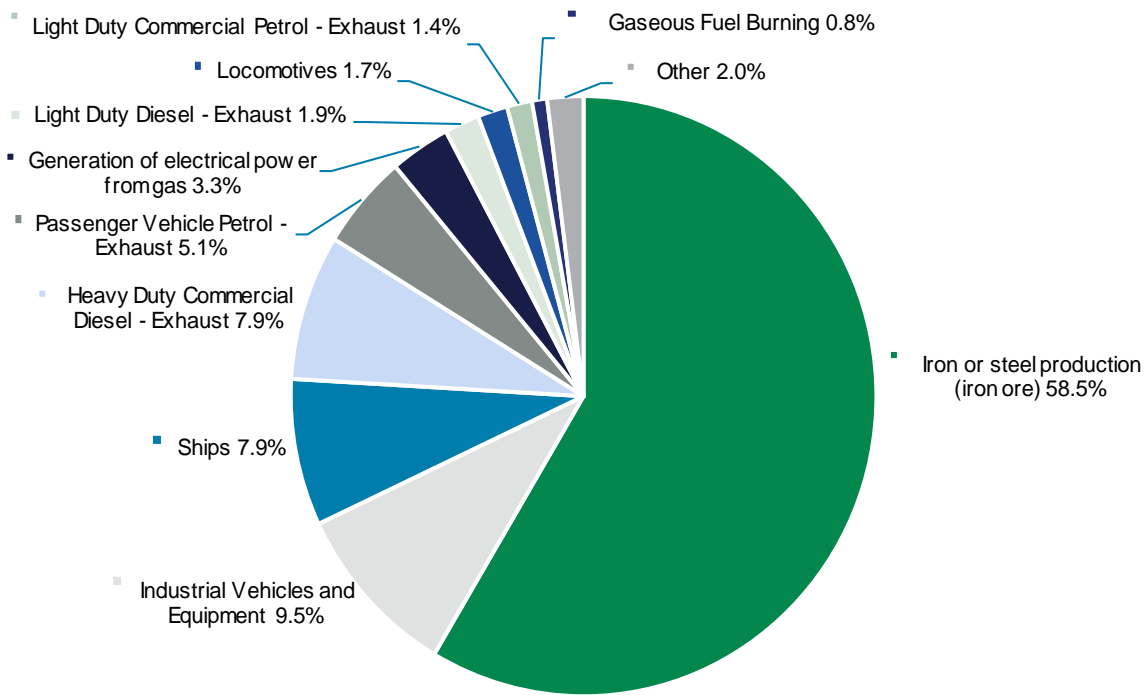


Figure ES-20: Wollongong region: top 10 human-made sources of oxides of nitrogen

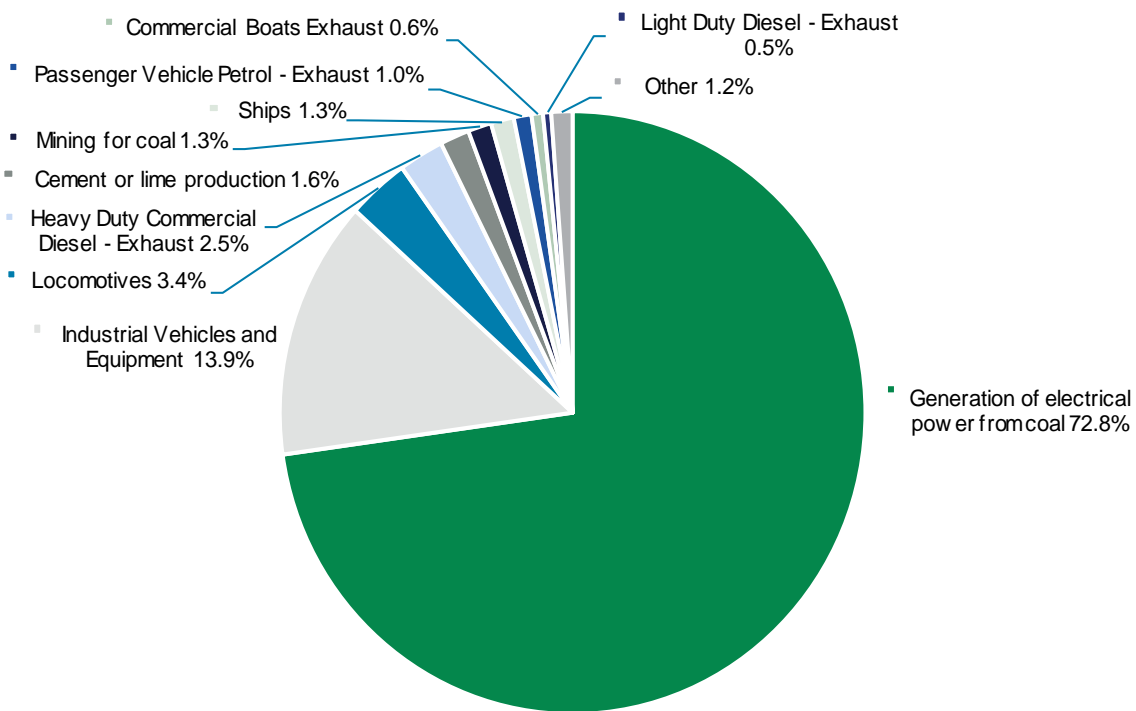


Figure ES-21: Non-urban region: top 10 human-made sources of oxides of nitrogen

Table ES-8 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table ES-8: Top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$  in each region**

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made particulate matter <math>\leq 10\mu\text{m}</math> sources in the GMR</b>				
Industrial	Mining for coal	68,020	67.2	67.2
Domestic-Commercial	Solid Fuel Burning (Domestic)	7,036	6.95	74.2
Industrial	Generation of electrical power from coal	3,623	3.58	77.7
Industrial	Land-based extractive activity	3,071	3.03	80.8
Industrial	Ceramics production	1,580	1.56	82.3
Industrial	Waste disposal (application to land)	1,563	1.54	83.9
On-Road Mobile	All - Non-Exhaust PM	1,548	1.53	85.4
Off-Road Mobile	Industrial Vehicles and Equipment	1,371	1.35	86.8
Off-Road Mobile	Ships	1,275	1.26	88.0
Industrial	Coal works	1,169	1.15	89.2
Human-made	Other	10,955	10.8	100.0
<b>Top 10 human-made particulate matter <math>\leq 10\mu\text{m}</math> sources in the Sydney region</b>				
Domestic-Commercial	Solid Fuel Burning (Domestic)	5,203	33.8	33.8
Industrial	Waste disposal (application to land)	1,221	7.92	41.7
On-Road Mobile	All - Non-Exhaust PM	1,148	7.44	49.1
Industrial	Ceramics production	890	5.78	54.9
Off-Road Mobile	Ships	774	5.02	59.9
Industrial	Crushing, grinding or separating	666	4.32	64.2
Industrial	Mining for coal	479	3.11	67.3
Industrial	Land-based extractive activity	451	2.92	70.3
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	431	2.79	73.1
Commercial	Gravel and Sand Quarrying	342	2.22	75.3
Human-made	Other	3,810	24.7	100.0
<b>Top 10 human-made particulate matter <math>\leq 10\mu\text{m}</math> sources in the Newcastle region</b>				
Industrial	Mining for coal	1,480	29.8	29.8
Industrial	Coal works	901	18.1	47.9
Industrial	Aluminium production (alumina)	506	10.2	58.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	393	7.91	66.0
Industrial	Ammonium nitrate production	328	6.61	72.6
Industrial	Land-based extractive activity	225	4.53	77.2
Off-Road Mobile	Ships	215	4.32	81.5
Industrial	Waste disposal (application to land)	121	2.43	83.9

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
On-Road Mobile	All - Non-Exhaust PM	99.69	2.01	85.9
Industrial	Non-thermal treatment of waste	87.42	1.76	87.7
Human-made	Other	612	12.3	100.0
<b>Top 10 human-made particulate matter ≤ 10µm sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	915	51.1	51.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	234	13.1	64.2
Industrial	Coal works	131	7.30	71.5
Industrial	Mining for coal	113	6.32	77.8
Off-Road Mobile	Ships	78.06	4.36	82.2
Industrial	Generation of electrical power from gas	65.58	3.66	85.9
On-Road Mobile	All - Non-Exhaust PM	53.21	2.97	88.8
Off-Road Mobile	Industrial Vehicles and Equipment	41.95	2.34	91.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	22.13	1.24	92.4
Industrial	Waste disposal (application to land)	20.03	1.12	93.5
Human-made	Other	116	6.47	100.0
<b>Top 10 human-made particulate matter ≤ 10µm sources in the Non-urban region</b>				
Industrial	Mining for coal	65,948	83.4	83.4
Industrial	Generation of electrical power from coal	3,623	4.58	88.0
Industrial	Land-based extractive activity	2,395	3.03	91.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,205	1.53	92.6
Off-Road Mobile	Industrial Vehicles and Equipment	1,196	1.51	94.1
Industrial	Boat mooring and storage	945	1.20	95.3
Industrial	Ceramics production	689	0.87	96.2
Industrial	Cement or lime production	482	0.61	96.8
Commercial	Gravel and Sand Quarrying	336	0.43	97.2
On-Road Mobile	All - Non-Exhaust PM	248	0.31	97.5
Human-made	Other	1,969	2.49	100.0



Figure ES-22, Figure ES-23, Figure ES-24, Figure ES-25 and Figure ES-26 show the proportions of total estimated annual emissions for the top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

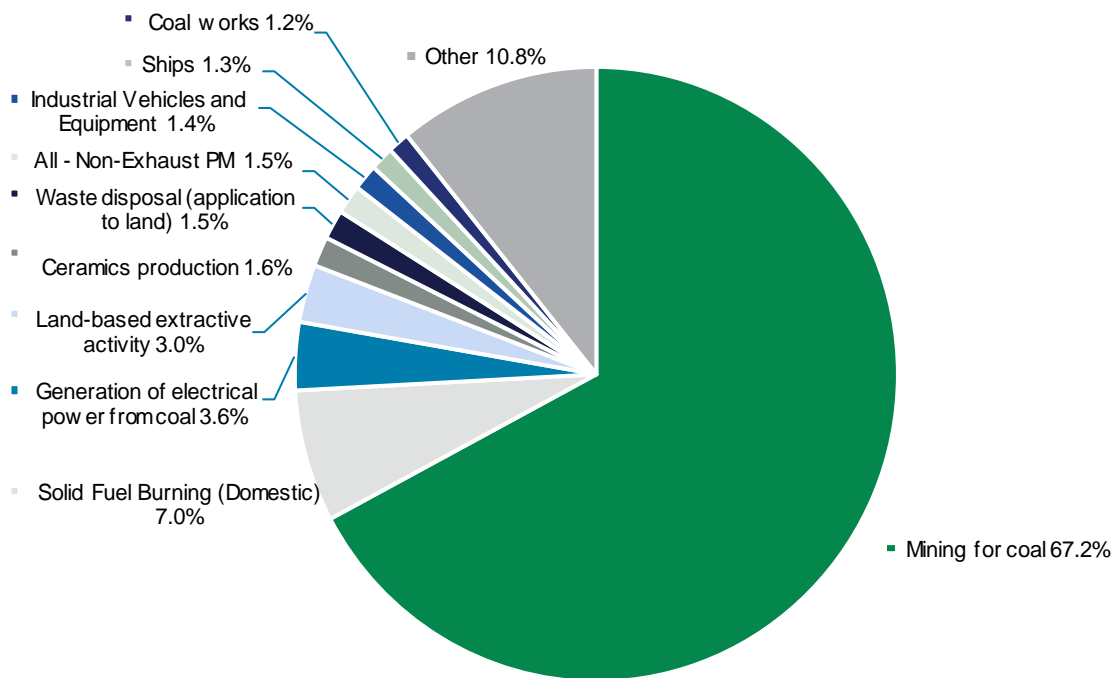


Figure ES-22: GMR: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$

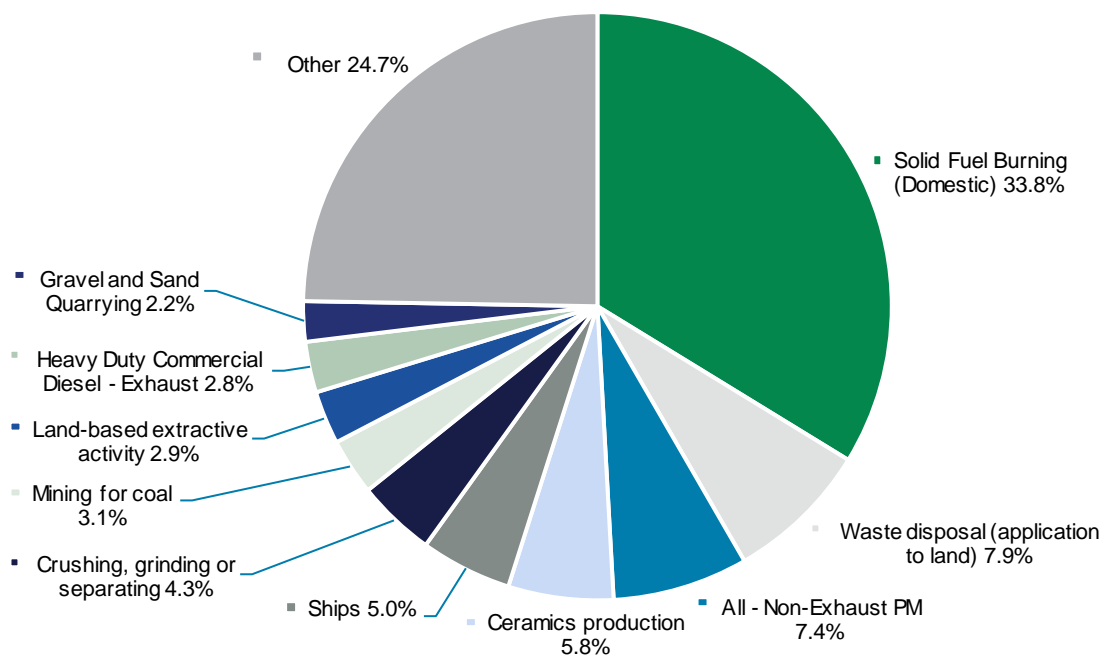


Figure ES-23: Sydney region: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$

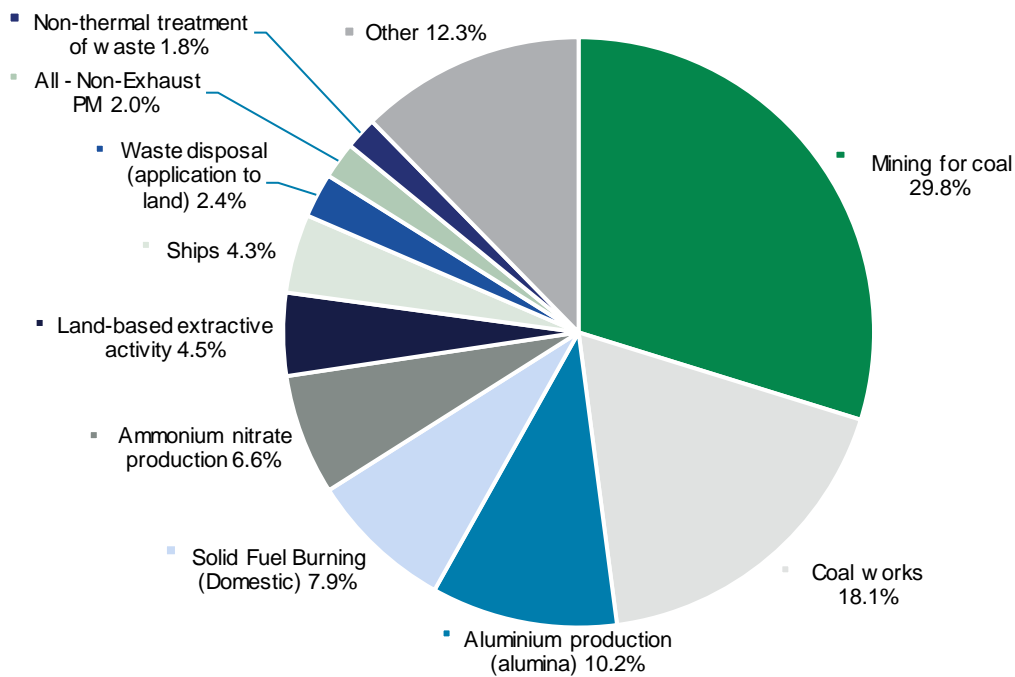


Figure ES-24: Newcastle region: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$

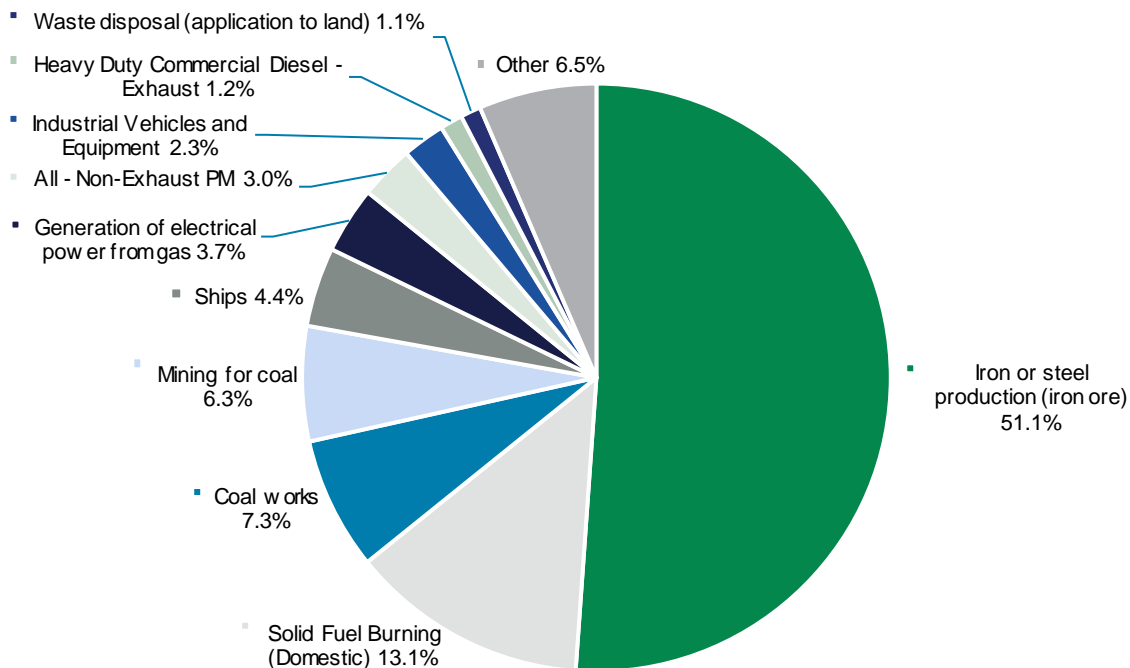


Figure ES-25: Wollongong region: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$

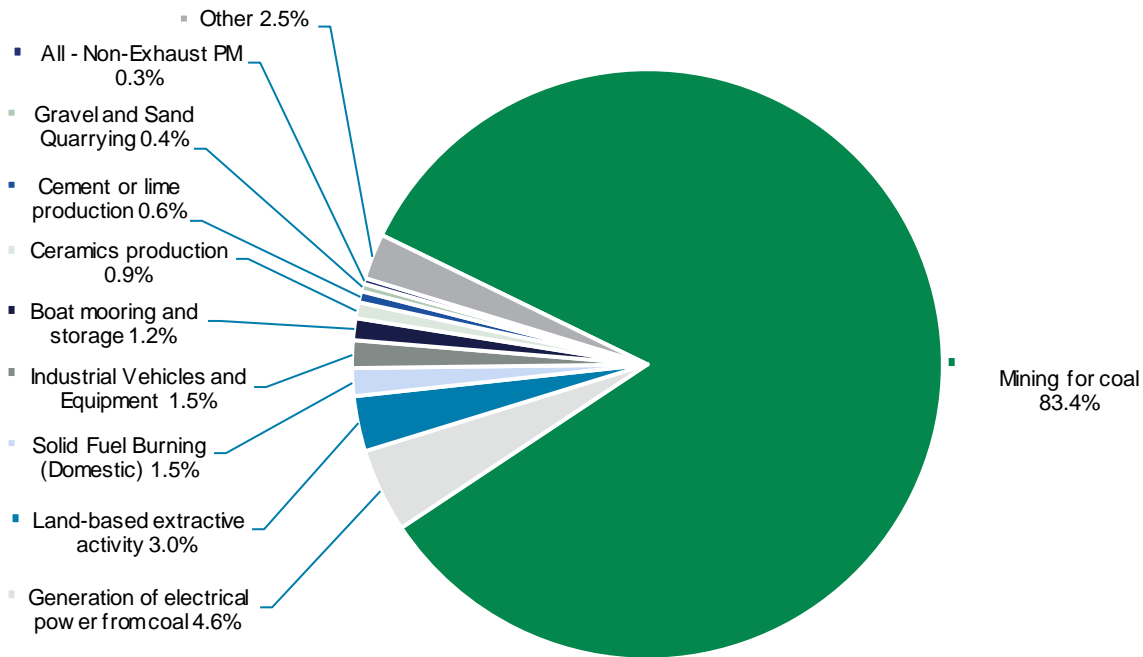


Figure ES-26: Non-urban region: top 10 human-made sources of particulate matter ≤ 10µm

Table ES-9 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of particulate matter ≤ 2.5µm in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-9: Top 10 human-made sources of particulate matter ≤ 2.5µm in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made particulate matter ≤ 2.5µm sources in the GMR</b>				
Industrial	Mining for coal	10,238	35.0	35.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	6,773	23.2	58.2
Industrial	Generation of electrical power from coal	1,477	5.05	63.3
Off-Road Mobile	Industrial Vehicles and Equipment	1,330	4.55	67.8
Off-Road Mobile	Ships	1,173	4.01	71.8
Industrial	Land-based extractive activity	837	2.86	74.7
On-Road Mobile	All - Non-Exhaust PM	824	2.82	77.5
Industrial	Ceramics production	621	2.13	79.6
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	604	2.07	81.7
Industrial	Cement or lime production	392	1.34	83.0
Human-made	Other	4,960	17.0	100.0
<b>Top 10 human-made particulate matter ≤ 2.5µm sources in the Sydney region</b>				
Domestic-Commercial	Solid Fuel Burning (Domestic)	5,009	50.4	50.4
Off-Road Mobile	Ships	712	7.16	57.5

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
On-Road Mobile	All - Non-Exhaust PM	610	6.14	63.7
Industrial	Ceramics production	504	5.07	68.7
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	418	4.20	72.9
Industrial	Waste disposal (application to land)	232	2.33	75.3
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	200	2.01	77.3
On-Road Mobile	Light Duty Diesel - Exhaust	185	1.86	79.1
Industrial	Crushing, grinding or separating	149	1.50	80.6
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	142	1.43	82.1
Human-made	Other	1,784	17.9	100.0
<b>Top 10 human-made particulate matter ≤ 2.5µm sources in the Newcastle region</b>				
Domestic-Commercial	Solid Fuel Burning (Domestic)	378	18.1	18.1
Industrial	Aluminium production (alumina)	363	17.4	35.4
Industrial	Ammonium nitrate production	322	15.4	50.8
Industrial	Mining for coal	240	11.4	62.2
Off-Road Mobile	Ships	197	9.43	71.7
Industrial	Coal works	107	5.11	76.8
Industrial	Land-based extractive activity	61.02	2.92	79.7
On-Road Mobile	All - Non-Exhaust PM	53.04	2.53	82.2
Industrial	Iron or steel production (scrap metal)	44.28	2.12	84.4
Industrial	Agricultural fertiliser (phosphate) production	40.87	1.95	86.3
Human-made	Other	287	13.7	100.0
<b>Top 10 human-made particulate matter ≤ 2.5µm sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	378	40.1	40.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	225	23.9	64.0
Off-Road Mobile	Ships	71.81	7.62	71.6
Industrial	Generation of electrical power from gas	65.58	6.96	78.6
Off-Road Mobile	Industrial Vehicles and Equipment	40.69	4.32	82.9
On-Road Mobile	All - Non-Exhaust PM	28.31	3.00	85.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	21.47	2.28	88.2
Industrial	Coal works	20.52	2.18	90.4
Industrial	Mining for coal	16.02	1.70	92.1
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	11.20	1.19	93.3
Human-made	Other	63.55	6.74	100.0
<b>Top 10 human-made particulate matter ≤ 2.5µm sources in the Non-urban region</b>				
Industrial	Mining for coal	9,898	60.9	60.9
Industrial	Generation of electrical power from coal	1,477	9.09	70.0
Off-Road Mobile	Industrial Vehicles and Equipment	1,160	7.14	77.2

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,160	7.14	84.3
Industrial	Land-based extractive activity	683	4.20	88.5
Industrial	Cement or lime production	337	2.08	90.6
Off-Road Mobile	Ships	192	1.18	91.8
Industrial	Boat mooring and storage	183	1.12	92.9
Off-Road Mobile	Commercial Boats Exhaust	138	0.85	93.7
On-Road Mobile	All - Non-Exhaust PM	132	0.81	94.5
Human-made	Other	887	5.46	100.0

Figure ES-27, Figure ES-28, Figure ES-29, Figure ES-30 and Figure ES-31 show the proportions of total estimated annual emissions for the top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

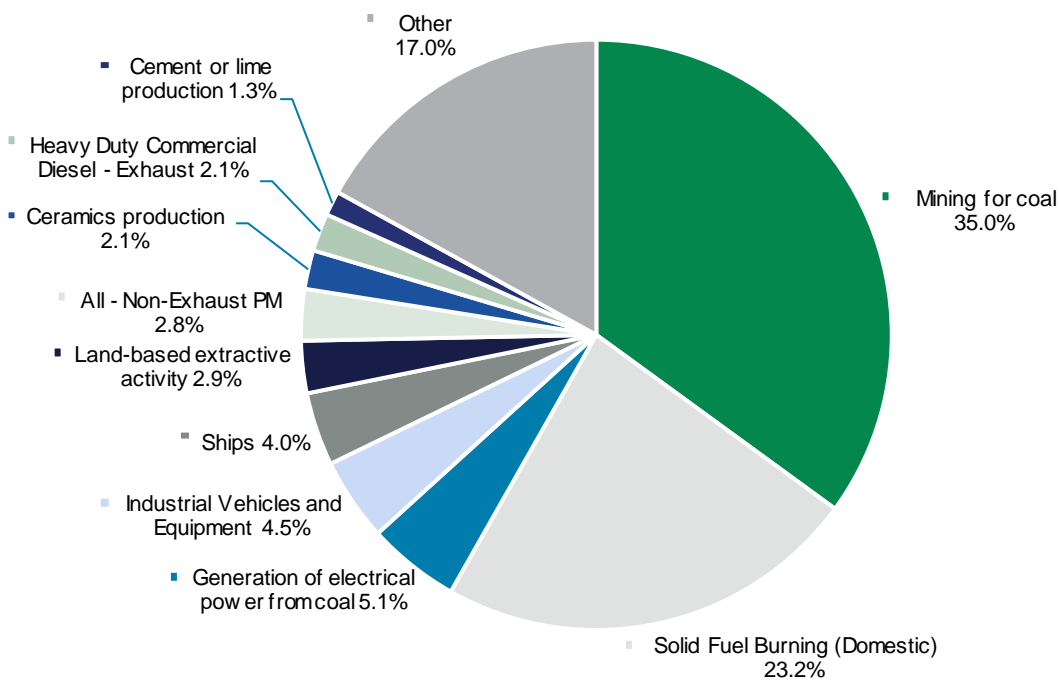


Figure ES-27: GMR: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

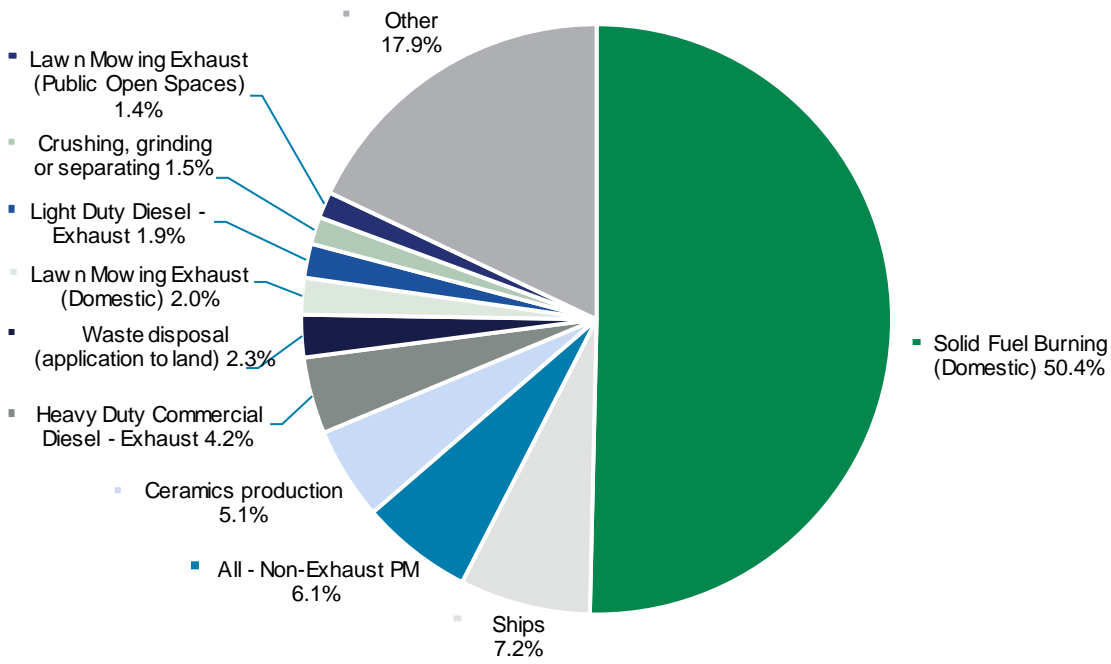


Figure ES-28: Sydney region: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

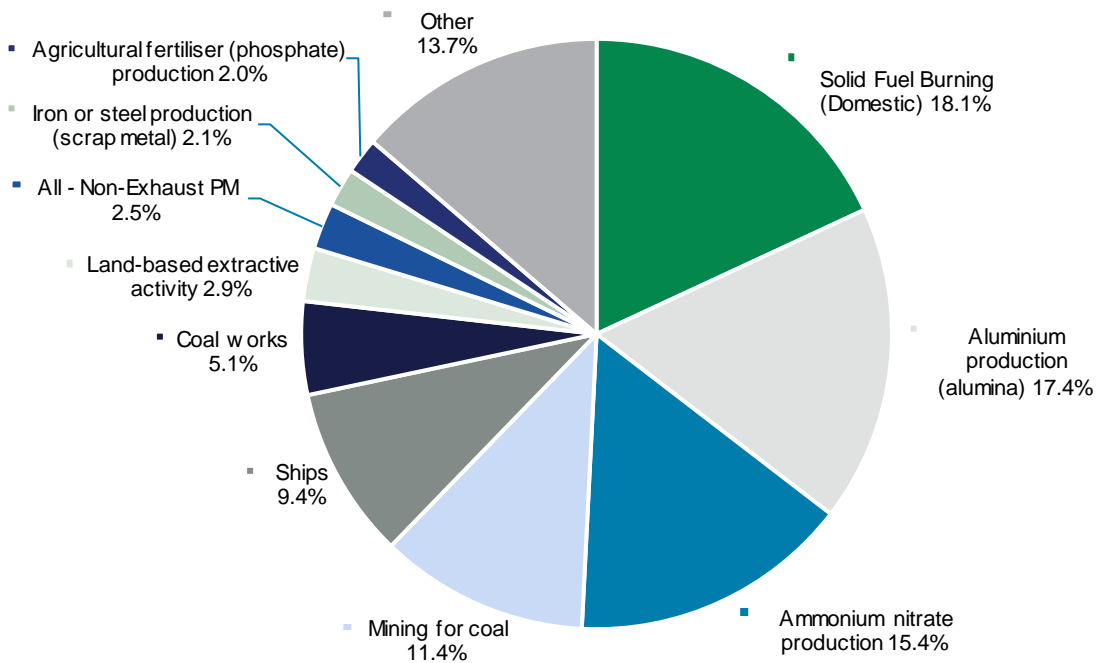


Figure ES-29: Newcastle region: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

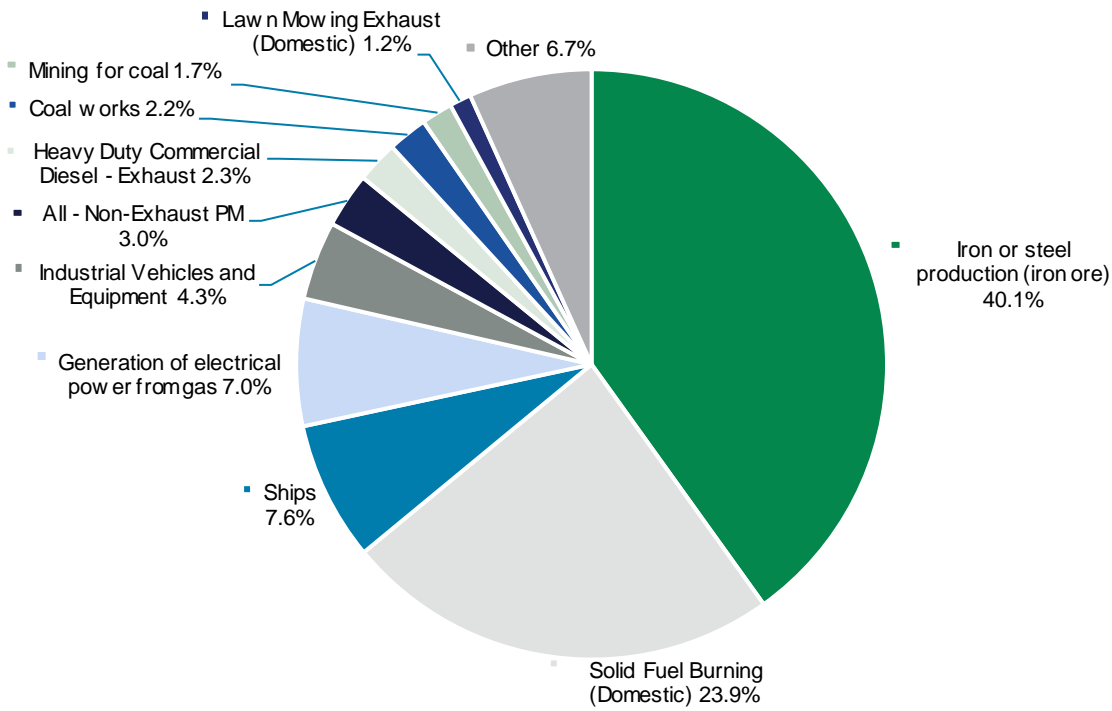


Figure ES-30: Wollongong region: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

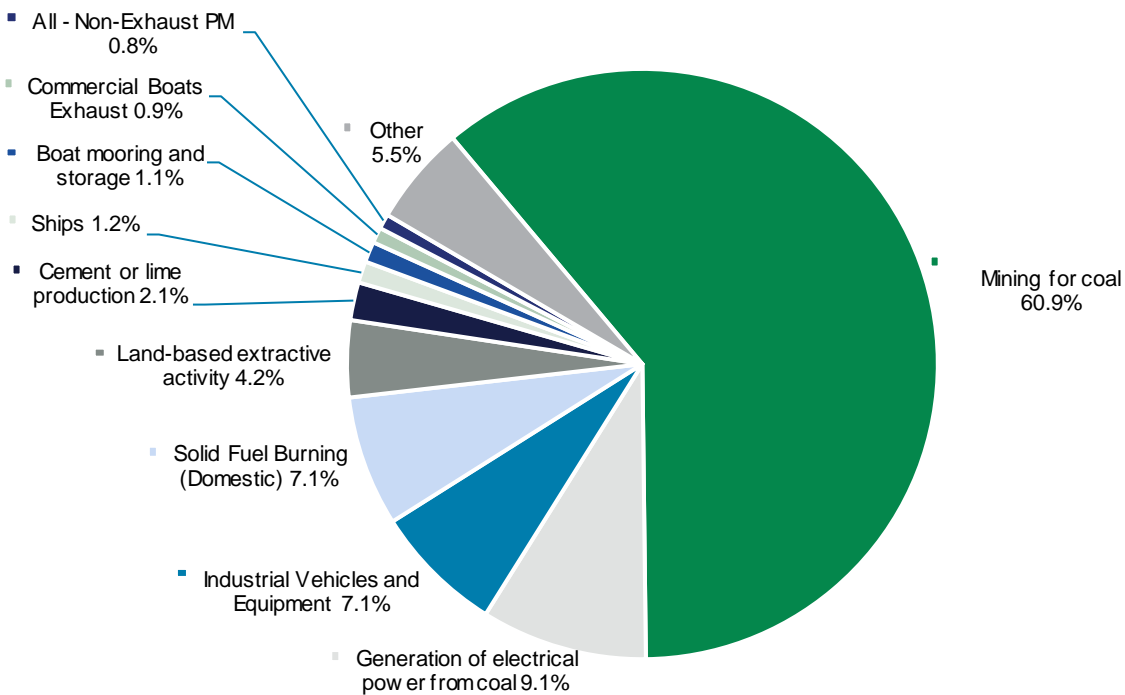


Figure ES-31: Non-urban region: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

Table ES-10 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of sulfur dioxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table ES-10: Top 10 human-made sources of sulfur dioxide in each region**

Module	Activity <sup>9</sup>	Emissions (tonnes/year)	Proportion <sup>10</sup> (%)	Cumulative proportion (%)
<b>Top 10 human-made sulfur dioxide sources in the GMR</b>				
Industrial	Generation of electrical power from coal	198,191	87.9	87.9
Off-Road Mobile	Ships	10,536	4.68	92.6
Industrial	Aluminium production (alumina)	8,168	3.62	96.2
Industrial	Iron or steel production (iron ore)	4,176	1.85	98.1
Industrial	Petroleum products and fuel	1,841	0.82	98.9
Industrial	Ceramics production	477	0.21	99.1
Industrial	Petrochemical production	473	0.21	99.3
Industrial	Mining for coal	264	0.12	99.5
Industrial	Glass production (container)	213	9.46×10 <sup>-2</sup>	99.6
Off-Road Mobile	Aircraft (Flight Operations)	180	7.97×10 <sup>-2</sup>	99.6
Human-made	Other	833	0.37	100.0
<b>Top 10 human-made sulfur dioxide sources in the Sydney region</b>				
Off-Road Mobile	Ships	6,606	65.1	65.1
Industrial	Petroleum products and fuel	1,840	18.1	83.2
Industrial	Petrochemical production	473	4.67	87.9
Industrial	Ceramics production	458	4.52	92.4
Industrial	Glass production (container)	213	2.10	94.5
Off-Road Mobile	Aircraft (Flight Operations)	173	1.70	96.2
Domestic-Commercial	Solid Fuel Burning (Domestic)	84.16	0.83	97.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	70.01	0.69	97.7
Commercial	Ceramic Product Manufacturing	36.80	0.36	98.1
Industrial	Generation of electrical power from gas	23.07	0.23	98.3
Human-made	Other	169	1.67	100.0
<b>Top 10 human-made sulfur dioxide sources in the Newcastle region</b>				
Industrial	Aluminium production (alumina)	8,168	81.8	81.8
Off-Road Mobile	Ships	1,703	17.1	98.8
Industrial	Chemical production	64.36	0.64	99.5
Industrial	Slaughtering or processing of animals	9.32	9.33×10 <sup>-2</sup>	99.6
Industrial	Iron or steel production (scrap metal)	9.06	9.07×10 <sup>-2</sup>	99.7
Domestic-Commercial	Solid Fuel Burning (Domestic)	6.36	6.37×10 <sup>-2</sup>	99.7

<sup>9</sup> n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006)

<sup>10</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10<sup>-2</sup> = 0.0946).



Module	Activity <sup>9</sup>	Emissions (tonnes/year)	Proportion <sup>10</sup> (%)	Cumulative proportion (%)
Industrial	Bitumen mixing	6.04	6.04×10 <sup>-2</sup>	99.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	5.03	5.04×10 <sup>-2</sup>	99.8
Off-Road Mobile	Aircraft (Flight Operations)	3.41	3.41×10 <sup>-2</sup>	99.9
Industrial	Generation of electrical power not coal, diesel or gas	2.17	2.17×10 <sup>-2</sup>	99.9
Human-made	Other	11.01	0.11	100.0
<b>Top 10 human-made sulfur dioxide sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	4,176	86.3	86.3
Off-Road Mobile	Ships	639	13.2	99.5
Industrial	Metal plating or coating	8.09	0.17	99.6
Industrial	Generation of electrical power from gas	5.09	0.11	99.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	3.79	7.82×10 <sup>-2</sup>	99.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2.89	5.98×10 <sup>-2</sup>	99.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	0.56	1.15×10 <sup>-2</sup>	99.9
Domestic-Commercial	Gaseous Fuel Burning	0.53	1.10×10 <sup>-2</sup>	99.9
Commercial	Funeral Directors, Crematoria and Cemeteries	0.53	1.09×10 <sup>-2</sup>	99.9
Off-Road Mobile	Recreational Boats Exhaust	0.51	1.05×10 <sup>-2</sup>	99.9
Human-made	Other	3.23	6.67×10 <sup>-2</sup>	100.0
<b>Top 10 human-made sulfur dioxide sources in the Non-urban region</b>				
Industrial	Generation of electrical power from coal	198,191	98.9	98.9
Off-Road Mobile	Ships	1,589	0.79	99.7
Industrial	Mining for coal	263	0.13	99.8
Industrial	Cement or lime production	121	6.04×10 <sup>-2</sup>	99.9
Commercial	Log Sawmilling	69.71	3.48×10 <sup>-2</sup>	99.9
Commercial	Food Manufacturing n.e.c.	37.47	1.87×10 <sup>-2</sup>	99.9
Domestic-Commercial	Solid Fuel Burning (Domestic)	19.50	9.73×10 <sup>-3</sup>	100.0
Industrial	Ceramics production	18.19	9.08×10 <sup>-3</sup>	100.0
Off-Road Mobile	Industrial Vehicles and Equipment	13.99	6.98×10 <sup>-3</sup>	100.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	11.22	5.60×10 <sup>-3</sup>	100.0
Human-made	Other	41.82	2.09×10 <sup>-2</sup>	100.0

Figure ES-32, Figure ES-33, Figure ES-34, Figure ES-35 and Figure ES-36 show the proportions of total estimated annual emissions for the top 10 human-made sources of sulfur dioxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

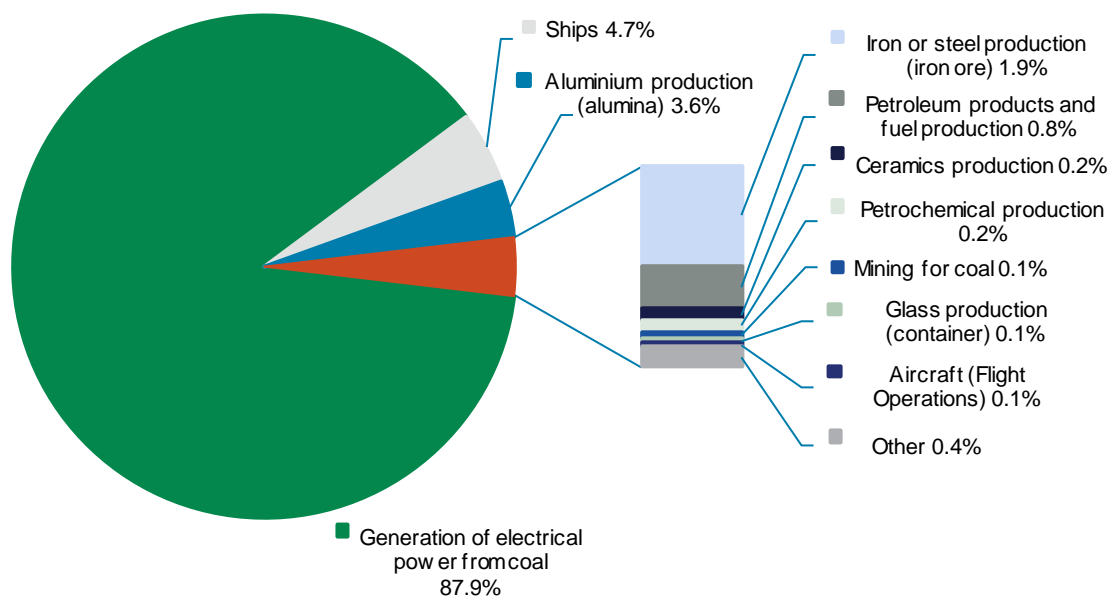


Figure ES-32: GMR: top 10 human-made sources of sulfur dioxide

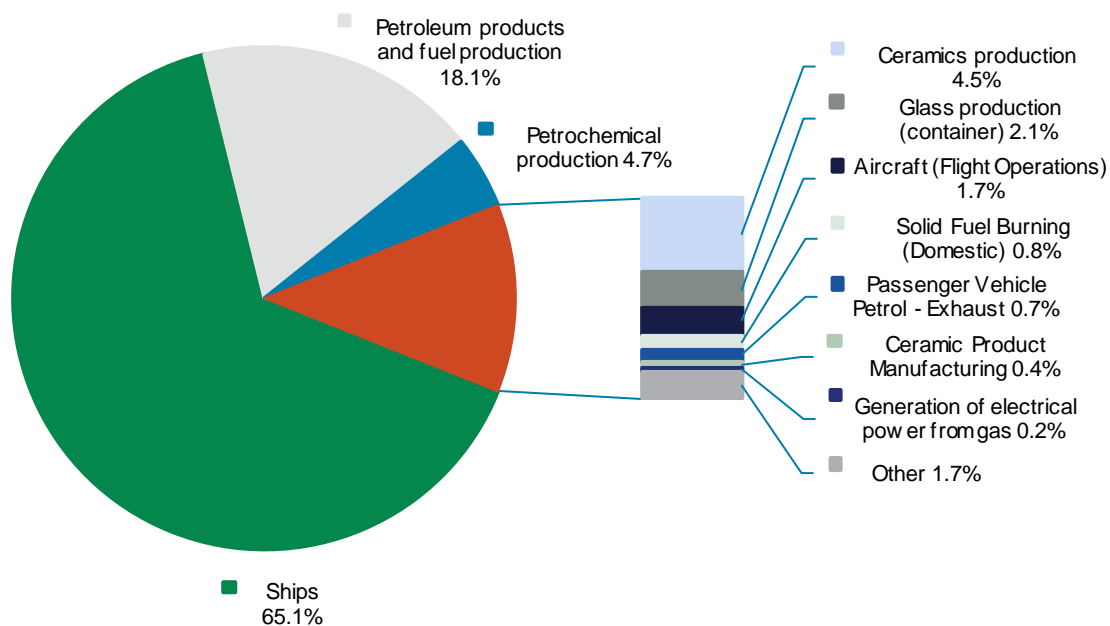


Figure ES-33: Sydney region: top 10 human-made sources of sulfur dioxide

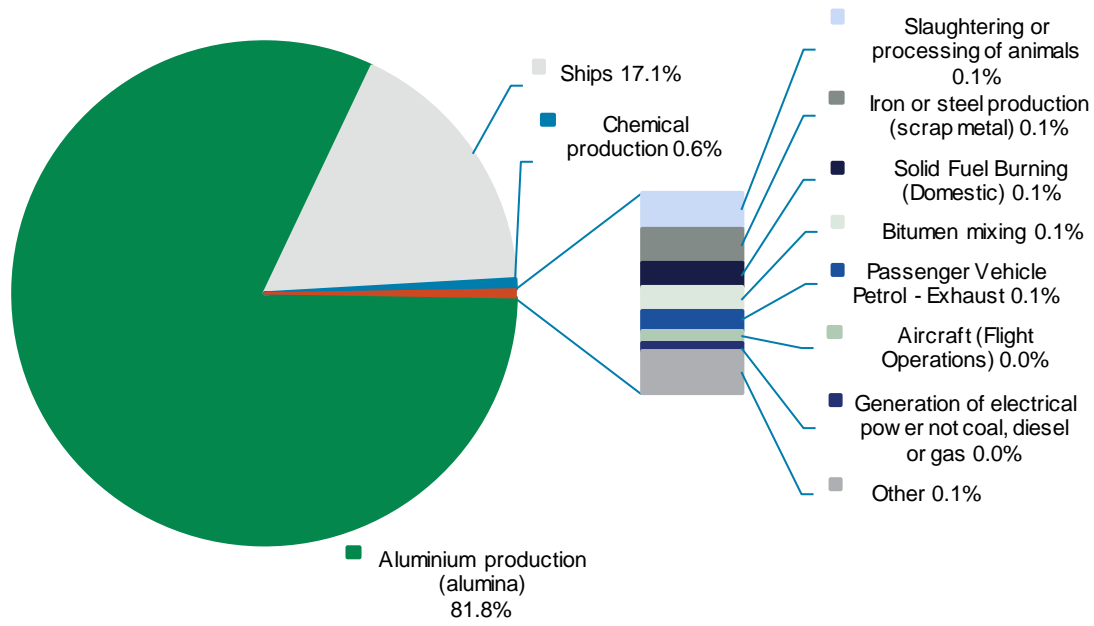


Figure ES-34: Newcastle region: top 10 human-made sources of sulfur dioxide

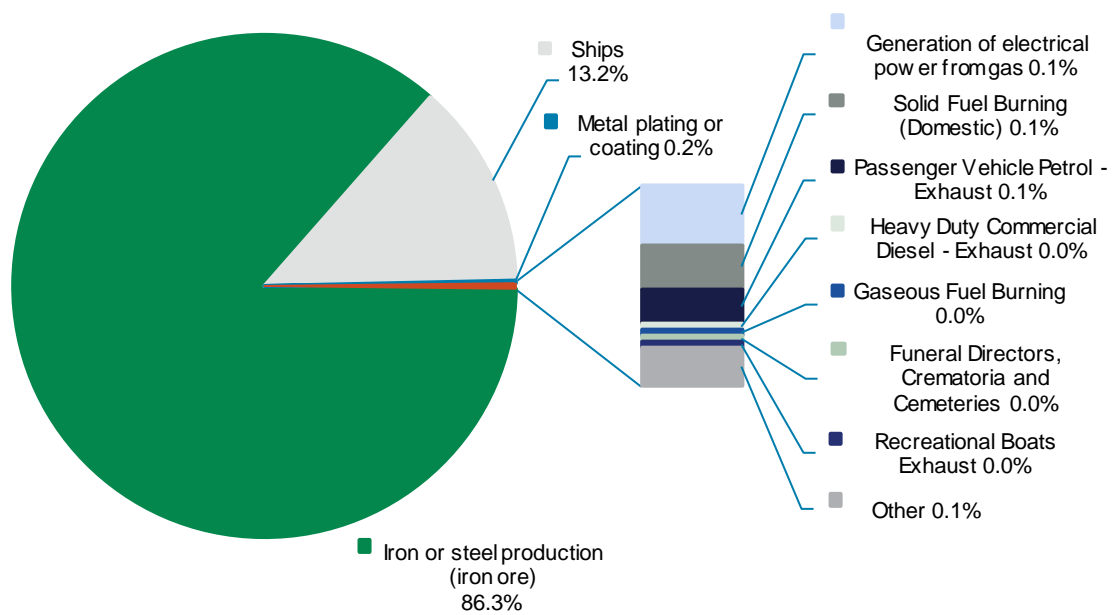


Figure ES-35: Wollongong region: top 10 human-made sources of sulfur dioxide

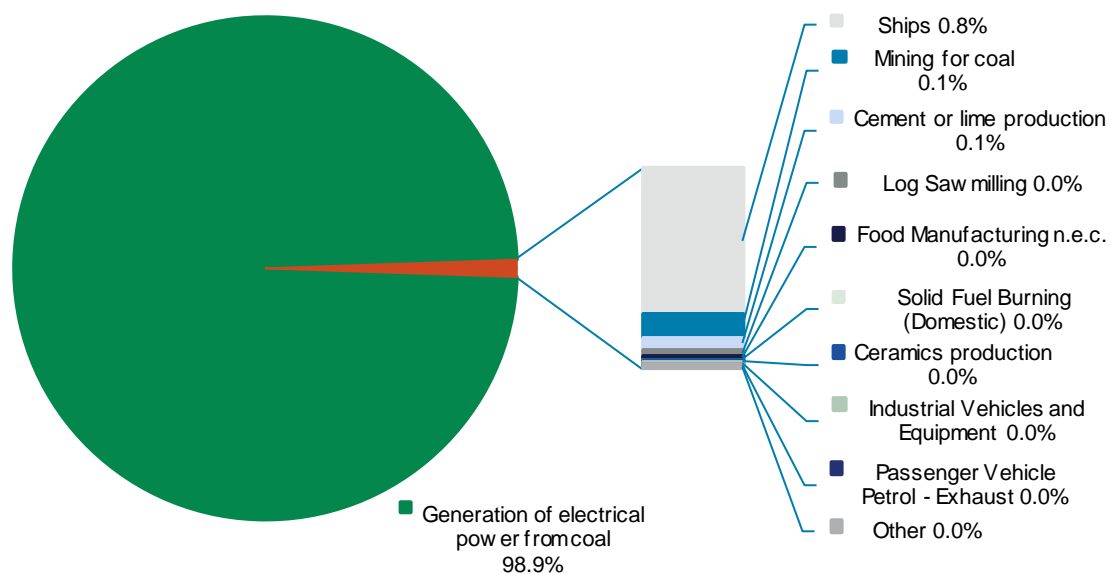


Figure ES-36: Non-urban region: top 10 human-made sources of sulfur dioxide

Table ES-11 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of VOC in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table ES-11: Top 10 human-made sources of VOC in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made total volatile organic compounds sources in the GMR</b>				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	27,715	20.7	20.7
Off-Road Mobile	Commercial Boats Exhaust	10,778	8.03	28.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	10,277	7.66	36.3
Domestic-Commercial	Surface Coatings	9,728	7.25	43.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	8,239	6.14	49.7
On-Road Mobile	All - Evaporative	6,956	5.18	54.9
Commercial	Automotive Fuel Retailing	6,646	4.95	59.9
Off-Road Mobile	Recreational Boats Exhaust	6,266	4.67	64.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	5,803	4.32	68.9
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	5,590	4.16	73.0
Human-made	Other	36,211	27.0	100.0

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made total volatile organic compounds sources in the Sydney region</b>				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	21,929	22.7	22.7
Domestic-Commercial	Surface Coatings	7,682	7.96	30.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	7,673	7.95	38.6
Commercial	Automotive Fuel Retailing	6,646	6.89	45.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	6,093	6.31	51.8
On-Road Mobile	All - Evaporative	5,289	5.48	57.3
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	4,652	4.82	62.1
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	4,492	4.65	66.8
Off-Road Mobile	Recreational Boats Exhaust	3,196	3.31	70.1
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	3,109	3.22	73.3
Human-made	Other	25,761	26.7	100.0
<b>Top 10 human-made total volatile organic compounds sources in the Newcastle region</b>				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	1,364	17.8	17.8
Off-Road Mobile	Commercial Boats Exhaust	1,016	13.3	31.1
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	644	8.41	39.5
Industrial	Petroleum products storage	567	7.41	46.9
Domestic-Commercial	Surface Coatings	514	6.71	53.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	460	6.02	59.6
On-Road Mobile	All - Evaporative	446	5.83	65.5
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	325	4.25	69.7
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	286	3.74	73.5
Off-Road Mobile	Recreational Boats Exhaust	280	3.65	77.1
Human-made	Other	1,752	22.9	100.0
<b>Top 10 human-made total volatile organic compounds sources in the Wollongong region</b>				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	997	23.2	23.2
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	430	10.0	33.2
Off-Road Mobile	Recreational Boats Exhaust	397	9.23	42.4
Domestic-Commercial	Surface Coatings	370	8.61	51.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	274	6.38	57.4
On-Road Mobile	All - Evaporative	235	5.46	62.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	213	4.95	67.8
Industrial	Waste disposal (application to land)	193	4.48	72.3
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	173	4.03	76.3

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	171	3.97	80.3
Human-made	Other	847	19.7	100.0
<b>Top 10 human-made total volatile organic compounds sources in the Non-urban region</b>				
Off-Road Mobile	Commercial Boats Exhaust	6,710	26.1	26.1
Domestic-Commercial	Domestic/Commercial Solvents/ Aerosols	3,425	13.3	39.4
Off-Road Mobile	Recreational Boats Exhaust	2,393	9.30	48.7
Off-Road Mobile	Industrial Vehicles and Equipment	1,890	7.34	56.0
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1,530	5.95	62.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,412	5.49	67.5
Domestic-Commercial	Surface Coatings	1,161	4.51	72.0
On-Road Mobile	All - Evaporative	987	3.83	75.8
Industrial	Generation of electrical power from coal	840	3.26	79.1
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	653	2.54	81.6
Human-made	Other	4,734	18.4	100.0

Figure ES-37, Figure ES-38, Figure ES-39, Figure ES-40 and Figure ES-41 show the proportions of total estimated annual emissions for the top 10 human-made sources of VOC in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

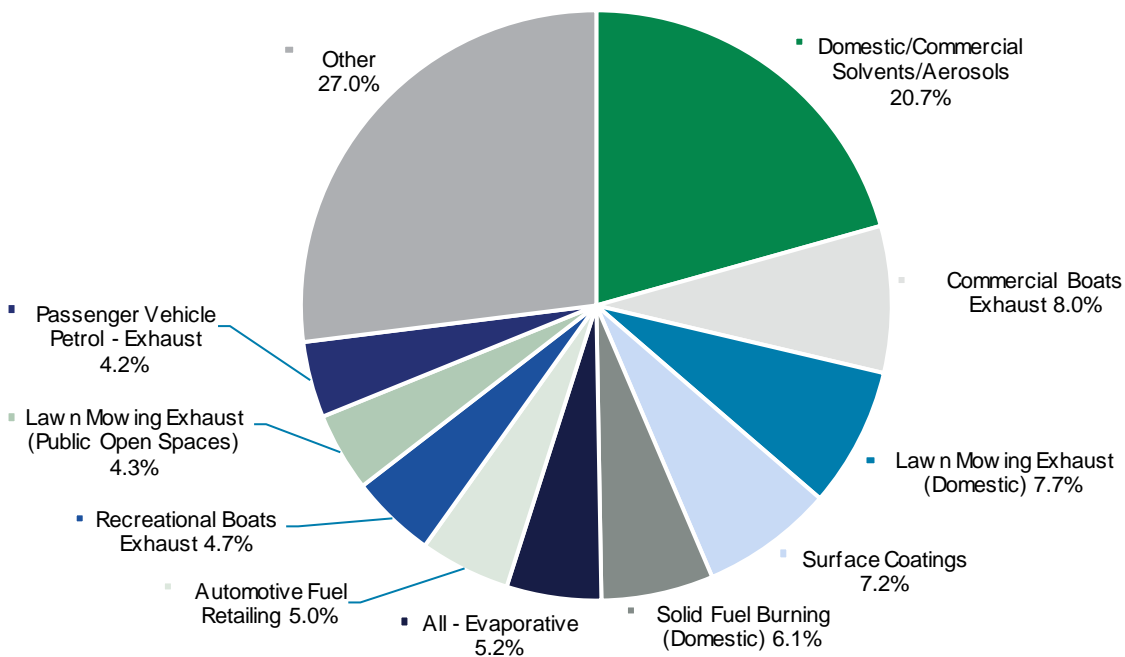


Figure ES-37: GMR: top 10 human-made sources of VOC

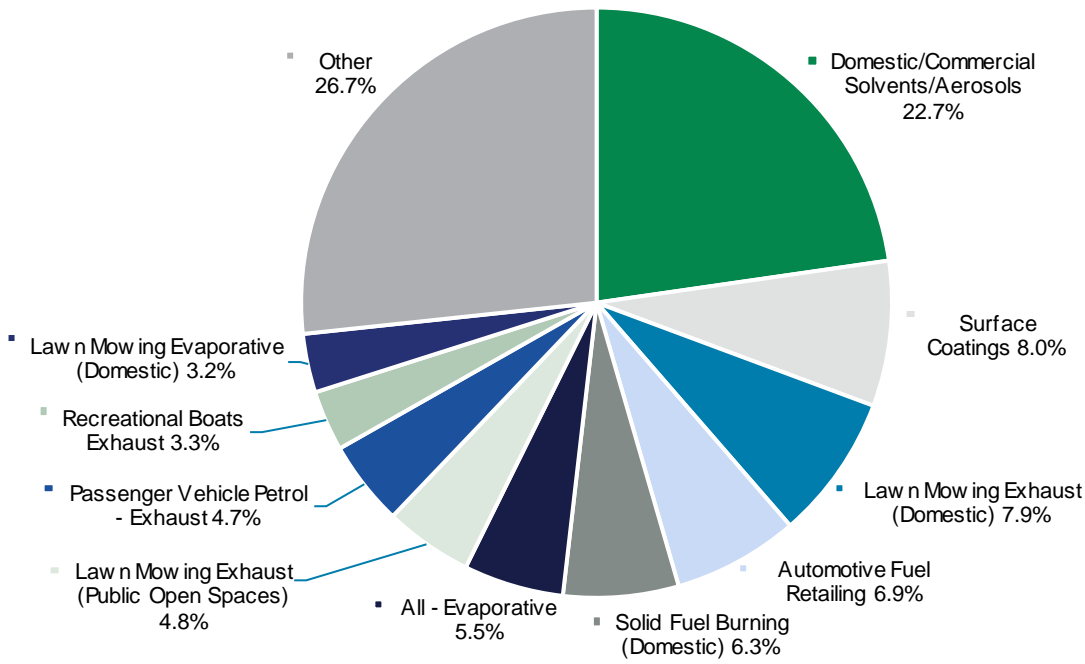


Figure ES-38: Sydney region: top 10 human-made sources of VOC

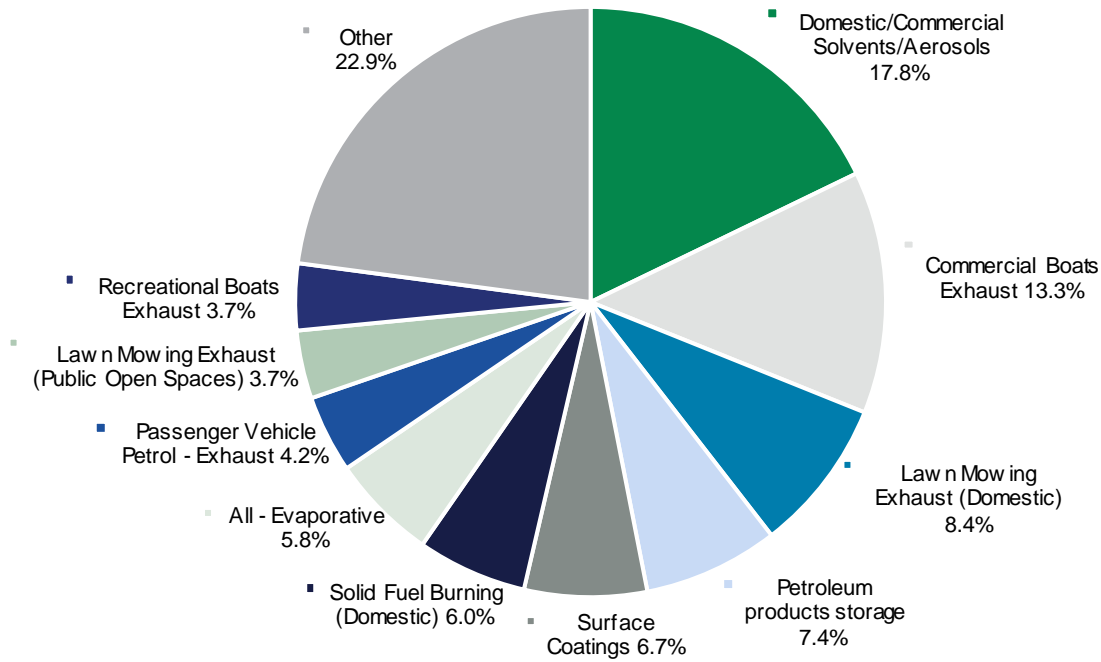


Figure ES-39: Newcastle region: top 10 human-made sources of VOC

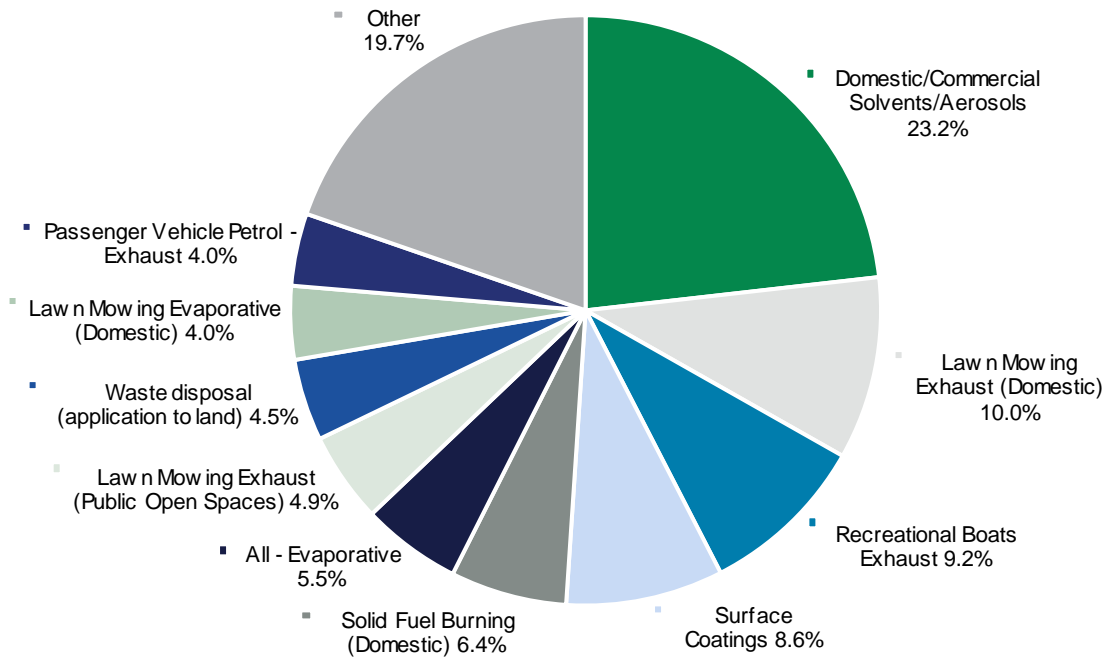


Figure ES-40: Wollongong region: top 10 human-made sources of VOC

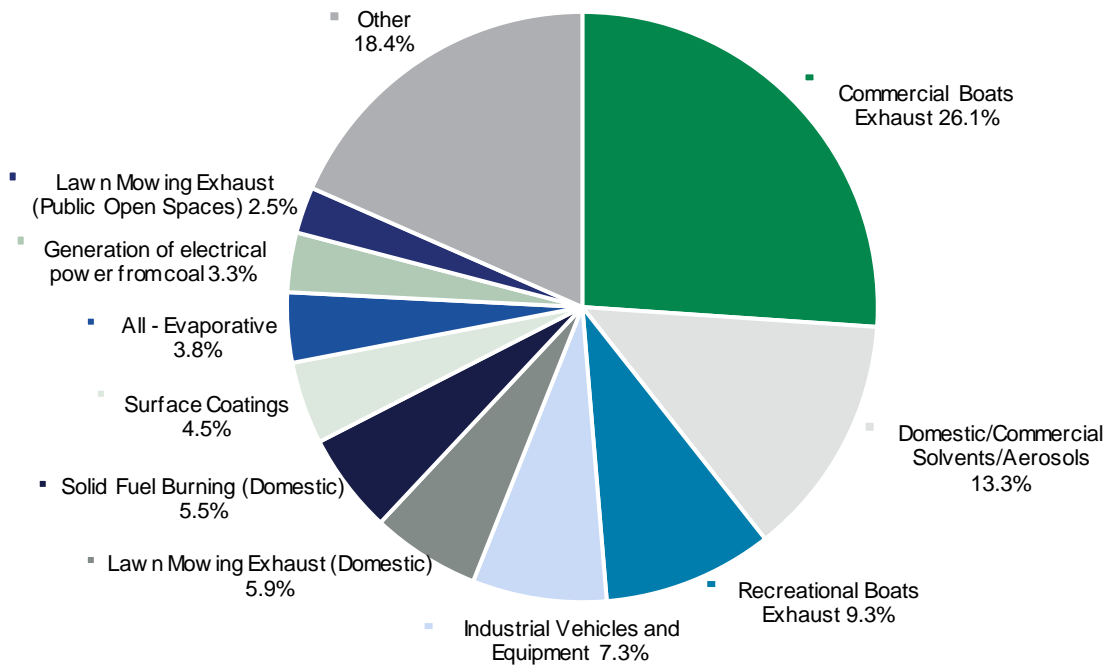


Figure ES-41: Non-urban region: top 10 human-made sources of VOC



# 1. Introduction

The NSW Environment Protection Authority (EPA) has produced an air emissions inventory (the 'inventory') for natural and human-made sources in NSW. The base year of the inventory represents activities that took place during the 2013 calendar year. The area included in the inventory covers the greater Sydney, Newcastle, and Wollongong regions, known collectively as the Greater Metropolitan Region (GMR).

The air emissions inventory includes emissions from biogenic (natural living organisms), geogenic (natural non-living) and anthropogenic (human-made) sources, grouped into six modules as follows:

- **Natural** – biogenic and geogenic (e.g. bushfires, marine aerosol and vegetation)
- **Commercial** – non-EPA licensed<sup>11</sup> premises (e.g. printers, quarries and service stations)
- **Domestic-Commercial** – domestic activities (e.g. residential lawn mowing, wood heaters and portable fuel containers) and non-premises based commercial activities (e.g. public open space lawn mowing)
- **Industrial** – EPA-licensed<sup>12</sup> premises (e.g. coal mines, oil refineries and power stations)
- **Off-Road Mobile** – unregistered non-road vehicles and equipment (e.g. dump trucks, bulldozers, locomotives and marine vessels)
- **On-Road Mobile** – road registered vehicles (e.g. registered cars, trucks and buses).

This report presents emissions of criteria pollutants referred to in the Ambient Air Quality (AAQ) National Environment Protection Measure (NEPM) (NEPC, 2016), including<sup>13</sup>:

- carbon monoxide (CO)
- oxides of nitrogen (NO<sub>x</sub>)
- particulate matter ≤ 10µm (PM<sub>10</sub>)
- particulate matter ≤ 2.5µm (PM<sub>2.5</sub>)
- sulfur dioxide (SO<sub>2</sub>)
- total volatile organic compounds (VOC).

The emission estimation methodologies used for the 2013 inventory are largely consistent with those developed and implemented for the 2008 inventory. Refer to the 2008 inventory reports for further information (EPA, 2012a; EPA, 2012b; EPA, 2012c; EPA, 2012d; EPA, 2012e; and EPA, 2012f). Section 2.7 of this report lists key differences in emission estimation methodologies implemented for this inventory.

Emissions for 17 pollutants, including those listed above, are available to a higher spatial resolution (postcode level) in the [Air Emissions in My Community web tool](#)<sup>14</sup>. Data for the 2003 and 2008 air emissions inventories are also available in the web tool.

---

<sup>11</sup> Not a scheduled activity or scheduled development work as defined in the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>12</sup> An activity listed in Schedule 1 of the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>13</sup> VOC is not included in the AAQ NEPM but is included in this report due to its importance as a precursor to the formation of secondary pollution in the atmosphere. Lead is an AAQ NEPM pollutant but is not included in this report as monitoring for lead ceased in 2005 with NSW annual average ambient levels having fallen to less than 10% of the NEPM standard (OEH, 2019).

<sup>14</sup> <https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-my-community/air-emissions-in-my-community-tool>.

The purpose of this document is to present the results of the 2013 air emissions inventory. The information is structured as follows:

- a description of the air emissions inventory specification (Section 2), including
  - inventory year (Section 2.1)
  - inventory region (Section 2.2)
  - grid coordinate system (Section 2.3)
  - emission sources considered (Section 2.4)
  - pollutants evaluated (Section 2.5)as well as a broad discussion of the methodology (Section 2.6 and Section 2.7).
- an emissions summary for criteria pollutants presented by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions (Section 3).
- an emissions summary for criteria pollutants presented for **all** natural and human-made sources in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions (Section 4).
- a list of references (Section 5).

## 2. Inventory specifications

### 2.1. The inventory year

The air emissions inventory results presented in this report are based on activities that took place in the 2013 calendar year.

### 2.2. The inventory region

The inventory region defined as the GMR measures 210km (east–west) by 273km (north–south). The GMR and the three urban subregions defined in the inventory are presented in Table 2-1 and shown in Figure 2-2.

Table 2-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions

Region	South-west corner MGA <sup>15</sup> coordinates		North-east corner MGA coordinates	
	Easting (km)	Northing (km)	Easting (km)	Northing (km)
Greater Metropolitan	210	6159	420	6432
Sydney	261	6201	360	6300
Newcastle	360	6348	408	6372
Wollongong	279	6174	318	6201

### 2.3. Grid coordinate system

The grid coordinate system used for the air emissions inventory uses 1km by 1km grid cells. Each grid cell is referenced by the Map Grid of Australia coordinates of the bottom left corner of the grid cell: Easting (km) in the horizontal direction and Northing (km) in the vertical. The grid coordinate system is shown in Figure 2-2.

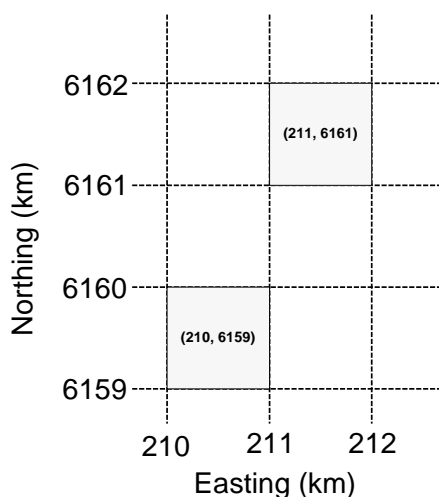


Figure 2-2: Grid coordinate system

<sup>15</sup> Map Grid of Australia based on the Geocentric Datum of Australia 1994 (GDA94) (ICSM, 2014).



Figure 2-1: Definition of Greater Metropolitan, Sydney, Newcastle and Wollongong regions

## 2.4. Emission sources considered

The air emissions inventory includes emissions from biogenic (natural living organisms), geogenic (natural non-living) and anthropogenic (human-made) sources, grouped into six modules as follows:

- **Natural** – biogenic and geogenic (e.g. bushfires, marine aerosol and vegetation)
- **Commercial** – non-EPA licensed<sup>16</sup> premises (e.g. printers, quarries and service stations)
- **Domestic-Commercial** – domestic activities (e.g. residential lawn mowing, wood heaters and portable fuel containers) and non-premises based commercial activities (e.g. public open space lawn mowing)
- **Industrial** – EPA-licensed<sup>17</sup> premises (e.g. coal mines, oil refineries and power stations)
- **Off-Road Mobile** – unregistered non-road vehicles and equipment (e.g. dump trucks, bulldozers, locomotives and marine vessels)
- **On-Road Mobile** – road registered vehicles (e.g. registered cars, trucks and buses).

## 2.5. Pollutants evaluated

The following pollutants have been considered:

- substances included in the National Environment Protection (National Pollutant Inventory) Measure (NEPC, 2008)
- pollutants included in the National Environment Protection (Ambient Air Quality) Measure (NEPC, 2016)
- pollutants included in the National Environment Protection (Air Toxics) Measure (NEPC, 2004)
- pollutants associated with the Protection of the Environment Operations (Clean Air) Regulation 2010 (PCO, 2011)
- air pollutants associated with the Protection of the Environment Operations (General) Regulation 2009 (PCO, 2010b)
- EPA regulated pollutants with criteria ground level concentrations (DEC, 2005)
- speciated particulate emissions, that is TSP (total suspended particulate), PM<sub>10</sub> (particulate matter with an aerodynamic diameter ≤ 10µm) and PM<sub>2.5</sub> (particulate matter with an aerodynamic diameter ≤ 2.5µm)
- speciation of oxides of nitrogen (i.e. nitric oxide and nitrogen dioxide) for photochemical modelling (USEPA, 2003)<sup>18</sup>
- speciated organic compounds for photochemical modelling (Carter, 2010)
- Environment Protection Authority of Victoria air toxic pollutants sourced from *Hazardous Air Pollutants: A Review of Studies Performed in Australia and New Zealand* (EPAV, 1999)
- Commonwealth Government Air Toxics Program Technical Advisory Group (13 March 2000) priority air pollutants (EA, 2001)
- US Environmental Protection Agency list of 189 hazardous air pollutants (USEPA, 2010)
- air pollutants included in the Office of Environmental Human Health Assessment (OEHHA)/Air Resources Board (ARB) 'hot spots' list (CARB, 2011)
- USEPA 16 priority polycyclic aromatic hydrocarbons (PAH) (Keith & Telliard, 1979)

---

<sup>16</sup> Not a scheduled activity or scheduled development work as defined in the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>17</sup> An activity listed in Schedule 1 of the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>18</sup> The default NO<sub>x</sub> speciation profile used in the inventory is 95% NO and 5% NO<sub>2</sub> where source specific speciation data are not available.

- WHO97 polychlorinated dibenzo-p-dioxins (PCDD), polychlorinated dibenzofurans (PCDF) and polychlorinated biphenyls (PCB) (Van den Berg et al., 1998)
- greenhouse gases (i.e. carbon dioxide, methane and nitrous oxide) included in the *National Greenhouse Accounts (NGA) Factors* (DEE, 2017).

This report presents emissions of criteria pollutants referred to in the Ambient Air Quality NEPM (NEPC, 2016), including<sup>19</sup>:

- carbon monoxide (CO)
- oxides of nitrogen (NO<sub>x</sub>)
- particulate matter ≤ 10µm (PM<sub>10</sub>)
- particulate matter ≤ 2.5µm (PM<sub>2.5</sub>)
- sulfur dioxide (SO<sub>2</sub>)
- total volatile organic compounds (VOC).

Emissions for 17 pollutants, including those listed above, are available to a higher spatial resolution (postcode level) in the [Air Emissions in My Community web tool](#)<sup>20</sup>. Data for the 2003 and 2008 air emissions inventories are also available in the web tool.

## 2.6. Methodology overview

This section contains a broad overview of the methodology used to develop the air emissions inventory. The emission estimation methodologies used for the 2013 inventory are largely consistent with those developed and implemented for the 2008 inventory. Refer to the 2008 inventory reports for further information (EPA, 2012a; EPA, 2012b; EPA, 2012c; EPA, 2012d; EPA, 2012e; and EPA, 2012f). Section 2.7 of this report lists key differences in emission estimation methodologies implemented for this inventory.

The methodology used to develop the air emissions inventory involves the following steps.

### 2.6.1. Identify sources

Natural and human-made sources considered in this report include all sources defined in Section 2.4 with the potential for air emissions in the GMR.

Natural and human-made air emission sources have been identified from a variety of sources, including:

- *ARB's Emissions Inventory, Area-Wide Source Methodologies, Index of Methodologies by Major Category* (CARB, 2008)
- *EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016* (EEA, 2016)
- *USEPA AP 42, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*, 5th edition (USEPA, 1995)
- *USEPA Emission Inventory Improvement Program, EIIP Technical Report Series, Volumes 1–10* (USEPA, 2007)
- *USEPA 2008 National Emissions Inventory Data* (USEPA, 2011a)
- *USEPA Nonroad Engines, Equipment, and Vehicles* (USEPA, 2011b).

---

<sup>19</sup> VOC is not included in the AAQ NEPM but is included in this report due to its importance as a precursor to the formation of secondary pollution in the atmosphere. Lead is an AAQ NEPM pollutant but is not included in this report as monitoring for lead ceased in 2005 with NSW annual average ambient levels having fallen to less than 10% of the NEPM standard (OEH, 2019).

<sup>20</sup> <https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-my-community/air-emissions-in-my-community-tool>.

## 2.6.2. Select emission estimation methodologies

Emissions have been estimated by combining activity data with emission factors. The emissions have been allocated spatially to each 1km by 1km grid cell, and temporally to months, weekdays/weekend days and hours.

State of the art emission estimation methodologies have been identified from a variety of sources, including those listed in Section 2.6.1.

## 2.6.3. Acquire activity, spatial and temporal data

Activity, spatial and temporal data have been acquired through:

- a domestic survey of residential households (TR, 2014a)
- a survey of all automotive fuel retailing service stations (TR, 2014b)
- an industrial survey of EPA-licensed premises (UMWELT, 2015)
- modelled vehicle kilometres travelled (BTS, 2016)

and from a variety of government departments and service providers.

Refer to the 2008 inventory reports for more information on the range of activity data sources (EPA, 2012a; EPA, 2012b; EPA, 2012c; EPA, 2012d; EPA, 2012e; and EPA, 2012f).

## 2.6.4. Design and implement emission estimation techniques

All emissions have been calculated within bespoke relational databases for each natural and human-made source type. They contain all the data necessary for estimating emissions to air from natural and human-made sources, including activity data; emission factors; PM and VOC speciation profiles; spatial allocation data; and hourly, daily and monthly temporal variation data.

In general, emissions have been estimated using Equation 1.

$$E_{i,j} = A_j \times EF_{i,j} \times (1 - ER_{i,j} / 100)$$

Equation 1

### where:

$E_{i,j}$	=	Emissions of substance i from source j	(kg/year)
$A_j$	=	Activity rate for source j	(activity unit/year)
$EF_{i,j}$	=	Emission factor for substance i from source j	(kg/activity unit)
$ER_{i,j}$	=	Emission reduction efficiency for substance i for source j	(-)

## 2.7. Emission estimation techniques relative to the 2008 inventory

The 2013 inventory used emissions estimation techniques largely consistent with and comparable to those used for the 2008 inventory. Any changes that may impact on the direct comparability of the 2013 and 2008 inventories are listed in the sections below.

### 2.7.1. Natural (biogenic-geogenic)

Emissions from natural sources were estimated using the same methodologies as used for the 2008 inventory (EPA, 2012a). Speciation profiles for particulate matter and organic gases were updated as applicable from CARB (2014) and CARB (2015), respectively.

Two new natural sources were estimated in the 2013 inventory:

- oxides of nitrogen from lightning
- dimethyl sulfide from marine aerosol.

Agapides (2017) and Agapides (2018), respectively, detail the methodology developed for these two sources.

### 2.7.2. Commercial

Emissions from commercial sources were estimated using the same methodologies as used for the 2008 inventory (EPA, 2012b), with the following exception. VOC from automotive fuel retailing were estimated using the same methodologies in 2013 as in 2008; however, some input assumptions differ. The 2013 estimates were made using actual service station fuel throughput and vapour recovery (VR) emission control implementation status from a comprehensive survey of all service stations in the GMR (TR, 2014b). The 2008 estimates used a population proxy to apportion NSW state fuel sales totals to the GMR and applied an assumption regarding the implementation of VR Stage 1. The result of the 2008 assumptions is an **underestimation** of the VOC emissions relative to the 2013 inventory.

Speciation profiles for particulate matter and organic gases were updated as applicable from CARB (2014) and CARB (2015), respectively.

### 2.7.3. Domestic-Commercial

Emissions from Domestic-Commercial sources were estimated using the same methodologies as used for the 2008 inventory (EPA, 2012c). Speciation profiles for particulate matter and organic gases were updated as applicable from CARB (2014) and CARB (2015), respectively.

### 2.7.4. Industrial

Emissions from Industrial sources were estimated using the same methodologies as used for the 2008 inventory (EPA, 2012d). Speciation profiles for particulate matter and organic gases were updated as applicable from CARB (2014) and CARB (2015), respectively. The speciation of wind erosion particulate matter sources has been updated to more specifically reflect the composition of the materials subject to wind erosion.

### 2.7.5. Off-Road Mobile

Emissions from Off-Road Mobile sources were estimated using the same methodologies as used for the 2008 inventory (EPA, 2012e), with the following enhancements:

- Emission factors for industrial off-road mobile vehicles and equipment (excluding ships and locomotives) were based on the engine's USEPA emission certification (tier level) as reported by industrial premises in the Industrial Survey (UMWELT, 2015). In the 2008 inventory all equipment was assumed to be Tier 0.
- Emission factors for diesel locomotives were based on emission measurements performed on representative Australian locomotives (EPA, 2016a, 2016b). Emission factors for locomotives not represented by the locomotive models tested were taken from USEPA (2009). In the 2008 inventory all locomotives were assumed to be Tier 0.
- Aircraft emissions were estimated using an updated version (v5.1.4.1) of the US FAA Emission and Dispersion Modelling System model (FAA, 2015). Emission factor changes are not significant.

Speciation profiles for particulate matter and organic gases were updated as applicable from CARB (2014) and CARB (2015), respectively.



## 2.7.6. On-Road Mobile

Emissions from On-Road Mobile sources were estimated using similar methodologies as used for the 2008 inventory (EPA, 2012f), with the following significant enhancements and changes:

- Vehicle kilometres travelled (VKT) were produced by the Bureau of Transport Statistics (BTS) using a significantly updated version of the Strategic Transport Model (STM) (BTS, 2016). For the 2013 base year, VKT estimated for 2013 by the updated STM resulted in the following changes relative to that estimated for 2013 using the 2008 inventory VKT model
  - passenger vehicle VKT 11% higher
  - motorcycle VKT 74% higher
  - light commercial vehicle VKT 15% higher
  - rigid truck VKT 11% lower
  - articulated truck VKT 34% higher
  - bus VKT 5% lower.
- Emission factors for vehicles up to ADR79/01 and ADR80/00 were revised by re-analysis of Australian test data and consideration of European emission factors (EEA, 2017).
- Emission factors for ADR79/02 and ADR80/01 and newer vehicles (Euro 4/IV and newer) were revised using the updated emission factors from the latest European model (EEA, 2017).
- Petrol vehicle emission deterioration factors were revised downwards, resulting in relatively lower fleet average emission factors.
- Speed correction factors were revised by micro-segment<sup>21</sup> analysis of the NISE2 Australian emission data for vehicles up to ADR79/01 (DEWHA, 2009) and consideration of the latest European emission factors (EEA, 2017).
- The emission impact of NSW petrol sulfur levels was revised using the USEPA MOVES2014 model (USEPA, 2016).
- Emissions from natural gas public transport buses were discretely estimated whereas all buses were assumed diesel in the 2008 inventory.
- Cold start emission factors were decoupled from hot running emissions, and trip start distance VKT was directly estimated in the BTS STM modelling for each vehicle type and road type combination.

---

<sup>21</sup> A 'micro-segment' is a period of driving comprising idle, acceleration, cruise, and deceleration to rest.

# 3. Emission results

This section presents emission estimates for the 2013 calendar year for the following natural and human-made sources:

- **Natural** – biogenic and geogenic (e.g. bushfires, marine aerosol and vegetation)
- **Commercial** – non-EPA licensed<sup>22</sup> premises (e.g. printers, quarries and service stations)
- **Domestic-Commercial** – domestic activities (e.g. residential lawn mowing, wood heaters and portable fuel containers) and non-premises based commercial activities (e.g. public open space lawn mowing)
- **Industrial** – EPA-licensed<sup>23</sup> premises (e.g. coal mines, oil refineries and power stations)
- **Off-Road Mobile** – unregistered non-road vehicles and equipment (e.g. dump trucks, bulldozers, locomotives and marine vessels)
- **On-Road Mobile** – road registered vehicles (e.g. registered cars, trucks and buses).

For each pollutant, the information in this section is structured as follows:

- natural and human-made emissions
- priority natural and human-made emissions.

Emissions have been estimated by combining activity data with emission factors. The emissions have been allocated spatially to each 1km by 1km grid cell, and temporally to months, weekdays/weekend days and hours. All emissions have been calculated within customised relational databases for each natural and human-made source type. They contain all the data necessary for estimating emissions to air from natural and human-made sources, including activity data; emission factors; PM and VOC speciation profiles; spatial allocation data; hourly, daily and monthly temporal variation data.

In this section total estimated emissions are presented for each natural and human-made source type in the whole GMR and the Sydney, Newcastle and Wollongong regions (refer to Figure 2-1). Total estimated emissions are also presented for the region defined as Non-urban. This region is the area of the GMR minus the combined areas of the Sydney, Newcastle and Wollongong regions. Emissions are presented for the criteria pollutants referred to in the Ambient Air Quality NEPM (NEPC, 2016), including<sup>24</sup>:

- carbon monoxide (CO)
- oxides of nitrogen (NO<sub>x</sub>)
- particulate matter ≤ 10µm (PM<sub>10</sub>)
- particulate matter ≤ 2.5µm (PM<sub>2.5</sub>)
- sulfur dioxide (SO<sub>2</sub>)
- total volatile organic compounds (VOC).

---

<sup>22</sup> Not a scheduled activity or scheduled development work as defined in the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>23</sup> An activity listed in Schedule 1 of the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>24</sup> VOC is not included in the Ambient Air Quality NEPM but is included in this report due to its importance as a precursor to the formation of secondary pollution in the atmosphere. Lead is an AAQ NEPM pollutant but is not included in this report as monitoring for lead ceased in 2005 with NSW annual average ambient levels having fallen to less than 10% of the NEPM standard (OEH, 2019).

## 3.1. Carbon monoxide

### 3.1.1. Natural and human-made emissions

Table 3-1 presents total estimated annual emissions of carbon monoxide by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-1: Total estimated annual emissions of carbon monoxide by natural and human-made source type in each region**

Substance	Region	Emissions (tonnes/year)						Total <sup>25</sup>
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Carbon monoxide	Sydney	42,008	320	90,299	5,968	22,465	91,239	252,299
	Newcastle	20,261	9.68	6,838	43,489	3,802	6,649	81,050
	Wollongong	1,083	16.69	4,456	104,510	1,640	3,547	115,253
	Non-urban	810,795	31.26	18,072	17,179	33,720	13,827	893,625
	GMR <sup>25</sup>	874,147	378	119,664	171,147	61,628	115,262	1,342,226

Table 3-2 presents the proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

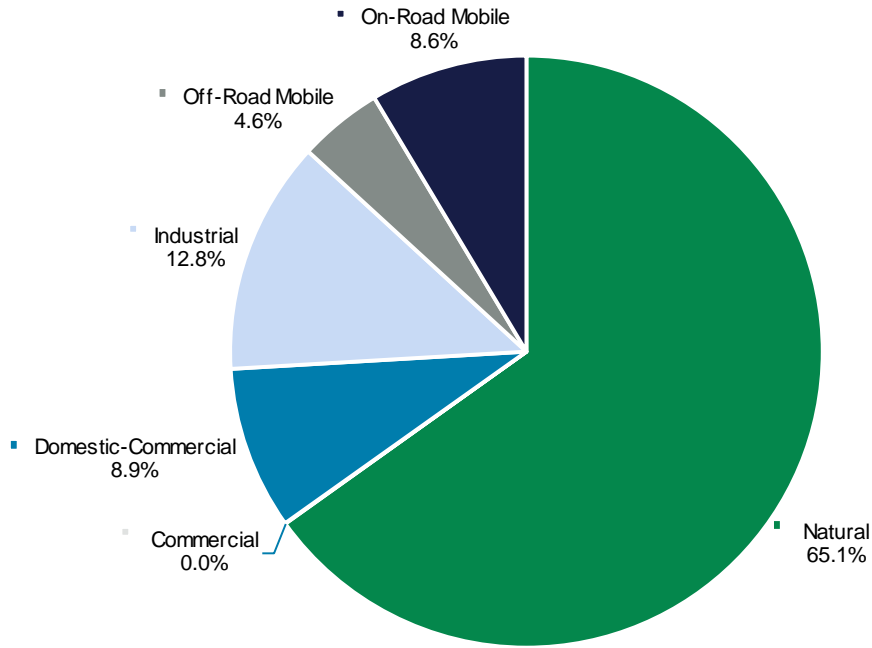
**Table 3-2: Proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type in each region**

Substance	Region	Proportion (%) <sup>26</sup>					
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Carbon monoxide	Sydney	16.7	0.13	35.8	2.37	8.90	36.2
	Newcastle	25.0	1.19×10 <sup>-2</sup>	8.44	53.7	4.69	8.20
	Wollongong	0.94	1.45×10 <sup>-2</sup>	3.87	90.7	1.42	3.08
	Non-urban	90.7	3.50×10 <sup>-3</sup>	2.02	1.92	3.77	1.55
	GMR	65.1	2.82×10 <sup>-2</sup>	8.92	12.8	4.59	8.59

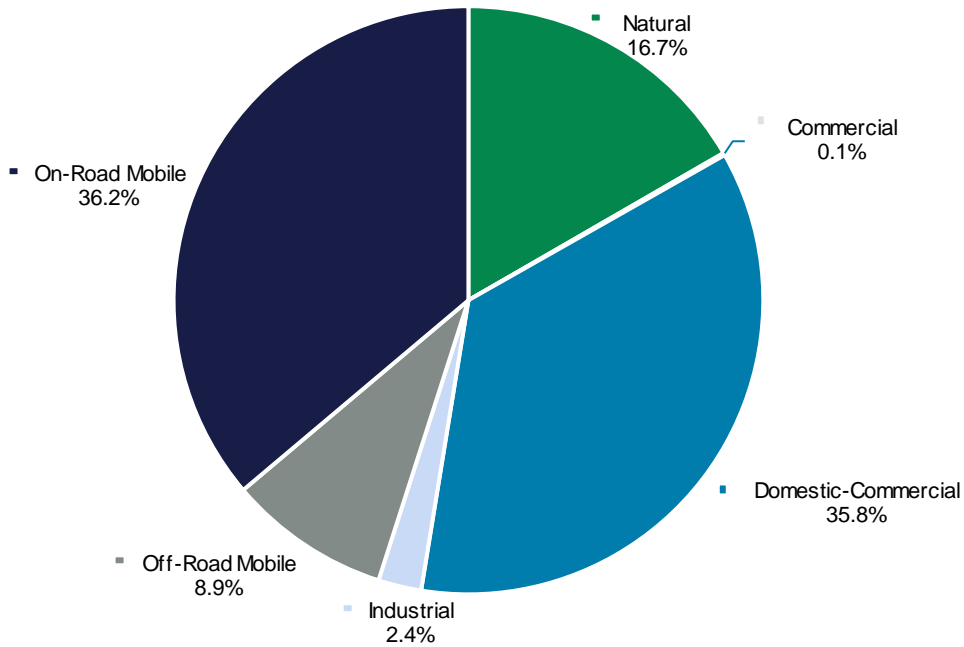
Figure 3-1, Figure 3-2, Figure 3-3, Figure 3-4 and Figure 3-5 show the proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

<sup>25</sup> The totals may differ from the sum of the addends due to rounding.

<sup>26</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10<sup>-2</sup> = 0.0946).



**Figure 3-1: GMR: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type**



**Figure 3-2: Sydney region: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type**

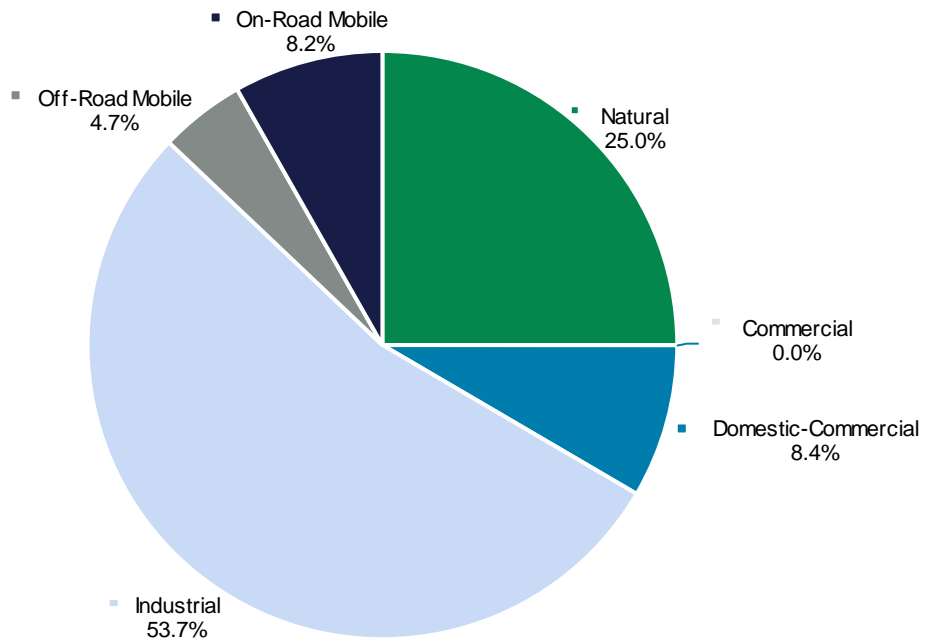


Figure 3-3: Newcastle region: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type

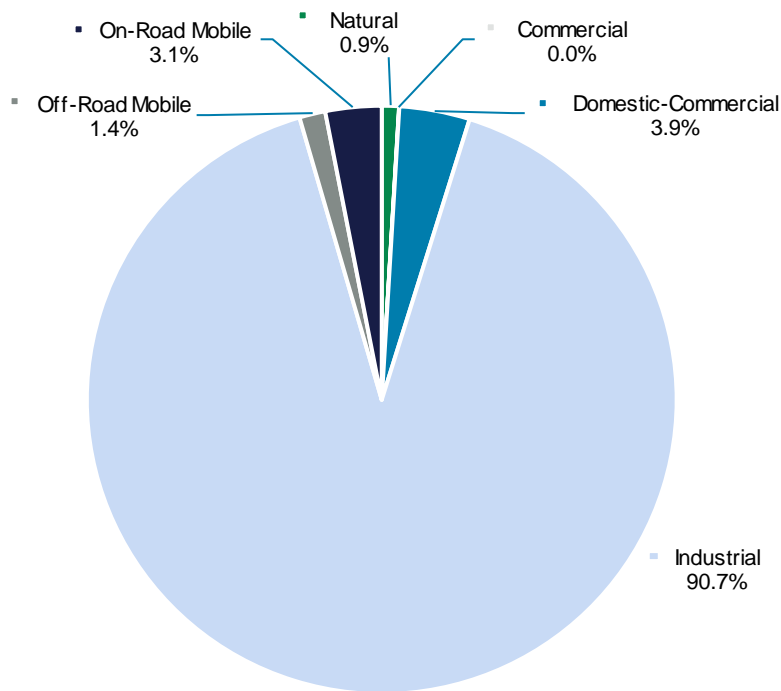


Figure 3-4: Wollongong region: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type

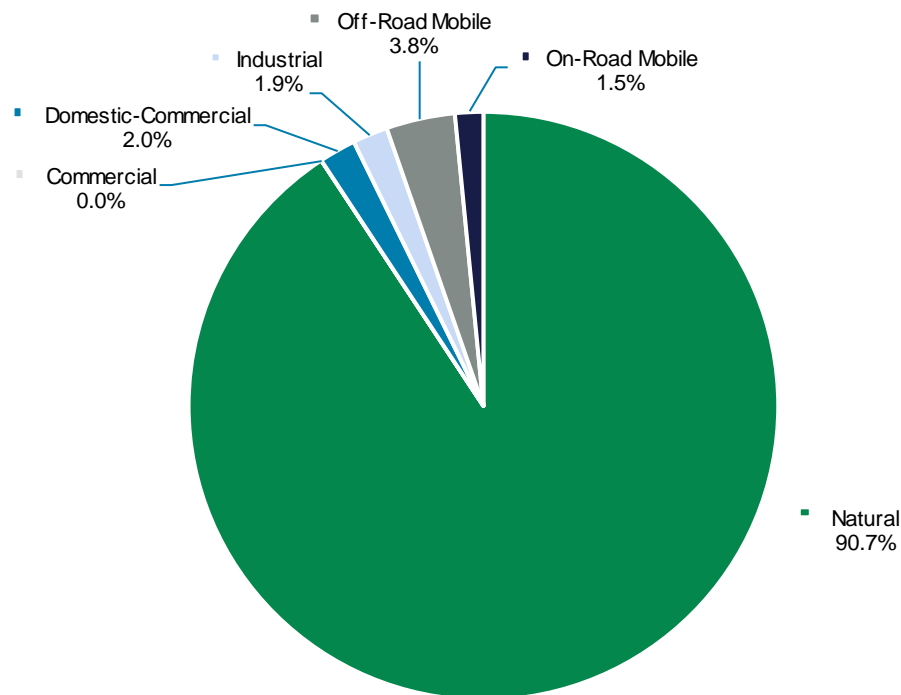


Figure 3-5: Non-urban region: proportions of total estimated annual emissions of carbon monoxide by natural and human-made source type

### 3.1.2. Priority natural and human-made emissions

Table 3-3 presents total estimated annual emissions, proportions and cumulative proportions of natural and human-made sources of carbon monoxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 3-3: Natural and human-made sources of carbon monoxide in each region

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
<b>Carbon monoxide in the GMR</b>				
Natural	Bushfire and Prescribed Burning	873,809	65.1	65.1
Industrial	Iron or steel production (iron ore)	103,354	7.70	72.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	79,074	5.89	78.7
Domestic-Commercial	Solid Fuel Burning (Domestic)	50,117	3.73	82.4
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	45,363	3.38	85.8
Industrial	Aluminium production (alumina)	40,709	3.03	88.8
Off-Road Mobile	Commercial Boats Exhaust	27,225	2.03	90.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	23,995	1.79	92.7

<sup>27</sup> n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006)

<sup>28</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g.  $9.46 \times 10^{-2} = 0.0946$ ).

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	22,657	1.69	94.3
Off-Road Mobile	Recreational Boats Exhaust	16,490	1.23	95.6
Off-Road Mobile	Industrial Vehicles and Equipment	11,822	0.88	96.5
Industrial	Mining for coal	9,201	0.69	97.1
Industrial	Generation of electrical power from coal	6,093	0.45	97.6
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	5,610	0.42	98.0
On-Road Mobile	Others - Exhaust	3,773	0.28	98.3
Off-Road Mobile	Aircraft (Flight Operations)	3,426	0.26	98.5
Industrial	Generation of electrical power from gas	3,150	0.23	98.8
Industrial	Iron or steel production (scrap metal)	2,811	0.21	99.0
On-Road Mobile	Light Duty Diesel - Exhaust	2,810	0.21	99.2
Industrial	Cement or lime production	1,465	0.11	99.3
Off-Road Mobile	Aircraft (Ground Operations)	981	7.31×10 <sup>-2</sup>	99.4
Domestic-Commercial	Gaseous Fuel Burning	932	6.94×10 <sup>-2</sup>	99.5
Off-Road Mobile	Locomotives	890	6.63×10 <sup>-2</sup>	99.5
Industrial	Ceramics production	809	6.03×10 <sup>-2</sup>	99.6
Industrial	Generation of electrical power not coal, diesel or gas	724	5.39×10 <sup>-2</sup>	99.6
Off-Road Mobile	Ships	615	4.58×10 <sup>-2</sup>	99.7
Industrial	Petroleum products and fuel production	606	4.51×10 <sup>-2</sup>	99.7
Domestic-Commercial	Barbeques	587	4.37×10 <sup>-2</sup>	99.8
Industrial	Ammonium nitrate production	411	3.06×10 <sup>-2</sup>	99.8
Natural	Agricultural Burning	338	2.52×10 <sup>-2</sup>	99.8
Industrial	Bitumen mixing	332	2.47×10 <sup>-2</sup>	99.8
Industrial	Metal plating or coating	312	2.32×10 <sup>-2</sup>	99.9
Industrial	Crushing, grinding or separating	208	1.55×10 <sup>-2</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	180	1.34×10 <sup>-2</sup>	99.9
Industrial	Waste disposal (application to land)	143	1.07×10 <sup>-2</sup>	99.9
Industrial	Sewage treatment - large plants	138	1.03×10 <sup>-2</sup>	99.9
Industrial	Cement or lime handling	109	8.13×10 <sup>-3</sup>	99.9
Commercial	Plaster Product Manufacturing	100	7.46×10 <sup>-3</sup>	99.9
Industrial	Petrochemical production	73.91	5.51×10 <sup>-3</sup>	99.9
Commercial	Hospitals (Except Psychiatric Hospitals)	56.60	4.22×10 <sup>-3</sup>	99.9

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Industrial	Paper or pulp production	54.04	4.03×10 <sup>-3</sup>	99.9
Industrial	Chemical production	53.57	3.99×10 <sup>-3</sup>	100.0
Industrial	General agricultural processing	46.31	3.45×10 <sup>-3</sup>	100.0
Industrial	Metal processing	34.11	2.54×10 <sup>-3</sup>	100.0
Industrial	Non-ferrous metal production (scrap)	31.74	2.37×10 <sup>-3</sup>	100.0
Commercial	Port Operators	30.53	2.27×10 <sup>-3</sup>	100.0
Commercial	Food Manufacturing n.e.c.	29.74	2.22×10 <sup>-3</sup>	100.0
Industrial	Glass production (container)	28.76	2.14×10 <sup>-3</sup>	100.0
Industrial	Rendering or fat extraction	27.51	2.05×10 <sup>-3</sup>	100.0
Industrial	Land-based extractive activity	26.70	1.99×10 <sup>-3</sup>	100.0
Industrial	General animal products production	25.78	1.92×10 <sup>-3</sup>	100.0
Industrial	Brewing and distilling	23.77	1.77×10 <sup>-3</sup>	100.0
Commercial	Ceramic Product Manufacturing	22.13	1.65×10 <sup>-3</sup>	100.0
Commercial	Bread Manufacturing	17.65	1.31×10 <sup>-3</sup>	100.0
Commercial	Gas Supply	17.12	1.28×10 <sup>-3</sup>	100.0
Industrial	Non-thermal treatment of waste	16.39	1.22×10 <sup>-3</sup>	100.0
Industrial	Solid waste landfilling	14.47	1.08×10 <sup>-3</sup>	100.0
Commercial	Waste Disposal Services	14.30	1.07×10 <sup>-3</sup>	100.0
Industrial	Petroleum products storage	12.80	9.54×10 <sup>-4</sup>	100.0
Industrial	Aluminium production (scrap metal)	12.09	9.01×10 <sup>-4</sup>	100.0
Industrial	Slaughtering or processing of animals	10.48	7.81×10 <sup>-4</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	9.57	7.13×10 <sup>-4</sup>	100.0
Commercial	Biscuit Manufacturing	9.22	6.87×10 <sup>-4</sup>	100.0
Industrial	Paper production using recycled materials	9.16	6.82×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	8.77	6.53×10 <sup>-4</sup>	100.0
Commercial	Printing	8.65	6.44×10 <sup>-4</sup>	100.0
Commercial	Corrugated Paperboard Container Manufacturing	7.24	5.39×10 <sup>-4</sup>	100.0
Industrial	Glass production	7.16	5.33×10 <sup>-4</sup>	100.0
Industrial	Sewage treatment - small plants	7.04	5.24×10 <sup>-4</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	6.06	4.51×10 <sup>-4</sup>	100.0
Industrial	Composting	5.65	4.21×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	5.62	4.19×10 <sup>-4</sup>	100.0
Commercial	Laundries and Dry-Cleaners	5.60	4.17×10 <sup>-4</sup>	100.0
Industrial	Dairy processing	5.56	4.14×10 <sup>-4</sup>	100.0



Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Industrial	Concrete works	5.47	4.07×10 <sup>-4</sup>	100.0
Commercial	Basic Iron and Steel Manufacturing	5.29	3.94×10 <sup>-4</sup>	100.0
Commercial	Metal Coating and Finishing	5.03	3.75×10 <sup>-4</sup>	100.0
Commercial	Log Sawmilling	4.63	3.45×10 <sup>-4</sup>	100.0
Commercial	Beer and Malt Manufacturing	4.54	3.38×10 <sup>-4</sup>	100.0
Industrial	Printing, packaging and visual media production	3.90	2.91×10 <sup>-4</sup>	100.0
Industrial	Water-based extractive activity	3.86	2.88×10 <sup>-4</sup>	100.0
Industrial	Soap and detergent production	3.52	2.62×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	3.40	2.53×10 <sup>-4</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	3.29	2.45×10 <sup>-4</sup>	100.0
Commercial	Oil and Fat Manufacturing	3.02	2.25×10 <sup>-4</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	2.88	2.14×10 <sup>-4</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	2.49	1.86×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste	2.33	1.73×10 <sup>-4</sup>	100.0
Commercial	Services to Air Transport	2.19	1.63×10 <sup>-4</sup>	100.0
Industrial	General chemicals storage	1.89	1.41×10 <sup>-4</sup>	100.0
Commercial	Cake and Pastry Manufacturing	1.78	1.32×10 <sup>-4</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	1.77	1.32×10 <sup>-4</sup>	100.0
Commercial	Milk and Cream Processing	1.77	1.32×10 <sup>-4</sup>	100.0
Commercial	Fruit and Vegetable Processing	1.77	1.32×10 <sup>-4</sup>	100.0
Industrial	Inert waste landfilling	1.61	1.20×10 <sup>-4</sup>	100.0
Commercial	Aircraft Manufacturing	1.56	1.17×10 <sup>-4</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	1.50	1.12×10 <sup>-4</sup>	100.0
Industrial	Container reconditioning	1.44	1.07×10 <sup>-4</sup>	100.0
Commercial	Scientific Research	1.37	1.02×10 <sup>-4</sup>	100.0
Industrial	Paints/polishes/adhesives production	1.27	9.43×10 <sup>-5</sup>	100.0
Industrial	Sterilisation activities	1.23	9.15×10 <sup>-5</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	1.16	8.62×10 <sup>-5</sup>	100.0
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	0.91	6.80×10 <sup>-5</sup>	100.0
Industrial	Bird accommodation	0.81	6.06×10 <sup>-5</sup>	100.0
Commercial	Synthetic Resin Manufacturing	0.57	4.23×10 <sup>-5</sup>	100.0

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	0.55	4.07×10 <sup>-5</sup>	100.0
Commercial	Ice Cream Manufacturing	0.51	3.77×10 <sup>-5</sup>	100.0
Industrial	Waste storage	0.40	2.98×10 <sup>-5</sup>	100.0
Industrial	Other land-based extraction	0.36	2.66×10 <sup>-5</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	0.35	2.62×10 <sup>-5</sup>	100.0
Industrial	Rubber products/tyre production	0.21	1.59×10 <sup>-5</sup>	100.0
Industrial	Helicopter-related activity	0.21	1.56×10 <sup>-5</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	0.17	1.29×10 <sup>-5</sup>	100.0
Industrial	Plastics resins production	0.17	1.27×10 <sup>-5</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	0.17	1.26×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	0.14	1.04×10 <sup>-5</sup>	100.0
Industrial	Explosives production	0.13	1.00×10 <sup>-5</sup>	100.0
Industrial	Chemical storage	0.13	9.77×10 <sup>-6</sup>	100.0
Commercial	Confectionery Manufacturing	0.11	8.32×10 <sup>-6</sup>	100.0
Industrial	Pesticides and related products production	9.52×10 <sup>-2</sup>	7.09×10 <sup>-6</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	2.45×10 <sup>-2</sup>	1.82×10 <sup>-6</sup>	100.0
Commercial	Non-Building Construction n.e.c.	2.34×10 <sup>-2</sup>	1.74×10 <sup>-6</sup>	100.0
Industrial	Shipping in bulk	1.40×10 <sup>-2</sup>	1.05×10 <sup>-6</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	9.81×10 <sup>-3</sup>	7.31×10 <sup>-7</sup>	100.0
Industrial	Animal accommodation	9.22×10 <sup>-3</sup>	6.87×10 <sup>-7</sup>	100.0
Commercial	Non-Ferrous Metal Casting	7.02×10 <sup>-3</sup>	5.23×10 <sup>-7</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	4.99×10 <sup>-3</sup>	3.72×10 <sup>-7</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	3.72×10 <sup>-3</sup>	2.77×10 <sup>-7</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	3.12×10 <sup>-3</sup>	2.33×10 <sup>-7</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	2.81×10 <sup>-3</sup>	2.09×10 <sup>-7</sup>	100.0
Commercial	Industrial Gas Manufacturing	7.35×10 <sup>-4</sup>	5.47×10 <sup>-8</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	7.04×10 <sup>-4</sup>	5.25×10 <sup>-8</sup>	100.0
Industrial	Coal works	3.12×10 <sup>-4</sup>	2.32×10 <sup>-8</sup>	100.0
Commercial	Wine Manufacturing	1.80×10 <sup>-4</sup>	1.34×10 <sup>-8</sup>	100.0

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
<b>Carbon monoxide in the Sydney region</b>				
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	62,708	24.9	24.9
Natural	Bushfire and Prescribed Burning	41,979	16.6	41.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	37,063	14.7	56.2
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	33,868	13.4	69.6
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	19,688	7.80	77.4
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	18,161	7.20	84.6
Off-Road Mobile	Recreational Boats Exhaust	8,411	3.33	87.9
Off-Road Mobile	Commercial Boats Exhaust	7,616	3.02	91.0
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	3,706	1.47	92.4
Off-Road Mobile	Aircraft (Flight Operations)	2,936	1.16	93.6
On-Road Mobile	Others - Exhaust	2,897	1.15	94.7
On-Road Mobile	Light Duty Diesel - Exhaust	2,240	0.89	95.6
Industrial	Generation of electrical power from gas	2,161	0.86	96.5
Off-Road Mobile	Industrial Vehicles and Equipment	1,975	0.78	97.3
Off-Road Mobile	Aircraft (Ground Operations)	942	0.37	97.6
Industrial	Iron or steel production (scrap metal)	773	0.31	97.9
Domestic-Commercial	Gaseous Fuel Burning	736	0.29	98.2
Industrial	Ceramics production	715	0.28	98.5
Industrial	Petroleum products and fuel production	600	0.24	98.8
Domestic-Commercial	Barbeques	464	0.18	98.9
Off-Road Mobile	Ships	362	0.14	99.1
Industrial	Generation of electrical power not coal, diesel or gas	354	0.14	99.2
Industrial	Bitumen mixing	277	0.11	99.3
Industrial	Crushing, grinding or separating	207	8.21×10 <sup>-2</sup>	99.4
Industrial	Sewage treatment - large plants	128	5.06×10 <sup>-2</sup>	99.5
Off-Road Mobile	Locomotives	128	5.05×10 <sup>-2</sup>	99.5
Industrial	Cement or lime handling	109	4.31×10 <sup>-2</sup>	99.6
Commercial	Plaster Product Manufacturing	100	3.97×10 <sup>-2</sup>	99.6
Off-Road Mobile	Commercial Vehicles and Equipment	94.63	3.75×10 <sup>-2</sup>	99.6
Industrial	Waste disposal (application to land)	87.54	3.47×10 <sup>-2</sup>	99.7

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Industrial	Mining for coal	76.09	3.02×10 <sup>-2</sup>	99.7
Industrial	Petrochemical production	73.91	2.93×10 <sup>-2</sup>	99.7
Industrial	Paper or pulp production	54.04	2.14×10 <sup>-2</sup>	99.8
Industrial	Cement or lime production	51.78	2.05×10 <sup>-2</sup>	99.8
Commercial	Hospitals (Except Psychiatric Hospitals)	39.94	1.58×10 <sup>-2</sup>	99.8
Industrial	Non-ferrous metal production (scrap)	31.74	1.26×10 <sup>-2</sup>	99.8
Commercial	Port Operators	30.53	1.21×10 <sup>-2</sup>	99.8
Natural	Agricultural Burning	29.34	1.16×10 <sup>-2</sup>	99.8
Industrial	General agricultural processing	29.12	1.15×10 <sup>-2</sup>	99.8
Industrial	Glass production (container)	28.76	1.14×10 <sup>-2</sup>	99.9
Industrial	General animal products production	23.96	9.50×10 <sup>-3</sup>	99.9
Industrial	Brewing and distilling	23.77	9.42×10 <sup>-3</sup>	99.9
Industrial	Rendering or fat extraction	22.41	8.88×10 <sup>-3</sup>	99.9
Industrial	Chemical production	19.52	7.74×10 <sup>-3</sup>	99.9
Industrial	Metal plating or coating	19.08	7.56×10 <sup>-3</sup>	99.9
Commercial	Gas Supply	17.12	6.79×10 <sup>-3</sup>	99.9
Commercial	Food Manufacturing n.e.c.	16.99	6.73×10 <sup>-3</sup>	99.9
Industrial	Non-thermal treatment of waste	15.77	6.25×10 <sup>-3</sup>	99.9
Commercial	Bread Manufacturing	15.41	6.11×10 <sup>-3</sup>	99.9
Commercial	Waste Disposal Services	14.29	5.67×10 <sup>-3</sup>	99.9
Industrial	Petroleum products storage	12.80	5.07×10 <sup>-3</sup>	99.9
Commercial	Ceramic Product Manufacturing	12.15	4.81×10 <sup>-3</sup>	99.9
Industrial	Pharmaceutical and veterinary products production	9.53	3.78×10 <sup>-3</sup>	99.9
Commercial	Biscuit Manufacturing	9.22	3.66×10 <sup>-3</sup>	99.9
Industrial	Paper production using recycled materials	9.16	3.63×10 <sup>-3</sup>	100.0
Commercial	Printing	8.65	3.43×10 <sup>-3</sup>	100.0
Commercial	Corrugated Paperboard Container Manufacturing	7.24	2.87×10 <sup>-3</sup>	100.0
Industrial	Glass production	7.16	2.84×10 <sup>-3</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	6.93	2.75×10 <sup>-3</sup>	100.0
Industrial	Solid waste landfilling	6.47	2.57×10 <sup>-3</sup>	100.0
Industrial	Composting	5.65	2.24×10 <sup>-3</sup>	100.0
Commercial	Laundries and Dry-Cleaners	5.60	2.22×10 <sup>-3</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	4.99	1.98×10 <sup>-3</sup>	100.0
Commercial	Beer and Malt Manufacturing	4.54	1.80×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	4.30	1.70×10 <sup>-3</sup>	100.0

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Industrial	Printing, packaging and visual media production	3.90	1.55×10 <sup>-3</sup>	100.0
Industrial	Dairy processing	3.90	1.55×10 <sup>-3</sup>	100.0
Industrial	Slaughtering or processing of animals	3.75	1.49×10 <sup>-3</sup>	100.0
Industrial	Soap and detergent production	3.52	1.39×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste oil	3.47	1.38×10 <sup>-3</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	3.29	1.30×10 <sup>-3</sup>	100.0
Industrial	Metal processing	3.19	1.26×10 <sup>-3</sup>	100.0
Commercial	Oil and Fat Manufacturing	3.02	1.20×10 <sup>-3</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	2.88	1.14×10 <sup>-3</sup>	100.0
Commercial	Metal Coating and Finishing	2.64	1.05×10 <sup>-3</sup>	100.0
Industrial	Concrete works	2.47	9.77×10 <sup>-4</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	2.33	9.22×10 <sup>-4</sup>	100.0
Commercial	Services to Air Transport	2.19	8.67×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	2.12	8.42×10 <sup>-4</sup>	100.0
Commercial	Cake and Pastry Manufacturing	1.78	7.05×10 <sup>-4</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	1.77	7.03×10 <sup>-4</sup>	100.0
Commercial	Milk and Cream Processing	1.77	7.03×10 <sup>-4</sup>	100.0
Commercial	Fruit and Vegetable Processing	1.77	7.01×10 <sup>-4</sup>	100.0
Commercial	Aircraft Manufacturing	1.56	6.20×10 <sup>-4</sup>	100.0
Industrial	Container reconditioning	1.44	5.70×10 <sup>-4</sup>	100.0
Commercial	Scientific Research	1.37	5.42×10 <sup>-4</sup>	100.0
Industrial	Paints/polishes/adhesives production	1.27	5.01×10 <sup>-4</sup>	100.0
Industrial	Sterilisation activities	1.23	4.87×10 <sup>-4</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	1.16	4.58×10 <sup>-4</sup>	100.0
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	0.91	3.62×10 <sup>-4</sup>	100.0
Commercial	Basic Iron and Steel Manufacturing	0.83	3.30×10 <sup>-4</sup>	100.0
Industrial	Land-based extractive activity	0.56	2.22×10 <sup>-4</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	0.55	2.16×10 <sup>-4</sup>	100.0
Commercial	Ice Cream Manufacturing	0.51	2.01×10 <sup>-4</sup>	100.0
Industrial	Waste storage	0.40	1.58×10 <sup>-4</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	0.35	1.39×10 <sup>-4</sup>	100.0

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Commercial	Synthetic Resin Manufacturing	0.35	1.39×10 <sup>-4</sup>	100.0
Industrial	Bird accommodation	0.27	1.09×10 <sup>-4</sup>	100.0
Industrial	Rubber products/tyre production	0.21	8.46×10 <sup>-5</sup>	100.0
Industrial	Helicopter-related activity	0.21	8.32×10 <sup>-5</sup>	100.0
Industrial	Plastics resins production	0.17	6.73×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	0.14	5.48×10 <sup>-5</sup>	100.0
Industrial	Chemical storage	0.13	5.20×10 <sup>-5</sup>	100.0
Commercial	Confectionery Manufacturing	0.11	4.42×10 <sup>-5</sup>	100.0
Industrial	Pesticides and related products production	9.52×10 <sup>-2</sup>	3.77×10 <sup>-5</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	9.23×10 <sup>-2</sup>	3.66×10 <sup>-5</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	2.45×10 <sup>-2</sup>	9.71×10 <sup>-6</sup>	100.0
Commercial	Non-Building Construction n.e.c.	1.63×10 <sup>-2</sup>	6.48×10 <sup>-6</sup>	100.0
Industrial	Shipping in bulk	1.40×10 <sup>-2</sup>	5.56×10 <sup>-6</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	9.81×10 <sup>-3</sup>	3.89×10 <sup>-6</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	4.40×10 <sup>-3</sup>	1.75×10 <sup>-6</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	3.12×10 <sup>-3</sup>	1.24×10 <sup>-6</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	1.66×10 <sup>-3</sup>	6.56×10 <sup>-7</sup>	100.0
Commercial	Industrial Gas Manufacturing	7.35×10 <sup>-4</sup>	2.91×10 <sup>-7</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	7.04×10 <sup>-4</sup>	2.79×10 <sup>-7</sup>	100.0
Commercial	Wine Manufacturing	1.80×10 <sup>-4</sup>	7.12×10 <sup>-8</sup>	100.0
<b>Carbon monoxide in the Newcastle region</b>				
Industrial	Aluminium production (alumina)	40,709	50.2	50.2
Natural	Bushfire and Prescribed Burning	20,255	25.0	75.2
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	4,776	5.89	81.1
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	2,840	3.50	84.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	2,800	3.46	88.1
Off-Road Mobile	Commercial Boats Exhaust	2,560	3.16	91.2
Industrial	Iron or steel production (scrap metal)	2,038	2.51	93.7
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1,126	1.39	95.1
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	1,116	1.38	96.5

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Off-Road Mobile	Recreational Boats Exhaust	736	0.91	97.4
Industrial	Ammonium nitrate production	411	0.51	97.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	375	0.46	98.4
On-Road Mobile	Others - Exhaust	227	0.28	98.7
Off-Road Mobile	Industrial Vehicles and Equipment	204	0.25	98.9
Industrial	Generation of electrical power not coal, diesel or gas	180	0.22	99.1
On-Road Mobile	Light Duty Diesel - Exhaust	145	0.18	99.3
Off-Road Mobile	Locomotives	109	0.13	99.5
Off-Road Mobile	Ships	106	0.13	99.6
Domestic-Commercial	Gaseous Fuel Burning	49.21	6.07×10 <sup>-2</sup>	99.6
Off-Road Mobile	Aircraft (Flight Operations)	44.75	5.52×10 <sup>-2</sup>	99.7
Off-Road Mobile	Aircraft (Ground Operations)	33.07	4.08×10 <sup>-2</sup>	99.7
Industrial	Chemical production	32.30	3.99×10 <sup>-2</sup>	99.8
Domestic-Commercial	Barbeques	31.00	3.82×10 <sup>-2</sup>	99.8
Industrial	Generation of electrical power from gas	29.56	3.65×10 <sup>-2</sup>	99.9
Industrial	Metal processing	28.46	3.51×10 <sup>-2</sup>	99.9
Industrial	Bitumen mixing	26.84	3.31×10 <sup>-2</sup>	99.9
Industrial	General agricultural processing	11.55	1.43×10 <sup>-2</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	8.99	1.11×10 <sup>-2</sup>	100.0
Industrial	Slaughtering or processing of animals	6.73	8.30×10 <sup>-3</sup>	100.0
Natural	Agricultural Burning	6.37	7.86×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	4.62	5.70×10 <sup>-3</sup>	100.0
Industrial	Petroleum products and fuel production	3.34	4.12×10 <sup>-3</sup>	100.0
Industrial	Metal plating or coating	2.86	3.52×10 <sup>-3</sup>	100.0
Industrial	Mining for coal	2.77	3.42×10 <sup>-3</sup>	100.0
Commercial	Metal Coating and Finishing	2.40	2.96×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste	2.33	2.87×10 <sup>-3</sup>	100.0
Commercial	Bread Manufacturing	2.24	2.76×10 <sup>-3</sup>	100.0
Industrial	Dairy processing	1.66	2.05×10 <sup>-3</sup>	100.0
Industrial	Waste disposal (application to land)	0.96	1.19×10 <sup>-3</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.46	5.71×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	0.42	5.13×10 <sup>-4</sup>	100.0
Industrial	Other land-based extraction	0.36	4.41×10 <sup>-4</sup>	100.0

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Industrial	Cement or lime handling	0.35	4.36×10 <sup>-4</sup>	100.0
Industrial	Land-based extractive activity	0.24	2.97×10 <sup>-4</sup>	100.0
Industrial	Non-thermal treatment of waste	4.14×10 <sup>-2</sup>	5.11×10 <sup>-5</sup>	100.0
Commercial	Waste Disposal Services	9.52×10 <sup>-3</sup>	1.17×10 <sup>-5</sup>	100.0
Industrial	Petroleum products storage	5.60×10 <sup>-3</sup>	6.91×10 <sup>-6</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	3.72×10 <sup>-3</sup>	4.59×10 <sup>-6</sup>	100.0
Industrial	Crushing, grinding or separating	4.12×10 <sup>-7</sup>	5.08×10 <sup>-10</sup>	100.0
<b>Carbon monoxide in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	103,354	89.7	89.7
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2,541	2.20	91.9
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1,899	1.65	93.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,668	1.45	95.0
Natural	Bushfire and Prescribed Burning	1,083	0.94	95.9
Off-Road Mobile	Recreational Boats Exhaust	1,045	0.91	96.8
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	831	0.72	97.5
Industrial	Generation of electrical power from gas	820	0.71	98.3
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	586	0.51	98.8
Off-Road Mobile	Industrial Vehicles and Equipment	333	0.29	99.1
Industrial	Metal plating or coating	289	0.25	99.3
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	215	0.19	99.5
Off-Road Mobile	Commercial Boats Exhaust	177	0.15	99.6
On-Road Mobile	Others - Exhaust	127	0.11	99.8
On-Road Mobile	Light Duty Diesel - Exhaust	76.84	6.67×10 <sup>-2</sup>	99.8
Off-Road Mobile	Ships	41.85	3.63×10 <sup>-2</sup>	99.9
Domestic-Commercial	Gaseous Fuel Burning	35.48	3.08×10 <sup>-2</sup>	99.9
Off-Road Mobile	Aircraft (Flight Operations)	26.49	2.30×10 <sup>-2</sup>	99.9
Domestic-Commercial	Barbeques	22.35	1.94×10 <sup>-2</sup>	99.9
Industrial	Waste disposal (application to land)	16.03	1.39×10 <sup>-2</sup>	99.9
Off-Road Mobile	Locomotives	15.92	1.38×10 <sup>-2</sup>	100.0
Industrial	Bitumen mixing	15.86	1.38×10 <sup>-2</sup>	100.0
Industrial	Sewage treatment - large plants	10.12	8.78×10 <sup>-3</sup>	100.0
Commercial	Ceramic Product Manufacturing	9.99	8.67×10 <sup>-3</sup>	100.0
Commercial	Basic Iron and Steel Manufacturing	4.46	3.87×10 <sup>-3</sup>	100.0



Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Industrial	Metal processing	2.46	2.14×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	2.10	1.82×10 <sup>-3</sup>	100.0
Industrial	General chemicals storage	1.86	1.62×10 <sup>-3</sup>	100.0
Industrial	Chemical production	0.87	7.58×10 <sup>-4</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	0.65	5.62×10 <sup>-4</sup>	100.0
Industrial	Non-thermal treatment of waste	0.49	4.24×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.33	2.90×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	0.14	1.19×10 <sup>-4</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	2.81×10 <sup>-3</sup>	2.44×10 <sup>-6</sup>	100.0
Industrial	Container reconditioning	2.40×10 <sup>-3</sup>	2.08×10 <sup>-6</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	1.79×10 <sup>-3</sup>	1.55×10 <sup>-6</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	5.85×10 <sup>-4</sup>	5.08×10 <sup>-7</sup>	100.0
Commercial	Synthetic Resin Manufacturing	5.77×10 <sup>-4</sup>	5.01×10 <sup>-7</sup>	100.0
<b>Carbon monoxide in the Non-urban region</b>				
Natural	Bushfire and Prescribed Burning	810,493	90.7	90.7
Off-Road Mobile	Commercial Boats Exhaust	16,871	1.89	92.6
Off-Road Mobile	Industrial Vehicles and Equipment	9,309	1.04	93.6
Industrial	Mining for coal	9,122	1.02	94.6
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	9,050	1.01	95.7
Domestic-Commercial	Solid Fuel Burning (Domestic)	8,586	0.96	96.6
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	6,755	0.76	97.4
Off-Road Mobile	Recreational Boats Exhaust	6,298	0.70	98.1
Industrial	Generation of electrical power from coal	6,093	0.68	98.8
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	2,594	0.29	99.1
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	2,549	0.29	99.3
Industrial	Cement or lime production	1,413	0.16	99.5
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	1,314	0.15	99.6
Off-Road Mobile	Locomotives	637	7.13×10 <sup>-2</sup>	99.7
On-Road Mobile	Others - Exhaust	521	5.83×10 <sup>-2</sup>	99.8
Off-Road Mobile	Aircraft (Flight Operations)	418	4.68×10 <sup>-2</sup>	99.8
On-Road Mobile	Light Duty Diesel - Exhaust	348	3.89×10 <sup>-2</sup>	99.9

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Natural	Agricultural Burning	302	3.38×10 <sup>-2</sup>	99.9
Industrial	Generation of electrical power not coal, diesel or gas	189	2.12×10 <sup>-2</sup>	99.9
Industrial	Generation of electrical power from gas	140	1.57×10 <sup>-2</sup>	99.9
Domestic-Commercial	Gaseous Fuel Burning	111	1.24×10 <sup>-2</sup>	99.9
Off-Road Mobile	Ships	104	1.17×10 <sup>-2</sup>	100.0
Industrial	Ceramics production	93.84	1.05×10 <sup>-2</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	75.94	8.50×10 <sup>-3</sup>	100.0
Domestic-Commercial	Barbeques	70.06	7.84×10 <sup>-3</sup>	100.0
Industrial	Waste disposal (application to land)	38.53	4.31×10 <sup>-3</sup>	100.0
Industrial	Land-based extractive activity	25.90	2.90×10 <sup>-3</sup>	100.0
Commercial	Food Manufacturing n.e.c.	12.76	1.43×10 <sup>-3</sup>	100.0
Industrial	Aluminium production (scrap metal)	12.09	1.35×10 <sup>-3</sup>	100.0
Industrial	Bitumen mixing	11.65	1.30×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	9.94	1.11×10 <sup>-3</sup>	100.0
Industrial	Solid waste landfilling	8.00	8.95×10 <sup>-4</sup>	100.0
Industrial	General agricultural processing	5.63	6.30×10 <sup>-4</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	5.54	6.20×10 <sup>-4</sup>	100.0
Industrial	Rendering or fat extraction	5.10	5.71×10 <sup>-4</sup>	100.0
Commercial	Log Sawmilling	4.63	5.18×10 <sup>-4</sup>	100.0
Industrial	Water-based extractive activity	3.86	4.32×10 <sup>-4</sup>	100.0
Industrial	Concrete works	3.00	3.36×10 <sup>-4</sup>	100.0
Industrial	Sewage treatment - small plants	2.74	3.07×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	2.15	2.41×10 <sup>-4</sup>	100.0
Industrial	Petroleum products and fuel production	1.84	2.06×10 <sup>-4</sup>	100.0
Industrial	General animal products production	1.81	2.03×10 <sup>-4</sup>	100.0
Industrial	Inert waste landfilling	1.61	1.81×10 <sup>-4</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	1.50	1.67×10 <sup>-4</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	1.06	1.19×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	1.05	1.17×10 <sup>-4</sup>	100.0
Industrial	Metal plating or coating	0.95	1.07×10 <sup>-4</sup>	100.0
Industrial	Chemical production	0.87	9.75×10 <sup>-5</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	0.72	8.10×10 <sup>-5</sup>	100.0

Module	Activity <sup>27</sup>	Emissions (tonnes/year)	Proportion (%) <sup>28</sup>	Cumulative proportion (%)
Industrial	Sewage treatment - large plants	0.56	6.24×10 <sup>-5</sup>	100.0
Industrial	Bird accommodation	0.54	6.04×10 <sup>-5</sup>	100.0
Industrial	Crushing, grinding or separating	0.27	3.04×10 <sup>-5</sup>	100.0
Commercial	Synthetic Resin Manufacturing	0.22	2.42×10 <sup>-5</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	0.17	1.89×10 <sup>-5</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	0.17	1.86×10 <sup>-5</sup>	100.0
Industrial	Explosives production	0.13	1.51×10 <sup>-5</sup>	100.0
Industrial	Non-thermal treatment of waste	9.45×10 <sup>-2</sup>	1.06×10 <sup>-5</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	8.13×10 <sup>-2</sup>	9.10×10 <sup>-6</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	3.70×10 <sup>-2</sup>	4.14×10 <sup>-6</sup>	100.0
Industrial	General chemicals storage	2.81×10 <sup>-2</sup>	3.15×10 <sup>-6</sup>	100.0
Industrial	Animal accommodation	9.22×10 <sup>-3</sup>	1.03×10 <sup>-6</sup>	100.0
Commercial	Non-Building Construction n.e.c.	7.03×10 <sup>-3</sup>	7.87×10 <sup>-7</sup>	100.0
Commercial	Non-Ferrous Metal Casting	7.02×10 <sup>-3</sup>	7.86×10 <sup>-7</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	3.42×10 <sup>-3</sup>	3.83×10 <sup>-7</sup>	100.0
Industrial	Coal works	3.12×10 <sup>-4</sup>	3.49×10 <sup>-8</sup>	100.0
Commercial	Printing	2.03×10 <sup>-5</sup>	2.27×10 <sup>-9</sup>	100.0

Figure 3-6, Figure 3-7, Figure 3-8, Figure 3-9 and Figure 3-10 show the estimated annual emissions for the top 15 natural and human-made sources of carbon monoxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

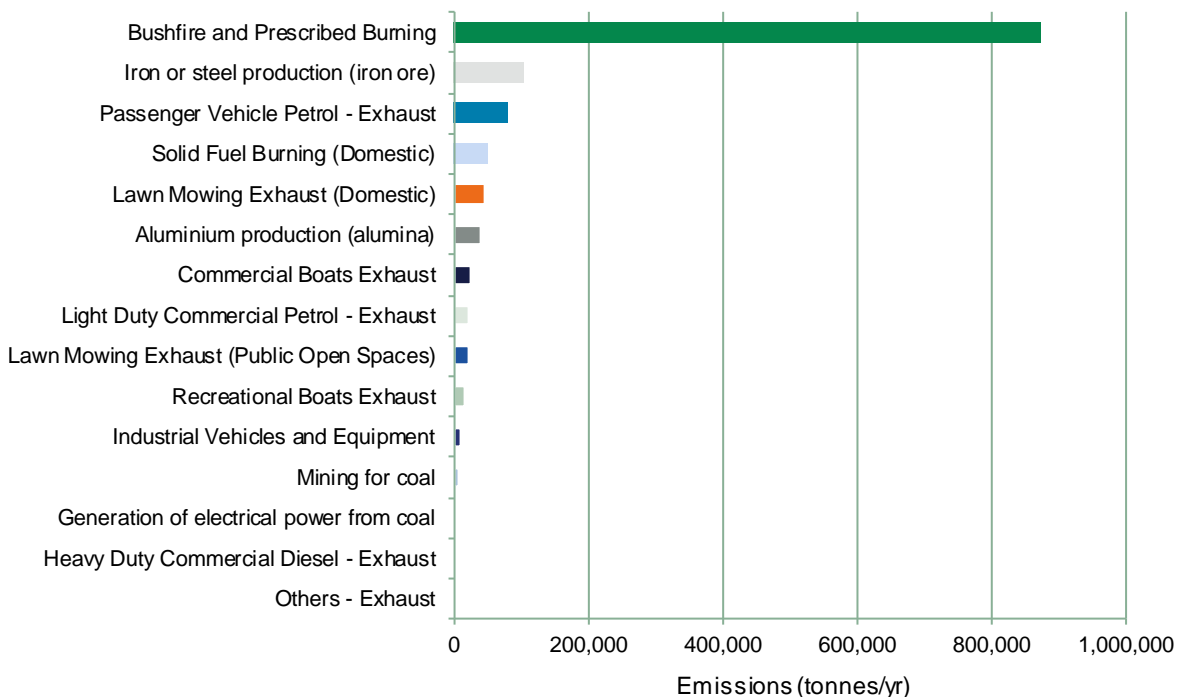


Figure 3-6: GMR: top 15 natural and human-made sources of carbon monoxide

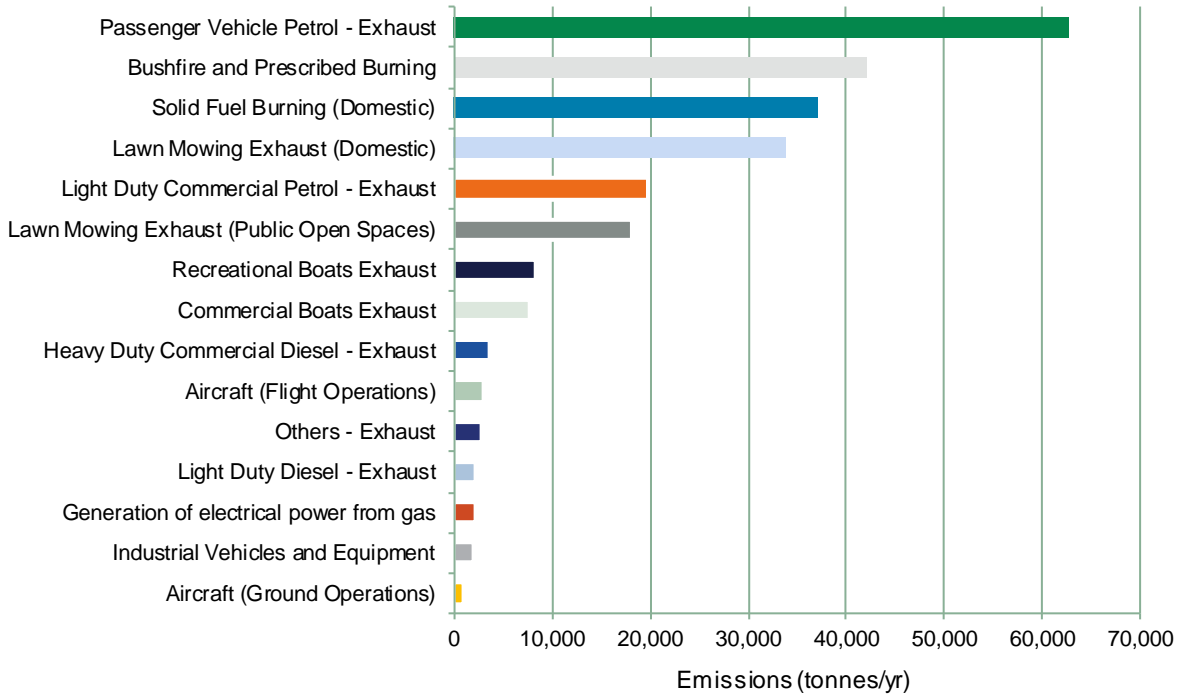


Figure 3-7: Sydney region: top 15 natural and human-made sources of carbon monoxide

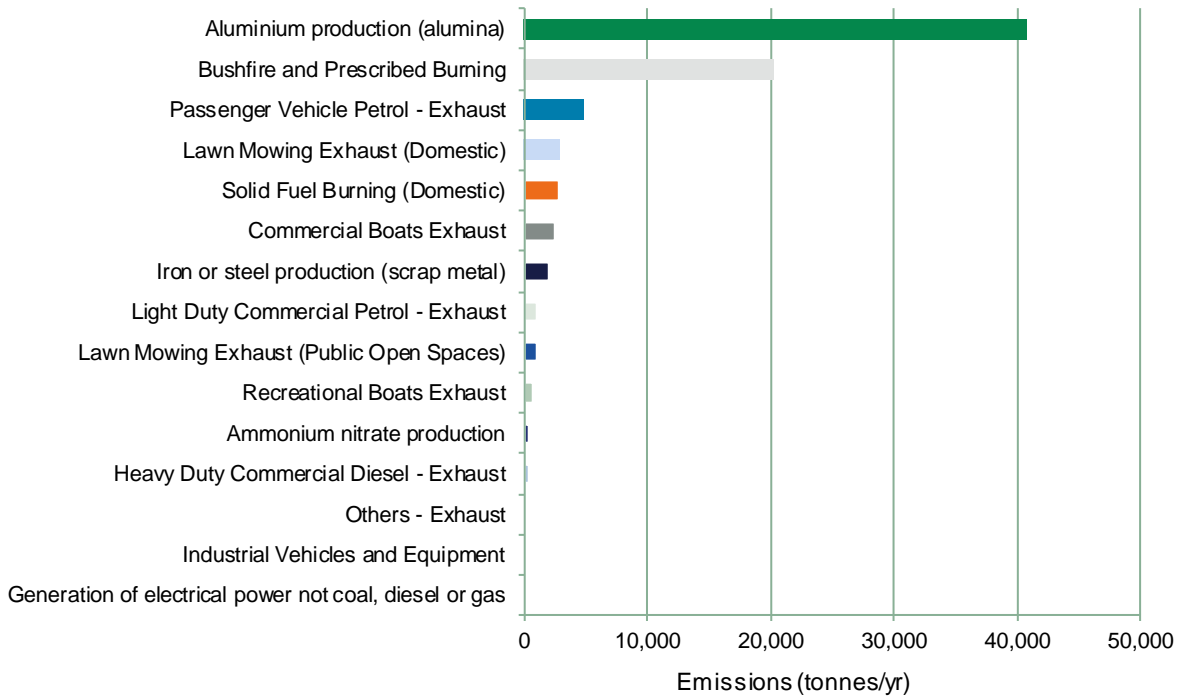


Figure 3-8: Newcastle region: top 15 natural and human-made sources of carbon monoxide

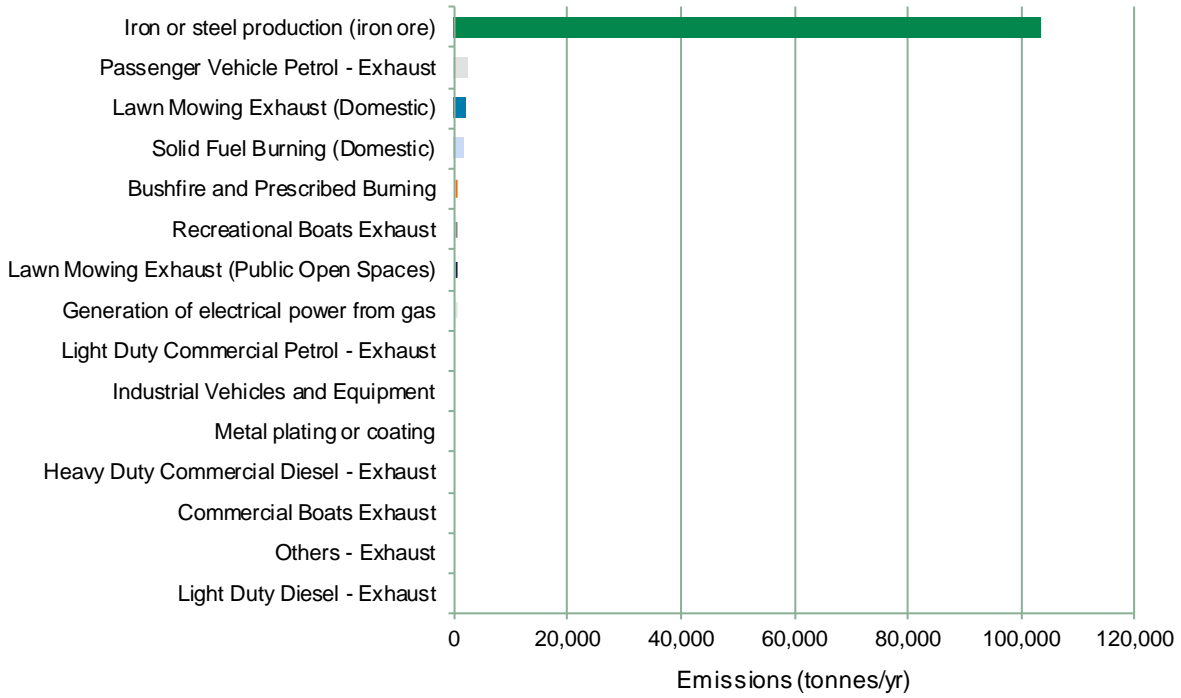


Figure 3-9: Wollongong region: top 15 natural and human-made sources of carbon monoxide

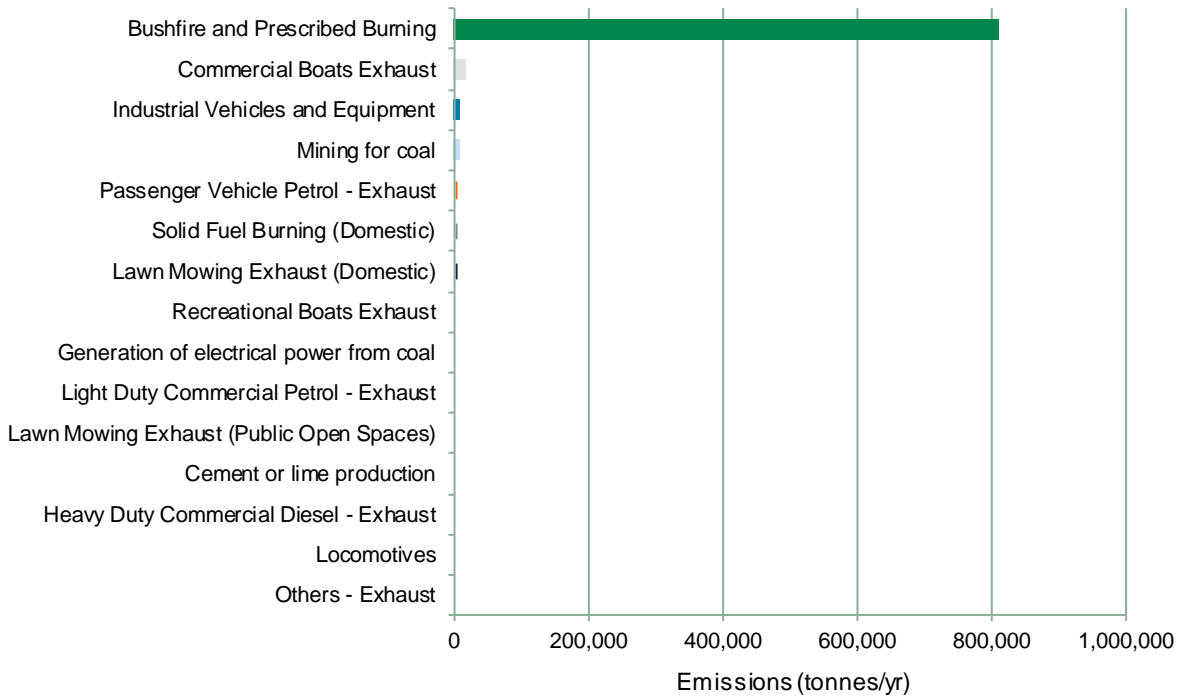


Figure 3-10: Non-urban region: top 15 natural and human-made sources of carbon monoxide

## 3.2. Oxides of nitrogen

### 3.2.1. Natural and human-made emissions

Table 3-4 presents total estimated annual emissions of oxides of nitrogen by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-4: Total estimated annual emissions of oxides of nitrogen by natural and human-made source type in each region**

Substance	Region	Emissions (tonnes/year)						Total <sup>29</sup>
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Oxides of nitrogen	Sydney	2,605	359	2,701	7,387	15,734	32,496	61,282
	Newcastle	739	38.13	187	2,016	4,104	2,788	9,872
	Wollongong	110	11.12	129	6,166	1,946	1,610	9,973
	Non-urban	32,466	154	457	145,396	37,136	8,191	223,800
	GMR <sup>29</sup>	35,920	562	3,473	160,966	58,920	45,085	304,927

Table 3-5 presents the proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-5: Proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type in each region**

Substance	Region	Proportion (%) <sup>30</sup>					
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Oxides of nitrogen	Sydney	4.25	0.59	4.41	12.1	25.7	53.0
	Newcastle	7.49	0.39	1.89	20.4	41.6	28.2
	Wollongong	1.11	0.11	1.30	61.8	19.5	16.1
	Non-urban	14.5	6.89×10 <sup>-2</sup>	0.20	65.0	16.6	3.66
	GMR	11.8	0.18	1.14	52.8	19.3	14.8

Figure 3-11, Figure 3-12, Figure 3-13, Figure 3-14 and Figure 3-15 show the proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

<sup>29</sup> The totals may differ from the sum of the addends due to rounding.

<sup>30</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10<sup>-2</sup> = 0.0946).

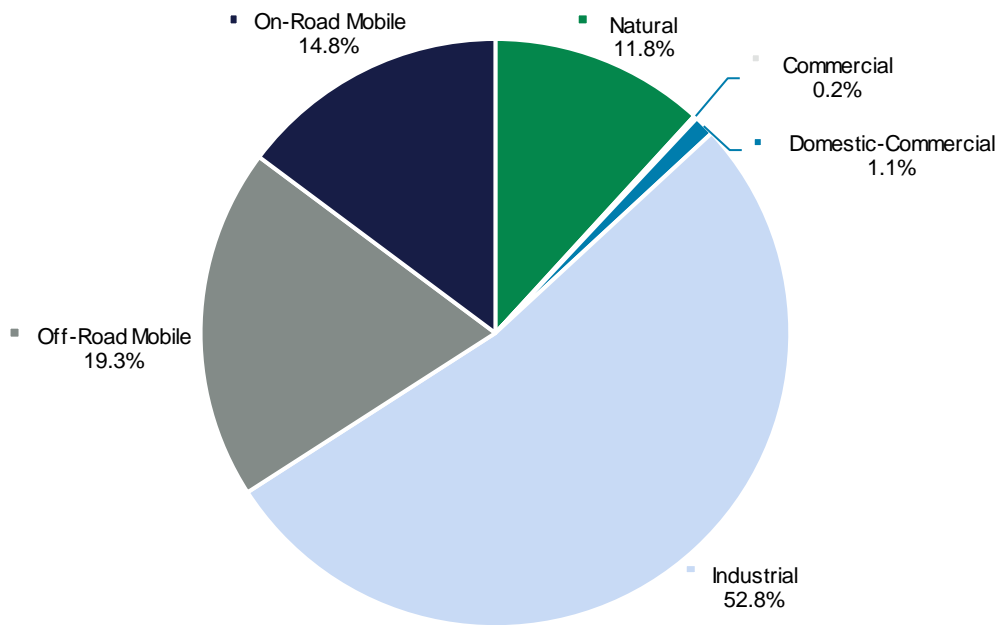


Figure 3-11: GMR: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type

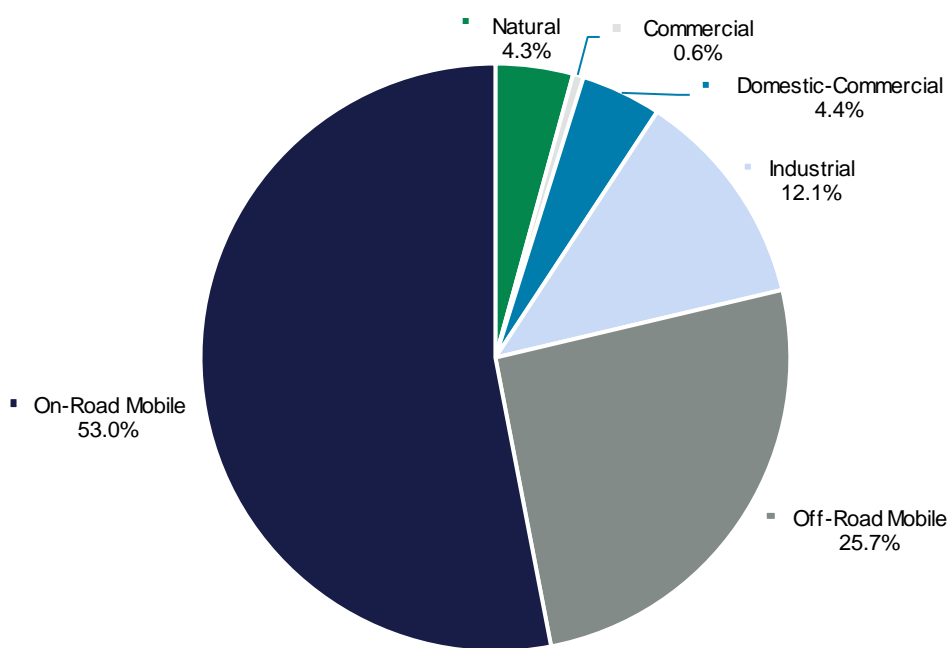


Figure 3-12: Sydney region: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type

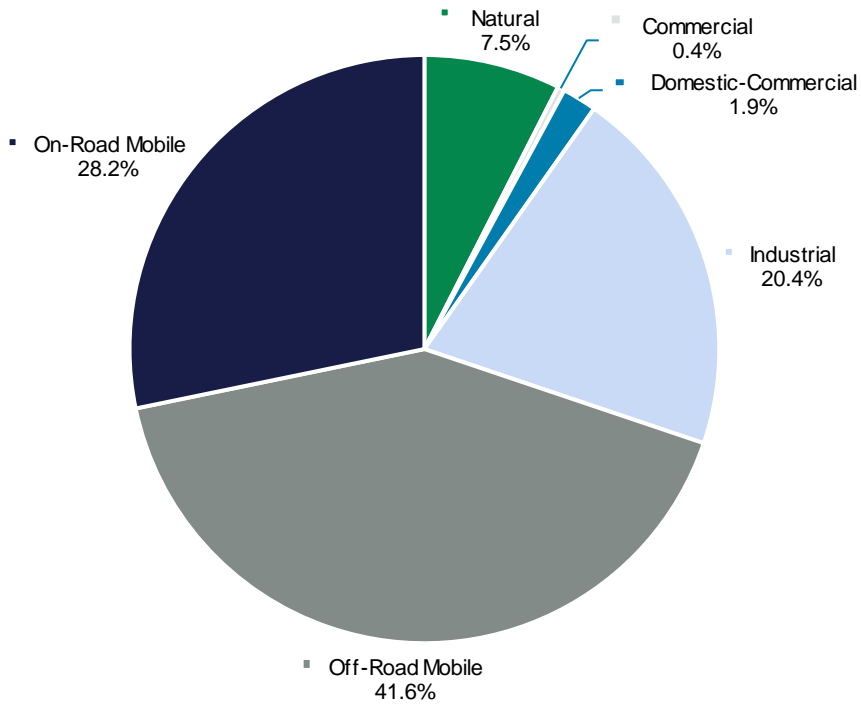


Figure 3-13: Newcastle region: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type

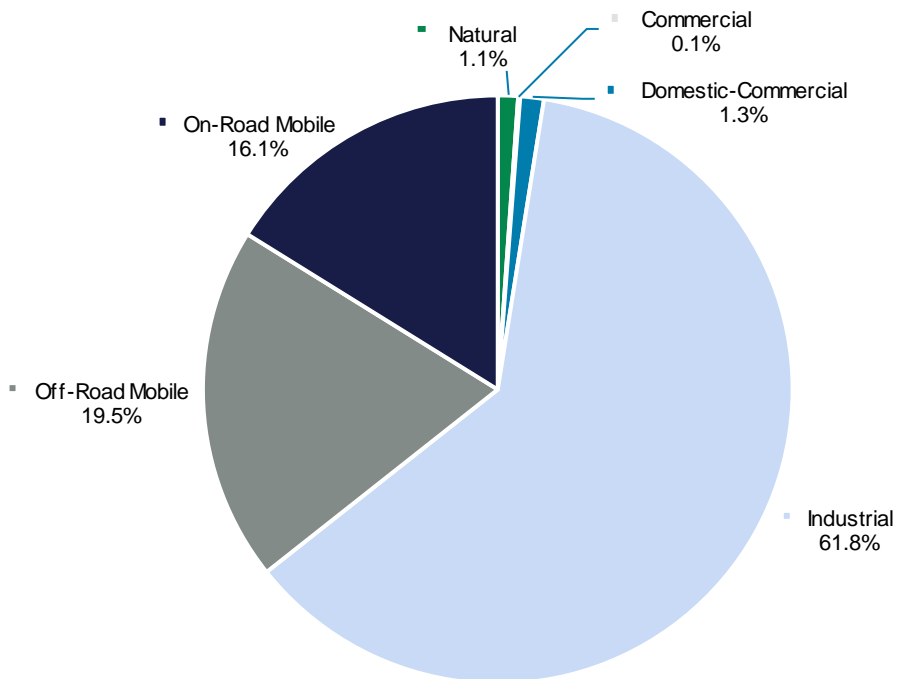


Figure 3-14: Wollongong region: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type



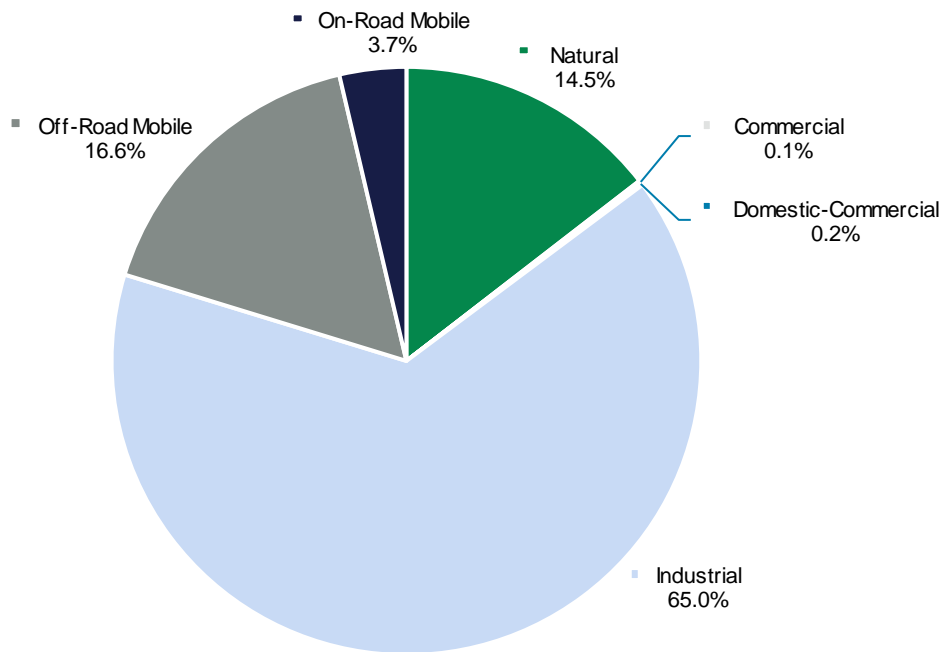


Figure 3-15: Non-urban region: proportions of total estimated annual emissions of oxides of nitrogen by natural and human-made source type

### 3.2.2. Priority natural and human-made emissions

Table 3-6 presents total estimated annual emissions, proportions and cumulative proportions of natural and human-made sources of oxides of nitrogen in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 3-6: Natural and human-made sources of oxides of nitrogen in each region

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
<b>Oxides of nitrogen in the GMR</b>				
Industrial	Generation of electrical power from coal	139,246	45.7	45.7
Off-Road Mobile	Industrial Vehicles and Equipment	30,767	10.1	55.8
Natural	Bushfire and Prescribed Burning	25,812	8.47	64.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	20,564	6.74	71.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	13,273	4.35	75.3
Off-Road Mobile	Ships	12,373	4.06	79.4
Off-Road Mobile	Locomotives	9,093	2.98	82.4
Natural	Soil	7,971	2.61	85.0

<sup>31</sup> n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006)

<sup>32</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g.  $9.46 \times 10^{-2} = 0.0946$ ).

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
On-Road Mobile	Light Duty Diesel - Exhaust	6,631	2.17	87.1
Industrial	Iron or steel production (iron ore)	5,772	1.89	89.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	4,490	1.47	90.5
Industrial	Cement or lime production	3,985	1.31	91.8
Off-Road Mobile	Commercial Boats Exhaust	3,627	1.19	93.0
Industrial	Mining for coal	2,557	0.84	93.8
Industrial	Generation of electrical power from gas	2,453	0.80	94.7
Domestic-Commercial	Gaseous Fuel Burning	2,160	0.71	95.4
Natural	Lightning	2,125	0.70	96.1
Off-Road Mobile	Aircraft (Flight Operations)	2,038	0.67	96.7
Industrial	Petroleum products and fuel production	1,435	0.47	97.2
Industrial	Ammonium nitrate production	1,301	0.43	97.6
Industrial	Glass production (container)	892	0.29	97.9
Off-Road Mobile	Recreational Boats Exhaust	748	0.25	98.2
Domestic-Commercial	Solid Fuel Burning (Domestic)	728	0.24	98.4
Industrial	Petrochemical production	715	0.23	98.6
Industrial	Generation of electrical power not coal, diesel or gas	332	0.11	98.7
Industrial	Sewage treatment - large plants	320	0.11	98.8
Industrial	Ceramics production	277	9.08×10 <sup>-2</sup>	98.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	245	8.02×10 <sup>-2</sup>	99.0
Industrial	Chemical production	227	7.44×10 <sup>-2</sup>	99.1
Industrial	Iron or steel production (scrap metal)	219	7.20×10 <sup>-2</sup>	99.2
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	197	6.48×10 <sup>-2</sup>	99.2
Industrial	Waste disposal (application to land)	171	5.60×10 <sup>-2</sup>	99.3
Off-Road Mobile	Aircraft (Ground Operations)	168	5.50×10 <sup>-2</sup>	99.3
Industrial	Aluminium production (alumina)	135	4.41×10 <sup>-2</sup>	99.4
On-Road Mobile	Others - Exhaust	127	4.17×10 <sup>-2</sup>	99.4
Industrial	Paper or pulp production	121	3.97×10 <sup>-2</sup>	99.5
Domestic-Commercial	Barbeques	112	3.69×10 <sup>-2</sup>	99.5
Off-Road Mobile	Commercial Vehicles and Equipment	105	3.45×10 <sup>-2</sup>	99.5
Commercial	Port Operators	99.70	3.27×10 <sup>-2</sup>	99.6
Commercial	Log Sawmilling	91.21	2.99×10 <sup>-2</sup>	99.6
Commercial	Hospitals (Except Psychiatric Hospitals)	69.14	2.27×10 <sup>-2</sup>	99.6

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Industrial	Land-based extractive activity	67.80	2.22×10 <sup>-2</sup>	99.6
Industrial	General agricultural processing	66.18	2.17×10 <sup>-2</sup>	99.7
Commercial	Food Manufacturing n.e.c.	64.45	2.11×10 <sup>-2</sup>	99.7
Industrial	Metal plating or coating	61.80	2.03×10 <sup>-2</sup>	99.7
Industrial	Rendering or fat extraction	56.99	1.87×10 <sup>-2</sup>	99.7
Industrial	Brewing and distilling	56.88	1.87×10 <sup>-2</sup>	99.7
Industrial	Metal processing	54.47	1.79×10 <sup>-2</sup>	99.8
Industrial	General animal products production	49.32	1.62×10 <sup>-2</sup>	99.8
Industrial	Crushing, grinding or separating	45.81	1.50×10 <sup>-2</sup>	99.8
Industrial	Non-thermal treatment of waste	44.71	1.47×10 <sup>-2</sup>	99.8
Industrial	Bitumen mixing	38.94	1.28×10 <sup>-2</sup>	99.8
Industrial	Cement or lime handling	36.68	1.20×10 <sup>-2</sup>	99.8
Commercial	Metal Coating and Finishing	31.61	1.04×10 <sup>-2</sup>	99.8
Domestic-Commercial	Liquid Fuel Burning (Domestic)	31.57	1.04×10 <sup>-2</sup>	99.9
Commercial	Plaster Product Manufacturing	27.02	8.86×10 <sup>-3</sup>	99.9
Industrial	Composting	26.03	8.54×10 <sup>-3</sup>	99.9
Commercial	Bread Manufacturing	21.01	6.89×10 <sup>-3</sup>	99.9
Industrial	Non-ferrous metal production (scrap)	20.85	6.84×10 <sup>-3</sup>	99.9
Industrial	Paper production using recycled materials	20.77	6.81×10 <sup>-3</sup>	99.9
Commercial	Gas Supply	20.38	6.68×10 <sup>-3</sup>	99.9
Commercial	Waste Disposal Services	20.16	6.61×10 <sup>-3</sup>	99.9
Industrial	Slaughtering or processing of animals	18.42	6.04×10 <sup>-3</sup>	99.9
Industrial	Pharmaceutical and veterinary products production	17.97	5.89×10 <sup>-3</sup>	99.9
Industrial	Petroleum products storage	17.22	5.65×10 <sup>-3</sup>	99.9
Industrial	Water-based extractive activity	15.91	5.22×10 <sup>-3</sup>	99.9
Commercial	Printing	15.08	4.95×10 <sup>-3</sup>	99.9
Industrial	Sewage treatment - small plants	12.76	4.18×10 <sup>-3</sup>	99.9
Natural	Agricultural Burning	11.77	3.86×10 <sup>-3</sup>	99.9
Commercial	Biscuit Manufacturing	10.98	3.60×10 <sup>-3</sup>	99.9
Industrial	Recovery of waste oil	9.41	3.09×10 <sup>-3</sup>	99.9
Commercial	Corrugated Paperboard Container Manufacturing	8.62	2.83×10 <sup>-3</sup>	99.9
Industrial	Glass production	8.52	2.80×10 <sup>-3</sup>	100.0
Commercial	Basic Iron and Steel Manufacturing	8.39	2.75×10 <sup>-3</sup>	100.0
Industrial	Scrap metal processing	7.93	2.60×10 <sup>-3</sup>	100.0

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Industrial	Aluminium production (scrap metal)	7.53	2.47×10 <sup>-3</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	7.45	2.44×10 <sup>-3</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	7.39	2.42×10 <sup>-3</sup>	100.0
Commercial	Laundries and Dry-Cleaners	6.78	2.22×10 <sup>-3</sup>	100.0
Industrial	Concrete works	6.51	2.14×10 <sup>-3</sup>	100.0
Commercial	Oil and Fat Manufacturing	6.46	2.12×10 <sup>-3</sup>	100.0
Industrial	General chemicals storage	6.00	1.97×10 <sup>-3</sup>	100.0
Industrial	Dairy processing	5.62	1.84×10 <sup>-3</sup>	100.0
Commercial	Beer and Malt Manufacturing	5.40	1.77×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste	5.28	1.73×10 <sup>-3</sup>	100.0
Industrial	Solid waste landfilling	5.16	1.69×10 <sup>-3</sup>	100.0
Commercial	Ceramic Product Manufacturing	4.99	1.64×10 <sup>-3</sup>	100.0
Industrial	Printing, packaging and visual media production	4.64	1.52×10 <sup>-3</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	3.92	1.28×10 <sup>-3</sup>	100.0
Commercial	Ice Cream Manufacturing	3.59	1.18×10 <sup>-3</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	3.54	1.16×10 <sup>-3</sup>	100.0
Industrial	Soap and detergent production	3.22	1.06×10 <sup>-3</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	3.04	9.96×10 <sup>-4</sup>	100.0
Commercial	Services to Air Transport	2.60	8.54×10 <sup>-4</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	2.16	7.09×10 <sup>-4</sup>	100.0
Commercial	Cake and Pastry Manufacturing	2.12	6.94×10 <sup>-4</sup>	100.0
Commercial	Milk and Cream Processing	2.11	6.92×10 <sup>-4</sup>	100.0
Industrial	Bird accommodation	1.96	6.42×10 <sup>-4</sup>	100.0
Commercial	Aircraft Manufacturing	1.86	6.11×10 <sup>-4</sup>	100.0
Industrial	Container reconditioning	1.83	6.01×10 <sup>-4</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	1.79	5.86×10 <sup>-4</sup>	100.0
Industrial	Paints/polishes/adhesives production	1.53	5.01×10 <sup>-4</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	1.38	4.54×10 <sup>-4</sup>	100.0
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	1.09	3.57×10 <sup>-4</sup>	100.0
Commercial	Fruit and Vegetable Processing	1.05	3.45×10 <sup>-4</sup>	100.0
Commercial	Scientific Research	0.81	2.67×10 <sup>-4</sup>	100.0

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Industrial	Helicopter-related activity	0.79	2.59×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	0.76	2.50×10 <sup>-4</sup>	100.0
Industrial	Sterilisation activities	0.74	2.43×10 <sup>-4</sup>	100.0
Commercial	Steel Pipe and Tube Manufacturing	0.73	2.38×10 <sup>-4</sup>	100.0
Industrial	Other land-based extraction	0.72	2.35×10 <sup>-4</sup>	100.0
Commercial	Synthetic Resin Manufacturing	0.68	2.22×10 <sup>-4</sup>	100.0
Industrial	Explosives production	0.68	2.22×10 <sup>-4</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	0.65	2.13×10 <sup>-4</sup>	100.0
Industrial	Boat construction/maintenance (general)	0.58	1.90×10 <sup>-4</sup>	100.0
Industrial	Waste storage	0.57	1.87×10 <sup>-4</sup>	100.0
Commercial	Confectionery Manufacturing	0.45	1.46×10 <sup>-4</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	0.42	1.37×10 <sup>-4</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	0.36	1.19×10 <sup>-4</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	0.28	9.21×10 <sup>-5</sup>	100.0
Industrial	Rubber products/tyre production	0.25	8.34×10 <sup>-5</sup>	100.0
Industrial	Plastics resins production	0.21	6.76×10 <sup>-5</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	0.20	6.61×10 <sup>-5</sup>	100.0
Commercial	Non-Building Construction n.e.c.	0.17	5.56×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	0.17	5.46×10 <sup>-5</sup>	100.0
Industrial	Chemical storage	0.16	5.12×10 <sup>-5</sup>	100.0
Industrial	Pesticides and related products production	0.15	4.92×10 <sup>-5</sup>	100.0
Commercial	Lifting and Material Handling Equipment Manufacturing	8.24×10 <sup>-2</sup>	2.70×10 <sup>-5</sup>	100.0
Industrial	Shipping in bulk	6.53×10 <sup>-2</sup>	2.14×10 <sup>-5</sup>	100.0
Industrial	Animal accommodation	4.28×10 <sup>-2</sup>	1.41×10 <sup>-5</sup>	100.0
Commercial	Non-Ferrous Metal Casting	2.81×10 <sup>-2</sup>	9.21×10 <sup>-6</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	2.70×10 <sup>-2</sup>	8.84×10 <sup>-6</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	1.17×10 <sup>-2</sup>	3.85×10 <sup>-6</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	1.17×10 <sup>-2</sup>	3.83×10 <sup>-6</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	1.12×10 <sup>-2</sup>	3.69×10 <sup>-6</sup>	100.0
Commercial	Industrial Gas Manufacturing	5.33×10 <sup>-3</sup>	1.75×10 <sup>-6</sup>	100.0

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Industrial	Coal works	1.45×10 <sup>-3</sup>	4.76×10 <sup>-7</sup>	100.0
Commercial	Wine Manufacturing	1.30×10 <sup>-3</sup>	4.27×10 <sup>-7</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	8.38×10 <sup>-4</sup>	2.75×10 <sup>-7</sup>	100.0
<b>Oxides of nitrogen in the Sydney region</b>				
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	13,694	22.3	22.3
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	10,039	16.4	38.7
Off-Road Mobile	Ships	6,874	11.2	49.9
On-Road Mobile	Light Duty Diesel - Exhaust	5,230	8.53	58.5
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	3,443	5.62	64.1
Off-Road Mobile	Industrial Vehicles and Equipment	2,840	4.63	68.7
Off-Road Mobile	Commercial Boats Exhaust	2,154	3.52	72.2
Off-Road Mobile	Aircraft (Flight Operations)	1,966	3.21	75.5
Industrial	Generation of electrical power from gas	1,905	3.11	78.6
Domestic-Commercial	Gaseous Fuel Burning	1,705	2.78	81.3
Industrial	Petroleum products and fuel production	1,412	2.30	83.6
Off-Road Mobile	Locomotives	1,302	2.12	85.8
Natural	Bushfire and Prescribed Burning	1,240	2.02	87.8
Natural	Soil	1,044	1.70	89.5
Industrial	Glass production (container)	892	1.45	91.0
Industrial	Cement or lime production	882	1.44	92.4
Industrial	Petrochemical production	715	1.17	93.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	538	0.88	94.4
Off-Road Mobile	Recreational Boats Exhaust	382	0.62	95.1
Natural	Lightning	320	0.52	95.6
Industrial	Sewage treatment - large plants	296	0.48	96.1
Industrial	Ceramics production	208	0.34	96.4
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	196	0.32	96.7
Industrial	Generation of electrical power not coal, diesel or gas	162	0.27	97.0
Off-Road Mobile	Aircraft (Ground Operations)	161	0.26	97.3
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	147	0.24	97.5
Industrial	Paper or pulp production	121	0.20	97.7
Industrial	Waste disposal (application to land)	101	0.16	97.9
Commercial	Port Operators	99.70	0.16	98.0

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
On-Road Mobile	Others - Exhaust	89.98	0.15	98.2
Domestic-Commercial	Barbeques	88.83	0.14	98.3
Industrial	Mining for coal	65.14	0.11	98.4
Industrial	Chemical production	59.54	9.72×10 <sup>-2</sup>	98.5
Industrial	Brewing and distilling	56.88	9.28×10 <sup>-2</sup>	98.6
Off-Road Mobile	Commercial Vehicles and Equipment	55.04	8.98×10 <sup>-2</sup>	98.7
Commercial	Hospitals (Except Psychiatric Hospitals)	48.00	7.83×10 <sup>-2</sup>	98.8
Industrial	Rendering or fat extraction	47.72	7.79×10 <sup>-2</sup>	98.9
Industrial	General animal products production	46.92	7.66×10 <sup>-2</sup>	98.9
Industrial	General agricultural processing	45.71	7.46×10 <sup>-2</sup>	99.0
Industrial	Crushing, grinding or separating	45.49	7.42×10 <sup>-2</sup>	99.1
Industrial	Non-thermal treatment of waste	43.90	7.16×10 <sup>-2</sup>	99.2
Industrial	Cement or lime handling	36.26	5.92×10 <sup>-2</sup>	99.2
Industrial	Iron or steel production (scrap metal)	33.38	5.45×10 <sup>-2</sup>	99.3
Commercial	Plaster Product Manufacturing	27.02	4.41×10 <sup>-2</sup>	99.3
Industrial	Metal plating or coating	26.82	4.38×10 <sup>-2</sup>	99.4
Industrial	Composting	26.03	4.25×10 <sup>-2</sup>	99.4
Domestic-Commercial	Liquid Fuel Burning (Domestic)	24.93	4.07×10 <sup>-2</sup>	99.4
Industrial	Bitumen mixing	21.55	3.52×10 <sup>-2</sup>	99.5
Industrial	Non-ferrous metal production (scrap)	20.85	3.40×10 <sup>-2</sup>	99.5
Industrial	Paper production using recycled materials	20.77	3.39×10 <sup>-2</sup>	99.5
Commercial	Gas Supply	20.38	3.33×10 <sup>-2</sup>	99.6
Commercial	Food Manufacturing n.e.c.	20.22	3.30×10 <sup>-2</sup>	99.6
Commercial	Waste Disposal Services	20.15	3.29×10 <sup>-2</sup>	99.6
Commercial	Bread Manufacturing	18.35	2.99×10 <sup>-2</sup>	99.7
Industrial	Pharmaceutical and veterinary products production	17.93	2.93×10 <sup>-2</sup>	99.7
Industrial	Petroleum products storage	17.20	2.81×10 <sup>-2</sup>	99.7
Commercial	Printing	15.08	2.46×10 <sup>-2</sup>	99.8
Commercial	Biscuit Manufacturing	10.98	1.79×10 <sup>-2</sup>	99.8
Industrial	Sewage treatment - small plants	9.14	1.49×10 <sup>-2</sup>	99.8
Commercial	Corrugated Paperboard Container Manufacturing	8.62	1.41×10 <sup>-2</sup>	99.8
Industrial	Glass production	8.52	1.39×10 <sup>-2</sup>	99.8
Industrial	Recovery of waste oil	6.85	1.12×10 <sup>-2</sup>	99.8
Commercial	Laundries and Dry-Cleaners	6.78	1.11×10 <sup>-2</sup>	99.8

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Commercial	Oil and Fat Manufacturing	6.46	1.05×10 <sup>-2</sup>	99.8
Commercial	Medicinal and Pharmaceutical Product Manufacturing	6.12	9.99×10 <sup>-3</sup>	99.9
Commercial	Beer and Malt Manufacturing	5.40	8.82×10 <sup>-3</sup>	99.9
Industrial	Slaughtering or processing of animals	4.84	7.89×10 <sup>-3</sup>	99.9
Industrial	Scrap metal processing	4.81	7.85×10 <sup>-3</sup>	99.9
Commercial	Funeral Directors, Crematoria and Cemeteries	4.65	7.60×10 <sup>-3</sup>	99.9
Industrial	Printing, packaging and visual media production	4.64	7.58×10 <sup>-3</sup>	99.9
Commercial	Soft Drink, Cordial and Syrup Manufacturing	3.92	6.39×10 <sup>-3</sup>	99.9
Industrial	Metal processing	3.79	6.19×10 <sup>-3</sup>	99.9
Commercial	Metal Coating and Finishing	3.73	6.09×10 <sup>-3</sup>	99.9
Industrial	Dairy processing	3.64	5.95×10 <sup>-3</sup>	99.9
Commercial	Ice Cream Manufacturing	3.59	5.85×10 <sup>-3</sup>	99.9
Industrial	Soap and detergent production	3.22	5.26×10 <sup>-3</sup>	99.9
Commercial	Basic Iron and Steel Manufacturing	3.09	5.03×10 <sup>-3</sup>	99.9
Commercial	Glass and Glass Product Manufacturing	3.01	4.91×10 <sup>-3</sup>	99.9
Industrial	Concrete works	2.94	4.79×10 <sup>-3</sup>	99.9
Commercial	Paper Product Manufacturing n.e.c.	2.77	4.52×10 <sup>-3</sup>	99.9
Industrial	Land-based extractive activity	2.61	4.25×10 <sup>-3</sup>	100.0
Commercial	Services to Air Transport	2.60	4.25×10 <sup>-3</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	2.16	3.53×10 <sup>-3</sup>	100.0
Commercial	Cake and Pastry Manufacturing	2.12	3.45×10 <sup>-3</sup>	100.0
Commercial	Milk and Cream Processing	2.11	3.44×10 <sup>-3</sup>	100.0
Commercial	Ceramic Product Manufacturing	1.99	3.24×10 <sup>-3</sup>	100.0
Commercial	Aircraft Manufacturing	1.86	3.04×10 <sup>-3</sup>	100.0
Industrial	Container reconditioning	1.82	2.98×10 <sup>-3</sup>	100.0
Industrial	Paints/polishes/adhesives production	1.53	2.49×10 <sup>-3</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	1.38	2.26×10 <sup>-3</sup>	100.0
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	1.09	1.77×10 <sup>-3</sup>	100.0
Commercial	Fruit and Vegetable Processing	1.05	1.72×10 <sup>-3</sup>	100.0
Natural	Agricultural Burning	1.02	1.67×10 <sup>-3</sup>	100.0
Industrial	Bird accommodation	0.88	1.43×10 <sup>-3</sup>	100.0



Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Commercial	Scientific Research	0.81	1.33×10 <sup>-3</sup>	100.0
Industrial	Helicopter-related activity	0.79	1.29×10 <sup>-3</sup>	100.0
Industrial	Sterilisation activities	0.74	1.21×10 <sup>-3</sup>	100.0
Commercial	Steel Pipe and Tube Manufacturing	0.73	1.18×10 <sup>-3</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	0.65	1.06×10 <sup>-3</sup>	100.0
Industrial	Waste storage	0.57	9.29×10 <sup>-4</sup>	100.0
Commercial	Confectionery Manufacturing	0.45	7.29×10 <sup>-4</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	0.42	6.83×10 <sup>-4</sup>	100.0
Commercial	Synthetic Resin Manufacturing	0.42	6.83×10 <sup>-4</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	0.28	4.58×10 <sup>-4</sup>	100.0
Industrial	Rubber products/tyre production	0.25	4.15×10 <sup>-4</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	0.22	3.61×10 <sup>-4</sup>	100.0
Industrial	Plastics resins production	0.21	3.36×10 <sup>-4</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	0.16	2.68×10 <sup>-4</sup>	100.0
Industrial	Chemical storage	0.16	2.55×10 <sup>-4</sup>	100.0
Industrial	Pesticides and related products production	0.15	2.45×10 <sup>-4</sup>	100.0
Commercial	Non-Building Construction n.e.c.	0.12	1.93×10 <sup>-4</sup>	100.0
Commercial	Lifting and Material Handling Equipment Manufacturing	8.24×10 <sup>-2</sup>	1.35×10 <sup>-4</sup>	100.0
Industrial	Shipping in bulk	6.53×10 <sup>-2</sup>	1.06×10 <sup>-4</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	1.17×10 <sup>-2</sup>	1.91×10 <sup>-5</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	1.17×10 <sup>-2</sup>	1.91×10 <sup>-5</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	6.62×10 <sup>-3</sup>	1.08×10 <sup>-5</sup>	100.0
Commercial	Industrial Gas Manufacturing	5.33×10 <sup>-3</sup>	8.69×10 <sup>-6</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	5.24×10 <sup>-3</sup>	8.56×10 <sup>-6</sup>	100.0
Commercial	Wine Manufacturing	1.30×10 <sup>-3</sup>	2.13×10 <sup>-6</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	8.38×10 <sup>-4</sup>	1.37×10 <sup>-6</sup>	100.0
<b>Oxides of nitrogen in the Newcastle region</b>				
Off-Road Mobile	Ships	2,293	23.2	23.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	1,339	13.6	36.8
Industrial	Ammonium nitrate production	1,301	13.2	50.0

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Off-Road Mobile	Locomotives	1,115	11.3	61.3
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	857	8.68	69.9
Natural	Bushfire and Prescribed Burning	598	6.06	76.0
Off-Road Mobile	Industrial Vehicles and Equipment	360	3.64	79.6
On-Road Mobile	Light Duty Diesel - Exhaust	344	3.49	83.1
Off-Road Mobile	Commercial Boats Exhaust	251	2.54	85.7
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	240	2.43	88.1
Industrial	Iron or steel production (scrap metal)	186	1.88	90.0
Industrial	Chemical production	164	1.66	91.6
Industrial	Aluminium production (alumina)	135	1.36	93.0
Domestic-Commercial	Gaseous Fuel Burning	114	1.16	94.2
Natural	Soil	108	1.09	95.3
Industrial	Generation of electrical power not coal, diesel or gas	82.39	0.83	96.1
Industrial	Metal processing	47.23	0.48	96.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	40.66	0.41	97.0
Off-Road Mobile	Aircraft (Flight Operations)	38.84	0.39	97.4
Off-Road Mobile	Recreational Boats Exhaust	33.39	0.34	97.7
Natural	Lightning	32.88	0.33	98.0
Commercial	Metal Coating and Finishing	27.88	0.28	98.3
Industrial	Generation of electrical power from gas	21.15	0.21	98.5
Industrial	Petroleum products and fuel production	15.51	0.16	98.7
Industrial	General agricultural processing	13.76	0.14	98.8
Industrial	Slaughtering or processing of animals	13.58	0.14	99.0
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	12.36	0.13	99.1
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	12.05	0.12	99.2
Industrial	Mining for coal	10.66	0.11	99.3
Industrial	Bitumen mixing	9.50	9.62×10 <sup>-2</sup>	99.4
On-Road Mobile	Others - Exhaust	8.54	8.65×10 <sup>-2</sup>	99.5
Off-Road Mobile	Commercial Vehicles and Equipment	7.81	7.91×10 <sup>-2</sup>	99.6
Commercial	Hospitals (Except Psychiatric Hospitals)	6.59	6.68×10 <sup>-2</sup>	99.7
Domestic-Commercial	Barbeques	5.94	6.02×10 <sup>-2</sup>	99.7
Off-Road Mobile	Aircraft (Ground Operations)	5.66	5.73×10 <sup>-2</sup>	99.8
Industrial	Recovery of waste	5.28	5.34×10 <sup>-2</sup>	99.8

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Industrial	Metal plating or coating	3.59	3.63×10 <sup>-2</sup>	99.9
Industrial	Scrap metal processing	3.11	3.15×10 <sup>-2</sup>	99.9
Commercial	Bread Manufacturing	2.66	2.70×10 <sup>-2</sup>	99.9
Industrial	Dairy processing	1.98	2.01×10 <sup>-2</sup>	99.9
Domestic-Commercial	Liquid Fuel Burning (Domestic)	1.67	1.69×10 <sup>-2</sup>	100.0
Industrial	Land-based extractive activity	0.95	9.63×10 <sup>-3</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	0.91	9.23×10 <sup>-3</sup>	100.0
Industrial	Other land-based extraction	0.72	7.24×10 <sup>-3</sup>	100.0
Industrial	Boat construction/maintenance (general)	0.58	5.86×10 <sup>-3</sup>	100.0
Industrial	Cement or lime handling	0.42	4.26×10 <sup>-3</sup>	100.0
Natural	Agricultural Burning	0.22	2.25×10 <sup>-3</sup>	100.0
Industrial	Non-thermal treatment of waste	4.93×10 <sup>-2</sup>	5.00×10 <sup>-4</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	4.39×10 <sup>-2</sup>	4.44×10 <sup>-4</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	2.70×10 <sup>-2</sup>	2.73×10 <sup>-4</sup>	100.0
Industrial	Petroleum products storage	2.10×10 <sup>-2</sup>	2.13×10 <sup>-4</sup>	100.0
Commercial	Waste Disposal Services	1.13×10 <sup>-2</sup>	1.15×10 <sup>-4</sup>	100.0
Industrial	Crushing, grinding or separating	3.53×10 <sup>-7</sup>	3.57×10 <sup>-9</sup>	100.0
<b>Oxides of nitrogen in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	5,772	57.9	57.9
Off-Road Mobile	Industrial Vehicles and Equipment	935	9.38	67.3
Off-Road Mobile	Ships	781	7.83	75.1
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	774	7.76	82.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	504	5.05	87.9
Industrial	Generation of electrical power from gas	328	3.29	91.2
On-Road Mobile	Light Duty Diesel - Exhaust	190	1.91	93.1
Off-Road Mobile	Locomotives	163	1.63	94.7
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	136	1.37	96.1
Domestic-Commercial	Gaseous Fuel Burning	82.22	0.82	96.9
Natural	Soil	48.49	0.49	97.4
Off-Road Mobile	Recreational Boats Exhaust	47.41	0.48	97.9
Natural	Bushfire and Prescribed Burning	31.98	0.32	98.2
Industrial	Metal plating or coating	30.26	0.30	98.5
Natural	Lightning	29.92	0.30	98.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	24.21	0.24	99.0

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Industrial	Sewage treatment - large plants	24.16	0.24	99.3
Off-Road Mobile	Commercial Boats Exhaust	17.91	0.18	99.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	8.96	8.99×10 <sup>-2</sup>	99.6
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	8.27	8.29×10 <sup>-2</sup>	99.6
Industrial	General chemicals storage	5.96	5.98×10 <sup>-2</sup>	99.7
On-Road Mobile	Others - Exhaust	5.32	5.33×10 <sup>-2</sup>	99.8
Commercial	Basic Iron and Steel Manufacturing	5.31	5.32×10 <sup>-2</sup>	99.8
Domestic-Commercial	Barbeques	4.28	4.29×10 <sup>-2</sup>	99.9
Industrial	Metal processing	3.45	3.46×10 <sup>-2</sup>	99.9
Commercial	Ceramic Product Manufacturing	3.00	3.01×10 <sup>-2</sup>	99.9
Commercial	Hospitals (Except Psychiatric Hospitals)	2.50	2.51×10 <sup>-2</sup>	99.9
Industrial	Bitumen mixing	1.21	1.22×10 <sup>-2</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	1.20	1.21×10 <sup>-2</sup>	100.0
Industrial	Chemical production	1.04	1.04×10 <sup>-2</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	0.89	8.97×10 <sup>-3</sup>	100.0
Industrial	Non-thermal treatment of waste	0.65	6.48×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Flight Operations)	0.37	3.66×10 <sup>-3</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	0.30	3.00×10 <sup>-3</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	1.12×10 <sup>-2</sup>	1.13×10 <sup>-4</sup>	100.0
Industrial	Container reconditioning	9.60×10 <sup>-3</sup>	9.63×10 <sup>-5</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	4.24×10 <sup>-3</sup>	4.25×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	2.13×10 <sup>-3</sup>	2.13×10 <sup>-5</sup>	100.0
Commercial	Synthetic Resin Manufacturing	6.87×10 <sup>-4</sup>	6.89×10 <sup>-6</sup>	100.0
<b>Oxides of nitrogen in the Non-urban region</b>				
Industrial	Generation of electrical power from coal	139,246	62.2	62.2
Off-Road Mobile	Industrial Vehicles and Equipment	26,632	11.9	74.1
Natural	Bushfire and Prescribed Burning	23,942	10.7	84.8
Natural	Soil	6,771	3.03	87.8
Off-Road Mobile	Locomotives	6,513	2.91	90.8
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	4,757	2.13	92.9
Industrial	Cement or lime production	3,104	1.39	94.3
Industrial	Mining for coal	2,481	1.11	95.4
Off-Road Mobile	Ships	2,425	1.08	96.5

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	1,874	0.84	97.3
Natural	Lightning	1,742	0.78	98.1
Off-Road Mobile	Commercial Boats Exhaust	1,205	0.54	98.6
On-Road Mobile	Light Duty Diesel - Exhaust	867	0.39	99.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	671	0.30	99.3
Off-Road Mobile	Recreational Boats Exhaust	286	0.13	99.4
Domestic-Commercial	Gaseous Fuel Burning	258	0.12	99.5
Industrial	Generation of electrical power from gas	199	8.90×10 <sup>-2</sup>	99.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	125	5.57×10 <sup>-2</sup>	99.7
Commercial	Log Sawmilling	91.21	4.08×10 <sup>-2</sup>	99.7
Industrial	Generation of electrical power not coal, diesel or gas	86.81	3.88×10 <sup>-2</sup>	99.8
Industrial	Waste disposal (application to land)	69.78	3.12×10 <sup>-2</sup>	99.8
Industrial	Ceramics production	68.51	3.06×10 <sup>-2</sup>	99.8
Industrial	Land-based extractive activity	64.25	2.87×10 <sup>-2</sup>	99.9
Commercial	Food Manufacturing n.e.c.	44.22	1.98×10 <sup>-2</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	41.31	1.85×10 <sup>-2</sup>	99.9
Off-Road Mobile	Aircraft (Flight Operations)	32.98	1.47×10 <sup>-2</sup>	99.9
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	29.40	1.31×10 <sup>-2</sup>	99.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	27.51	1.23×10 <sup>-2</sup>	99.9
On-Road Mobile	Others - Exhaust	23.20	1.04×10 <sup>-2</sup>	99.9
Industrial	Water-based extractive activity	15.91	7.11×10 <sup>-3</sup>	100.0
Domestic-Commercial	Barbeques	13.43	6.00×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	12.05	5.38×10 <sup>-3</sup>	100.0
Natural	Agricultural Burning	10.52	4.70×10 <sup>-3</sup>	100.0
Industrial	Rendering or fat extraction	9.28	4.14×10 <sup>-3</sup>	100.0
Industrial	Aluminium production (scrap metal)	7.53	3.36×10 <sup>-3</sup>	100.0
Industrial	Petroleum products and fuel production	7.44	3.32×10 <sup>-3</sup>	100.0
Industrial	General agricultural processing	6.71	3.00×10 <sup>-3</sup>	100.0
Industrial	Bitumen mixing	6.68	2.99×10 <sup>-3</sup>	100.0
Industrial	Solid waste landfilling	5.16	2.31×10 <sup>-3</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	3.77	1.68×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	3.62	1.62×10 <sup>-3</sup>	100.0
Industrial	Concrete works	3.57	1.60×10 <sup>-3</sup>	100.0

Module	Activity <sup>31</sup>	Emissions (tonnes/year)	Proportion (%) <sup>32</sup>	Cumulative proportion (%)
Industrial	Recovery of waste oil	2.56	1.15×10 <sup>-3</sup>	100.0
Industrial	General animal products production	2.41	1.07×10 <sup>-3</sup>	100.0
Industrial	Chemical production	2.17	9.68×10 <sup>-4</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	1.78	7.96×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	1.59	7.09×10 <sup>-4</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	1.27	5.66×10 <sup>-4</sup>	100.0
Industrial	Metal plating or coating	1.13	5.06×10 <sup>-4</sup>	100.0
Industrial	Bird accommodation	1.08	4.83×10 <sup>-4</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	0.95	4.24×10 <sup>-4</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	0.77	3.45×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	0.75	3.36×10 <sup>-4</sup>	100.0
Industrial	Explosives production	0.68	3.02×10 <sup>-4</sup>	100.0
Industrial	Sewage treatment - large plants	0.51	2.27×10 <sup>-4</sup>	100.0
Industrial	Crushing, grinding or separating	0.32	1.44×10 <sup>-4</sup>	100.0
Commercial	Synthetic Resin Manufacturing	0.26	1.15×10 <sup>-4</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	0.20	9.00×10 <sup>-5</sup>	100.0
Industrial	Non-thermal treatment of waste	0.11	5.03×10 <sup>-5</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	9.68×10 <sup>-2</sup>	4.33×10 <sup>-5</sup>	100.0
Commercial	Non-Building Construction n.e.c.	5.10×10 <sup>-2</sup>	2.28×10 <sup>-5</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	4.40×10 <sup>-2</sup>	1.97×10 <sup>-5</sup>	100.0
Industrial	Animal accommodation	4.28×10 <sup>-2</sup>	1.91×10 <sup>-5</sup>	100.0
Industrial	General chemicals storage	3.35×10 <sup>-2</sup>	1.50×10 <sup>-5</sup>	100.0
Commercial	Non-Ferrous Metal Casting	2.81×10 <sup>-2</sup>	1.26×10 <sup>-5</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	2.76×10 <sup>-2</sup>	1.23×10 <sup>-5</sup>	100.0
Industrial	Coal works	1.45×10 <sup>-3</sup>	6.48×10 <sup>-7</sup>	100.0
Commercial	Printing	2.41×10 <sup>-5</sup>	1.08×10 <sup>-8</sup>	100.0

Figure 3-16, Figure 3-17, Figure 3-18, Figure 3-19 and Figure 3-20 show the estimated annual emissions for the top 15 natural and human-made sources of oxides of nitrogen in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

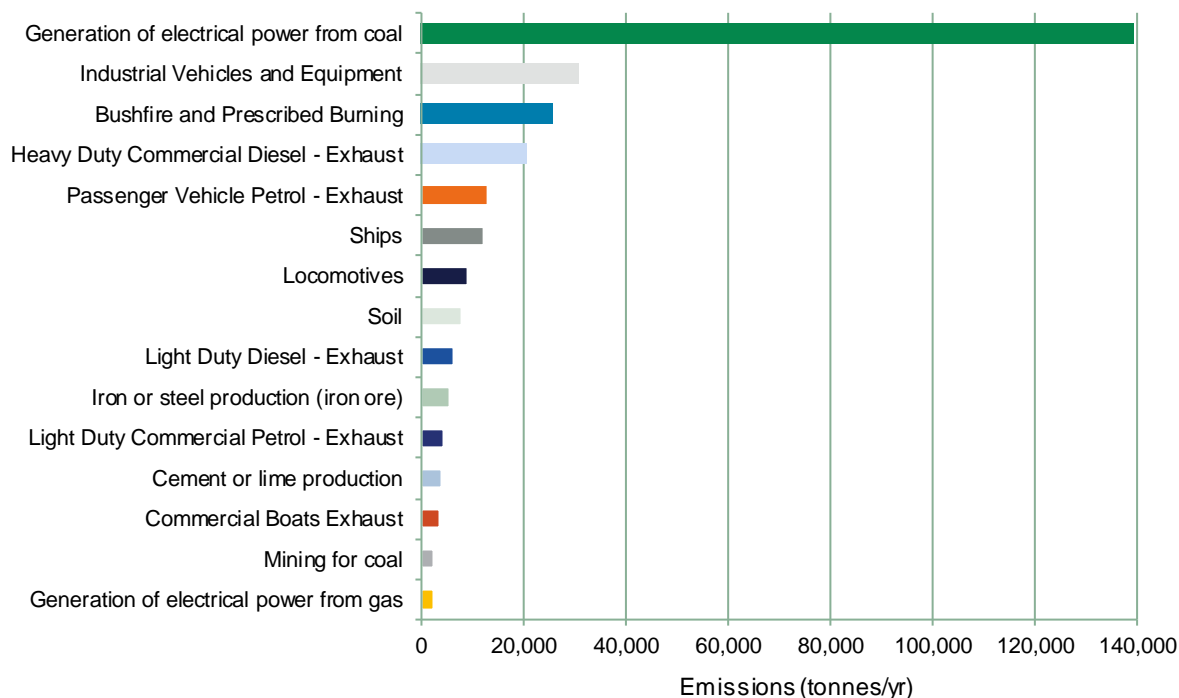


Figure 3-16: GMR: top 15 natural and human-made sources of oxides of nitrogen

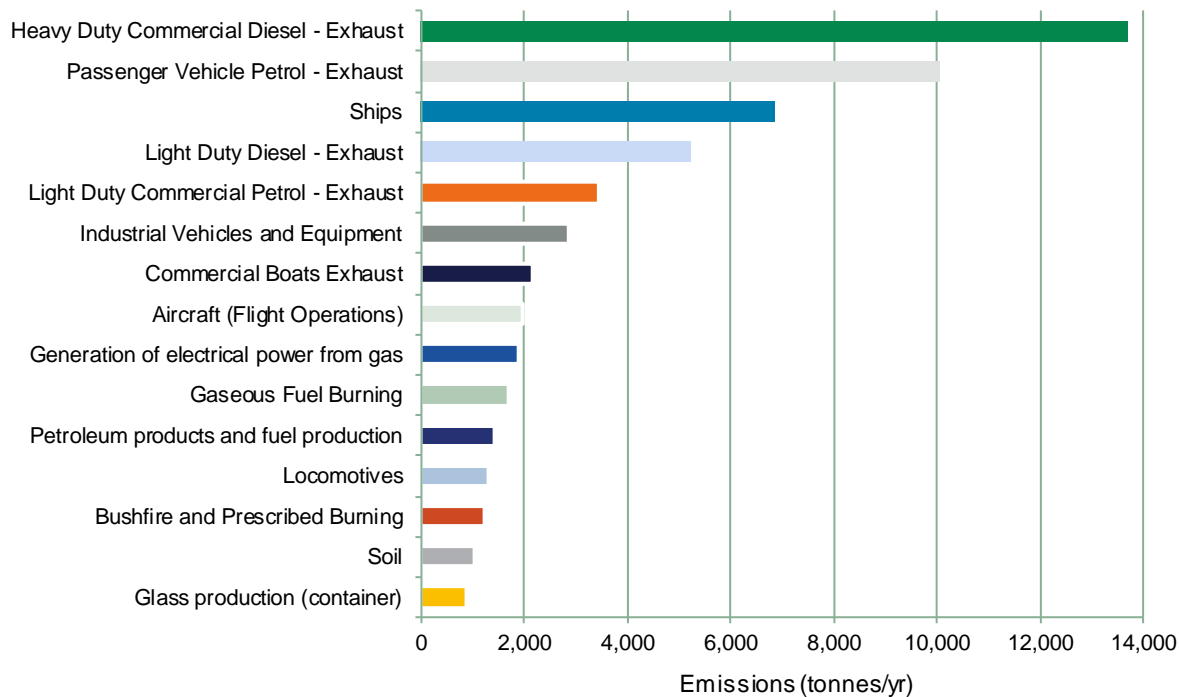


Figure 3-17: Sydney region: top 15 natural and human-made sources of oxides of nitrogen

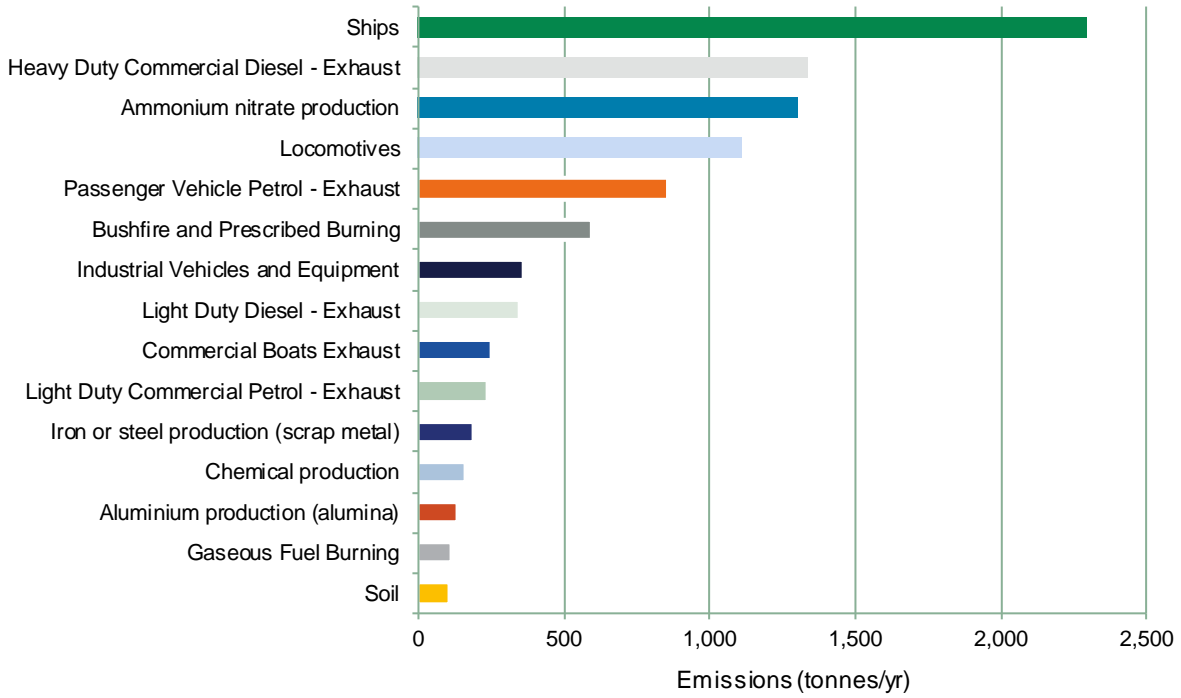


Figure 3-18: Newcastle region: top 15 natural and human-made sources of oxides of nitrogen

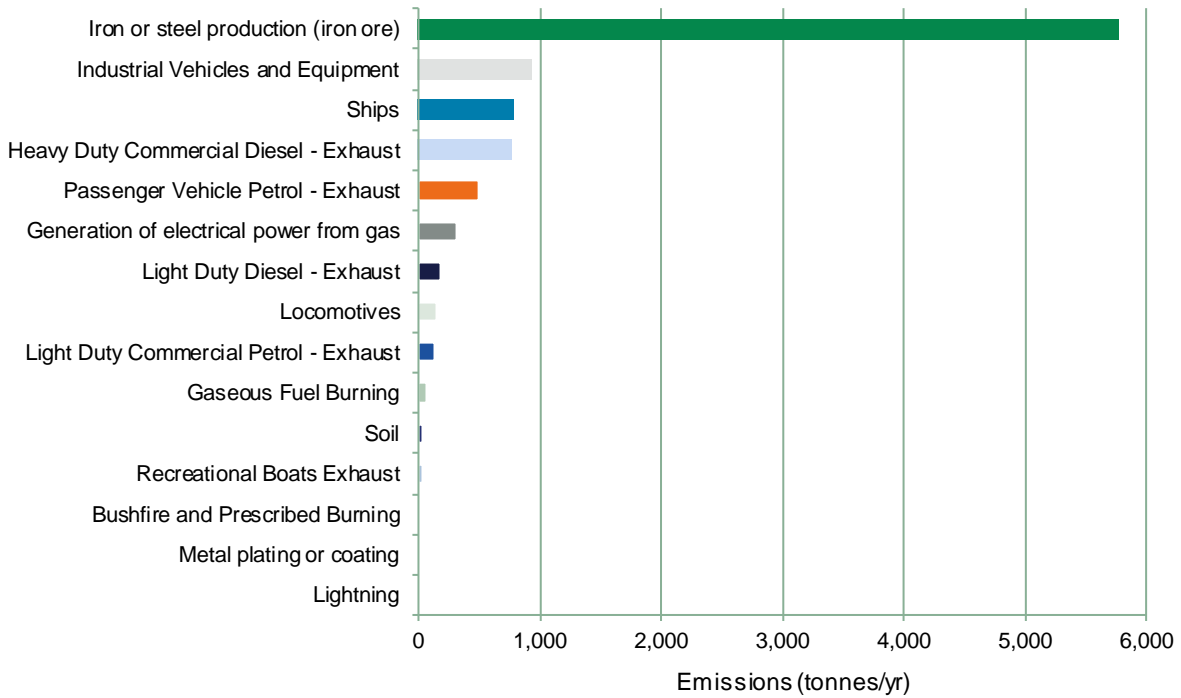


Figure 3-19: Wollongong region: top 15 natural and human-made sources of oxides of nitrogen



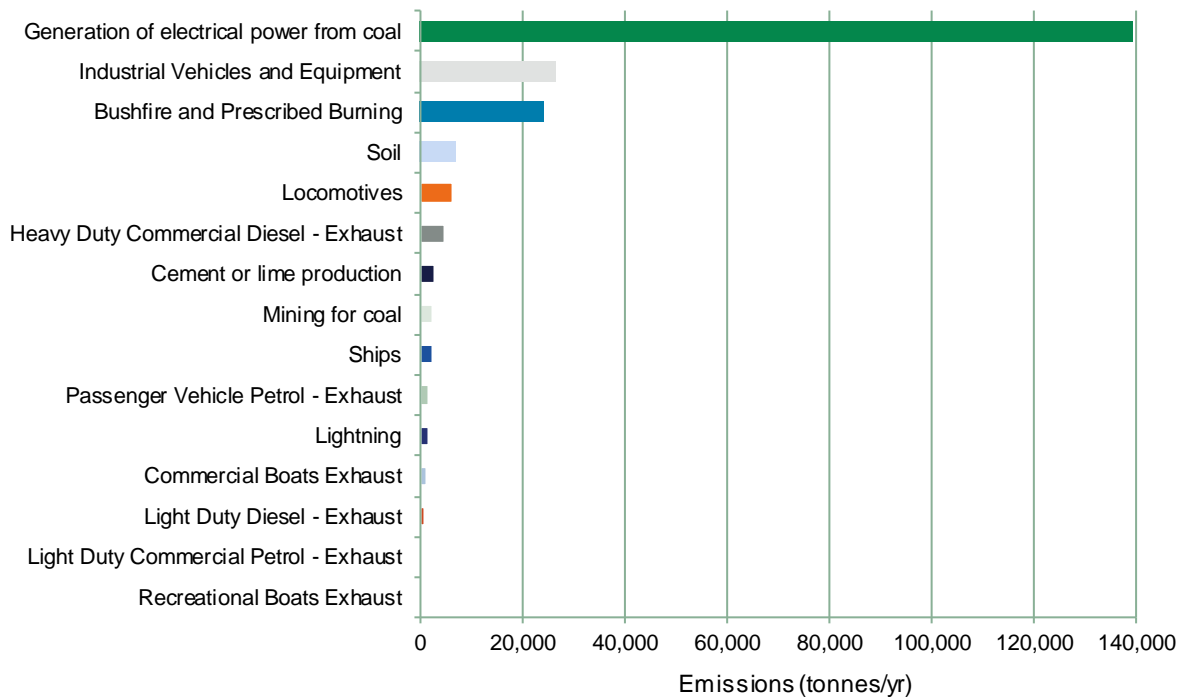


Figure 3-20: Non-urban region: top 15 natural and human-made sources of oxides of nitrogen

### 3.3. Particulate matter $\leq 10\mu\text{m}$

#### 3.3.1. Natural and human-made emissions

Table 3-7 presents total estimated annual emissions of particulate matter  $\leq 10\mu\text{m}$  by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 3-7: Total estimated annual emissions of particulate matter  $\leq 10\mu\text{m}$  by natural and human-made source type in each region

Substance	Region	Emissions (tonnes/year)						Total <sup>33</sup>
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Particulate matter $\leq 10\mu\text{m}$	Sydney	5,786	682	5,744	6,040	1,111	1,838	21,200
	Newcastle	2,300	82.44	432	4,016	283	156	7,269
	Wollongong	239	30.41	262	1,280	133	85.34	2,029
	Non-urban	95,222	492	1,296	75,087	1,736	427	174,260
	GMR <sup>33</sup>	103,547	1,287	7,734	86,422	3,263	2,505	204,758

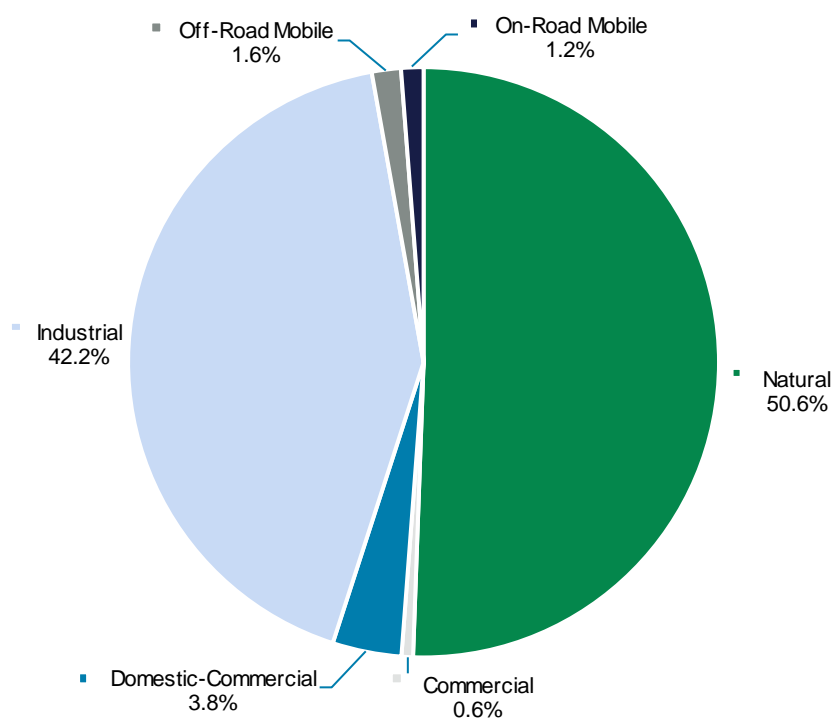
<sup>33</sup> The totals may differ from the sum of the addends due to rounding.

Table 3-8 presents the proportions of total estimated annual emissions of particulate matter  $\leq 10\mu\text{m}$  by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-8: Proportions of total estimated annual emissions of particulate matter  $\leq 10\mu\text{m}$  by natural and human-made source type in each region**

Substance	Region	Proportion (%)					
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Particulate matter $\leq 10\mu\text{m}$	Sydney	27.3	3.22	27.1	28.5	5.24	8.67
	Newcastle	31.6	1.13	5.95	55.2	3.89	2.14
	Wollongong	11.8	1.50	12.9	63.1	6.56	4.21
	Non-urban	54.6	0.28	0.74	43.1	1.00	0.24
	GMR	50.6	0.63	3.78	42.2	1.59	1.22

Figure 3-21, Figure 3-22, Figure 3-23, Figure 3-24 and Figure 3-25 show the proportions of total estimated annual emissions of particulate matter  $\leq 10\mu\text{m}$  by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.



**Figure 3-21: GMR: proportions of total estimated annual emissions of particulate matter  $\leq 10\mu\text{m}$  by natural and human-made source type**

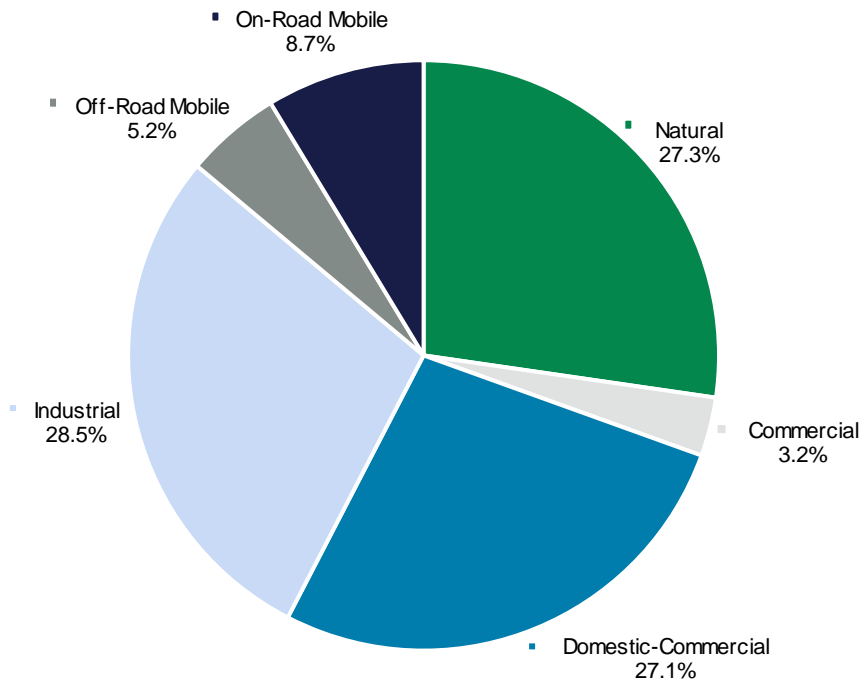


Figure 3-22: Sydney region: proportions of total estimated annual emissions of particulate matter ≤ 10µm by natural and human-made source type

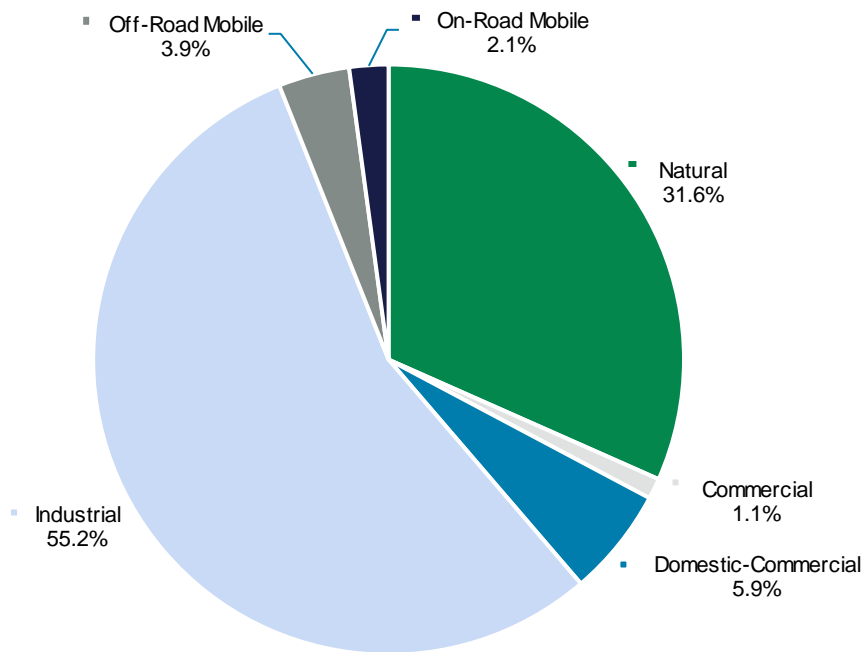


Figure 3-23: Newcastle region: proportions of total estimated annual emissions of particulate matter ≤ 10µm by natural and human-made source type

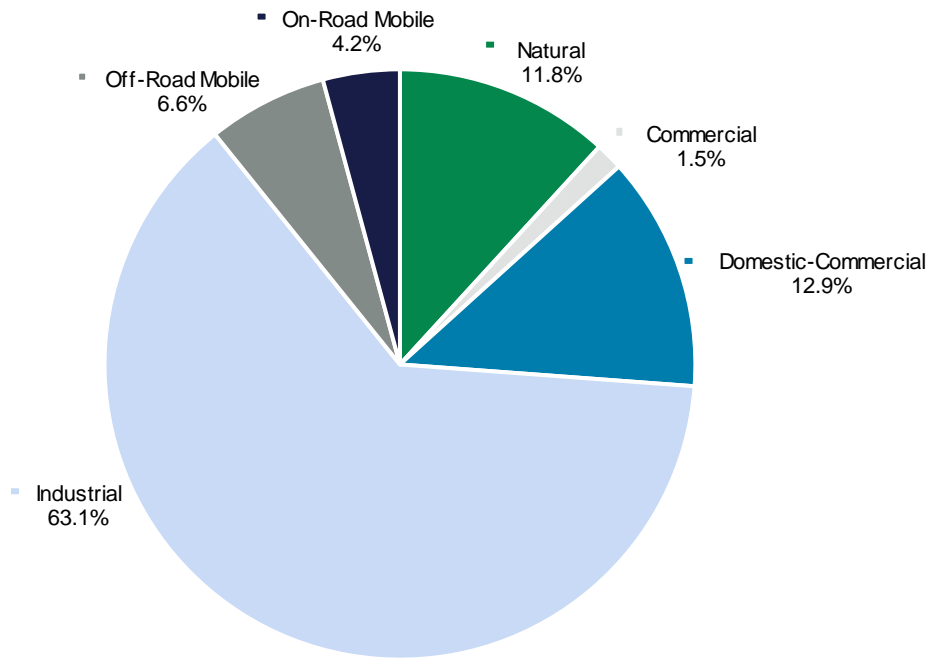


Figure 3-24: Wollongong region: proportions of total estimated annual emissions of particulate matter ≤ 10µm by natural and human-made source type

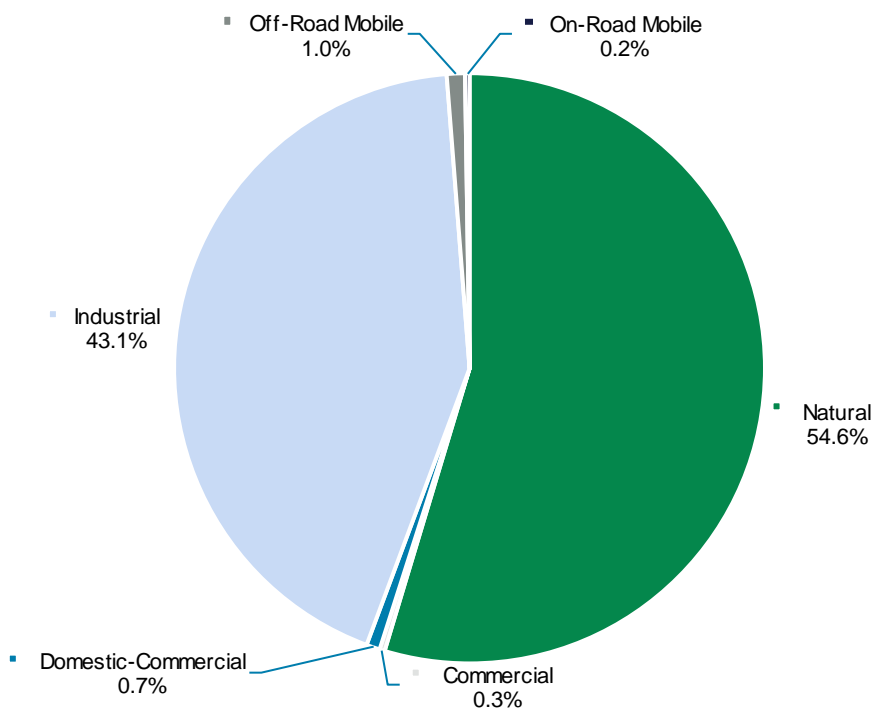


Figure 3-25: Non-urban region: proportions of total estimated annual emissions of particulate matter ≤ 10µm by natural and human-made source type

### 3.3.2. Priority natural and human-made emissions

Table 3-9 presents total estimated annual emissions, proportions and cumulative proportions of natural and human-made sources of particulate matter  $\leq 10\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-9: Natural and human-made sources of particulate matter  $\leq 10\mu\text{m}$  in each region**

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
<b>Particulate matter <math>\leq 10\mu\text{m}</math> in the GMR</b>				
Natural	Bushfire and Prescribed Burning	88,012	43.0	43.0
Industrial	Mining for coal	68,020	33.2	76.2
Natural	Marine Aerosol	14,852	7.25	83.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	7,036	3.44	86.9
Industrial	Generation of electrical power from coal	3,623	1.77	88.7
Industrial	Land-based extractive activity	3,071	1.50	90.2
Industrial	Ceramics production	1,580	0.77	90.9
Industrial	Waste disposal (application to land)	1,563	0.76	91.7
On-Road Mobile	All - Non-Exhaust PM	1,548	0.76	92.5
Off-Road Mobile	Industrial Vehicles and Equipment	1,371	0.67	93.1
Off-Road Mobile	Ships	1,275	0.62	93.7
Industrial	Coal works	1,169	0.57	94.3
Industrial	Boat mooring and storage	945	0.46	94.8
Industrial	Iron or steel production (iron ore)	915	0.45	95.2
Commercial	Gravel and Sand Quarrying	744	0.36	95.6
Industrial	Crushing, grinding or separating	720	0.35	95.9
Natural	Fugitive/Windborne	644	0.31	96.3
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	622	0.30	96.6
Industrial	Cement or lime production	615	0.30	96.9
Industrial	Aluminium production (alumina)	506	0.25	97.1
Industrial	Other land-based extraction	353	0.17	97.3
Industrial	Bird accommodation	350	0.17	97.4
Industrial	Ammonium nitrate production	328	0.16	97.6
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	291	0.14	97.8
Off-Road Mobile	Commercial Boats Exhaust	276	0.13	97.9
Industrial	Composting	256	0.13	98.0
On-Road Mobile	Light Duty Diesel - Exhaust	248	0.12	98.1

<sup>34</sup> n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006).

<sup>35</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g.  $9.46 \times 10^{-2} = 0.0946$ ).

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Mining for minerals	210	0.10	98.2
Industrial	Non-thermal treatment of waste	201	9.83×10 <sup>-2</sup>	98.3
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	192	9.38×10 <sup>-2</sup>	98.4
Off-Road Mobile	Locomotives	181	8.84×10 <sup>-2</sup>	98.5
Commercial	Poultry Farming (Meat)	178	8.70×10 <sup>-2</sup>	98.6
Industrial	Petroleum products and fuel production	178	8.67×10 <sup>-2</sup>	98.7
Domestic-Commercial	Gaseous Fuel Burning	172	8.41×10 <sup>-2</sup>	98.8
Industrial	Railway systems activities	164	7.99×10 <sup>-2</sup>	98.9
Industrial	Recovery of waste	159	7.74×10 <sup>-2</sup>	98.9
Industrial	Concrete works	147	7.20×10 <sup>-2</sup>	99.0
Off-Road Mobile	Recreational Boats Exhaust	128	6.27×10 <sup>-2</sup>	99.1
Industrial	Bitumen mixing	125	6.12×10 <sup>-2</sup>	99.1
Industrial	Generation of electrical power from gas	106	5.19×10 <sup>-2</sup>	99.2
Industrial	Iron or steel production (scrap metal)	106	5.18×10 <sup>-2</sup>	99.2
Industrial	Glass production (container)	96.72	4.72×10 <sup>-2</sup>	99.3
Industrial	Dairy animal accommodation	94.30	4.61×10 <sup>-2</sup>	99.3
Industrial	General chemicals storage	84.43	4.12×10 <sup>-2</sup>	99.4
Commercial	Synthetic Resin Manufacturing	74.64	3.65×10 <sup>-2</sup>	99.4
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	66.86	3.27×10 <sup>-2</sup>	99.4
Industrial	General agricultural processing	63.90	3.12×10 <sup>-2</sup>	99.5
Industrial	Scrap metal processing	57.28	2.80×10 <sup>-2</sup>	99.5
Industrial	Solid waste landfilling	54.35	2.65×10 <sup>-2</sup>	99.5
Industrial	Cement or lime handling	52.02	2.54×10 <sup>-2</sup>	99.5
Industrial	Inert waste landfilling	46.19	2.26×10 <sup>-2</sup>	99.6
Industrial	Metal processing	45.17	2.21×10 <sup>-2</sup>	99.6
Commercial	Poultry Farming (Eggs)	44.93	2.19×10 <sup>-2</sup>	99.6
Industrial	Agricultural fertiliser (phosphate) production	41.59	2.03×10 <sup>-2</sup>	99.6
Industrial	Waste storage	40.85	1.99×10 <sup>-2</sup>	99.7
Industrial	Road construction	38.84	1.90×10 <sup>-2</sup>	99.7
Domestic-Commercial	Barbeques	38.63	1.89×10 <sup>-2</sup>	99.7
Natural	Agricultural Burning	38.50	1.88×10 <sup>-2</sup>	99.7
Commercial	Construction Material Mining n.e.c.	35.52	1.73×10 <sup>-2</sup>	99.7
Industrial	Metal plating or coating	35.17	1.72×10 <sup>-2</sup>	99.7
Industrial	Shipping in bulk	29.11	1.42×10 <sup>-2</sup>	99.8
Industrial	Water-based extractive activity	26.41	1.29×10 <sup>-2</sup>	99.8

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Commercial	Log Sawmilling	25.94	1.27×10 <sup>-2</sup>	99.8
Commercial	Paint Manufacturing	24.83	1.21×10 <sup>-2</sup>	99.8
Commercial	Ceramic Product Manufacturing	23.87	1.17×10 <sup>-2</sup>	99.8
Industrial	Boat construction/maintenance (general)	22.00	1.07×10 <sup>-2</sup>	99.8
Industrial	Animal accommodation	21.37	1.04×10 <sup>-2</sup>	99.8
Commercial	Metal Coating and Finishing	20.09	9.81×10 <sup>-3</sup>	99.8
Industrial	Petrochemical production	18.67	9.12×10 <sup>-3</sup>	99.8
Commercial	Wine Manufacturing	18.06	8.82×10 <sup>-3</sup>	99.9
Industrial	Chemical production	17.37	8.48×10 <sup>-3</sup>	99.9
Off-Road Mobile	Aircraft (Flight Operations)	14.32	7.00×10 <sup>-3</sup>	99.9
Industrial	Aluminium production (scrap metal)	14.08	6.88×10 <sup>-3</sup>	99.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	12.78	6.24×10 <sup>-3</sup>	99.9
Industrial	Paints/polishes/adhesives production	11.28	5.51×10 <sup>-3</sup>	99.9
Off-Road Mobile	Aircraft (Ground Operations)	11.03	5.39×10 <sup>-3</sup>	99.9
Industrial	Dairy processing	10.67	5.21×10 <sup>-3</sup>	99.9
Commercial	Plaster Product Manufacturing	9.84	4.81×10 <sup>-3</sup>	99.9
Industrial	Miscellaneous licensed discharges to waters (at any time)	9.82	4.79×10 <sup>-3</sup>	99.9
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	9.80	4.79×10 <sup>-3</sup>	99.9
Commercial	Basic Iron and Steel Manufacturing	9.67	4.72×10 <sup>-3</sup>	99.9
Commercial	Port Operators	8.72	4.26×10 <sup>-3</sup>	99.9
Industrial	Contaminated soil treatment	8.30	4.05×10 <sup>-3</sup>	99.9
Industrial	Slaughtering or processing of animals	8.11	3.96×10 <sup>-3</sup>	99.9
Industrial	Sewage treatment - large plants	8.10	3.96×10 <sup>-3</sup>	99.9
On-Road Mobile	Others - Exhaust	6.97	3.40×10 <sup>-3</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	6.95	3.39×10 <sup>-3</sup>	99.9
Industrial	Petroleum products storage	6.93	3.39×10 <sup>-3</sup>	99.9
Commercial	Food Manufacturing n.e.c.	6.92	3.38×10 <sup>-3</sup>	99.9
Commercial	Road and Bridge Construction	6.70	3.27×10 <sup>-3</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	6.53	3.19×10 <sup>-3</sup>	100.0
Industrial	Generation of electrical power not coal, diesel or gas	5.23	2.55×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	5.22	2.55×10 <sup>-3</sup>	100.0

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Paper or pulp production	5.21	2.55×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	5.05	2.47×10 <sup>-3</sup>	100.0
Commercial	Steel Pipe and Tube Manufacturing	4.57	2.23×10 <sup>-3</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	4.17	2.04×10 <sup>-3</sup>	100.0
Industrial	Rendering or fat extraction	4.05	1.98×10 <sup>-3</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	3.96	1.93×10 <sup>-3</sup>	100.0
Industrial	General animal products production	3.24	1.58×10 <sup>-3</sup>	100.0
Commercial	Beer and Malt Manufacturing	3.22	1.57×10 <sup>-3</sup>	100.0
Industrial	Hazardous, industrial or group A waste D	3.14	1.53×10 <sup>-3</sup>	100.0
Industrial	Container reconditioning	3.02	1.47×10 <sup>-3</sup>	100.0
Commercial	Waste Disposal Services	2.64	1.29×10 <sup>-3</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	2.43	1.19×10 <sup>-3</sup>	100.0
Industrial	Pesticides and related products production	2.22	1.08×10 <sup>-3</sup>	100.0
Industrial	Rubber products/tyre production	2.19	1.07×10 <sup>-3</sup>	100.0
Industrial	Boat construction/maintenance (dry/float)	2.17	1.06×10 <sup>-3</sup>	100.0
Commercial	Fruit and Vegetable Processing	2.04	9.96×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	1.88	9.16×10 <sup>-4</sup>	100.0
Commercial	Bread Manufacturing	1.83	8.93×10 <sup>-4</sup>	100.0
Industrial	Paper production using recycled materials	1.62	7.90×10 <sup>-4</sup>	100.0
Commercial	Gas Supply	1.55	7.57×10 <sup>-4</sup>	100.0
Industrial	Explosives production	1.43	6.96×10 <sup>-4</sup>	100.0
Industrial	Non-ferrous metal production (scrap)	1.18	5.76×10 <sup>-4</sup>	100.0
Industrial	Pig accommodation	1.04	5.09×10 <sup>-4</sup>	100.0
Industrial	Brewing and distilling	1.02	5.00×10 <sup>-4</sup>	100.0
Commercial	Petroleum Product Wholesaling	0.98	4.81×10 <sup>-4</sup>	100.0
Commercial	Printing	0.85	4.14×10 <sup>-4</sup>	100.0
Industrial	Glass production	0.84	4.12×10 <sup>-4</sup>	100.0
Commercial	Biscuit Manufacturing	0.83	4.08×10 <sup>-4</sup>	100.0
Commercial	Electric Cable and Wire Manufacturing	0.79	3.87×10 <sup>-4</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	0.79	3.86×10 <sup>-4</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	0.73	3.54×10 <sup>-4</sup>	100.0



Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Commercial	Corrugated Paperboard Container Manufacturing	0.65	3.20×10 <sup>-4</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	0.57	2.80×10 <sup>-4</sup>	100.0
Commercial	Chemical Wholesaling	0.55	2.67×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	0.53	2.57×10 <sup>-4</sup>	100.0
Commercial	Laundries and Dry-Cleaners	0.52	2.52×10 <sup>-4</sup>	100.0
Commercial	Ink Manufacturing	0.52	2.52×10 <sup>-4</sup>	100.0
Industrial	Battery production	0.40	1.96×10 <sup>-4</sup>	100.0
Industrial	Printing, packaging and visual media production	0.39	1.89×10 <sup>-4</sup>	100.0
Commercial	Plastic Bag and Film Manufacturing	0.35	1.71×10 <sup>-4</sup>	100.0
Industrial	Soap and detergent production	0.34	1.66×10 <sup>-4</sup>	100.0
Commercial	Non-Building Construction n.e.c.	0.33	1.59×10 <sup>-4</sup>	100.0
Commercial	Ice Cream Manufacturing	0.31	1.53×10 <sup>-4</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	0.30	1.45×10 <sup>-4</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	0.29	1.39×10 <sup>-4</sup>	100.0
Commercial	Oil and Fat Manufacturing	0.27	1.34×10 <sup>-4</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	0.26	1.29×10 <sup>-4</sup>	100.0
Commercial	Non-Ferrous Metal Casting	0.24	1.16×10 <sup>-4</sup>	100.0
Commercial	Services to Air Transport	0.20	9.67×10 <sup>-5</sup>	100.0
Commercial	Industrial Gas Manufacturing	0.17	8.11×10 <sup>-5</sup>	100.0
Commercial	Cake and Pastry Manufacturing	0.16	7.86×10 <sup>-5</sup>	100.0
Commercial	Milk and Cream Processing	0.16	7.83×10 <sup>-5</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	0.14	7.02×10 <sup>-5</sup>	100.0
Commercial	Aircraft Manufacturing	0.14	6.91×10 <sup>-5</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	0.14	6.63×10 <sup>-5</sup>	100.0
Commercial	Scientific Research	0.12	6.05×10 <sup>-5</sup>	100.0
Industrial	Sterilisation activities	0.11	5.46×10 <sup>-5</sup>	100.0
Commercial	Structural Steel Fabricating	0.11	5.40×10 <sup>-5</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	0.11	5.16×10 <sup>-5</sup>	100.0
Commercial	Soap and Other Detergent Manufacturing	0.11	5.14×10 <sup>-5</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	8.66×10 <sup>-2</sup>	4.23×10 <sup>-5</sup>	100.0
Commercial	Confectionery Manufacturing	7.18×10 <sup>-2</sup>	3.51×10 <sup>-5</sup>	100.0

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Commercial	Aluminium Rolling, Drawing, Extruding	6.88×10 <sup>-2</sup>	3.36×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	5.48×10 <sup>-2</sup>	2.68×10 <sup>-5</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	3.46×10 <sup>-2</sup>	1.69×10 <sup>-5</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	3.18×10 <sup>-2</sup>	1.55×10 <sup>-5</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	2.80×10 <sup>-2</sup>	1.37×10 <sup>-5</sup>	100.0
Industrial	Helicopter-related activity	2.46×10 <sup>-2</sup>	1.20×10 <sup>-5</sup>	100.0
Industrial	Chemical storage	2.04×10 <sup>-2</sup>	9.95×10 <sup>-6</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	1.86×10 <sup>-2</sup>	9.07×10 <sup>-6</sup>	100.0
Industrial	Plastics resins production	1.82×10 <sup>-2</sup>	8.90×10 <sup>-6</sup>	100.0
Commercial	Lifting and Material Handling Equipment Manufacturing	1.63×10 <sup>-2</sup>	7.95×10 <sup>-6</sup>	100.0
Commercial	Structural Metal Product Manufacturing n.e.c.	6.83×10 <sup>-3</sup>	3.33×10 <sup>-6</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	8.87×10 <sup>-4</sup>	4.33×10 <sup>-7</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	8.37×10 <sup>-4</sup>	4.09×10 <sup>-7</sup>	100.0
<b>Particulate matter ≤ 10µm in the Sydney region</b>				
Domestic-Commercial	Solid Fuel Burning (Domestic)	5,203	24.5	24.5
Natural	Bushfire and Prescribed Burning	4,228	19.9	44.5
Natural	Marine Aerosol	1,509	7.12	51.6
Industrial	Waste disposal (application to land)	1,221	5.76	57.4
On-Road Mobile	All - Non-Exhaust PM	1,148	5.41	62.8
Industrial	Ceramics production	890	4.20	67.0
Off-Road Mobile	Ships	774	3.65	70.6
Industrial	Crushing, grinding or separating	666	3.14	73.8
Industrial	Mining for coal	479	2.26	76.0
Industrial	Land-based extractive activity	451	2.13	78.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	431	2.03	80.2
Commercial	Gravel and Sand Quarrying	342	1.61	81.8
Industrial	Other land-based extraction	327	1.54	83.3
Industrial	Bird accommodation	226	1.07	84.4
Industrial	Composting	226	1.07	85.5
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	217	1.02	86.5
On-Road Mobile	Light Duty Diesel - Exhaust	191	0.90	87.4

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Petroleum products and fuel production	169	0.80	88.2
Industrial	Railway systems activities	154	0.73	88.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	154	0.73	89.7
Domestic-Commercial	Gaseous Fuel Burning	136	0.64	90.3
Industrial	Cement or lime production	130	0.61	90.9
Industrial	Recovery of waste	130	0.61	91.5
Off-Road Mobile	Industrial Vehicles and Equipment	117	0.55	92.1
Industrial	Non-thermal treatment of waste	112	0.53	92.6
Industrial	Concrete works	110	0.52	93.1
Off-Road Mobile	Commercial Boats Exhaust	101	0.48	93.6
Industrial	Glass production (container)	96.72	0.46	94.1
Industrial	Dairy animal accommodation	94.30	0.44	94.5
Commercial	Poultry Farming (Meat)	78.16	0.37	94.9
Commercial	Synthetic Resin Manufacturing	74.62	0.35	95.2
Industrial	Bitumen mixing	67.53	0.32	95.5
Off-Road Mobile	Recreational Boats Exhaust	65.46	0.31	95.9
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	52.76	0.25	96.1
Industrial	Scrap metal processing	52.39	0.25	96.4
Industrial	Iron or steel production (scrap metal)	50.77	0.24	96.6
Industrial	General agricultural processing	46.67	0.22	96.8
Natural	Fugitive/Windborne	44.82	0.21	97.0
Commercial	Poultry Farming (Eggs)	40.37	0.19	97.2
Industrial	Generation of electrical power from gas	40.20	0.19	97.4
Industrial	Waste storage	39.33	0.19	97.6
Industrial	Road construction	38.84	0.18	97.8
Industrial	Cement or lime handling	36.21	0.17	97.9
Domestic-Commercial	Barbeques	30.51	0.14	98.1
Off-Road Mobile	Locomotives	25.64	0.12	98.2
Industrial	Metal plating or coating	25.47	0.12	98.3
Commercial	Paint Manufacturing	24.83	0.12	98.4
Industrial	Boat construction/maintenance (general)	19.67	9.28×10 <sup>-2</sup>	98.5
Industrial	Petrochemical production	18.67	8.80×10 <sup>-2</sup>	98.6
Commercial	Ceramic Product Manufacturing	18.03	8.51×10 <sup>-2</sup>	98.7
Commercial	Metal Coating and Finishing	16.50	7.78×10 <sup>-2</sup>	98.8
Off-Road Mobile	Aircraft (Flight Operations)	13.55	6.39×10 <sup>-2</sup>	98.9

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Paints/polishes/adhesives production	11.28	5.32×10 <sup>-2</sup>	98.9
Off-Road Mobile	Aircraft (Ground Operations)	10.60	5.00×10 <sup>-2</sup>	99.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	10.30	4.86×10 <sup>-2</sup>	99.0
Industrial	Dairy processing	9.91	4.68×10 <sup>-2</sup>	99.1
Commercial	Plaster Product Manufacturing	9.84	4.64×10 <sup>-2</sup>	99.1
Industrial	Miscellaneous licensed discharges to waters (at any time)	9.81	4.63×10 <sup>-2</sup>	99.1
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	9.80	4.62×10 <sup>-2</sup>	99.2
Commercial	Basic Iron and Steel Manufacturing	9.23	4.35×10 <sup>-2</sup>	99.2
Industrial	Solid waste landfilling	9.00	4.24×10 <sup>-2</sup>	99.3
Commercial	Port Operators	8.72	4.11×10 <sup>-2</sup>	99.3
Industrial	Contaminated soil treatment	8.24	3.89×10 <sup>-2</sup>	99.4
Industrial	Chemical production	8.03	3.79×10 <sup>-2</sup>	99.4
Industrial	Sewage treatment - large plants	7.65	3.61×10 <sup>-2</sup>	99.4
Industrial	Slaughtering or processing of animals	6.76	3.19×10 <sup>-2</sup>	99.5
Commercial	Road and Bridge Construction	6.64	3.13×10 <sup>-2</sup>	99.5
Industrial	Petroleum products storage	6.61	3.12×10 <sup>-2</sup>	99.5
Commercial	Glass and Glass Product Manufacturing	6.53	3.08×10 <sup>-2</sup>	99.6
On-Road Mobile	Others - Exhaust	5.27	2.49×10 <sup>-2</sup>	99.6
Industrial	Paper or pulp production	5.21	2.46×10 <sup>-2</sup>	99.6
Industrial	General chemicals storage	4.05	1.91×10 <sup>-2</sup>	99.6
Commercial	Food Manufacturing n.e.c.	4.02	1.90×10 <sup>-2</sup>	99.6
Commercial	Chemical Product Manufacturing n.e.c.	3.77	1.78×10 <sup>-2</sup>	99.7
Commercial	Hospitals (Except Psychiatric Hospitals)	3.62	1.71×10 <sup>-2</sup>	99.7
Off-Road Mobile	Commercial Vehicles and Equipment	3.46	1.63×10 <sup>-2</sup>	99.7
Natural	Agricultural Burning	3.34	1.58×10 <sup>-2</sup>	99.7
Domestic-Commercial	Liquid Fuel Burning (Domestic)	3.30	1.55×10 <sup>-2</sup>	99.7
Commercial	Beer and Malt Manufacturing	3.22	1.52×10 <sup>-2</sup>	99.7
Industrial	Hazardous, industrial or group A waste D	3.14	1.48×10 <sup>-2</sup>	99.8
Industrial	Container reconditioning	3.02	1.42×10 <sup>-2</sup>	99.8
Industrial	Rendering or fat extraction	2.90	1.37×10 <sup>-2</sup>	99.8
Industrial	Generation of electrical power not coal, diesel or gas	2.68	1.27×10 <sup>-2</sup>	99.8

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Commercial	Waste Disposal Services	2.64	1.25×10 <sup>-2</sup>	99.8
Industrial	Shipping in bulk	2.62	1.24×10 <sup>-2</sup>	99.8
Commercial	Wine Manufacturing	2.55	1.20×10 <sup>-2</sup>	99.8
Commercial	Plastic Injection Moulded Product Manufacturing	2.42	1.14×10 <sup>-2</sup>	99.8
Industrial	General animal products production	2.24	1.06×10 <sup>-2</sup>	99.9
Industrial	Rubber products/tyre production	2.19	1.03×10 <sup>-2</sup>	99.9
Industrial	Boat construction/maintenance (dry/float)	2.17	1.03×10 <sup>-2</sup>	99.9
Commercial	Fruit and Vegetable Processing	2.04	9.62×10 <sup>-3</sup>	99.9
Industrial	Pesticides and related products production	1.91	9.01×10 <sup>-3</sup>	99.9
Industrial	Recovery of waste oil	1.68	7.93×10 <sup>-3</sup>	99.9
Industrial	Paper production using recycled materials	1.62	7.63×10 <sup>-3</sup>	99.9
Commercial	Gas Supply	1.55	7.31×10 <sup>-3</sup>	99.9
Commercial	Bread Manufacturing	1.39	6.58×10 <sup>-3</sup>	99.9
Industrial	Non-ferrous metal production (scrap)	1.18	5.56×10 <sup>-3</sup>	99.9
Commercial	Steel Pipe and Tube Manufacturing	1.14	5.40×10 <sup>-3</sup>	99.9
Industrial	Brewing and distilling	1.02	4.83×10 <sup>-3</sup>	99.9
Commercial	Printing	0.85	4.00×10 <sup>-3</sup>	99.9
Industrial	Glass production	0.84	3.98×10 <sup>-3</sup>	99.9
Commercial	Biscuit Manufacturing	0.83	3.94×10 <sup>-3</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	0.75	3.54×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	0.73	3.47×10 <sup>-3</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	0.72	3.41×10 <sup>-3</sup>	100.0
Commercial	Corrugated Paperboard Container Manufacturing	0.65	3.09×10 <sup>-3</sup>	100.0
Commercial	Laundries and Dry-Cleaners	0.52	2.44×10 <sup>-3</sup>	100.0
Commercial	Ink Manufacturing	0.52	2.44×10 <sup>-3</sup>	100.0
Commercial	Chemical Wholesaling	0.47	2.21×10 <sup>-3</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	0.46	2.15×10 <sup>-3</sup>	100.0
Industrial	Battery production	0.40	1.90×10 <sup>-3</sup>	100.0
Industrial	Printing, packaging and visual media production	0.39	1.82×10 <sup>-3</sup>	100.0
Industrial	Metal processing	0.36	1.70×10 <sup>-3</sup>	100.0
Commercial	Plastic Bag and Film Manufacturing	0.35	1.66×10 <sup>-3</sup>	100.0

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Soap and detergent production	0.34	1.61×10 <sup>-3</sup>	100.0
Commercial	Non-Building Construction n.e.c.	0.32	1.53×10 <sup>-3</sup>	100.0
Commercial	Ice Cream Manufacturing	0.31	1.48×10 <sup>-3</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	0.30	1.40×10 <sup>-3</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	0.29	1.35×10 <sup>-3</sup>	100.0
Commercial	Petroleum Product Wholesaling	0.28	1.31×10 <sup>-3</sup>	100.0
Commercial	Oil and Fat Manufacturing	0.27	1.29×10 <sup>-3</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	0.21	9.93×10 <sup>-4</sup>	100.0
Commercial	Services to Air Transport	0.20	9.34×10 <sup>-4</sup>	100.0
Commercial	Industrial Gas Manufacturing	0.17	7.83×10 <sup>-4</sup>	100.0
Commercial	Cake and Pastry Manufacturing	0.16	7.59×10 <sup>-4</sup>	100.0
Commercial	Milk and Cream Processing	0.16	7.57×10 <sup>-4</sup>	100.0
Commercial	Aircraft Manufacturing	0.14	6.67×10 <sup>-4</sup>	100.0
Commercial	Scientific Research	0.12	5.84×10 <sup>-4</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	0.11	5.37×10 <sup>-4</sup>	100.0
Industrial	Sterilisation activities	0.11	5.27×10 <sup>-4</sup>	100.0
Commercial	Structural Steel Fabricating	0.11	5.22×10 <sup>-4</sup>	100.0
Commercial	Soap and Other Detergent Manufacturing	0.11	4.97×10 <sup>-4</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	7.71×10 <sup>-2</sup>	3.64×10 <sup>-4</sup>	100.0
Commercial	Confectionery Manufacturing	7.18×10 <sup>-2</sup>	3.39×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	6.60×10 <sup>-2</sup>	3.11×10 <sup>-4</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	5.46×10 <sup>-2</sup>	2.58×10 <sup>-4</sup>	100.0
Industrial	Boat mooring and storage	5.42×10 <sup>-2</sup>	2.56×10 <sup>-4</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	3.18×10 <sup>-2</sup>	1.50×10 <sup>-4</sup>	100.0
Industrial	Helicopter-related activity	2.46×10 <sup>-2</sup>	1.16×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	2.12×10 <sup>-2</sup>	1.00×10 <sup>-4</sup>	100.0
Industrial	Chemical storage	2.04×10 <sup>-2</sup>	9.61×10 <sup>-5</sup>	100.0
Industrial	Plastics resins production	1.82×10 <sup>-2</sup>	8.60×10 <sup>-5</sup>	100.0
Commercial	Lifting and Material Handling Equipment Manufacturing	1.63×10 <sup>-2</sup>	7.68×10 <sup>-5</sup>	100.0
Commercial	Structural Metal Product Manufacturing n.e.c.	6.83×10 <sup>-3</sup>	3.22×10 <sup>-5</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	2.26×10 <sup>-3</sup>	1.06×10 <sup>-5</sup>	100.0

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	8.87×10 <sup>-4</sup>	4.19×10 <sup>-6</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	4.66×10 <sup>-4</sup>	2.20×10 <sup>-6</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	3.59×10 <sup>-4</sup>	1.69×10 <sup>-6</sup>	100.0
<b>Particulate matter ≤ 10µm in the Newcastle region</b>				
Natural	Bushfire and Prescribed Burning	2,040	28.1	28.1
Industrial	Mining for coal	1,480	20.4	48.4
Industrial	Coal works	901	12.4	60.8
Industrial	Aluminium production (alumina)	506	6.97	67.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	393	5.41	73.2
Industrial	Ammonium nitrate production	328	4.52	77.7
Natural	Marine Aerosol	245	3.37	81.1
Industrial	Land-based extractive activity	225	3.10	84.2
Off-Road Mobile	Ships	215	2.95	87.1
Industrial	Waste disposal (application to land)	121	1.66	88.8
On-Road Mobile	All - Non-Exhaust PM	99.69	1.37	90.2
Industrial	Non-thermal treatment of waste	87.42	1.20	91.4
Industrial	General chemicals storage	80.15	1.10	92.5
Industrial	Iron or steel production (scrap metal)	55.38	0.76	93.2
Commercial	Gravel and Sand Quarrying	46.70	0.64	93.9
Industrial	Metal processing	42.05	0.58	94.5
Industrial	Agricultural fertiliser (phosphate) production	41.59	0.57	95.0
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	37.60	0.52	95.5
Industrial	Inert waste landfilling	26.28	0.36	95.9
Commercial	Construction Material Mining n.e.c.	26.04	0.36	96.3
Off-Road Mobile	Commercial Boats Exhaust	24.08	0.33	96.6
Off-Road Mobile	Locomotives	22.16	0.30	96.9
Industrial	Recovery of waste	20.64	0.28	97.2
Industrial	Shipping in bulk	20.38	0.28	97.5
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	18.21	0.25	97.7
Off-Road Mobile	Industrial Vehicles and Equipment	15.30	0.21	97.9
Natural	Fugitive/Windborne	14.12	0.19	98.1
On-Road Mobile	Light Duty Diesel - Exhaust	13.41	0.18	98.3
Industrial	Bitumen mixing	11.40	0.16	98.5
Industrial	Other land-based extraction	11.28	0.16	98.6
Industrial	Concrete works	10.58	0.15	98.8

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	9.46	0.13	98.9
Industrial	General agricultural processing	9.42	0.13	99.0
Domestic-Commercial	Gaseous Fuel Burning	9.10	0.13	99.1
Industrial	Crushing, grinding or separating	8.95	0.12	99.3
Industrial	Petroleum products and fuel production	7.72	0.11	99.4
Off-Road Mobile	Recreational Boats Exhaust	5.73	7.88×10 <sup>-2</sup>	99.5
Industrial	Scrap metal processing	4.89	6.73×10 <sup>-2</sup>	99.5
Commercial	Poultry Farming (Meat)	4.82	6.63×10 <sup>-2</sup>	99.6
Industrial	Metal plating or coating	4.18	5.75×10 <sup>-2</sup>	99.6
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	3.84	5.28×10 <sup>-2</sup>	99.7
Commercial	Metal Coating and Finishing	3.59	4.94×10 <sup>-2</sup>	99.8
Industrial	Cement or lime handling	2.43	3.35×10 <sup>-2</sup>	99.8
Industrial	Boat construction/maintenance (general)	2.32	3.19×10 <sup>-2</sup>	99.8
Domestic-Commercial	Barbeques	2.04	2.81×10 <sup>-2</sup>	99.8
Industrial	Slaughtering or processing of animals	1.35	1.85×10 <sup>-2</sup>	99.9
Industrial	Generation of electrical power not coal, diesel or gas	1.24	1.70×10 <sup>-2</sup>	99.9
Industrial	Chemical production	1.05	1.45×10 <sup>-2</sup>	99.9
Industrial	Railway systems activities	1.04	1.42×10 <sup>-2</sup>	99.9
Industrial	Water-based extractive activity	0.99	1.36×10 <sup>-2</sup>	99.9
Industrial	Dairy processing	0.76	1.05×10 <sup>-2</sup>	99.9
Natural	Agricultural Burning	0.73	9.98×10 <sup>-3</sup>	99.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	0.61	8.44×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	0.59	8.08×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.49	6.78×10 <sup>-3</sup>	100.0
On-Road Mobile	Others - Exhaust	0.45	6.21×10 <sup>-3</sup>	100.0
Commercial	Bread Manufacturing	0.44	5.99×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	0.37	5.12×10 <sup>-3</sup>	100.0
Industrial	Waste storage	0.31	4.25×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Flight Operations)	0.26	3.55×10 <sup>-3</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.22	3.03×10 <sup>-3</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	0.17	2.39×10 <sup>-3</sup>	100.0
Commercial	Chemical Wholesaling	7.97×10 <sup>-2</sup>	1.10×10 <sup>-3</sup>	100.0
Industrial	Contaminated soil treatment	5.31×10 <sup>-2</sup>	7.31×10 <sup>-4</sup>	100.0



Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Petroleum products storage	5.13×10 <sup>-2</sup>	7.06×10 <sup>-4</sup>	100.0
Commercial	Road and Bridge Construction	3.24×10 <sup>-2</sup>	4.45×10 <sup>-4</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	3.20×10 <sup>-2</sup>	4.41×10 <sup>-4</sup>	100.0
Commercial	Wine Manufacturing	2.59×10 <sup>-2</sup>	3.56×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	1.29×10 <sup>-2</sup>	1.78×10 <sup>-4</sup>	100.0
Industrial	Generation of electrical power from gas	7.18×10 <sup>-3</sup>	9.88×10 <sup>-5</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	4.88×10 <sup>-3</sup>	6.71×10 <sup>-5</sup>	100.0
Commercial	Aluminium Rolling, Drawing, Extruding	1.17×10 <sup>-3</sup>	1.61×10 <sup>-5</sup>	100.0
Commercial	Waste Disposal Services	8.61×10 <sup>-4</sup>	1.19×10 <sup>-5</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	8.37×10 <sup>-4</sup>	1.15×10 <sup>-5</sup>	100.0
Industrial	Printing, packaging and visual media production	2.88×10 <sup>-4</sup>	3.96×10 <sup>-6</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	1.33×10 <sup>-4</sup>	1.84×10 <sup>-6</sup>	100.0
<b>Particulate matter ≤ 10µm in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	915	45.1	45.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	234	11.5	56.6
Industrial	Coal works	131	6.44	63.1
Natural	Marine Aerosol	129	6.38	69.5
Industrial	Mining for coal	113	5.58	75.0
Natural	Bushfire and Prescribed Burning	109	5.37	80.4
Off-Road Mobile	Ships	78.06	3.85	84.2
Industrial	Generation of electrical power from gas	65.58	3.23	87.5
On-Road Mobile	All - Non-Exhaust PM	53.21	2.62	90.1
Off-Road Mobile	Industrial Vehicles and Equipment	41.95	2.07	92.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	22.13	1.09	93.3
Industrial	Waste disposal (application to land)	20.03	0.99	94.2
Commercial	Gravel and Sand Quarrying	19.30	0.95	95.2
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	12.18	0.60	95.8
Industrial	Bitumen mixing	8.42	0.41	96.2
Off-Road Mobile	Recreational Boats Exhaust	8.13	0.40	96.6
On-Road Mobile	Light Duty Diesel - Exhaust	7.43	0.37	97.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	7.04	0.35	97.3

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Domestic-Commercial	Gaseous Fuel Burning	6.56	0.32	97.7
Industrial	Shipping in bulk	6.11	0.30	98.0
Commercial	Ceramic Product Manufacturing	5.84	0.29	98.2
Industrial	Crushing, grinding or separating	5.53	0.27	98.5
Industrial	Metal plating or coating	4.75	0.23	98.7
Industrial	Concrete works	3.49	0.17	98.9
Commercial	Steel Pipe and Tube Manufacturing	3.42	0.17	99.1
Off-Road Mobile	Locomotives	3.26	0.16	99.2
Industrial	Metal processing	2.76	0.14	99.4
Industrial	Cement or lime production	2.56	0.13	99.5
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2.00	9.86×10 <sup>-2</sup>	99.6
Off-Road Mobile	Commercial Boats Exhaust	1.68	8.27×10 <sup>-2</sup>	99.7
Domestic-Commercial	Barbeques	1.47	7.25×10 <sup>-2</sup>	99.8
Commercial	Poultry Farming (Meat)	1.11	5.47×10 <sup>-2</sup>	99.8
Natural	Fugitive/Windborne	0.87	4.27×10 <sup>-2</sup>	99.9
Commercial	Basic Iron and Steel Manufacturing	0.45	2.20×10 <sup>-2</sup>	99.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	0.32	1.56×10 <sup>-2</sup>	99.9
Industrial	Petroleum products storage	0.27	1.32×10 <sup>-2</sup>	99.9
On-Road Mobile	Others - Exhaust	0.25	1.22×10 <sup>-2</sup>	99.9
Industrial	General chemicals storage	0.23	1.12×10 <sup>-2</sup>	99.9
Industrial	Cement or lime handling	0.20	1.01×10 <sup>-2</sup>	99.9
Commercial	Hospitals (Except Psychiatric Hospitals)	0.19	9.36×10 <sup>-3</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.16	7.83×10 <sup>-3</sup>	100.0
Industrial	Non-thermal treatment of waste	0.13	6.50×10 <sup>-3</sup>	100.0
Industrial	Waste storage	0.13	6.30×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - large plants	0.12	5.79×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste	9.59×10 <sup>-2</sup>	4.73×10 <sup>-3</sup>	100.0
Industrial	Chemical production	7.91×10 <sup>-2</sup>	3.90×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	7.68×10 <sup>-2</sup>	3.78×10 <sup>-3</sup>	100.0
Commercial	Aluminium Rolling, Drawing, Extruding	6.76×10 <sup>-2</sup>	3.33×10 <sup>-3</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	2.57×10 <sup>-2</sup>	1.27×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Flight Operations)	2.09×10 <sup>-2</sup>	1.03×10 <sup>-3</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	4.24×10 <sup>-3</sup>	2.09×10 <sup>-4</sup>	100.0

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Container reconditioning	5.20×10 <sup>-4</sup>	2.56×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	1.62×10 <sup>-4</sup>	7.97×10 <sup>-6</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	1.32×10 <sup>-4</sup>	6.49×10 <sup>-6</sup>	100.0
<b>Particulate matter ≤ 10µm in the Non-urban region</b>				
Natural	Bushfire and Prescribed Burning	81,635	46.8	46.8
Industrial	Mining for coal	65,948	37.8	84.7
Natural	Marine Aerosol	12,969	7.44	92.1
Industrial	Generation of electrical power from coal	3,623	2.08	94.2
Industrial	Land-based extractive activity	2,395	1.37	95.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,205	0.69	96.3
Off-Road Mobile	Industrial Vehicles and Equipment	1,196	0.69	97.0
Industrial	Boat mooring and storage	945	0.54	97.5
Industrial	Ceramics production	689	0.40	97.9
Natural	Fugitive/Windborne	584	0.34	98.2
Industrial	Cement or lime production	482	0.28	98.5
Commercial	Gravel and Sand Quarrying	336	0.19	98.7
On-Road Mobile	All - Non-Exhaust PM	248	0.14	98.9
Industrial	Mining for minerals	210	0.12	99.0
Off-Road Mobile	Ships	208	0.12	99.1
Industrial	Waste disposal (application to land)	201	0.12	99.2
Off-Road Mobile	Commercial Boats Exhaust	149	8.57×10 <sup>-2</sup>	99.3
Industrial	Coal works	137	7.86×10 <sup>-2</sup>	99.4
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	132	7.58×10 <sup>-2</sup>	99.4
Off-Road Mobile	Locomotives	130	7.45×10 <sup>-2</sup>	99.5
Industrial	Bird accommodation	124	7.12×10 <sup>-2</sup>	99.6
Commercial	Poultry Farming (Meat)	94.09	5.40×10 <sup>-2</sup>	99.6
Off-Road Mobile	Recreational Boats Exhaust	49.02	2.81×10 <sup>-2</sup>	99.7
Industrial	Solid waste landfilling	45.35	2.60×10 <sup>-2</sup>	99.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	43.31	2.49×10 <sup>-2</sup>	99.7
Industrial	Crushing, grinding or separating	39.79	2.28×10 <sup>-2</sup>	99.7
Industrial	Bitumen mixing	37.91	2.18×10 <sup>-2</sup>	99.8
On-Road Mobile	Light Duty Diesel - Exhaust	35.87	2.06×10 <sup>-2</sup>	99.8
Natural	Agricultural Burning	34.44	1.98×10 <sup>-2</sup>	99.8
Industrial	Composting	30.18	1.73×10 <sup>-2</sup>	99.8
Commercial	Log Sawmilling	25.94	1.49×10 <sup>-2</sup>	99.8
Industrial	Water-based extractive activity	25.42	1.46×10 <sup>-2</sup>	99.9

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Concrete works	23.00	1.32×10 <sup>-2</sup>	99.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	21.60	1.24×10 <sup>-2</sup>	99.9
Industrial	Animal accommodation	21.37	1.23×10 <sup>-2</sup>	99.9
Domestic-Commercial	Gaseous Fuel Burning	20.56	1.18×10 <sup>-2</sup>	99.9
Industrial	Inert waste landfilling	19.91	1.14×10 <sup>-2</sup>	99.9
Commercial	Wine Manufacturing	15.48	8.88×10 <sup>-3</sup>	99.9
Industrial	Other land-based extraction	14.72	8.45×10 <sup>-3</sup>	99.9
Industrial	Aluminium production (scrap metal)	14.08	8.08×10 <sup>-3</sup>	99.9
Industrial	Cement or lime handling	13.18	7.56×10 <sup>-3</sup>	100.0
Commercial	Construction Material Mining n.e.c.	9.48	5.44×10 <sup>-3</sup>	100.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	8.26	4.74×10 <sup>-3</sup>	100.0
Industrial	Chemical production	8.21	4.71×10 <sup>-3</sup>	100.0
Industrial	Railway systems activities	8.10	4.65×10 <sup>-3</sup>	100.0
Industrial	General agricultural processing	7.81	4.48×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste	7.81	4.48×10 <sup>-3</sup>	100.0
Domestic-Commercial	Barbeques	4.61	2.65×10 <sup>-3</sup>	100.0
Commercial	Poultry Farming (Eggs)	4.56	2.62×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	4.32	2.48×10 <sup>-3</sup>	100.0
Commercial	Food Manufacturing n.e.c.	2.89	1.66×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	2.82	1.62×10 <sup>-3</sup>	100.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1.55	8.88×10 <sup>-4</sup>	100.0
Industrial	Explosives production	1.43	8.18×10 <sup>-4</sup>	100.0
Industrial	Non-thermal treatment of waste	1.32	7.55×10 <sup>-4</sup>	100.0
Industrial	Generation of electrical power not coal, diesel or gas	1.31	7.52×10 <sup>-4</sup>	100.0
Industrial	Rendering or fat extraction	1.15	6.59×10 <sup>-4</sup>	100.0
Industrial	Waste storage	1.08	6.18×10 <sup>-4</sup>	100.0
Industrial	Pig accommodation	1.04	5.98×10 <sup>-4</sup>	100.0
Industrial	General animal products production	1.00	5.74×10 <sup>-4</sup>	100.0
On-Road Mobile	Others - Exhaust	1.00	5.72×10 <sup>-4</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.91	5.25×10 <sup>-4</sup>	100.0
Commercial	Electric Cable and Wire Manufacturing	0.79	4.55×10 <sup>-4</sup>	100.0
Industrial	Metal plating or coating	0.77	4.41×10 <sup>-4</sup>	100.0
Commercial	Petroleum Product Wholesaling	0.71	4.05×10 <sup>-4</sup>	100.0

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Generation of electrical power from gas	0.54	3.09×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	0.50	2.87×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.50	2.86×10 <sup>-4</sup>	100.0
Off-Road Mobile	Aircraft (Flight Operations)	0.49	2.81×10 <sup>-4</sup>	100.0
Industrial	Petroleum products and fuel production	0.38	2.18×10 <sup>-4</sup>	100.0
Industrial	Sewage treatment - large plants	0.34	1.93×10 <sup>-4</sup>	100.0
Industrial	Pesticides and related products production	0.31	1.76×10 <sup>-4</sup>	100.0
Commercial	Non-Ferrous Metal Casting	0.24	1.36×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	0.19	1.12×10 <sup>-4</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	0.14	7.77×10 <sup>-5</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	0.12	6.78×10 <sup>-5</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	6.24×10 <sup>-2</sup>	3.58×10 <sup>-5</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	5.43×10 <sup>-2</sup>	3.12×10 <sup>-5</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	3.44×10 <sup>-2</sup>	1.98×10 <sup>-5</sup>	100.0
Commercial	Road and Bridge Construction	3.22×10 <sup>-2</sup>	1.85×10 <sup>-5</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	2.97×10 <sup>-2</sup>	1.71×10 <sup>-5</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	2.25×10 <sup>-2</sup>	1.29×10 <sup>-5</sup>	100.0
Industrial	Aluminium production (alumina)	2.13×10 <sup>-2</sup>	1.22×10 <sup>-5</sup>	100.0
Commercial	Synthetic Resin Manufacturing	2.10×10 <sup>-2</sup>	1.21×10 <sup>-5</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	1.81×10 <sup>-2</sup>	1.04×10 <sup>-5</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	1.19×10 <sup>-2</sup>	6.84×10 <sup>-6</sup>	100.0
Industrial	Boat construction/maintenance (general)	1.10×10 <sup>-2</sup>	6.34×10 <sup>-6</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	9.48×10 <sup>-3</sup>	5.44×10 <sup>-6</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	7.36×10 <sup>-3</sup>	4.22×10 <sup>-6</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	6.94×10 <sup>-3</sup>	3.98×10 <sup>-6</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	4.44×10 <sup>-3</sup>	2.55×10 <sup>-6</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	3.82×10 <sup>-3</sup>	2.19×10 <sup>-6</sup>	100.0
Industrial	General chemicals storage	3.51×10 <sup>-3</sup>	2.02×10 <sup>-6</sup>	100.0

Module	Activity <sup>34</sup>	Emissions (tonnes/year)	Proportion (%) <sup>35</sup>	Cumulative proportion (%)
Industrial	Pharmaceutical and veterinary products production	3.35×10 <sup>-3</sup>	1.92×10 <sup>-6</sup>	100.0
Commercial	Non-Building Construction n.e.c.	1.58×10 <sup>-3</sup>	9.08×10 <sup>-7</sup>	100.0
Commercial	Printing	1.83×10 <sup>-6</sup>	1.05×10 <sup>-9</sup>	100.0

Figure 3-26, Figure 3-27, Figure 3-28, Figure 3-29 and Figure 3-30 show the estimated annual emissions for the top 15 natural and human-made sources of particulate matter ≤ 10µm in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

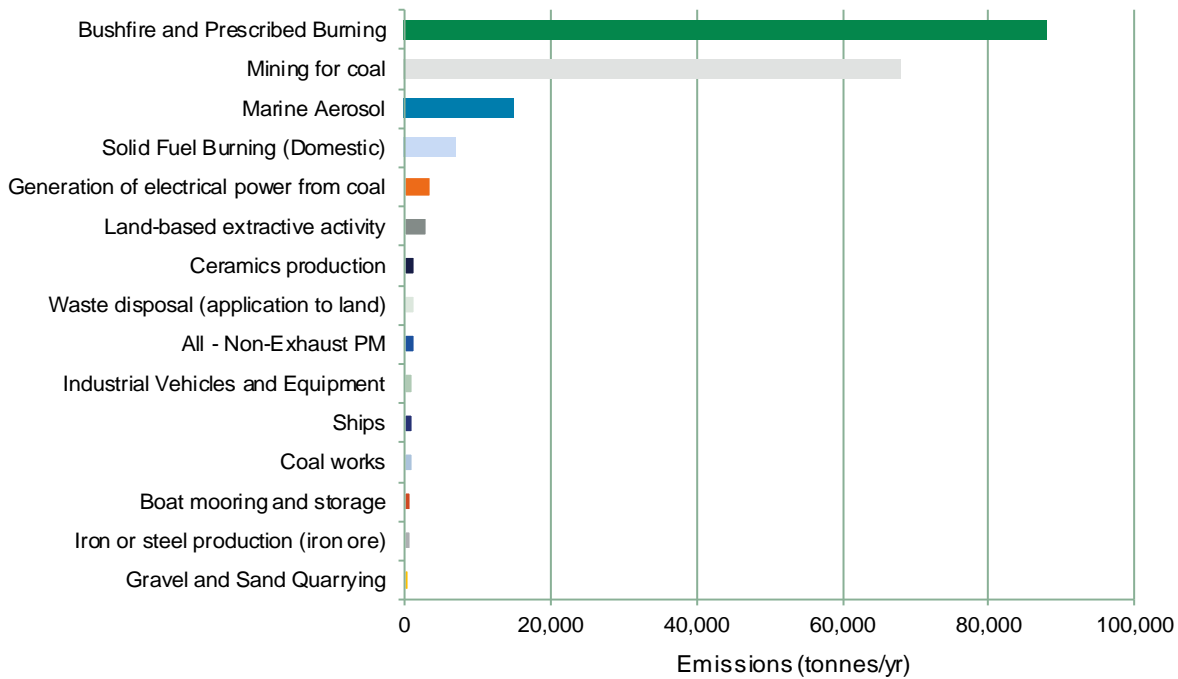


Figure 3-26: GMR: top 15 natural and human-made sources of particulate matter ≤ 10µm

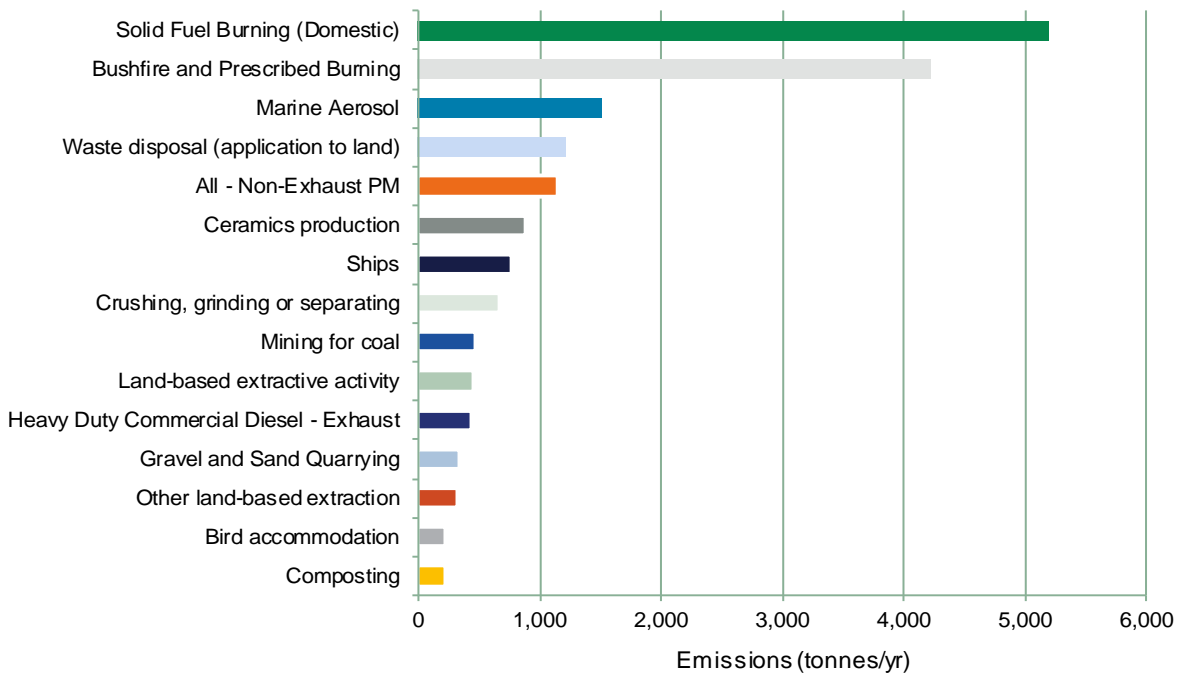


Figure 3-27: Sydney region: top 15 natural and human-made sources of particulate matter ≤ 10µm

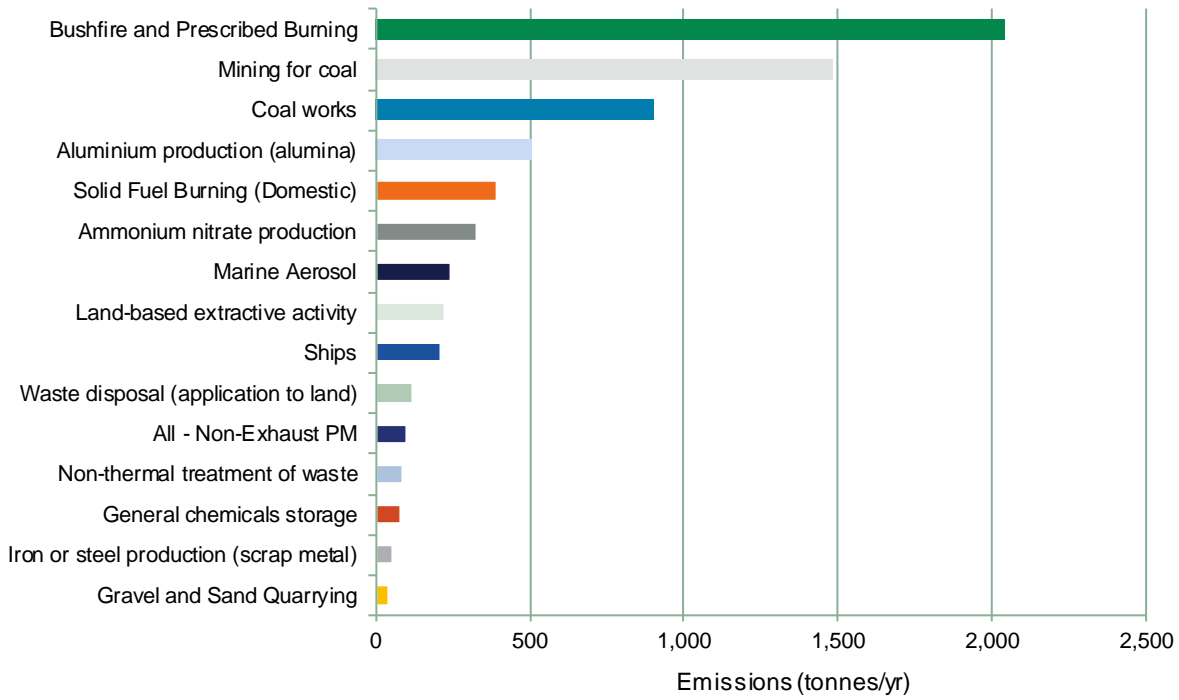


Figure 3-28: Newcastle region: top 15 natural and human-made sources of particulate matter  $\leq 10\mu\text{m}$

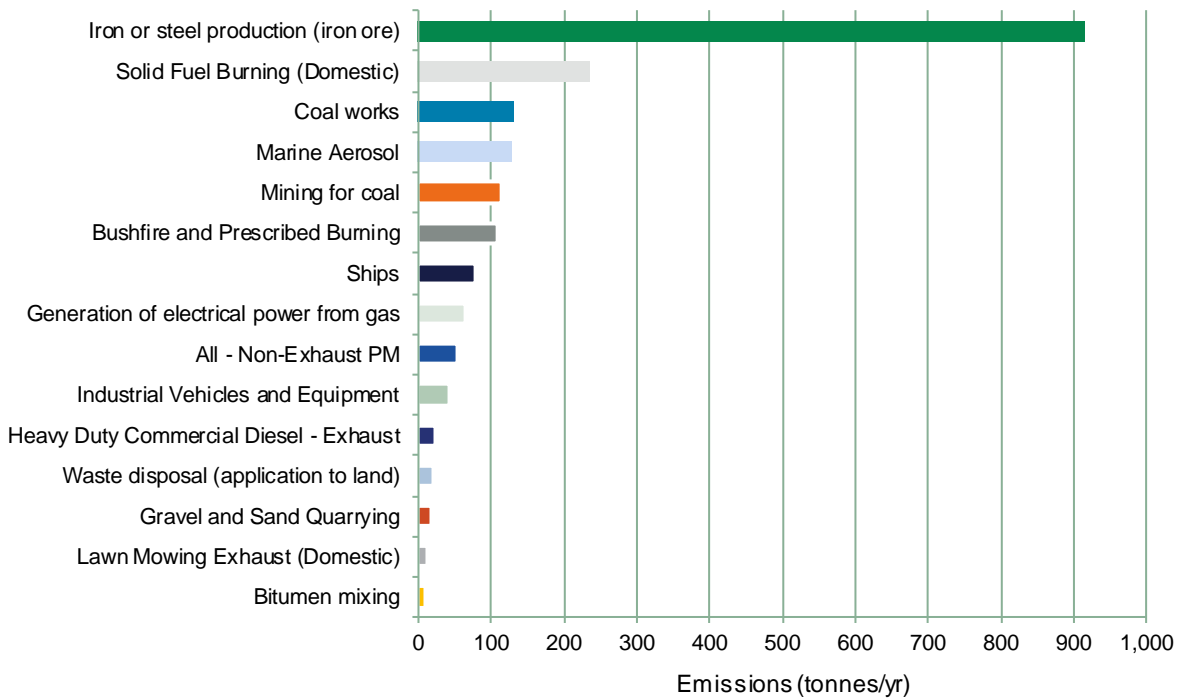


Figure 3-29: Wollongong region: top 15 natural and human-made sources of particulate matter  $\leq 10\mu\text{m}$

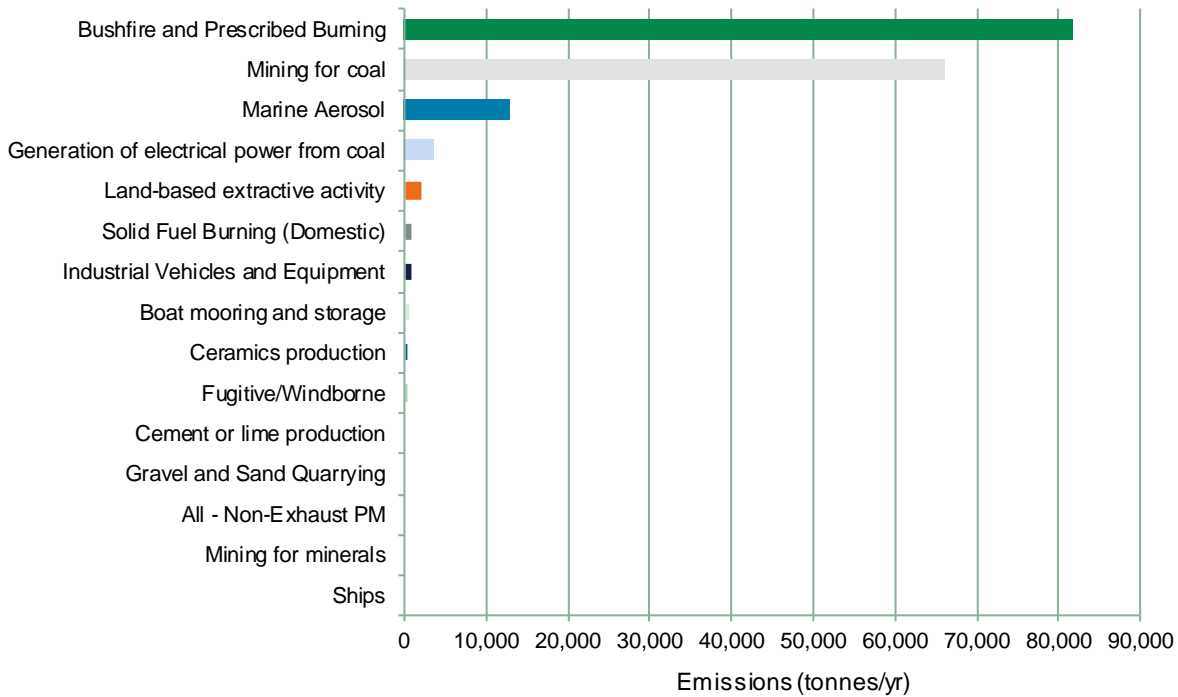


Figure 3-30: Non-urban region: top 15 natural and human-made sources of particulate matter ≤ 10µm

### 3.4. Particulate matter ≤ 2.5µm

#### 3.4.1. Natural and human-made emissions

Table 3-10 presents total estimated annual emissions of particulate matter ≤ 2.5µm by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 3-10: Total estimated annual emissions of particulate matter ≤ 2.5µm by natural and human-made source type in each region

Substance	Region	Emissions (tonnes/year)						Total <sup>36</sup>
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Particulate matter ≤ 2.5µm	Sydney	3,816	291	5,517	1,824	1,034	1,279	13,761
	Newcastle	1,769	19.28	415	1,289	263	107	3,862
	Wollongong	111	10.03	251	497	125	59.43	1,054
	Non-urban	71,269	112	1,245	12,921	1,665	305	87,517
	GMR <sup>36</sup>	76,965	433	7,429	16,530	3,086	1,750	106,194

<sup>36</sup> The totals may differ from the sum of the addends due to rounding.

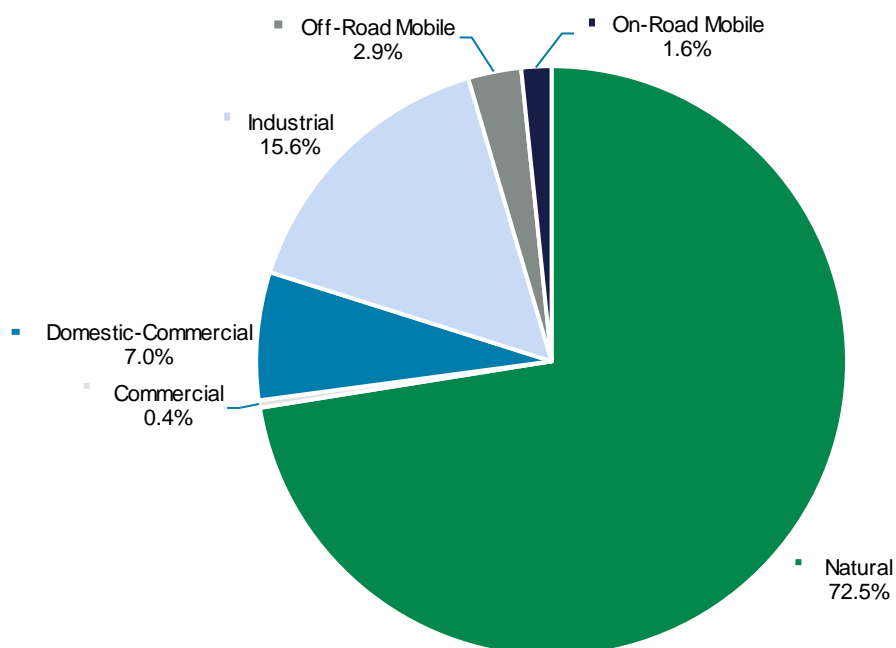


Table 3-11 presents the proportions of total estimated annual emissions of particulate matter  $\leq 2.5\mu\text{m}$  by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-11: Proportions of total estimated annual emissions of particulate matter  $\leq 2.5\mu\text{m}$  by natural and human-made source type in each region**

Substance	Region	Proportion (%)					
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Particulate matter $\leq 2.5\mu\text{m}$	Sydney	27.7	2.12	40.1	13.3	7.51	9.29
	Newcastle	45.8	0.50	10.7	33.4	6.80	2.78
	Wollongong	10.6	0.95	23.8	47.2	11.8	5.64
	Non-urban	81.4	0.13	1.42	14.8	1.90	0.35
	GMR	72.5	0.41	7.00	15.6	2.91	1.65

Figure 3-31, Figure 3-32, Figure 3-33, Figure 3-34 and Figure 3-35 show the proportions of total estimated annual emissions of particulate matter  $\leq 2.5\mu\text{m}$  by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.



**Figure 3-31: GMR: proportions of total estimated annual emissions of particulate matter  $\leq 2.5\mu\text{m}$  by natural and human-made source type**

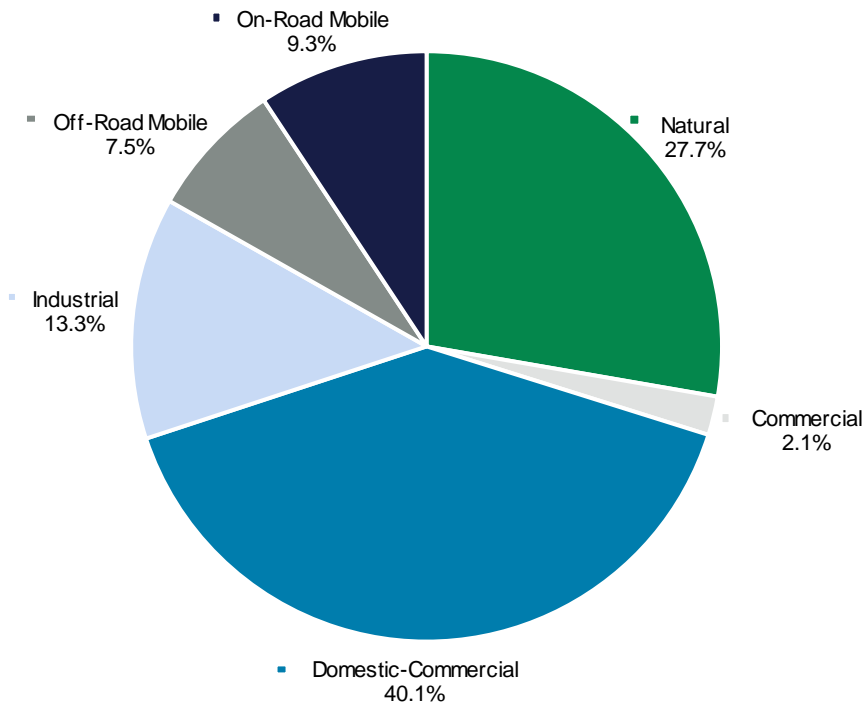


Figure 3-32: Sydney region: proportions of total estimated annual emissions of particulate matter ≤ 2.5µm by natural and human-made source type

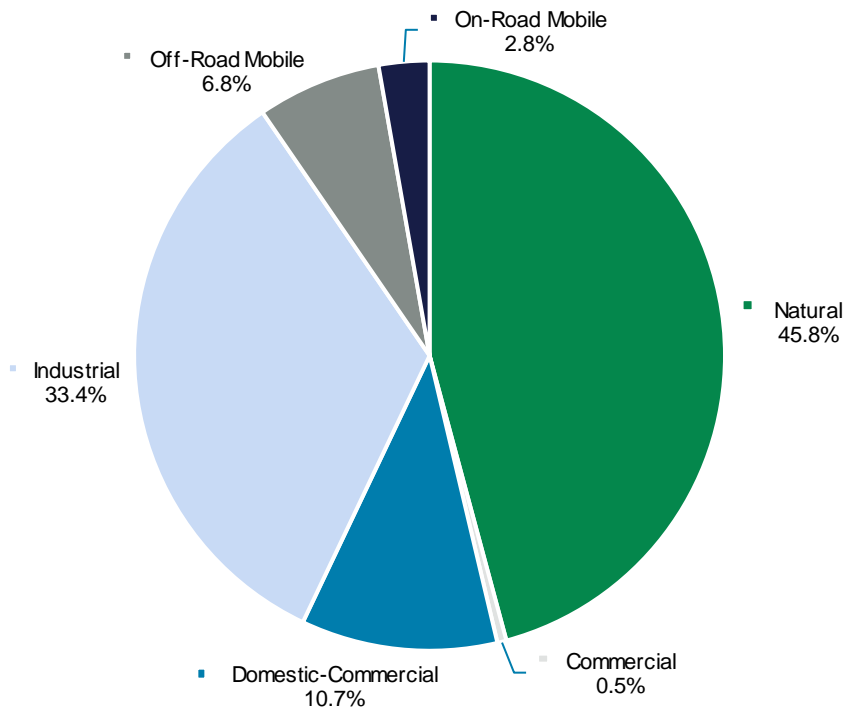


Figure 3-33: Newcastle region: proportions of total estimated annual emissions of particulate matter ≤ 2.5µm by natural and human-made source type

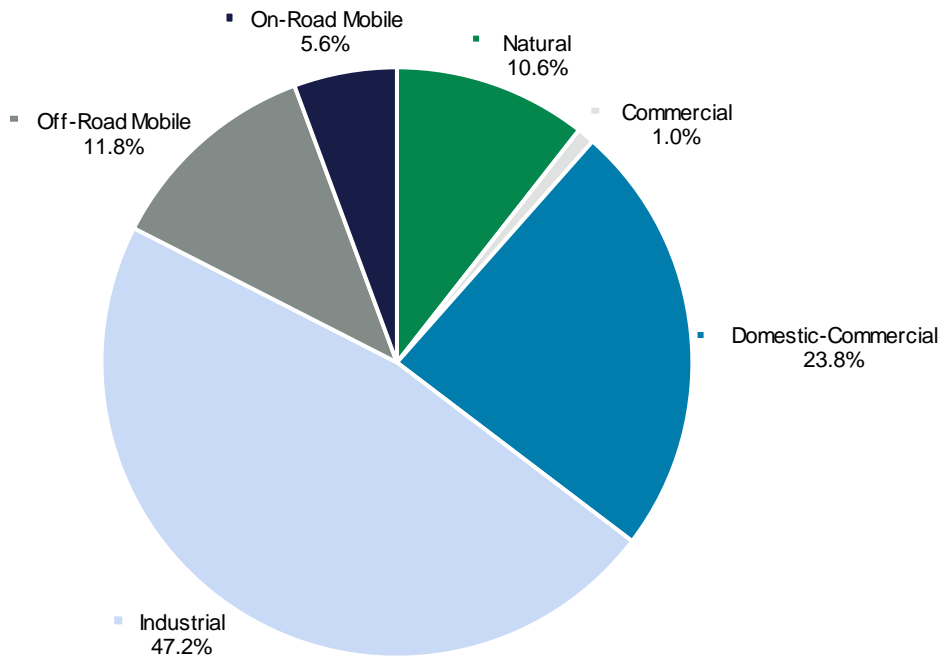


Figure 3-34: Wollongong region: proportions of total estimated annual emissions of particulate matter ≤ 2.5µm by natural and human-made source type

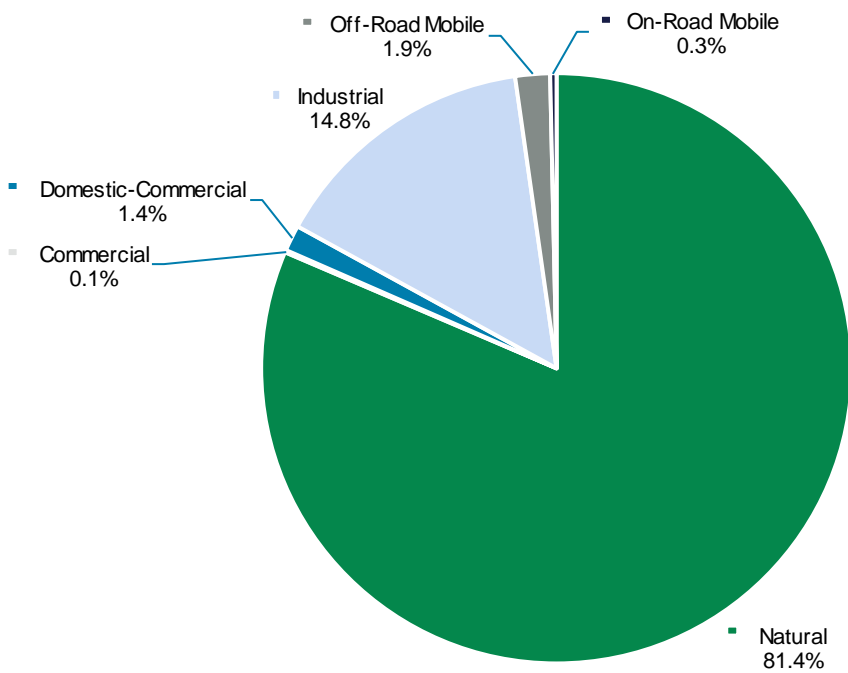


Figure 3-35: Non-urban region: proportions of total estimated annual emissions of particulate matter ≤ 2.5µm by natural and human-made source type

### 3.4.2. Priority natural and human-made emissions

Table 3-12 presents total estimated annual emissions, proportions and cumulative proportions of natural and human-made sources of particulate matter  $\leq 2.5\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 3-12: Natural and human-made sources of particulate matter  $\leq 2.5\mu\text{m}$  in each region

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
<b>Particulate matter <math>\leq 2.5\mu\text{m}</math> in the GMR</b>				
Natural	Bushfire and Prescribed Burning	74,688	70.3	70.3
Industrial	Mining for coal	10,238	9.64	80.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	6,773	6.38	86.4
Natural	Marine Aerosol	2,149	2.02	88.4
Industrial	Generation of electrical power from coal	1,477	1.39	89.8
Off-Road Mobile	Industrial Vehicles and Equipment	1,330	1.25	91.0
Off-Road Mobile	Ships	1,173	1.10	92.1
Industrial	Land-based extractive activity	837	0.79	92.9
On-Road Mobile	All - Non-Exhaust PM	824	0.78	93.7
Industrial	Ceramics production	621	0.59	94.3
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	604	0.57	94.8
Industrial	Cement or lime production	392	0.37	95.2
Industrial	Iron or steel production (iron ore)	378	0.36	95.6
Industrial	Aluminium production (alumina)	363	0.34	95.9
Industrial	Ammonium nitrate production	322	0.30	96.2
Industrial	Waste disposal (application to land)	293	0.28	96.5
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	268	0.25	96.7
Off-Road Mobile	Commercial Boats Exhaust	258	0.24	97.0
On-Road Mobile	Light Duty Diesel - Exhaust	240	0.23	97.2
Industrial	Boat mooring and storage	183	0.17	97.4
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	178	0.17	97.5
Off-Road Mobile	Locomotives	175	0.17	97.7
Domestic-Commercial	Gaseous Fuel Burning	172	0.16	97.9
Commercial	Gravel and Sand Quarrying	165	0.16	98.0
Industrial	Crushing, grinding or separating	160	0.15	98.2

<sup>37</sup> n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006).

<sup>38</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g.  $9.46 \times 10^{-2} = 0.0946$ ).

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Industrial	Coal works	143	0.13	98.3
Off-Road Mobile	Recreational Boats Exhaust	118	0.11	98.4
Industrial	Generation of electrical power from gas	106	1.0×10 <sup>-1</sup>	98.5
Industrial	Glass production (container)	94.85	8.93×10 <sup>-2</sup>	98.6
Natural	Fugitive/Windborne	92.14	8.68×10 <sup>-2</sup>	98.7
Industrial	Bitumen mixing	86.83	8.18×10 <sup>-2</sup>	98.8
Industrial	Iron or steel production (scrap metal)	84.08	7.92×10 <sup>-2</sup>	98.9
Commercial	Synthetic Resin Manufacturing	73.81	6.95×10 <sup>-2</sup>	98.9
Industrial	Bird accommodation	72.66	6.84×10 <sup>-2</sup>	99.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	63.72	6.00×10 <sup>-2</sup>	99.1
Industrial	Petroleum products and fuel production	55.82	5.26×10 <sup>-2</sup>	99.1
Industrial	Other land-based extraction	55.73	5.25×10 <sup>-2</sup>	99.2
Industrial	Non-thermal treatment of waste	45.65	4.30×10 <sup>-2</sup>	99.2
Industrial	Mining for minerals	42.72	4.02×10 <sup>-2</sup>	99.2
Industrial	Composting	41.66	3.92×10 <sup>-2</sup>	99.3
Industrial	Agricultural fertiliser (phosphate) production	40.87	3.85×10 <sup>-2</sup>	99.3
Industrial	Scrap metal processing	39.71	3.74×10 <sup>-2</sup>	99.4
Natural	Agricultural Burning	36.71	3.46×10 <sup>-2</sup>	99.4
Industrial	General agricultural processing	35.94	3.38×10 <sup>-2</sup>	99.4
Commercial	Poultry Farming (Meat)	35.46	3.34×10 <sup>-2</sup>	99.5
Domestic-Commercial	Barbeques	34.65	3.26×10 <sup>-2</sup>	99.5
Industrial	Railway systems activities	30.36	2.86×10 <sup>-2</sup>	99.5
Industrial	Metal plating or coating	30.18	2.84×10 <sup>-2</sup>	99.6
Industrial	Recovery of waste	25.19	2.37×10 <sup>-2</sup>	99.6
Industrial	Concrete works	24.31	2.29×10 <sup>-2</sup>	99.6
Commercial	Paint Manufacturing	23.90	2.25×10 <sup>-2</sup>	99.6
Industrial	Boat construction/maintenance (general)	20.05	1.89×10 <sup>-2</sup>	99.6
Commercial	Metal Coating and Finishing	18.94	1.78×10 <sup>-2</sup>	99.7
Industrial	Metal processing	18.40	1.73×10 <sup>-2</sup>	99.7
Commercial	Ceramic Product Manufacturing	17.96	1.69×10 <sup>-2</sup>	99.7
Off-Road Mobile	Aircraft (Flight Operations)	14.32	1.35×10 <sup>-2</sup>	99.7
Industrial	Cement or lime handling	13.50	1.27×10 <sup>-2</sup>	99.7
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	12.18	1.15×10 <sup>-2</sup>	99.7
Industrial	Solid waste landfilling	12.05	1.13×10 <sup>-2</sup>	99.7

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Industrial	General chemicals storage	10.96	1.03×10 <sup>-2</sup>	99.8
Off-Road Mobile	Aircraft (Ground Operations)	10.84	1.02×10 <sup>-2</sup>	99.8
Industrial	Aluminium production (scrap metal)	10.67	1.00×10 <sup>-2</sup>	99.8
Commercial	Log Sawmilling	10.46	9.85×10 <sup>-3</sup>	99.8
Industrial	Dairy animal accommodation	10.22	9.63×10 <sup>-3</sup>	99.8
Industrial	Shipping in bulk	10.12	9.53×10 <sup>-3</sup>	99.8
Industrial	Petrochemical production	9.93	9.35×10 <sup>-3</sup>	99.8
Commercial	Poultry Farming (Eggs)	8.94	8.42×10 <sup>-3</sup>	99.8
Commercial	Port Operators	8.72	8.22×10 <sup>-3</sup>	99.8
Industrial	Inert waste landfilling	8.62	8.11×10 <sup>-3</sup>	99.8
Commercial	Basic Iron and Steel Manufacturing	8.11	7.64×10 <sup>-3</sup>	99.8
Industrial	Chemical production	8.00	7.54×10 <sup>-3</sup>	99.9
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	7.36	6.93×10 <sup>-3</sup>	99.9
Industrial	Road construction	7.29	6.87×10 <sup>-3</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	6.74	6.35×10 <sup>-3</sup>	99.9
On-Road Mobile	Others - Exhaust	6.64	6.25×10 <sup>-3</sup>	99.9
Commercial	Construction Material Mining n.e.c.	6.44	6.06×10 <sup>-3</sup>	99.9
Commercial	Glass and Glass Product Manufacturing	6.40	6.03×10 <sup>-3</sup>	99.9
Industrial	Waste storage	6.11	5.75×10 <sup>-3</sup>	99.9
Industrial	Paints/polishes/adhesives production	5.84	5.50×10 <sup>-3</sup>	99.9
Industrial	Petroleum products storage	5.80	5.46×10 <sup>-3</sup>	99.9
Commercial	Plaster Product Manufacturing	5.66	5.33×10 <sup>-3</sup>	99.9
Industrial	Generation of electrical power not coal, diesel or gas	5.23	4.93×10 <sup>-3</sup>	99.9
Commercial	Hospitals (Except Psychiatric Hospitals)	5.21	4.91×10 <sup>-3</sup>	99.9
Industrial	Paper or pulp production	5.17	4.87×10 <sup>-3</sup>	99.9
Industrial	Water-based extractive activity	5.04	4.75×10 <sup>-3</sup>	99.9
Commercial	Steel Pipe and Tube Manufacturing	4.43	4.17×10 <sup>-3</sup>	99.9
Industrial	Sewage treatment - large plants	4.35	4.10×10 <sup>-3</sup>	99.9
Commercial	Food Manufacturing n.e.c.	3.88	3.65×10 <sup>-3</sup>	99.9
Domestic-Commercial	Liquid Fuel Burning (Domestic)	3.74	3.52×10 <sup>-3</sup>	99.9
Industrial	Animal accommodation	3.57	3.36×10 <sup>-3</sup>	100.0
Commercial	Beer and Malt Manufacturing	3.22	3.04×10 <sup>-3</sup>	100.0
Industrial	Rendering or fat extraction	3.15	2.96×10 <sup>-3</sup>	100.0

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Industrial	Dairy processing	2.76	2.60×10 <sup>-3</sup>	100.0
Commercial	Waste Disposal Services	2.59	2.44×10 <sup>-3</sup>	100.0
Industrial	General animal products production	2.56	2.41×10 <sup>-3</sup>	100.0
Industrial	Container reconditioning	2.19	2.06×10 <sup>-3</sup>	100.0
Industrial	Rubber products/tyre production	2.01	1.90×10 <sup>-3</sup>	100.0
Industrial	Boat construction/maintenance (dry/float)	1.99	1.87×10 <sup>-3</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	1.98	1.86×10 <sup>-3</sup>	100.0
Industrial	Pesticides and related products production	1.93	1.82×10 <sup>-3</sup>	100.0
Commercial	Wine Manufacturing	1.88	1.77×10 <sup>-3</sup>	100.0
Industrial	Slaughtering or processing of animals	1.87	1.76×10 <sup>-3</sup>	100.0
Commercial	Bread Manufacturing	1.81	1.70×10 <sup>-3</sup>	100.0
Industrial	Contaminated soil treatment	1.66	1.56×10 <sup>-3</sup>	100.0
Commercial	Gas Supply	1.55	1.46×10 <sup>-3</sup>	100.0
Industrial	Paper production using recycled materials	1.36	1.28×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	1.26	1.19×10 <sup>-3</sup>	100.0
Industrial	Brewing and distilling	1.00	9.42×10 <sup>-4</sup>	100.0
Commercial	Printing	0.85	7.98×10 <sup>-4</sup>	100.0
Commercial	Biscuit Manufacturing	0.83	7.86×10 <sup>-4</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	0.79	7.45×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	0.78	7.30×10 <sup>-4</sup>	100.0
Commercial	Road and Bridge Construction	0.69	6.50×10 <sup>-4</sup>	100.0
Industrial	Glass production	0.69	6.49×10 <sup>-4</sup>	100.0
Commercial	Corrugated Paperboard Container Manufacturing	0.65	6.17×10 <sup>-4</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	0.64	6.01×10 <sup>-4</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	0.56	5.25×10 <sup>-4</sup>	100.0
Commercial	Laundries and Dry-Cleaners	0.52	4.86×10 <sup>-4</sup>	100.0
Commercial	Electric Cable and Wire Manufacturing	0.47	4.47×10 <sup>-4</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	0.44	4.10×10 <sup>-4</sup>	100.0
Industrial	Battery production	0.40	3.78×10 <sup>-4</sup>	100.0
Industrial	Printing, packaging and visual media production	0.36	3.39×10 <sup>-4</sup>	100.0

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Plastic Injection Moulded Product Manufacturing	0.35	3.28×10 <sup>-4</sup>	100.0
Commercial	Fruit and Vegetable Processing	0.35	3.28×10 <sup>-4</sup>	100.0
Industrial	Soap and detergent production	0.33	3.07×10 <sup>-4</sup>	100.0
Commercial	Plastic Bag and Film Manufacturing	0.32	3.06×10 <sup>-4</sup>	100.0
Industrial	Hazardous, industrial or group A waste D	0.32	3.06×10 <sup>-4</sup>	100.0
Commercial	Ink Manufacturing	0.31	2.87×10 <sup>-4</sup>	100.0
Industrial	Explosives production	0.30	2.86×10 <sup>-4</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	0.30	2.80×10 <sup>-4</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	0.29	2.69×10 <sup>-4</sup>	100.0
Commercial	Oil and Fat Manufacturing	0.27	2.58×10 <sup>-4</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	0.26	2.49×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	0.23	2.14×10 <sup>-4</sup>	100.0
Commercial	Services to Air Transport	0.20	1.86×10 <sup>-4</sup>	100.0
Commercial	Ice Cream Manufacturing	0.20	1.86×10 <sup>-4</sup>	100.0
Commercial	Non-Ferrous Metal Casting	0.18	1.68×10 <sup>-4</sup>	100.0
Commercial	Petroleum Product Wholesaling	0.17	1.61×10 <sup>-4</sup>	100.0
Commercial	Cake and Pastry Manufacturing	0.16	1.51×10 <sup>-4</sup>	100.0
Commercial	Milk and Cream Processing	0.16	1.51×10 <sup>-4</sup>	100.0
Commercial	Aircraft Manufacturing	0.14	1.33×10 <sup>-4</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	0.14	1.28×10 <sup>-4</sup>	100.0
Commercial	Chemical Wholesaling	0.13	1.25×10 <sup>-4</sup>	100.0
Commercial	Scientific Research	0.12	1.17×10 <sup>-4</sup>	100.0
Industrial	Sterilisation activities	0.11	1.05×10 <sup>-4</sup>	100.0
Industrial	Non-ferrous metal production (scrap)	0.11	1.04×10 <sup>-4</sup>	100.0
Industrial	Pig accommodation	0.10	9.82×10 <sup>-5</sup>	100.0
Commercial	Non-Building Construction n.e.c.	8.29×10 <sup>-2</sup>	7.81×10 <sup>-5</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	7.04×10 <sup>-2</sup>	6.63×10 <sup>-5</sup>	100.0
Commercial	Aluminium Rolling, Drawing, Extruding	6.88×10 <sup>-2</sup>	6.48×10 <sup>-5</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	6.30×10 <sup>-2</sup>	5.94×10 <sup>-5</sup>	100.0
Commercial	Confectionery Manufacturing	3.42×10 <sup>-2</sup>	3.22×10 <sup>-5</sup>	100.0
Commercial	Structural Steel Fabricating	3.40×10 <sup>-2</sup>	3.20×10 <sup>-5</sup>	100.0



Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	3.18×10 <sup>-2</sup>	3.00×10 <sup>-5</sup>	100.0
Commercial	Industrial Gas Manufacturing	2.58×10 <sup>-2</sup>	2.43×10 <sup>-5</sup>	100.0
Industrial	Helicopter-related activity	2.43×10 <sup>-2</sup>	2.29×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	2.43×10 <sup>-2</sup>	2.29×10 <sup>-5</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	2.10×10 <sup>-2</sup>	1.98×10 <sup>-5</sup>	100.0
Commercial	Lifting and Material Handling Equipment Manufacturing	1.63×10 <sup>-2</sup>	1.53×10 <sup>-5</sup>	100.0
Industrial	Plastics resins production	1.62×10 <sup>-2</sup>	1.52×10 <sup>-5</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	1.61×10 <sup>-2</sup>	1.52×10 <sup>-5</sup>	100.0
Industrial	Chemical storage	1.39×10 <sup>-2</sup>	1.31×10 <sup>-5</sup>	100.0
Commercial	Soap and Other Detergent Manufacturing	1.12×10 <sup>-2</sup>	1.06×10 <sup>-5</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	8.47×10 <sup>-3</sup>	7.97×10 <sup>-6</sup>	100.0
Commercial	Structural Metal Product Manufacturing n.e.c.	6.83×10 <sup>-3</sup>	6.43×10 <sup>-6</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	3.82×10 <sup>-3</sup>	3.60×10 <sup>-6</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	8.87×10 <sup>-4</sup>	8.36×10 <sup>-7</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	8.29×10 <sup>-4</sup>	7.81×10 <sup>-7</sup>	100.0
<b>Particulate matter ≤ 2.5µm in the Sydney region</b>				
Domestic-Commercial	Solid Fuel Burning (Domestic)	5,009	36.4	36.4
Natural	Bushfire and Prescribed Burning	3,588	26.1	62.5
Off-Road Mobile	Ships	712	5.18	67.6
On-Road Mobile	All - Non-Exhaust PM	610	4.44	72.1
Industrial	Ceramics production	504	3.66	75.7
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	418	3.04	78.8
Industrial	Waste disposal (application to land)	232	1.68	80.5
Natural	Marine Aerosol	218	1.59	82.1
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	200	1.45	83.5
On-Road Mobile	Light Duty Diesel - Exhaust	185	1.35	84.9
Industrial	Crushing, grinding or separating	149	1.08	85.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	142	1.04	87.0
Domestic-Commercial	Gaseous Fuel Burning	136	0.99	88.0
Off-Road Mobile	Industrial Vehicles and Equipment	114	0.83	88.8
Off-Road Mobile	Commercial Boats Exhaust	95.45	0.69	89.5

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Industrial	Glass production (container)	94.85	0.69	90.2
Industrial	Land-based extractive activity	92.56	0.67	90.8
Industrial	Mining for coal	84.35	0.61	91.5
Commercial	Gravel and Sand Quarrying	76.93	0.56	92.0
Commercial	Synthetic Resin Manufacturing	73.79	0.54	92.5
Off-Road Mobile	Recreational Boats Exhaust	60.35	0.44	93.0
Industrial	Cement or lime production	54.48	0.40	93.4
Industrial	Petroleum products and fuel production	53.04	0.39	93.8
Industrial	Other land-based extraction	51.66	0.38	94.1
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	50.28	0.37	94.5
Industrial	Bird accommodation	45.69	0.33	94.8
Industrial	Bitumen mixing	40.07	0.29	95.1
Industrial	Generation of electrical power from gas	40.02	0.29	95.4
Industrial	Iron or steel production (scrap metal)	39.80	0.29	95.7
Industrial	Scrap metal processing	39.22	0.29	96.0
Industrial	Composting	36.14	0.26	96.3
Industrial	General agricultural processing	30.03	0.22	96.5
Industrial	Railway systems activities	28.66	0.21	96.7
Industrial	Non-thermal treatment of waste	27.97	0.20	96.9
Domestic-Commercial	Barbeques	27.37	0.20	97.1
Off-Road Mobile	Locomotives	24.87	0.18	97.3
Commercial	Paint Manufacturing	23.90	0.17	97.4
Industrial	Metal plating or coating	23.45	0.17	97.6
Industrial	Recovery of waste	20.25	0.15	97.8
Industrial	Boat construction/maintenance (general)	18.02	0.13	97.9
Industrial	Concrete works	17.91	0.13	98.0
Commercial	Ceramic Product Manufacturing	16.49	0.12	98.1
Commercial	Metal Coating and Finishing	16.09	0.12	98.3
Commercial	Poultry Farming (Meat)	15.56	0.11	98.4
Off-Road Mobile	Aircraft (Flight Operations)	13.55	$9.85 \times 10^{-2}$	98.5
Industrial	Cement or lime handling	10.66	$7.75 \times 10^{-2}$	98.5
Off-Road Mobile	Aircraft (Ground Operations)	10.42	$7.57 \times 10^{-2}$	98.6
Industrial	Dairy animal accommodation	10.22	$7.43 \times 10^{-2}$	98.7
Industrial	Petrochemical production	9.93	$7.21 \times 10^{-2}$	98.8
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	9.81	$7.13 \times 10^{-2}$	98.8

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Port Operators	8.72	6.34×10 <sup>-2</sup>	98.9
Commercial	Poultry Farming (Eggs)	8.03	5.84×10 <sup>-2</sup>	99.0
Commercial	Basic Iron and Steel Manufacturing	7.67	5.57×10 <sup>-2</sup>	99.0
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	7.36	5.35×10 <sup>-2</sup>	99.1
Industrial	Road construction	7.29	5.30×10 <sup>-2</sup>	99.1
Commercial	Glass and Glass Product Manufacturing	6.40	4.65×10 <sup>-2</sup>	99.2
Natural	Fugitive/Windborne	6.04	4.39×10 <sup>-2</sup>	99.2
Industrial	Paints/polishes/adhesives production	5.84	4.24×10 <sup>-2</sup>	99.3
Industrial	Waste storage	5.82	4.23×10 <sup>-2</sup>	99.3
Industrial	Petroleum products storage	5.72	4.16×10 <sup>-2</sup>	99.3
Commercial	Plaster Product Manufacturing	5.66	4.12×10 <sup>-2</sup>	99.4
Industrial	Paper or pulp production	5.17	3.76×10 <sup>-2</sup>	99.4
On-Road Mobile	Others - Exhaust	5.02	3.65×10 <sup>-2</sup>	99.5
Industrial	Chemical production	4.37	3.18×10 <sup>-2</sup>	99.5
Industrial	Sewage treatment - large plants	4.03	2.93×10 <sup>-2</sup>	99.5
Commercial	Hospitals (Except Psychiatric Hospitals)	3.62	2.63×10 <sup>-2</sup>	99.5
Off-Road Mobile	Commercial Vehicles and Equipment	3.36	2.44×10 <sup>-2</sup>	99.6
Commercial	Beer and Malt Manufacturing	3.22	2.34×10 <sup>-2</sup>	99.6
Natural	Agricultural Burning	3.19	2.32×10 <sup>-2</sup>	99.6
Domestic-Commercial	Liquid Fuel Burning (Domestic)	2.95	2.14×10 <sup>-2</sup>	99.6
Industrial	Generation of electrical power not coal, diesel or gas	2.68	1.95×10 <sup>-2</sup>	99.7
Commercial	Waste Disposal Services	2.59	1.88×10 <sup>-2</sup>	99.7
Industrial	Rendering or fat extraction	2.59	1.88×10 <sup>-2</sup>	99.7
Industrial	Dairy processing	2.46	1.79×10 <sup>-2</sup>	99.7
Industrial	Container reconditioning	2.19	1.59×10 <sup>-2</sup>	99.7
Industrial	General animal products production	2.19	1.59×10 <sup>-2</sup>	99.7
Commercial	Food Manufacturing n.e.c.	2.14	1.55×10 <sup>-2</sup>	99.8
Industrial	Rubber products/tyre production	2.01	1.46×10 <sup>-2</sup>	99.8
Industrial	Boat construction/maintenance (dry/float)	1.99	1.44×10 <sup>-2</sup>	99.8
Industrial	Miscellaneous licensed discharges to waters (at any time)	1.98	1.44×10 <sup>-2</sup>	99.8
Industrial	Solid waste landfilling	1.78	1.29×10 <sup>-2</sup>	99.8
Industrial	Contaminated soil treatment	1.65	1.20×10 <sup>-2</sup>	99.8

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Industrial	Pesticides and related products production	1.63	1.18×10 <sup>-2</sup>	99.8
Commercial	Gas Supply	1.55	1.13×10 <sup>-2</sup>	99.8
Commercial	Bread Manufacturing	1.39	1.01×10 <sup>-2</sup>	99.9
Industrial	Paper production using recycled materials	1.36	9.85×10 <sup>-3</sup>	99.9
Industrial	Slaughtering or processing of animals	1.13	8.18×10 <sup>-3</sup>	99.9
Commercial	Steel Pipe and Tube Manufacturing	1.01	7.34×10 <sup>-3</sup>	99.9
Industrial	Brewing and distilling	1.00	7.27×10 <sup>-3</sup>	99.9
Industrial	General chemicals storage	0.98	7.12×10 <sup>-3</sup>	99.9
Commercial	Printing	0.85	6.16×10 <sup>-3</sup>	99.9
Commercial	Biscuit Manufacturing	0.83	6.07×10 <sup>-3</sup>	99.9
Commercial	Chemical Product Manufacturing n.e.c.	0.76	5.50×10 <sup>-3</sup>	99.9
Industrial	Glass production	0.69	5.01×10 <sup>-3</sup>	99.9
Commercial	Road and Bridge Construction	0.68	4.92×10 <sup>-3</sup>	99.9
Commercial	Corrugated Paperboard Container Manufacturing	0.65	4.76×10 <sup>-3</sup>	99.9
Industrial	Pharmaceutical and veterinary products production	0.63	4.61×10 <sup>-3</sup>	99.9
Industrial	Recovery of waste oil	0.58	4.22×10 <sup>-3</sup>	99.9
Commercial	Laundries and Dry-Cleaners	0.52	3.75×10 <sup>-3</sup>	99.9
Commercial	Medicinal and Pharmaceutical Product Manufacturing	0.46	3.31×10 <sup>-3</sup>	99.9
Commercial	Fabricated Metal Product Manufacturing n.e.c.	0.41	2.95×10 <sup>-3</sup>	100.0
Industrial	Battery production	0.40	2.92×10 <sup>-3</sup>	100.0
Industrial	Printing, packaging and visual media production	0.36	2.61×10 <sup>-3</sup>	100.0
Commercial	Fruit and Vegetable Processing	0.35	2.53×10 <sup>-3</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	0.35	2.53×10 <sup>-3</sup>	100.0
Industrial	Metal processing	0.35	2.51×10 <sup>-3</sup>	100.0
Industrial	Soap and detergent production	0.33	2.37×10 <sup>-3</sup>	100.0
Commercial	Plastic Bag and Film Manufacturing	0.32	2.36×10 <sup>-3</sup>	100.0
Industrial	Hazardous, industrial or group A waste D	0.32	2.36×10 <sup>-3</sup>	100.0
Commercial	Ink Manufacturing	0.31	2.22×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	0.30	2.20×10 <sup>-3</sup>	100.0
Industrial	Shipping in bulk	0.30	2.18×10 <sup>-3</sup>	100.0

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Soft Drink, Cordial and Syrup Manufacturing	0.30	2.16×10 <sup>-3</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	0.29	2.07×10 <sup>-3</sup>	100.0
Commercial	Oil and Fat Manufacturing	0.27	1.99×10 <sup>-3</sup>	100.0
Commercial	Wine Manufacturing	0.27	1.93×10 <sup>-3</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	0.21	1.53×10 <sup>-3</sup>	100.0
Commercial	Services to Air Transport	0.20	1.44×10 <sup>-3</sup>	100.0
Commercial	Ice Cream Manufacturing	0.20	1.44×10 <sup>-3</sup>	100.0
Commercial	Cake and Pastry Manufacturing	0.16	1.17×10 <sup>-3</sup>	100.0
Commercial	Milk and Cream Processing	0.16	1.17×10 <sup>-3</sup>	100.0
Commercial	Aircraft Manufacturing	0.14	1.03×10 <sup>-3</sup>	100.0
Commercial	Scientific Research	0.12	9.00×10 <sup>-4</sup>	100.0
Commercial	Chemical Wholesaling	0.11	8.22×10 <sup>-4</sup>	100.0
Industrial	Sterilisation activities	0.11	8.12×10 <sup>-4</sup>	100.0
Industrial	Non-ferrous metal production (scrap)	0.11	8.02×10 <sup>-4</sup>	100.0
Commercial	Non-Building Construction n.e.c.	8.13×10 <sup>-2</sup>	5.91×10 <sup>-4</sup>	100.0
Commercial	Petroleum Product Wholesaling	6.74×10 <sup>-2</sup>	4.90×10 <sup>-4</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	5.58×10 <sup>-2</sup>	4.06×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	4.40×10 <sup>-2</sup>	3.20×10 <sup>-4</sup>	100.0
Commercial	Confectionery Manufacturing	3.42×10 <sup>-2</sup>	2.48×10 <sup>-4</sup>	100.0
Commercial	Structural Steel Fabricating	3.40×10 <sup>-2</sup>	2.47×10 <sup>-4</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	3.18×10 <sup>-2</sup>	2.31×10 <sup>-4</sup>	100.0
Commercial	Industrial Gas Manufacturing	2.58×10 <sup>-2</sup>	1.88×10 <sup>-4</sup>	100.0
Industrial	Helicopter-related activity	2.43×10 <sup>-2</sup>	1.77×10 <sup>-4</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	2.41×10 <sup>-2</sup>	1.75×10 <sup>-4</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	1.87×10 <sup>-2</sup>	1.36×10 <sup>-4</sup>	100.0
Commercial	Lifting and Material Handling Equipment Manufacturing	1.63×10 <sup>-2</sup>	1.18×10 <sup>-4</sup>	100.0
Industrial	Plastics resins production	1.62×10 <sup>-2</sup>	1.18×10 <sup>-4</sup>	100.0
Industrial	Chemical storage	1.39×10 <sup>-2</sup>	1.01×10 <sup>-4</sup>	100.0
Industrial	Boat mooring and storage	1.31×10 <sup>-2</sup>	9.52×10 <sup>-5</sup>	100.0
Commercial	Soap and Other Detergent Manufacturing	1.12×10 <sup>-2</sup>	8.15×10 <sup>-5</sup>	100.0
Commercial	Structural Metal Product Manufacturing n.e.c.	6.83×10 <sup>-3</sup>	4.96×10 <sup>-5</sup>	100.0

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Spring and Wire Product Manufacturing	5.43×10 <sup>-3</sup>	3.95×10 <sup>-5</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	8.87×10 <sup>-4</sup>	6.45×10 <sup>-6</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	3.56×10 <sup>-4</sup>	2.59×10 <sup>-6</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	1.13×10 <sup>-4</sup>	8.20×10 <sup>-7</sup>	100.0
<b>Particulate matter ≤ 2.5µm in the Newcastle region</b>				
Natural	Bushfire and Prescribed Burning	1,731	44.8	44.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	378	9.80	54.6
Industrial	Aluminium production (alumina)	363	9.40	64.0
Industrial	Ammonium nitrate production	322	8.33	72.4
Industrial	Mining for coal	240	6.20	78.6
Off-Road Mobile	Ships	197	5.11	83.7
Industrial	Coal works	107	2.77	86.4
Industrial	Land-based extractive activity	61.02	1.58	88.0
On-Road Mobile	All - Non-Exhaust PM	53.04	1.37	89.4
Industrial	Iron or steel production (scrap metal)	44.28	1.15	90.5
Industrial	Agricultural fertiliser (phosphate) production	40.87	1.06	91.6
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	36.47	0.94	92.5
Natural	Marine Aerosol	35.42	0.92	93.5
Off-Road Mobile	Commercial Boats Exhaust	22.36	0.58	94.0
Industrial	Waste disposal (application to land)	22.28	0.58	94.6
Off-Road Mobile	Locomotives	21.50	0.56	95.2
Industrial	Non-thermal treatment of waste	17.10	0.44	95.6
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	16.76	0.43	96.0
Industrial	Metal processing	15.91	0.41	96.5
Off-Road Mobile	Industrial Vehicles and Equipment	14.85	0.38	96.8
On-Road Mobile	Light Duty Diesel - Exhaust	13.01	0.34	97.2
Commercial	Gravel and Sand Quarrying	10.11	0.26	97.4
Industrial	General chemicals storage	9.79	0.25	97.7
Domestic-Commercial	Gaseous Fuel Burning	9.10	0.24	97.9
Industrial	Shipping in bulk	8.99	0.23	98.2
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	8.76	0.23	98.4
Industrial	Bitumen mixing	8.12	0.21	98.6
Off-Road Mobile	Recreational Boats Exhaust	5.28	0.14	98.7

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Industrial	Inert waste landfilling	5.26	0.14	98.9
Commercial	Construction Material Mining n.e.c.	4.36	0.11	99.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	3.66	9.47×10 <sup>-2</sup>	99.1
Industrial	General agricultural processing	3.43	8.89×10 <sup>-2</sup>	99.2
Industrial	Recovery of waste	3.29	8.52×10 <sup>-2</sup>	99.3
Commercial	Metal Coating and Finishing	2.85	7.37×10 <sup>-2</sup>	99.3
Industrial	Metal plating or coating	2.59	6.71×10 <sup>-2</sup>	99.4
Industrial	Petroleum products and fuel production	2.40	6.22×10 <sup>-2</sup>	99.5
Industrial	Boat construction/maintenance (general)	2.03	5.26×10 <sup>-2</sup>	99.5
Natural	Fugitive/Windborne	1.98	5.13×10 <sup>-2</sup>	99.6
Industrial	Other land-based extraction	1.93	4.99×10 <sup>-2</sup>	99.6
Domestic-Commercial	Barbeques	1.83	4.74×10 <sup>-2</sup>	99.7
Industrial	Concrete works	1.77	4.58×10 <sup>-2</sup>	99.7
Industrial	Crushing, grinding or separating	1.59	4.13×10 <sup>-2</sup>	99.7
Industrial	Generation of electrical power not coal, diesel or gas	1.24	3.20×10 <sup>-2</sup>	99.8
Commercial	Poultry Farming (Meat)	0.96	2.48×10 <sup>-2</sup>	99.8
Industrial	Cement or lime handling	0.82	2.13×10 <sup>-2</sup>	99.8
Industrial	Chemical production	0.82	2.11×10 <sup>-2</sup>	99.8
Industrial	Slaughtering or processing of animals	0.75	1.93×10 <sup>-2</sup>	99.9
Natural	Agricultural Burning	0.69	1.79×10 <sup>-2</sup>	99.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	0.58	1.51×10 <sup>-2</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	0.57	1.48×10 <sup>-2</sup>	99.9
Commercial	Hospitals (Except Psychiatric Hospitals)	0.49	1.27×10 <sup>-2</sup>	99.9
Industrial	Scrap metal processing	0.49	1.27×10 <sup>-2</sup>	99.9
On-Road Mobile	Others - Exhaust	0.43	1.11×10 <sup>-2</sup>	99.9
Commercial	Bread Manufacturing	0.41	1.07×10 <sup>-2</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	0.37	9.46×10 <sup>-3</sup>	100.0
Industrial	Dairy processing	0.30	7.71×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Flight Operations)	0.26	6.69×10 <sup>-3</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.20	5.11×10 <sup>-3</sup>	100.0
Industrial	Railway systems activities	0.19	4.92×10 <sup>-3</sup>	100.0
Industrial	Water-based extractive activity	0.19	4.83×10 <sup>-3</sup>	100.0
Industrial	Waste storage	5.08×10 <sup>-2</sup>	1.32×10 <sup>-3</sup>	100.0

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Chemical Product Manufacturing n.e.c.	3.01×10 <sup>-2</sup>	7.81×10 <sup>-4</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	2.32×10 <sup>-2</sup>	6.00×10 <sup>-4</sup>	100.0
Commercial	Chemical Wholesaling	1.93×10 <sup>-2</sup>	4.99×10 <sup>-4</sup>	100.0
Industrial	Petroleum products storage	1.09×10 <sup>-2</sup>	2.81×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	8.61×10 <sup>-3</sup>	2.23×10 <sup>-4</sup>	100.0
Industrial	Generation of electrical power from gas	7.18×10 <sup>-3</sup>	1.86×10 <sup>-4</sup>	100.0
Industrial	Contaminated soil treatment	6.70×10 <sup>-3</sup>	1.73×10 <sup>-4</sup>	100.0
Commercial	Road and Bridge Construction	6.51×10 <sup>-3</sup>	1.69×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	4.88×10 <sup>-3</sup>	1.26×10 <sup>-4</sup>	100.0
Commercial	Wine Manufacturing	2.69×10 <sup>-3</sup>	6.97×10 <sup>-5</sup>	100.0
Commercial	Aluminium Rolling, Drawing, Extruding	1.17×10 <sup>-3</sup>	3.03×10 <sup>-5</sup>	100.0
Commercial	Waste Disposal Services	8.61×10 <sup>-4</sup>	2.23×10 <sup>-5</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	8.29×10 <sup>-4</sup>	2.15×10 <sup>-5</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	1.33×10 <sup>-4</sup>	3.45×10 <sup>-6</sup>	100.0
Industrial	Printing, packaging and visual media production	6.96×10 <sup>-5</sup>	1.80×10 <sup>-6</sup>	100.0
<b>Particulate matter ≤ 2.5µm in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	378	35.9	35.9
Domestic-Commercial	Solid Fuel Burning (Domestic)	225	21.4	57.2
Natural	Bushfire and Prescribed Burning	92.54	8.78	66.0
Off-Road Mobile	Ships	71.81	6.81	72.8
Industrial	Generation of electrical power from gas	65.58	6.22	79.1
Off-Road Mobile	Industrial Vehicles and Equipment	40.69	3.86	82.9
On-Road Mobile	All - Non-Exhaust PM	28.31	2.69	85.6
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	21.47	2.04	87.7
Industrial	Coal works	20.52	1.95	89.6
Natural	Marine Aerosol	18.73	1.78	91.4
Industrial	Mining for coal	16.02	1.52	92.9
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	11.20	1.06	94.0
Off-Road Mobile	Recreational Boats Exhaust	7.50	0.71	94.7
On-Road Mobile	Light Duty Diesel - Exhaust	7.21	0.68	95.4
Domestic-Commercial	Gaseous Fuel Burning	6.56	0.62	96.0



Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	6.51	0.62	96.6
Commercial	Gravel and Sand Quarrying	4.20	0.40	97.0
Industrial	Waste disposal (application to land)	4.09	0.39	97.4
Industrial	Metal plating or coating	4.02	0.38	97.8
Commercial	Steel Pipe and Tube Manufacturing	3.42	0.32	98.1
Industrial	Bitumen mixing	3.25	0.31	98.4
Off-Road Mobile	Locomotives	3.16	0.30	98.7
Industrial	Metal processing	2.14	0.20	98.9
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	1.91	0.18	99.1
Off-Road Mobile	Commercial Boats Exhaust	1.56	0.15	99.2
Commercial	Ceramic Product Manufacturing	1.47	0.14	99.4
Domestic-Commercial	Barbeques	1.32	0.13	99.5
Industrial	Crushing, grinding or separating	1.12	0.11	99.6
Industrial	Shipping in bulk	0.83	$7.88 \times 10^{-2}$	99.7
Industrial	Concrete works	0.55	$5.17 \times 10^{-2}$	99.7
Commercial	Basic Iron and Steel Manufacturing	0.45	$4.23 \times 10^{-2}$	99.8
Industrial	Cement or lime production	0.43	$4.05 \times 10^{-2}$	99.8
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	0.30	$2.86 \times 10^{-2}$	99.8
On-Road Mobile	Others - Exhaust	0.24	$2.24 \times 10^{-2}$	99.9
Commercial	Poultry Farming (Meat)	0.22	$2.10 \times 10^{-2}$	99.9
Commercial	Hospitals (Except Psychiatric Hospitals)	0.19	$1.80 \times 10^{-2}$	99.9
Industrial	General chemicals storage	0.18	$1.73 \times 10^{-2}$	99.9
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.14	$1.35 \times 10^{-2}$	99.9
Industrial	Sewage treatment - large plants	0.12	$1.12 \times 10^{-2}$	99.9
Natural	Fugitive/Windborne	0.11	$1.09 \times 10^{-2}$	100.0
Industrial	Chemical production	$7.91 \times 10^{-2}$	$7.50 \times 10^{-3}$	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	$7.45 \times 10^{-2}$	$7.07 \times 10^{-3}$	100.0
Commercial	Aluminium Rolling, Drawing, Extruding	$6.76 \times 10^{-2}$	$6.41 \times 10^{-3}$	100.0
Industrial	Petroleum products storage	$6.50 \times 10^{-2}$	$6.17 \times 10^{-3}$	100.0
Industrial	Non-thermal treatment of waste	$6.01 \times 10^{-2}$	$5.70 \times 10^{-3}$	100.0
Industrial	Cement or lime handling	$3.84 \times 10^{-2}$	$3.64 \times 10^{-3}$	100.0
Industrial	Waste storage	$3.09 \times 10^{-2}$	$2.94 \times 10^{-3}$	100.0
Off-Road Mobile	Aircraft (Flight Operations)	$2.09 \times 10^{-2}$	$1.99 \times 10^{-3}$	100.0

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Industrial	Recovery of waste	9.55×10 <sup>-3</sup>	9.06×10 <sup>-4</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	3.82×10 <sup>-3</sup>	3.63×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	2.83×10 <sup>-3</sup>	2.69×10 <sup>-4</sup>	100.0
Industrial	Container reconditioning	5.16×10 <sup>-4</sup>	4.90×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	1.62×10 <sup>-4</sup>	1.53×10 <sup>-5</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	1.30×10 <sup>-4</sup>	1.24×10 <sup>-5</sup>	100.0
<b>Particulate matter ≤ 2.5µm in the Non-urban region</b>				
Natural	Bushfire and Prescribed Burning	69,276	79.2	79.2
Industrial	Mining for coal	9,898	11.3	90.5
Natural	Marine Aerosol	1,876	2.14	92.6
Industrial	Generation of electrical power from coal	1,477	1.69	94.3
Off-Road Mobile	Industrial Vehicles and Equipment	1,160	1.33	95.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,160	1.33	97.0
Industrial	Land-based extractive activity	683	0.78	97.7
Industrial	Cement or lime production	337	0.39	98.1
Off-Road Mobile	Ships	192	0.22	98.3
Industrial	Boat mooring and storage	183	0.21	98.5
Off-Road Mobile	Commercial Boats Exhaust	138	0.16	98.7
On-Road Mobile	All - Non-Exhaust PM	132	0.15	98.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	128	0.15	99.0
Off-Road Mobile	Locomotives	126	0.14	99.1
Industrial	Ceramics production	118	0.13	99.3
Natural	Fugitive/Windborne	84.01	9.60×10 <sup>-2</sup>	99.4
Commercial	Gravel and Sand Quarrying	74.03	8.46×10 <sup>-2</sup>	99.5
Off-Road Mobile	Recreational Boats Exhaust	45.19	5.16×10 <sup>-2</sup>	99.5
Industrial	Mining for minerals	42.72	4.88×10 <sup>-2</sup>	99.6
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	39.85	4.55×10 <sup>-2</sup>	99.6
Industrial	Bitumen mixing	35.39	4.04×10 <sup>-2</sup>	99.6
Industrial	Waste disposal (application to land)	35.22	4.02×10 <sup>-2</sup>	99.7
On-Road Mobile	Light Duty Diesel - Exhaust	34.80	3.98×10 <sup>-2</sup>	99.7
Natural	Agricultural Burning	32.83	3.75×10 <sup>-2</sup>	99.8
Industrial	Bird accommodation	26.97	3.08×10 <sup>-2</sup>	99.8
Domestic-Commercial	Gaseous Fuel Burning	20.56	2.35×10 <sup>-2</sup>	99.8
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	19.99	2.28×10 <sup>-2</sup>	99.8

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Poultry Farming (Meat)	18.72	2.14×10 <sup>-2</sup>	99.9
Industrial	Coal works	15.65	1.79×10 <sup>-2</sup>	99.9
Industrial	Aluminium production (scrap metal)	10.67	1.22×10 <sup>-2</sup>	99.9
Commercial	Log Sawmilling	10.46	1.19×10 <sup>-2</sup>	99.9
Industrial	Solid waste landfilling	10.28	1.17×10 <sup>-2</sup>	99.9
Industrial	Crushing, grinding or separating	7.91	9.03×10 <sup>-3</sup>	99.9
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	7.87	8.99×10 <sup>-3</sup>	99.9
Industrial	Composting	5.52	6.31×10 <sup>-3</sup>	99.9
Industrial	Water-based extractive activity	4.85	5.55×10 <sup>-3</sup>	99.9
Domestic-Commercial	Barbeques	4.14	4.73×10 <sup>-3</sup>	99.9
Industrial	Concrete works	4.09	4.67×10 <sup>-3</sup>	100.0
Industrial	Animal accommodation	3.57	4.08×10 <sup>-3</sup>	100.0
Industrial	Inert waste landfilling	3.36	3.84×10 <sup>-3</sup>	100.0
Industrial	Chemical production	2.74	3.13×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	2.74	3.13×10 <sup>-3</sup>	100.0
Industrial	General agricultural processing	2.47	2.83×10 <sup>-3</sup>	100.0
Industrial	Other land-based extraction	2.14	2.44×10 <sup>-3</sup>	100.0
Commercial	Construction Material Mining n.e.c.	2.08	2.38×10 <sup>-3</sup>	100.0
Industrial	Cement or lime handling	1.98	2.26×10 <sup>-3</sup>	100.0
Commercial	Food Manufacturing n.e.c.	1.74	1.99×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste	1.63	1.86×10 <sup>-3</sup>	100.0
Commercial	Wine Manufacturing	1.61	1.84×10 <sup>-3</sup>	100.0
Industrial	Railway systems activities	1.51	1.73×10 <sup>-3</sup>	100.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1.48	1.69×10 <sup>-3</sup>	100.0
Industrial	Generation of electrical power not coal, diesel or gas	1.31	1.50×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	0.96	1.09×10 <sup>-3</sup>	100.0
On-Road Mobile	Others - Exhaust	0.95	1.08×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.91	1.04×10 <sup>-3</sup>	100.0
Commercial	Poultry Farming (Eggs)	0.91	1.04×10 <sup>-3</sup>	100.0
Industrial	Rendering or fat extraction	0.56	6.38×10 <sup>-4</sup>	100.0
Industrial	Generation of electrical power from gas	0.54	6.15×10 <sup>-4</sup>	100.0
Industrial	Non-thermal treatment of waste	0.52	5.98×10 <sup>-4</sup>	100.0
Off-Road Mobile	Aircraft (Flight Operations)	0.49	5.59×10 <sup>-4</sup>	100.0

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Electric Cable and Wire Manufacturing	0.47	5.43×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.45	5.10×10 <sup>-4</sup>	100.0
Industrial	Petroleum products and fuel production	0.37	4.23×10 <sup>-4</sup>	100.0
Industrial	General animal products production	0.37	4.19×10 <sup>-4</sup>	100.0
Industrial	Pesticides and related products production	0.31	3.50×10 <sup>-4</sup>	100.0
Industrial	Explosives production	0.30	3.47×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	0.22	2.47×10 <sup>-4</sup>	100.0
Industrial	Waste storage	0.20	2.34×10 <sup>-4</sup>	100.0
Industrial	Sewage treatment - large plants	0.20	2.30×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	0.19	2.23×10 <sup>-4</sup>	100.0
Commercial	Non-Ferrous Metal Casting	0.18	2.04×10 <sup>-4</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	0.14	1.55×10 <sup>-4</sup>	100.0
Industrial	Metal plating or coating	0.12	1.35×10 <sup>-4</sup>	100.0
Industrial	Pig accommodation	0.10	1.19×10 <sup>-4</sup>	100.0
Commercial	Petroleum Product Wholesaling	0.10	1.19×10 <sup>-4</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	0.10	1.16×10 <sup>-4</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	6.13×10 <sup>-2</sup>	7.00×10 <sup>-5</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	5.38×10 <sup>-2</sup>	6.14×10 <sup>-5</sup>	100.0
Commercial	Synthetic Resin Manufacturing	2.10×10 <sup>-2</sup>	2.40×10 <sup>-5</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	1.60×10 <sup>-2</sup>	1.83×10 <sup>-5</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	1.50×10 <sup>-2</sup>	1.71×10 <sup>-5</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	8.33×10 <sup>-3</sup>	9.52×10 <sup>-6</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	7.36×10 <sup>-3</sup>	8.41×10 <sup>-6</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	7.19×10 <sup>-3</sup>	8.22×10 <sup>-6</sup>	100.0
Commercial	Road and Bridge Construction	6.46×10 <sup>-3</sup>	7.39×10 <sup>-6</sup>	100.0
Industrial	Aluminium production (alumina)	5.16×10 <sup>-3</sup>	5.90×10 <sup>-6</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	4.36×10 <sup>-3</sup>	4.99×10 <sup>-6</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	3.35×10 <sup>-3</sup>	3.83×10 <sup>-6</sup>	100.0
Industrial	General chemicals storage	2.78×10 <sup>-3</sup>	3.17×10 <sup>-6</sup>	100.0
Industrial	Boat construction/maintenance (general)	2.67×10 <sup>-3</sup>	3.05×10 <sup>-6</sup>	100.0

Module	Activity <sup>37</sup>	Emissions (tonnes/year)	Proportion (%) <sup>38</sup>	Cumulative proportion (%)
Commercial	Wood Product Manufacturing n.e.c.	2.29×10 <sup>-3</sup>	2.62×10 <sup>-6</sup>	100.0
Commercial	Non-Building Construction n.e.c.	1.57×10 <sup>-3</sup>	1.79×10 <sup>-6</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	1.52×10 <sup>-3</sup>	1.74×10 <sup>-6</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	1.07×10 <sup>-3</sup>	1.23×10 <sup>-6</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	3.82×10 <sup>-4</sup>	4.36×10 <sup>-7</sup>	100.0
Commercial	Printing	1.83×10 <sup>-6</sup>	2.10×10 <sup>-9</sup>	100.0

Figure 3-36, Figure 3-37, Figure 3-38, Figure 3-39 and Figure 3-40 show the estimated annual emissions for the top 15 natural and human-made sources of particulate matter ≤ 2.5µm in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

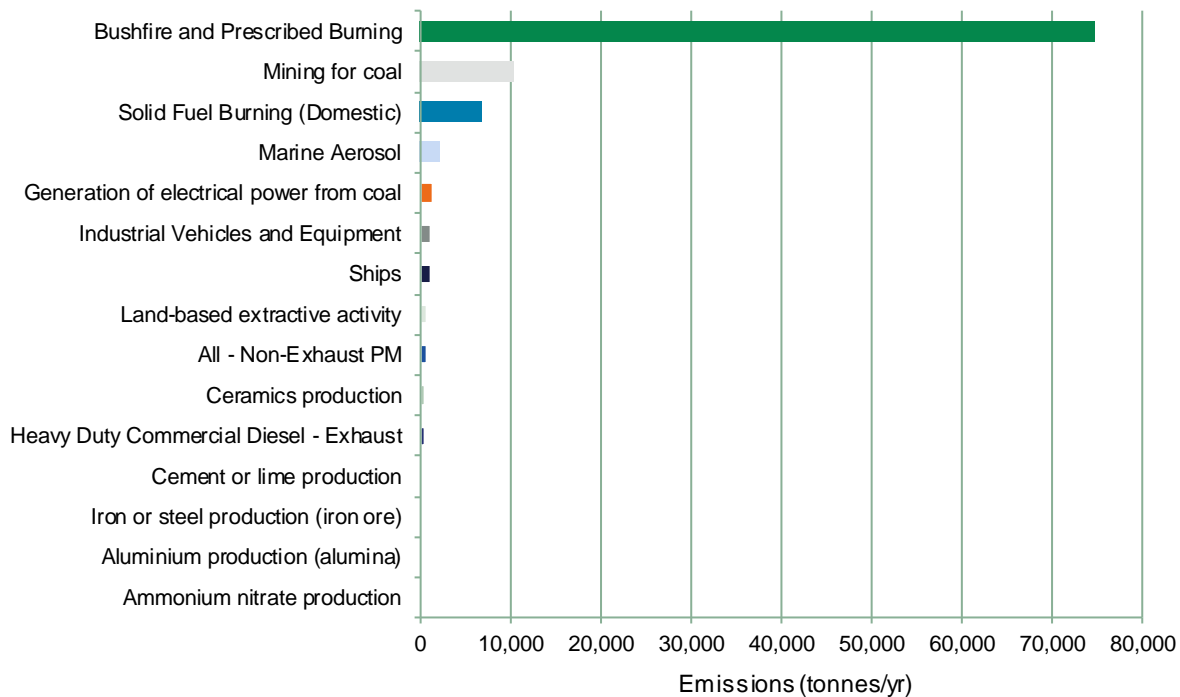


Figure 3-36: GMR: top 15 natural and human-made sources of particulate matter ≤ 2.5µm

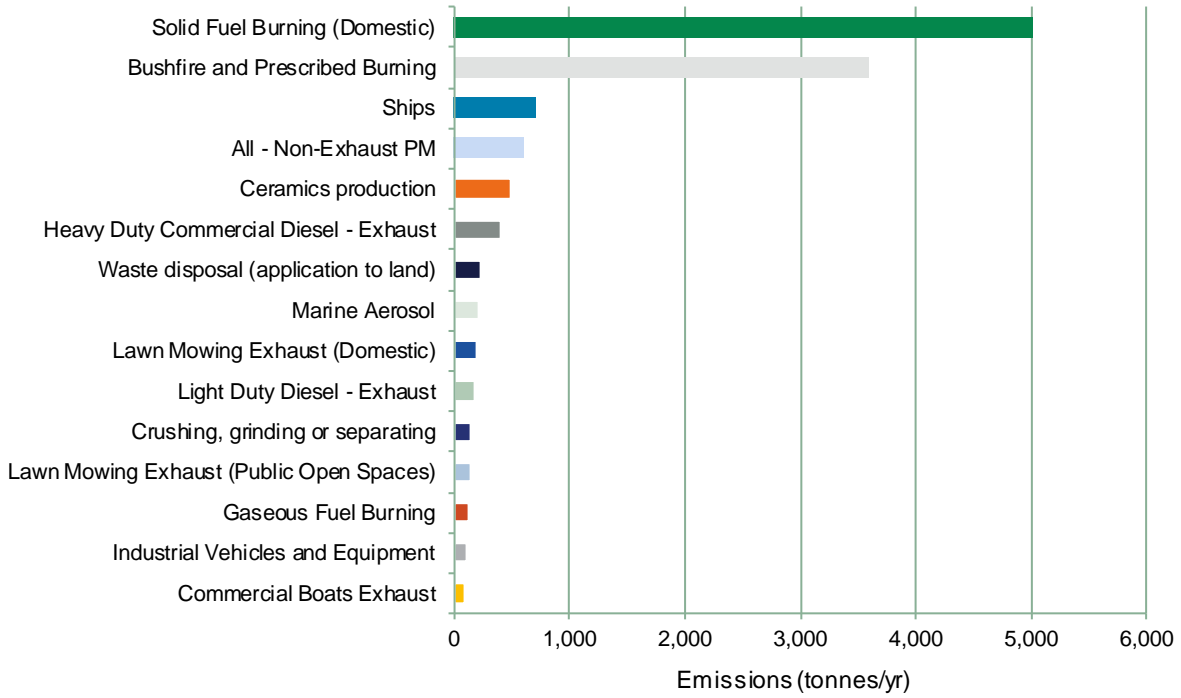


Figure 3-37: Sydney region: top 15 natural and human-made sources of particulate matter ≤ 2.5µm

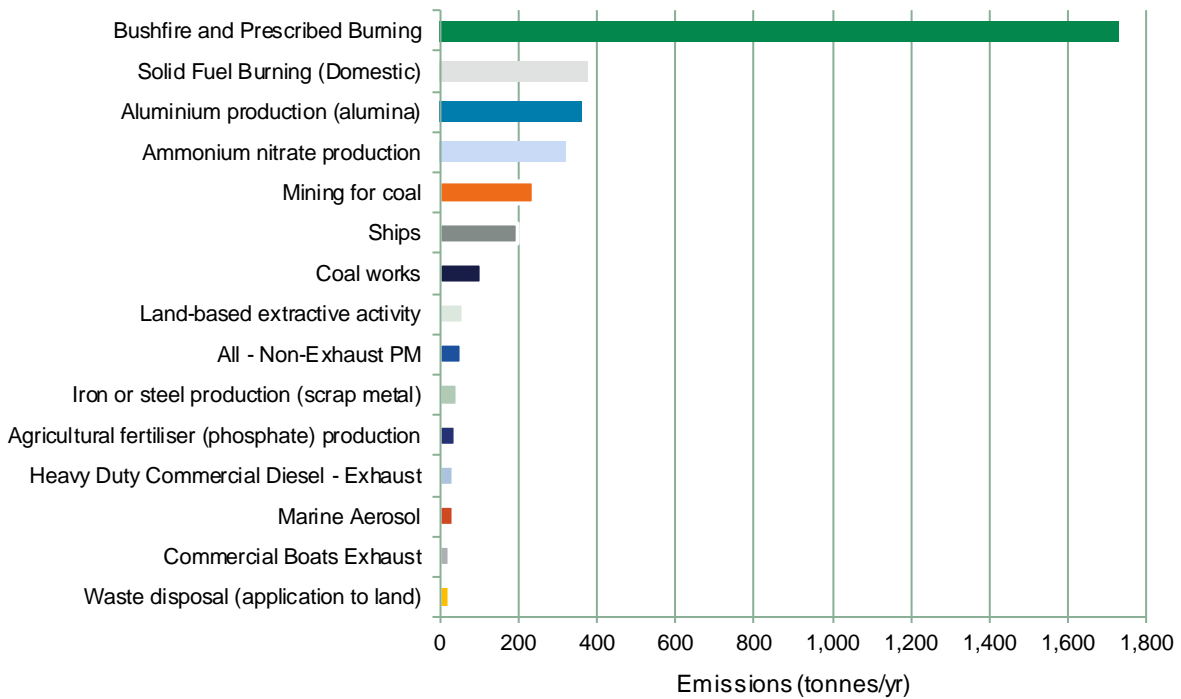


Figure 3-38: Newcastle region: top 15 natural and human-made sources of particulate matter ≤ 2.5µm

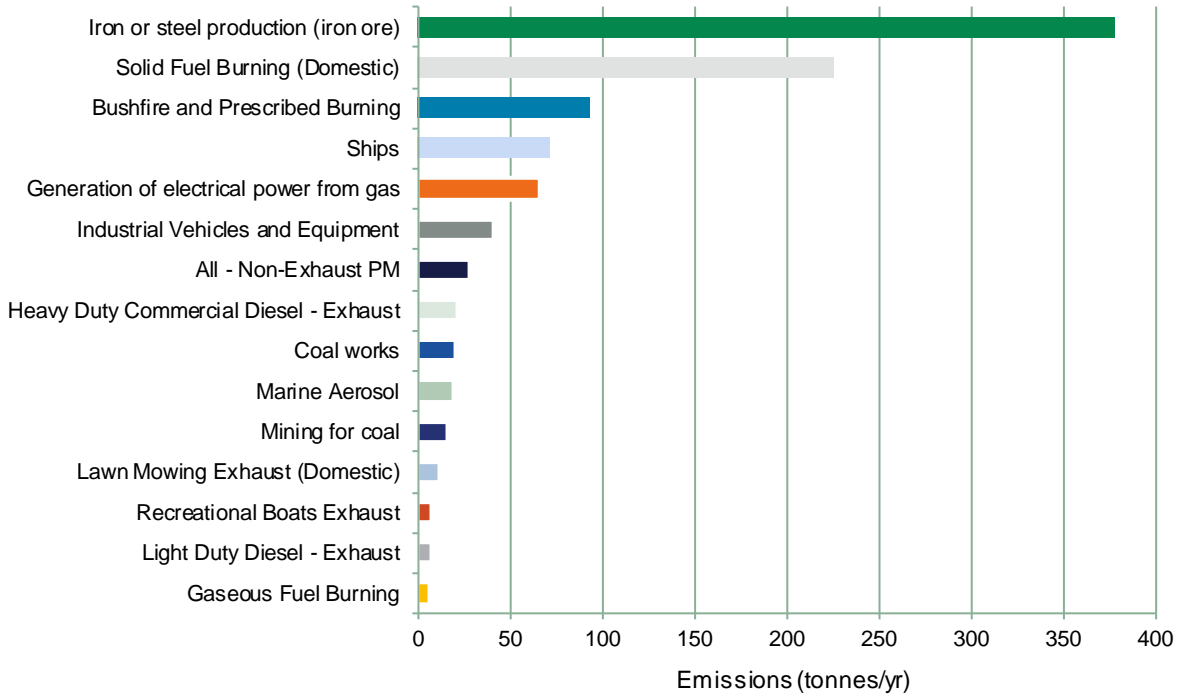


Figure 3-39: Wollongong region: top 15 natural and human-made sources of particulate matter ≤ 2.5µm

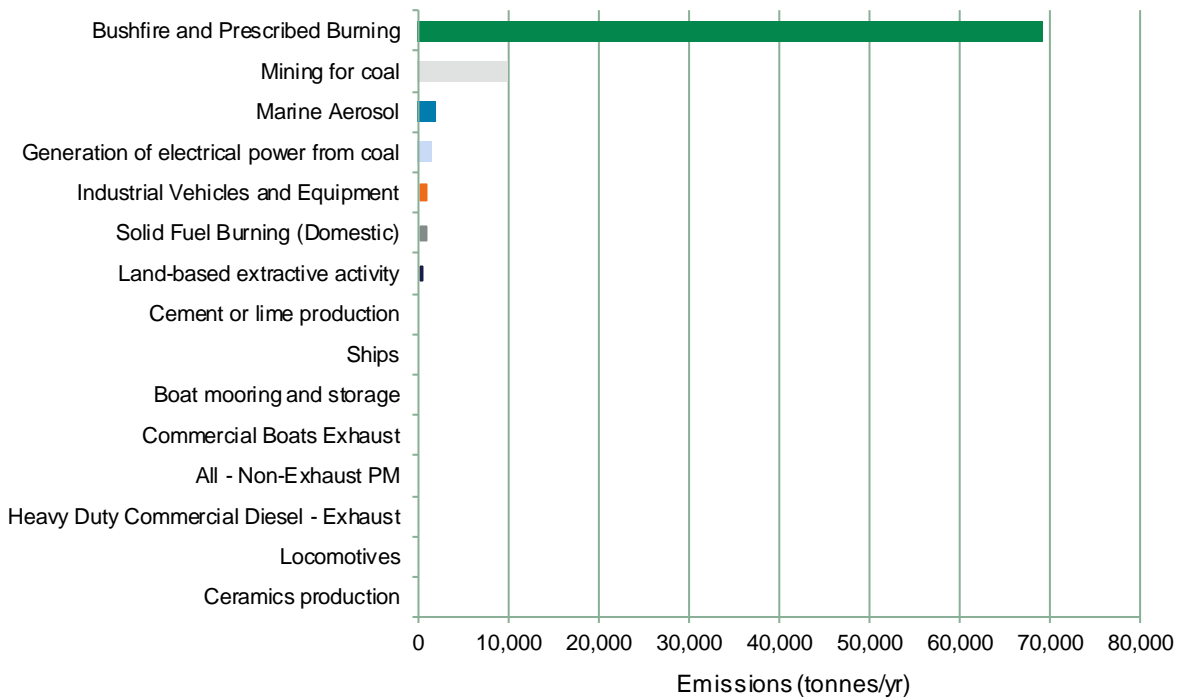


Figure 3-40: Non-urban region: top 15 natural and human-made sources of particulate matter ≤ 2.5µm

## 3.5. Sulfur dioxide

### 3.5.1. Natural and human-made emissions

Table 3-13 presents total estimated annual emissions of sulfur dioxide by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-13: Total estimated annual emissions of sulfur dioxide by natural and human-made source type in each region**

Substance	Region	Emissions (tonnes/year)						Total <sup>39</sup>
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Sulfur dioxide	Sydney	382	78.95	124	3,057	6,790	97.36	10,530
	Newcastle	184	1.76	9.12	8,261	1,709	7.12	10,172
	Wollongong	9.85	0.74	5.75	4,190	640	4.06	4,850
	Non-urban	7,378	110	25.81	198,604	1,618	17.43	207,754
	GMR <sup>39</sup>	7,955	192	165	214,112	10,757	126	233,306

Table 3-14 presents the proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-14: Proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type in each region**

Substance	Region	Proportion (%) <sup>40</sup>					
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Sulfur dioxide	Sydney	3.63	0.75	1.18	29.0	64.5	0.92
	Newcastle	1.81	1.73×10 <sup>-2</sup>	8.97×10 <sup>-2</sup>	81.2	16.8	7.0×10 <sup>-2</sup>
	Wollongong	0.20	1.53×10 <sup>-2</sup>	0.12	86.4	13.2	8.37×10 <sup>-2</sup>
	Non-urban	3.55	5.30×10 <sup>-2</sup>	1.24×10 <sup>-2</sup>	95.6	0.78	8.39×10 <sup>-3</sup>
	GMR	3.41	8.21×10 <sup>-2</sup>	7.06×10 <sup>-2</sup>	91.8	4.61	5.40×10 <sup>-2</sup>

Figure 3-41, Figure 3-42, Figure 3-43, Figure 3-44 and Figure 3-45 show the proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

<sup>39</sup> The totals may differ from the sum of the addends due to rounding.

<sup>40</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10<sup>-2</sup> = 0.0946).



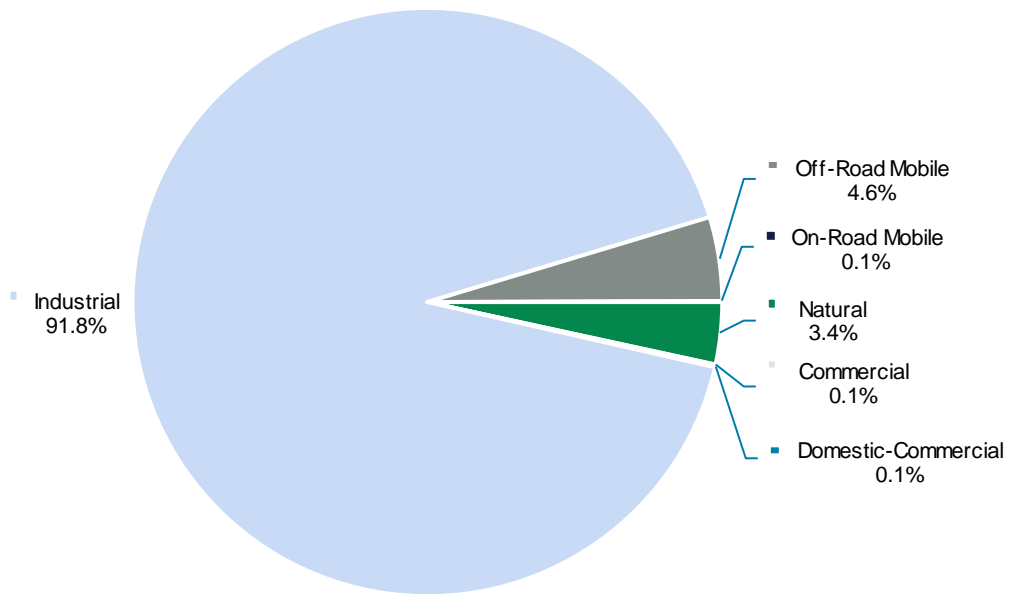


Figure 3-41: GMR: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type

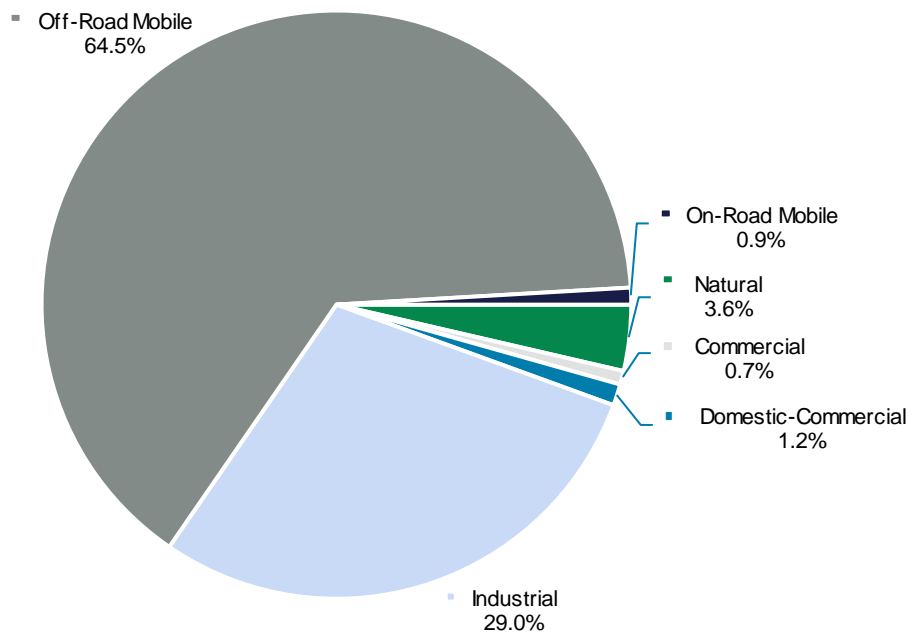
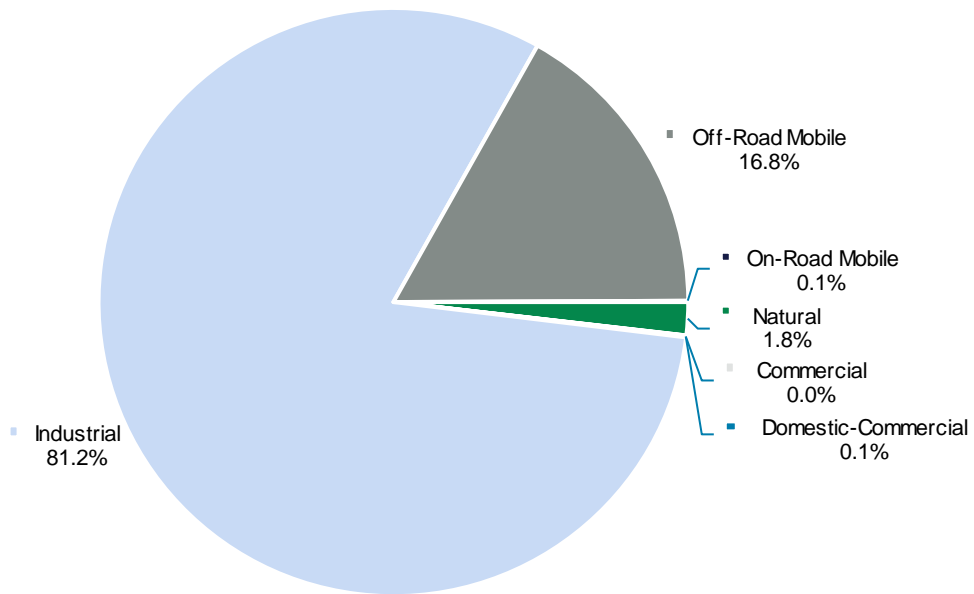
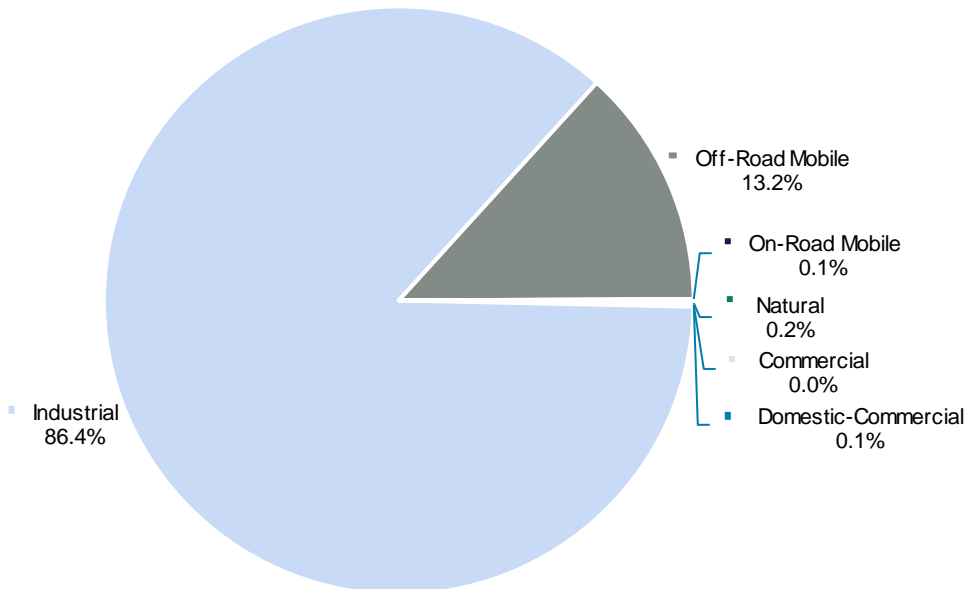


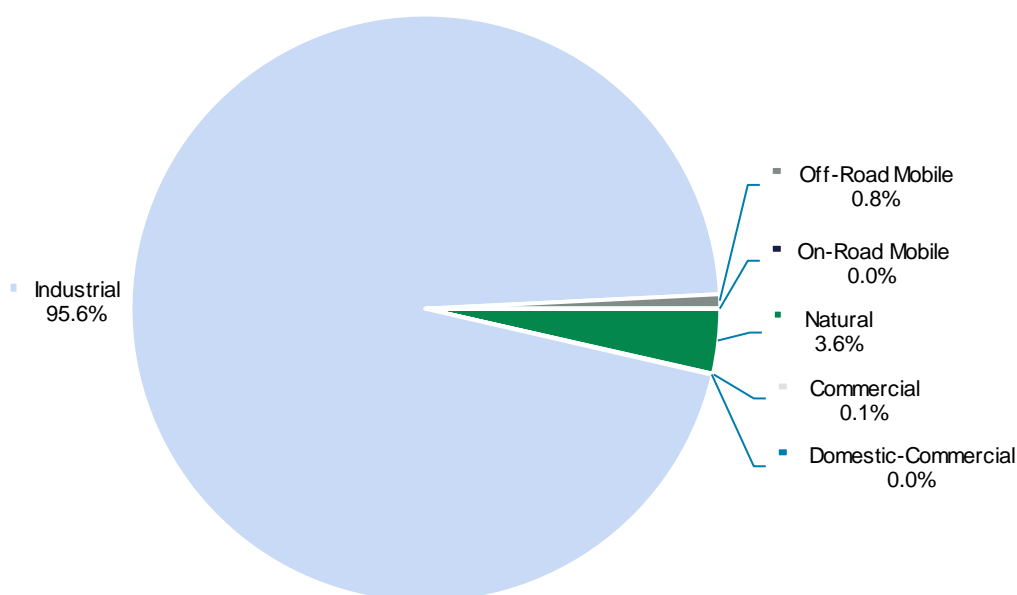
Figure 3-42: Sydney region: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type



**Figure 3-43: Newcastle region: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type**



**Figure 3-44: Wollongong region: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type**



**Figure 3-45: Non-urban region: proportions of total estimated annual emissions of sulfur dioxide by natural and human-made source type**

### 3.5.2. Priority natural and human-made emissions

Table 3-15 presents total estimated annual emissions, proportions and cumulative proportions of natural and human-made sources of sulfur dioxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-15: Natural and human-made sources of sulfur dioxide in each region**

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
<b>Sulfur dioxide in the GMR</b>				
Industrial	Generation of electrical power from coal	198,191	84.9	84.9
Off-Road Mobile	Ships	10,536	4.52	89.5
Industrial	Aluminium production (alumina)	8,168	3.50	93.0
Natural	Bushfire and Prescribed Burning	7,953	3.41	96.4
Industrial	Iron or steel production (iron ore)	4,176	1.79	98.2
Industrial	Petroleum products and fuel production	1,841	0.79	99.0
Industrial	Ceramics production	477	0.20	99.2

<sup>41</sup> n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006).

<sup>42</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g.  $9.46 \times 10^{-2} = 0.0946$ ).

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Industrial	Petrochemical production	473	0.20	99.4
Industrial	Mining for coal	264	0.11	99.5
Industrial	Glass production (container)	213	9.14×10 <sup>-2</sup>	99.6
Off-Road Mobile	Aircraft (Flight Operations)	180	7.70×10 <sup>-2</sup>	99.6
Industrial	Cement or lime production	130	5.57×10 <sup>-2</sup>	99.7
Domestic-Commercial	Solid Fuel Burning (Domestic)	114	4.88×10 <sup>-2</sup>	99.7
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	89.16	3.82×10 <sup>-2</sup>	99.8
Commercial	Log Sawmilling	69.71	2.99×10 <sup>-2</sup>	99.8
Industrial	Chemical production	64.72	2.77×10 <sup>-2</sup>	99.8
Commercial	Food Manufacturing n.e.c.	37.57	1.61×10 <sup>-2</sup>	99.9
Commercial	Ceramic Product Manufacturing	36.98	1.58×10 <sup>-2</sup>	99.9
Industrial	Generation of electrical power from gas	28.51	1.22×10 <sup>-2</sup>	99.9
Off-Road Mobile	Industrial Vehicles and Equipment	17.04	7.30×10 <sup>-3</sup>	99.9
Industrial	Bitumen mixing	14.93	6.40×10 <sup>-3</sup>	99.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	14.51	6.22×10 <sup>-3</sup>	99.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	14.25	6.11×10 <sup>-3</sup>	99.9
Domestic-Commercial	Gaseous Fuel Burning	13.96	5.98×10 <sup>-3</sup>	99.9
Industrial	Non-ferrous metal production (scrap)	13.68	5.86×10 <sup>-3</sup>	99.9
Commercial	Funeral Directors, Crematoria and Cemeteries	13.12	5.62×10 <sup>-3</sup>	99.9
Off-Road Mobile	Commercial Boats Exhaust	12.92	5.54×10 <sup>-3</sup>	99.9
Domestic-Commercial	Barbeques	12.89	5.52×10 <sup>-3</sup>	99.9
Domestic-Commercial	Liquid Fuel Burning (Domestic)	12.45	5.34×10 <sup>-3</sup>	99.9
Commercial	Chemical Product Manufacturing n.e.c.	11.54	4.95×10 <sup>-3</sup>	100.0
Industrial	Iron or steel production (scrap metal)	9.81	4.20×10 <sup>-3</sup>	100.0
Commercial	Port Operators	9.68	4.15×10 <sup>-3</sup>	100.0
Industrial	Slaughtering or processing of animals	9.34	4.00×10 <sup>-3</sup>	100.0
Industrial	Generation of electrical power not coal, diesel or gas	8.73	3.74×10 <sup>-3</sup>	100.0
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	8.61	3.69×10 <sup>-3</sup>	100.0
Commercial	Beer and Malt Manufacturing	8.47	3.63×10 <sup>-3</sup>	100.0
Industrial	Metal plating or coating	8.24	3.53×10 <sup>-3</sup>	100.0
Off-Road Mobile	Recreational Boats Exhaust	7.99	3.42×10 <sup>-3</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
On-Road Mobile	Light Duty Diesel - Exhaust	7.45	3.19×10 <sup>-3</sup>	100.0
Industrial	Crushing, grinding or separating	5.47	2.34×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste oil	3.08	1.32×10 <sup>-3</sup>	100.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	2.98	1.28×10 <sup>-3</sup>	100.0
Industrial	Cement or lime handling	2.72	1.17×10 <sup>-3</sup>	100.0
Off-Road Mobile	Locomotives	2.53	1.09×10 <sup>-3</sup>	100.0
Commercial	Plaster Product Manufacturing	2.46	1.06×10 <sup>-3</sup>	100.0
Industrial	Aluminium production (scrap metal)	2.38	1.02×10 <sup>-3</sup>	100.0
Industrial	Ammonium nitrate production	1.89	8.11×10 <sup>-4</sup>	100.0
Natural	Agricultural Burning	1.82	7.78×10 <sup>-4</sup>	100.0
Industrial	Non-thermal treatment of waste	1.44	6.17×10 <sup>-4</sup>	100.0
Industrial	Container reconditioning	1.06	4.55×10 <sup>-4</sup>	100.0
Industrial	Soap and detergent production	0.78	3.36×10 <sup>-4</sup>	100.0
On-Road Mobile	Others - Exhaust	0.60	2.58×10 <sup>-4</sup>	100.0
Commercial	Waste Disposal Services	0.55	2.35×10 <sup>-4</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.49	2.09×10 <sup>-4</sup>	100.0
Industrial	Land-based extractive activity	0.45	1.93×10 <sup>-4</sup>	100.0
Industrial	General agricultural processing	0.36	1.53×10 <sup>-4</sup>	100.0
Industrial	Paper or pulp production	0.34	1.44×10 <sup>-4</sup>	100.0
Industrial	Sewage treatment - large plants	0.30	1.29×10 <sup>-4</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	0.29	1.24×10 <sup>-4</sup>	100.0
Industrial	Metal processing	0.21	9.09×10 <sup>-5</sup>	100.0
Industrial	Waste disposal (application to land)	0.21	9.04×10 <sup>-5</sup>	100.0
Industrial	Rendering or fat extraction	0.17	7.32×10 <sup>-5</sup>	100.0
Industrial	General animal products production	0.16	6.99×10 <sup>-5</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	0.14	5.86×10 <sup>-5</sup>	100.0
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	0.13	5.60×10 <sup>-5</sup>	100.0
Industrial	Petroleum products storage	0.12	4.97×10 <sup>-5</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	0.11	4.86×10 <sup>-5</sup>	100.0
Commercial	Bread Manufacturing	0.11	4.70×10 <sup>-5</sup>	100.0
Commercial	Gas Supply	0.11	4.56×10 <sup>-5</sup>	100.0
Industrial	Brewing and distilling	7.60×10 <sup>-2</sup>	3.26×10 <sup>-5</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	6.53×10 <sup>-2</sup>	2.80×10 <sup>-5</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Commercial	Biscuit Manufacturing	5.74×10 <sup>-2</sup>	2.46×10 <sup>-5</sup>	100.0
Industrial	Paper production using recycled materials	5.71×10 <sup>-2</sup>	2.45×10 <sup>-5</sup>	100.0
Commercial	Printing	5.41×10 <sup>-2</sup>	2.32×10 <sup>-5</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	4.74×10 <sup>-2</sup>	2.03×10 <sup>-5</sup>	100.0
Commercial	Corrugated Paperboard Container Manufacturing	4.50×10 <sup>-2</sup>	1.93×10 <sup>-5</sup>	100.0
Industrial	Glass production	4.45×10 <sup>-2</sup>	1.91×10 <sup>-5</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	3.75×10 <sup>-2</sup>	1.61×10 <sup>-5</sup>	100.0
Commercial	Laundries and Dry-Cleaners	3.55×10 <sup>-2</sup>	1.52×10 <sup>-5</sup>	100.0
Industrial	Solid waste landfilling	3.53×10 <sup>-2</sup>	1.51×10 <sup>-5</sup>	100.0
Industrial	Dairy processing	3.46×10 <sup>-2</sup>	1.48×10 <sup>-5</sup>	100.0
Industrial	Concrete works	3.40×10 <sup>-2</sup>	1.46×10 <sup>-5</sup>	100.0
Commercial	Basic Iron and Steel Manufacturing	3.29×10 <sup>-2</sup>	1.41×10 <sup>-5</sup>	100.0
Commercial	Metal Coating and Finishing	3.13×10 <sup>-2</sup>	1.34×10 <sup>-5</sup>	100.0
Industrial	Composting	3.07×10 <sup>-2</sup>	1.32×10 <sup>-5</sup>	100.0
Industrial	Printing, packaging and visual media production	2.43×10 <sup>-2</sup>	1.04×10 <sup>-5</sup>	100.0
Industrial	Water-based extractive activity	2.24×10 <sup>-2</sup>	9.59×10 <sup>-6</sup>	100.0
Commercial	Non-Ferrous Metal Casting	2.12×10 <sup>-2</sup>	9.08×10 <sup>-6</sup>	100.0
Industrial	Sewage treatment - small plants	2.08×10 <sup>-2</sup>	8.91×10 <sup>-6</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	2.05×10 <sup>-2</sup>	8.77×10 <sup>-6</sup>	100.0
Commercial	Oil and Fat Manufacturing	1.88×10 <sup>-2</sup>	8.07×10 <sup>-6</sup>	100.0
Industrial	Paints/polishes/adhesives production	1.87×10 <sup>-2</sup>	8.00×10 <sup>-6</sup>	100.0
Industrial	Explosives production	1.79×10 <sup>-2</sup>	7.65×10 <sup>-6</sup>	100.0
Industrial	Recovery of waste	1.45×10 <sup>-2</sup>	6.22×10 <sup>-6</sup>	100.0
Commercial	Services to Air Transport	1.36×10 <sup>-2</sup>	5.83×10 <sup>-6</sup>	100.0
Industrial	General chemicals storage	1.18×10 <sup>-2</sup>	5.05×10 <sup>-6</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	1.16×10 <sup>-2</sup>	4.99×10 <sup>-6</sup>	100.0
Commercial	Cake and Pastry Manufacturing	1.11×10 <sup>-2</sup>	4.74×10 <sup>-6</sup>	100.0
Commercial	Milk and Cream Processing	1.10×10 <sup>-2</sup>	4.73×10 <sup>-6</sup>	100.0
Commercial	Ice Cream Manufacturing	1.10×10 <sup>-2</sup>	4.73×10 <sup>-6</sup>	100.0
Commercial	Fruit and Vegetable Processing	1.10×10 <sup>-2</sup>	4.71×10 <sup>-6</sup>	100.0
Industrial	Bird accommodation	1.09×10 <sup>-2</sup>	4.67×10 <sup>-6</sup>	100.0
Commercial	Aircraft Manufacturing	9.73×10 <sup>-3</sup>	4.17×10 <sup>-6</sup>	100.0
Commercial	Scientific Research	8.51×10 <sup>-3</sup>	3.65×10 <sup>-6</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Commercial	Plastic Injection Moulded Product Manufacturing	8.51×10 <sup>-3</sup>	3.65×10 <sup>-6</sup>	100.0
Industrial	Sterilisation activities	7.68×10 <sup>-3</sup>	3.29×10 <sup>-6</sup>	100.0
Industrial	Other land-based extraction	5.20×10 <sup>-3</sup>	2.23×10 <sup>-6</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	3.98×10 <sup>-3</sup>	1.71×10 <sup>-6</sup>	100.0
Commercial	Synthetic Resin Manufacturing	3.54×10 <sup>-3</sup>	1.52×10 <sup>-6</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	3.40×10 <sup>-3</sup>	1.46×10 <sup>-6</sup>	100.0
Industrial	Plastics resins production	3.00×10 <sup>-3</sup>	1.29×10 <sup>-6</sup>	100.0
Industrial	Waste storage	2.46×10 <sup>-3</sup>	1.06×10 <sup>-6</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	2.19×10 <sup>-3</sup>	9.37×10 <sup>-7</sup>	100.0
Commercial	Confectionery Manufacturing	1.52×10 <sup>-3</sup>	6.52×10 <sup>-7</sup>	100.0
Industrial	Rubber products/tyre production	1.33×10 <sup>-3</sup>	5.69×10 <sup>-7</sup>	100.0
Industrial	Helicopter-related activity	1.27×10 <sup>-3</sup>	5.44×10 <sup>-7</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	1.07×10 <sup>-3</sup>	4.59×10 <sup>-7</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	1.05×10 <sup>-3</sup>	4.51×10 <sup>-7</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	8.71×10 <sup>-4</sup>	3.73×10 <sup>-7</sup>	100.0
Industrial	Chemical storage	8.16×10 <sup>-4</sup>	3.50×10 <sup>-7</sup>	100.0
Industrial	Pesticides and related products production	5.55×10 <sup>-4</sup>	2.38×10 <sup>-7</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	1.52×10 <sup>-4</sup>	6.53×10 <sup>-8</sup>	100.0
Industrial	Shipping in bulk	7.61×10 <sup>-5</sup>	3.26×10 <sup>-8</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	6.10×10 <sup>-5</sup>	2.62×10 <sup>-8</sup>	100.0
Industrial	Animal accommodation	5.00×10 <sup>-5</sup>	2.14×10 <sup>-8</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	2.74×10 <sup>-5</sup>	1.18×10 <sup>-8</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	1.89×10 <sup>-5</sup>	8.09×10 <sup>-9</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	4.38×10 <sup>-6</sup>	1.88×10 <sup>-9</sup>	100.0
Industrial	Coal works	1.69×10 <sup>-6</sup>	7.25×10 <sup>-10</sup>	100.0
Commercial	Non-Building Construction n.e.c.	8.77×10 <sup>-7</sup>	3.76×10 <sup>-10</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	1.39×10 <sup>-7</sup>	5.98×10 <sup>-11</sup>	100.0
Commercial	Industrial Gas Manufacturing	2.76×10 <sup>-8</sup>	1.18×10 <sup>-11</sup>	100.0
Commercial	Wine Manufacturing	6.74×10 <sup>-9</sup>	2.89×10 <sup>-12</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
<b>Sulfur dioxide in the Sydney region</b>				
Off-Road Mobile	Ships	6,606	62.7	62.7
Industrial	Petroleum products and fuel production	1,840	17.5	80.2
Industrial	Petrochemical production	473	4.50	84.7
Industrial	Ceramics production	458	4.35	89.1
Natural	Bushfire and Prescribed Burning	382	3.63	92.7
Industrial	Glass production (container)	213	2.03	94.7
Off-Road Mobile	Aircraft (Flight Operations)	173	1.64	96.4
Domestic-Commercial	Solid Fuel Burning (Domestic)	84.16	0.80	97.2
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	70.01	0.66	97.8
Commercial	Ceramic Product Manufacturing	36.80	0.35	98.2
Industrial	Generation of electrical power from gas	23.07	0.22	98.4
Industrial	Non-ferrous metal production (scrap)	13.68	0.13	98.5
Commercial	Chemical Product Manufacturing n.e.c.	11.54	0.11	98.6
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	11.45	0.11	98.7
Domestic-Commercial	Gaseous Fuel Burning	11.02	0.10	98.8
Domestic-Commercial	Barbeques	10.18	9.66×10 <sup>-2</sup>	98.9
Domestic-Commercial	Liquid Fuel Burning (Domestic)	9.83	9.34×10 <sup>-2</sup>	99.0
Commercial	Port Operators	9.68	9.20×10 <sup>-2</sup>	99.1
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	9.63	9.15×10 <sup>-2</sup>	99.2
Industrial	Cement or lime production	8.95	8.50×10 <sup>-2</sup>	99.3
Commercial	Beer and Malt Manufacturing	8.47	8.05×10 <sup>-2</sup>	99.4
Commercial	Funeral Directors, Crematoria and Cemeteries	8.19	7.78×10 <sup>-2</sup>	99.5
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	6.43	6.10×10 <sup>-2</sup>	99.5
On-Road Mobile	Light Duty Diesel - Exhaust	5.80	5.51×10 <sup>-2</sup>	99.6
Industrial	Crushing, grinding or separating	5.46	5.19×10 <sup>-2</sup>	99.6
Industrial	Generation of electrical power not coal, diesel or gas	4.27	4.06×10 <sup>-2</sup>	99.7
Off-Road Mobile	Commercial Boats Exhaust	4.08	3.87×10 <sup>-2</sup>	99.7
Industrial	Bitumen mixing	4.08	3.87×10 <sup>-2</sup>	99.7
Off-Road Mobile	Recreational Boats Exhaust	4.07	3.87×10 <sup>-2</sup>	99.8
Industrial	Recovery of waste oil	3.07	2.91×10 <sup>-2</sup>	99.8
Industrial	Cement or lime handling	2.72	2.58×10 <sup>-2</sup>	99.8



Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Commercial	Plaster Product Manufacturing	2.46	2.34×10 <sup>-2</sup>	99.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	2.39	2.27×10 <sup>-2</sup>	99.9
Off-Road Mobile	Industrial Vehicles and Equipment	2.29	2.18×10 <sup>-2</sup>	99.9
Industrial	Non-thermal treatment of waste	1.44	1.36×10 <sup>-2</sup>	99.9
Industrial	Container reconditioning	1.06	1.01×10 <sup>-2</sup>	99.9
Industrial	Soap and detergent production	0.78	7.45×10 <sup>-3</sup>	99.9
Industrial	Iron or steel production (scrap metal)	0.75	7.09×10 <sup>-3</sup>	99.9
Commercial	Waste Disposal Services	0.55	5.20×10 <sup>-3</sup>	99.9
On-Road Mobile	Others - Exhaust	0.46	4.40×10 <sup>-3</sup>	100.0
Industrial	Mining for coal	0.45	4.23×10 <sup>-3</sup>	100.0
Off-Road Mobile	Locomotives	0.35	3.36×10 <sup>-3</sup>	100.0
Industrial	Paper or pulp production	0.34	3.20×10 <sup>-3</sup>	100.0
Industrial	Chemical production	0.32	3.05×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	0.28	2.65×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - large plants	0.28	2.63×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.27	2.55×10 <sup>-3</sup>	100.0
Industrial	General agricultural processing	0.25	2.38×10 <sup>-3</sup>	100.0
Industrial	Waste disposal (application to land)	0.16	1.50×10 <sup>-3</sup>	100.0
Natural	Agricultural Burning	0.16	1.50×10 <sup>-3</sup>	100.0
Industrial	General animal products production	0.15	1.42×10 <sup>-3</sup>	100.0
Industrial	Rendering or fat extraction	0.14	1.32×10 <sup>-3</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	0.13	1.28×10 <sup>-3</sup>	100.0
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	0.13	1.24×10 <sup>-3</sup>	100.0
Industrial	Metal plating or coating	0.12	1.18×10 <sup>-3</sup>	100.0
Industrial	Petroleum products storage	0.12	1.10×10 <sup>-3</sup>	100.0
Commercial	Gas Supply	0.11	1.01×10 <sup>-3</sup>	100.0
Commercial	Food Manufacturing n.e.c.	0.11	1.00×10 <sup>-3</sup>	100.0
Commercial	Bread Manufacturing	9.59×10 <sup>-2</sup>	9.10×10 <sup>-4</sup>	100.0
Industrial	Brewing and distilling	7.60×10 <sup>-2</sup>	7.21×10 <sup>-4</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	6.22×10 <sup>-2</sup>	5.91×10 <sup>-4</sup>	100.0
Commercial	Biscuit Manufacturing	5.74×10 <sup>-2</sup>	5.45×10 <sup>-4</sup>	100.0
Industrial	Paper production using recycled materials	5.71×10 <sup>-2</sup>	5.42×10 <sup>-4</sup>	100.0
Commercial	Printing	5.41×10 <sup>-2</sup>	5.14×10 <sup>-4</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Industrial	Pharmaceutical and veterinary products production	4.71×10 <sup>-2</sup>	4.48×10 <sup>-4</sup>	100.0
Commercial	Corrugated Paperboard Container Manufacturing	4.50×10 <sup>-2</sup>	4.28×10 <sup>-4</sup>	100.0
Industrial	Glass production	4.45×10 <sup>-2</sup>	4.23×10 <sup>-4</sup>	100.0
Commercial	Laundries and Dry-Cleaners	3.55×10 <sup>-2</sup>	3.37×10 <sup>-4</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	3.09×10 <sup>-2</sup>	2.93×10 <sup>-4</sup>	100.0
Industrial	Composting	3.07×10 <sup>-2</sup>	2.92×10 <sup>-4</sup>	100.0
Industrial	Printing, packaging and visual media production	2.43×10 <sup>-2</sup>	2.30×10 <sup>-4</sup>	100.0
Industrial	Dairy processing	2.43×10 <sup>-2</sup>	2.30×10 <sup>-4</sup>	100.0
Industrial	Slaughtering or processing of animals	2.36×10 <sup>-2</sup>	2.24×10 <sup>-4</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	2.05×10 <sup>-2</sup>	1.94×10 <sup>-4</sup>	100.0
Industrial	Metal processing	1.98×10 <sup>-2</sup>	1.88×10 <sup>-4</sup>	100.0
Commercial	Oil and Fat Manufacturing	1.88×10 <sup>-2</sup>	1.79×10 <sup>-4</sup>	100.0
Industrial	Paints/polishes/adhesives production	1.87×10 <sup>-2</sup>	1.77×10 <sup>-4</sup>	100.0
Commercial	Metal Coating and Finishing	1.64×10 <sup>-2</sup>	1.56×10 <sup>-4</sup>	100.0
Industrial	Concrete works	1.53×10 <sup>-2</sup>	1.46×10 <sup>-4</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	1.45×10 <sup>-2</sup>	1.37×10 <sup>-4</sup>	100.0
Commercial	Services to Air Transport	1.36×10 <sup>-2</sup>	1.29×10 <sup>-4</sup>	100.0
Commercial	Cake and Pastry Manufacturing	1.11×10 <sup>-2</sup>	1.05×10 <sup>-4</sup>	100.0
Commercial	Milk and Cream Processing	1.10×10 <sup>-2</sup>	1.05×10 <sup>-4</sup>	100.0
Commercial	Ice Cream Manufacturing	1.10×10 <sup>-2</sup>	1.05×10 <sup>-4</sup>	100.0
Commercial	Fruit and Vegetable Processing	1.10×10 <sup>-2</sup>	1.04×10 <sup>-4</sup>	100.0
Industrial	Sewage treatment - small plants	9.78×10 <sup>-3</sup>	9.29×10 <sup>-5</sup>	100.0
Commercial	Aircraft Manufacturing	9.73×10 <sup>-3</sup>	9.24×10 <sup>-5</sup>	100.0
Commercial	Scientific Research	8.51×10 <sup>-3</sup>	8.08×10 <sup>-5</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	8.51×10 <sup>-3</sup>	8.08×10 <sup>-5</sup>	100.0
Industrial	Sterilisation activities	7.68×10 <sup>-3</sup>	7.29×10 <sup>-5</sup>	100.0
Commercial	Basic Iron and Steel Manufacturing	5.17×10 <sup>-3</sup>	4.91×10 <sup>-5</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	3.40×10 <sup>-3</sup>	3.22×10 <sup>-5</sup>	100.0
Industrial	Land-based extractive activity	3.04×10 <sup>-3</sup>	2.89×10 <sup>-5</sup>	100.0
Industrial	Bird accommodation	3.03×10 <sup>-3</sup>	2.88×10 <sup>-5</sup>	100.0
Industrial	Plastics resins production	3.00×10 <sup>-3</sup>	2.85×10 <sup>-5</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Industrial	Waste storage	2.46×10 <sup>-3</sup>	2.34×10 <sup>-5</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	2.35×10 <sup>-3</sup>	2.23×10 <sup>-5</sup>	100.0
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	2.19×10 <sup>-3</sup>	2.08×10 <sup>-5</sup>	100.0
Commercial	Synthetic Resin Manufacturing	2.19×10 <sup>-3</sup>	2.08×10 <sup>-5</sup>	100.0
Commercial	Confectionery Manufacturing	1.52×10 <sup>-3</sup>	1.45×10 <sup>-5</sup>	100.0
Industrial	Rubber products/tyre production	1.33×10 <sup>-3</sup>	1.26×10 <sup>-5</sup>	100.0
Industrial	Helicopter-related activity	1.27×10 <sup>-3</sup>	1.21×10 <sup>-5</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	8.59×10 <sup>-4</sup>	8.16×10 <sup>-6</sup>	100.0
Industrial	Chemical storage	8.16×10 <sup>-4</sup>	7.75×10 <sup>-6</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	5.64×10 <sup>-4</sup>	5.36×10 <sup>-6</sup>	100.0
Industrial	Pesticides and related products production	5.55×10 <sup>-4</sup>	5.27×10 <sup>-6</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	1.52×10 <sup>-4</sup>	1.45×10 <sup>-6</sup>	100.0
Industrial	Shipping in bulk	7.61×10 <sup>-5</sup>	7.23×10 <sup>-7</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	6.10×10 <sup>-5</sup>	5.79×10 <sup>-7</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	2.74×10 <sup>-5</sup>	2.60×10 <sup>-7</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	1.89×10 <sup>-5</sup>	1.79×10 <sup>-7</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	4.38×10 <sup>-6</sup>	4.16×10 <sup>-8</sup>	100.0
Commercial	Non-Building Construction n.e.c.	6.13×10 <sup>-7</sup>	5.82×10 <sup>-9</sup>	100.0
Commercial	Industrial Gas Manufacturing	2.76×10 <sup>-8</sup>	2.62×10 <sup>-10</sup>	100.0
Commercial	Wine Manufacturing	6.74×10 <sup>-9</sup>	6.40×10 <sup>-11</sup>	100.0
<b>Sulfur dioxide in the Newcastle region</b>				
Industrial	Aluminium production (alumina)	8,168	80.3	80.3
Off-Road Mobile	Ships	1,703	16.7	97.0
Natural	Bushfire and Prescribed Burning	184	1.81	98.9
Industrial	Chemical production	64.36	0.63	99.5
Industrial	Slaughtering or processing of animals	9.32	9.16×10 <sup>-2</sup>	99.6
Industrial	Iron or steel production (scrap metal)	9.06	8.91×10 <sup>-2</sup>	99.7
Domestic-Commercial	Solid Fuel Burning (Domestic)	6.36	6.25×10 <sup>-2</sup>	99.7
Industrial	Bitumen mixing	6.04	5.93×10 <sup>-2</sup>	99.8

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	5.03	4.95×10 <sup>-2</sup>	99.8
Off-Road Mobile	Aircraft (Flight Operations)	3.41	3.35×10 <sup>-2</sup>	99.9
Industrial	Generation of electrical power not coal, diesel or gas	2.17	2.14×10 <sup>-2</sup>	99.9
Industrial	Ammonium nitrate production	1.89	1.86×10 <sup>-2</sup>	99.9
Commercial	Funeral Directors, Crematoria and Cemeteries	1.60	1.58×10 <sup>-2</sup>	99.9
Off-Road Mobile	Commercial Boats Exhaust	1.18	1.16×10 <sup>-2</sup>	99.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	0.95	9.34×10 <sup>-3</sup>	99.9
Domestic-Commercial	Gaseous Fuel Burning	0.74	7.25×10 <sup>-3</sup>	100.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	0.69	6.74×10 <sup>-3</sup>	100.0
Domestic-Commercial	Barbeques	0.68	6.69×10 <sup>-3</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.66	6.46×10 <sup>-3</sup>	100.0
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	0.54	5.30×10 <sup>-3</sup>	100.0
On-Road Mobile	Light Duty Diesel - Exhaust	0.42	4.09×10 <sup>-3</sup>	100.0
Off-Road Mobile	Recreational Boats Exhaust	0.36	3.50×10 <sup>-3</sup>	100.0
Off-Road Mobile	Locomotives	0.31	3.05×10 <sup>-3</sup>	100.0
Off-Road Mobile	Industrial Vehicles and Equipment	0.25	2.50×10 <sup>-3</sup>	100.0
Industrial	Metal processing	0.18	1.74×10 <sup>-3</sup>	100.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	0.15	1.44×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.12	1.22×10 <sup>-3</sup>	100.0
Industrial	General agricultural processing	7.19×10 <sup>-2</sup>	7.07×10 <sup>-4</sup>	100.0
Industrial	Generation of electrical power from gas	5.48×10 <sup>-2</sup>	5.39×10 <sup>-4</sup>	100.0
On-Road Mobile	Others - Exhaust	3.58×10 <sup>-2</sup>	3.52×10 <sup>-4</sup>	100.0
Natural	Agricultural Burning	3.42×10 <sup>-2</sup>	3.36×10 <sup>-4</sup>	100.0
Industrial	Mining for coal	2.72×10 <sup>-2</sup>	2.67×10 <sup>-4</sup>	100.0
Industrial	Petroleum products and fuel production	1.81×10 <sup>-2</sup>	1.78×10 <sup>-4</sup>	100.0
Industrial	Metal plating or coating	1.78×10 <sup>-2</sup>	1.75×10 <sup>-4</sup>	100.0
Commercial	Metal Coating and Finishing	1.49×10 <sup>-2</sup>	1.47×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste	1.45×10 <sup>-2</sup>	1.43×10 <sup>-4</sup>	100.0
Commercial	Bread Manufacturing	1.39×10 <sup>-2</sup>	1.37×10 <sup>-4</sup>	100.0
Industrial	Dairy processing	1.03×10 <sup>-2</sup>	1.02×10 <sup>-4</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	9.78×10 <sup>-3</sup>	9.61×10 <sup>-5</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Off-Road Mobile	Commercial Vehicles and Equipment	5.99×10 <sup>-3</sup>	5.89×10 <sup>-5</sup>	100.0
Industrial	Other land-based extraction	5.20×10 <sup>-3</sup>	5.12×10 <sup>-5</sup>	100.0
Industrial	Cement or lime handling	2.20×10 <sup>-3</sup>	2.16×10 <sup>-5</sup>	100.0
Industrial	Land-based extractive activity	1.42×10 <sup>-3</sup>	1.40×10 <sup>-5</sup>	100.0
Industrial	Non-thermal treatment of waste	2.58×10 <sup>-4</sup>	2.53×10 <sup>-6</sup>	100.0
Commercial	Waste Disposal Services	5.92×10 <sup>-5</sup>	5.82×10 <sup>-7</sup>	100.0
Industrial	Petroleum products storage	3.38×10 <sup>-5</sup>	3.33×10 <sup>-7</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	1.39×10 <sup>-7</sup>	1.37×10 <sup>-9</sup>	100.0
Industrial	Crushing, grinding or separating	2.41×10 <sup>-9</sup>	2.37×10 <sup>-11</sup>	100.0
<b>Sulfur dioxide in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	4,176	86.1	86.1
Off-Road Mobile	Ships	639	13.2	99.3
Natural	Bushfire and Prescribed Burning	9.85	0.20	99.5
Industrial	Metal plating or coating	8.09	0.17	99.6
Industrial	Generation of electrical power from gas	5.09	0.10	99.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	3.79	7.81×10 <sup>-2</sup>	99.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2.89	5.97×10 <sup>-2</sup>	99.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	0.56	1.15×10 <sup>-2</sup>	99.9
Domestic-Commercial	Gaseous Fuel Burning	0.53	1.10×10 <sup>-2</sup>	99.9
Commercial	Funeral Directors, Crematoria and Cemeteries	0.53	1.09×10 <sup>-2</sup>	99.9
Off-Road Mobile	Recreational Boats Exhaust	0.51	1.04×10 <sup>-2</sup>	99.9
Off-Road Mobile	Industrial Vehicles and Equipment	0.50	1.02×10 <sup>-2</sup>	99.9
Domestic-Commercial	Barbeques	0.49	1.01×10 <sup>-2</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.47	9.78×10 <sup>-3</sup>	100.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	0.36	7.49×10 <sup>-3</sup>	100.0
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	0.36	7.43×10 <sup>-3</sup>	100.0
Industrial	Bitumen mixing	0.23	4.81×10 <sup>-3</sup>	100.0
On-Road Mobile	Light Duty Diesel - Exhaust	0.22	4.62×10 <sup>-3</sup>	100.0
Commercial	Ceramic Product Manufacturing	0.17	3.51×10 <sup>-3</sup>	100.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	0.11	2.25×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Boats Exhaust	8.17×10 <sup>-2</sup>	1.69×10 <sup>-3</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Off-Road Mobile	Aircraft (Flight Operations)	5.51×10 <sup>-2</sup>	1.14×10 <sup>-3</sup>	100.0
Off-Road Mobile	Locomotives	4.61×10 <sup>-2</sup>	9.52×10 <sup>-4</sup>	100.0
Commercial	Basic Iron and Steel Manufacturing	2.77×10 <sup>-2</sup>	5.72×10 <sup>-4</sup>	100.0
Industrial	Sewage treatment - large plants	2.02×10 <sup>-2</sup>	4.17×10 <sup>-4</sup>	100.0
On-Road Mobile	Others - Exhaust	1.97×10 <sup>-2</sup>	4.07×10 <sup>-4</sup>	100.0
Industrial	Metal processing	1.53×10 <sup>-2</sup>	3.16×10 <sup>-4</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	1.31×10 <sup>-2</sup>	2.69×10 <sup>-4</sup>	100.0
Industrial	General chemicals storage	1.16×10 <sup>-2</sup>	2.39×10 <sup>-4</sup>	100.0
Industrial	Chemical production	5.44×10 <sup>-3</sup>	1.12×10 <sup>-4</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	3.98×10 <sup>-3</sup>	8.21×10 <sup>-5</sup>	100.0
Industrial	Non-thermal treatment of waste	3.03×10 <sup>-3</sup>	6.24×10 <sup>-5</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	4.23×10 <sup>-4</sup>	8.73×10 <sup>-6</sup>	100.0
Industrial	Container reconditioning	3.40×10 <sup>-4</sup>	7.01×10 <sup>-6</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	1.11×10 <sup>-5</sup>	2.29×10 <sup>-7</sup>	100.0
Commercial	Synthetic Resin Manufacturing	3.59×10 <sup>-6</sup>	7.41×10 <sup>-8</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	2.19×10 <sup>-8</sup>	4.52×10 <sup>-10</sup>	100.0
<b>Sulfur dioxide in the Non-urban region</b>				
Industrial	Generation of electrical power from coal	198,191	95.4	95.4
Natural	Bushfire and Prescribed Burning	7,377	3.55	98.9
Off-Road Mobile	Ships	1,589	0.76	99.7
Industrial	Mining for coal	263	0.13	99.8
Industrial	Cement or lime production	121	5.82×10 <sup>-2</sup>	99.9
Commercial	Log Sawmilling	69.71	3.36×10 <sup>-2</sup>	99.9
Commercial	Food Manufacturing n.e.c.	37.47	1.80×10 <sup>-2</sup>	99.9
Domestic-Commercial	Solid Fuel Burning (Domestic)	19.50	9.38×10 <sup>-3</sup>	100.0
Industrial	Ceramics production	18.19	8.76×10 <sup>-3</sup>	100.0
Off-Road Mobile	Industrial Vehicles and Equipment	13.99	6.74×10 <sup>-3</sup>	100.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	11.22	5.40×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Boats Exhaust	7.58	3.65×10 <sup>-3</sup>	100.0
Industrial	Bitumen mixing	4.59	2.21×10 <sup>-3</sup>	100.0
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	3.37	1.62×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Flight Operations)	3.23	1.55×10 <sup>-3</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Off-Road Mobile	Recreational Boats Exhaust	3.05	1.47×10 <sup>-3</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	2.79	1.34×10 <sup>-3</sup>	100.0
Industrial	Aluminium production (scrap metal)	2.38	1.15×10 <sup>-3</sup>	100.0
Industrial	Generation of electrical power not coal, diesel or gas	2.29	1.10×10 <sup>-3</sup>	100.0
Off-Road Mobile	Locomotives	1.82	8.78×10 <sup>-4</sup>	100.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1.75	8.40×10 <sup>-4</sup>	100.0
Domestic-Commercial	Gaseous Fuel Burning	1.67	8.02×10 <sup>-4</sup>	100.0
Natural	Agricultural Burning	1.62	7.82×10 <sup>-4</sup>	100.0
Domestic-Commercial	Barbeques	1.54	7.40×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	1.49	7.15×10 <sup>-4</sup>	100.0
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1.28	6.17×10 <sup>-4</sup>	100.0
On-Road Mobile	Light Duty Diesel - Exhaust	1.01	4.86×10 <sup>-4</sup>	100.0
Industrial	Land-based extractive activity	0.45	2.14×10 <sup>-4</sup>	100.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	0.34	1.61×10 <sup>-4</sup>	100.0
Industrial	Generation of electrical power from gas	0.30	1.42×10 <sup>-4</sup>	100.0
Industrial	Petroleum products and fuel production	0.29	1.41×10 <sup>-4</sup>	100.0
On-Road Mobile	Others - Exhaust	8.30×10 <sup>-2</sup>	4.00×10 <sup>-5</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	8.09×10 <sup>-2</sup>	3.89×10 <sup>-5</sup>	100.0
Industrial	Waste disposal (application to land)	5.30×10 <sup>-2</sup>	2.55×10 <sup>-5</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	5.08×10 <sup>-2</sup>	2.44×10 <sup>-5</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	4.48×10 <sup>-2</sup>	2.16×10 <sup>-5</sup>	100.0
Industrial	Chemical production	3.95×10 <sup>-2</sup>	1.90×10 <sup>-5</sup>	100.0
Industrial	Solid waste landfilling	3.53×10 <sup>-2</sup>	1.70×10 <sup>-5</sup>	100.0
Industrial	General agricultural processing	3.50×10 <sup>-2</sup>	1.69×10 <sup>-5</sup>	100.0
Industrial	Rendering or fat extraction	3.18×10 <sup>-2</sup>	1.53×10 <sup>-5</sup>	100.0
Industrial	Water-based extractive activity	2.24×10 <sup>-2</sup>	1.08×10 <sup>-5</sup>	100.0
Commercial	Non-Ferrous Metal Casting	2.12×10 <sup>-2</sup>	1.02×10 <sup>-5</sup>	100.0
Industrial	Concrete works	1.87×10 <sup>-2</sup>	8.99×10 <sup>-6</sup>	100.0
Industrial	Explosives production	1.79×10 <sup>-2</sup>	8.59×10 <sup>-6</sup>	100.0
Industrial	General animal products production	1.38×10 <sup>-2</sup>	6.65×10 <sup>-6</sup>	100.0
Industrial	Recovery of waste oil	1.34×10 <sup>-2</sup>	6.45×10 <sup>-6</sup>	100.0

Module	Activity <sup>41</sup>	Emissions (tonnes/year)	Proportion (%) <sup>42</sup>	Cumulative proportion (%)
Industrial	Sewage treatment - small plants	1.10×10 <sup>-2</sup>	5.29×10 <sup>-6</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	9.30×10 <sup>-3</sup>	4.48×10 <sup>-6</sup>	100.0
Industrial	Bird accommodation	7.86×10 <sup>-3</sup>	3.78×10 <sup>-6</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	6.62×10 <sup>-3</sup>	3.19×10 <sup>-6</sup>	100.0
Industrial	Metal plating or coating	5.92×10 <sup>-3</sup>	2.85×10 <sup>-6</sup>	100.0
Industrial	Sewage treatment - large plants	3.35×10 <sup>-3</sup>	1.61×10 <sup>-6</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	2.17×10 <sup>-3</sup>	1.04×10 <sup>-6</sup>	100.0
Industrial	Crushing, grinding or separating	1.69×10 <sup>-3</sup>	8.13×10 <sup>-7</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	1.64×10 <sup>-3</sup>	7.89×10 <sup>-7</sup>	100.0
Commercial	Synthetic Resin Manufacturing	1.35×10 <sup>-3</sup>	6.48×10 <sup>-7</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	1.05×10 <sup>-3</sup>	5.07×10 <sup>-7</sup>	100.0
Industrial	Non-thermal treatment of waste	5.88×10 <sup>-4</sup>	2.83×10 <sup>-7</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	5.06×10 <sup>-4</sup>	2.43×10 <sup>-7</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	2.30×10 <sup>-4</sup>	1.11×10 <sup>-7</sup>	100.0
Industrial	General chemicals storage	1.75×10 <sup>-4</sup>	8.41×10 <sup>-8</sup>	100.0
Industrial	Animal accommodation	5.00×10 <sup>-5</sup>	2.41×10 <sup>-8</sup>	100.0
Industrial	Coal works	1.69×10 <sup>-6</sup>	8.14×10 <sup>-10</sup>	100.0
Commercial	Non-Building Construction n.e.c.	2.64×10 <sup>-7</sup>	1.27×10 <sup>-10</sup>	100.0
Commercial	Printing	1.26×10 <sup>-7</sup>	6.07×10 <sup>-11</sup>	100.0



Figure 3-46, Figure 3-47, Figure 3-48, Figure 3-49 and Figure 3-50 show the estimated annual emissions for the top 15 natural and human-made sources of sulfur dioxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

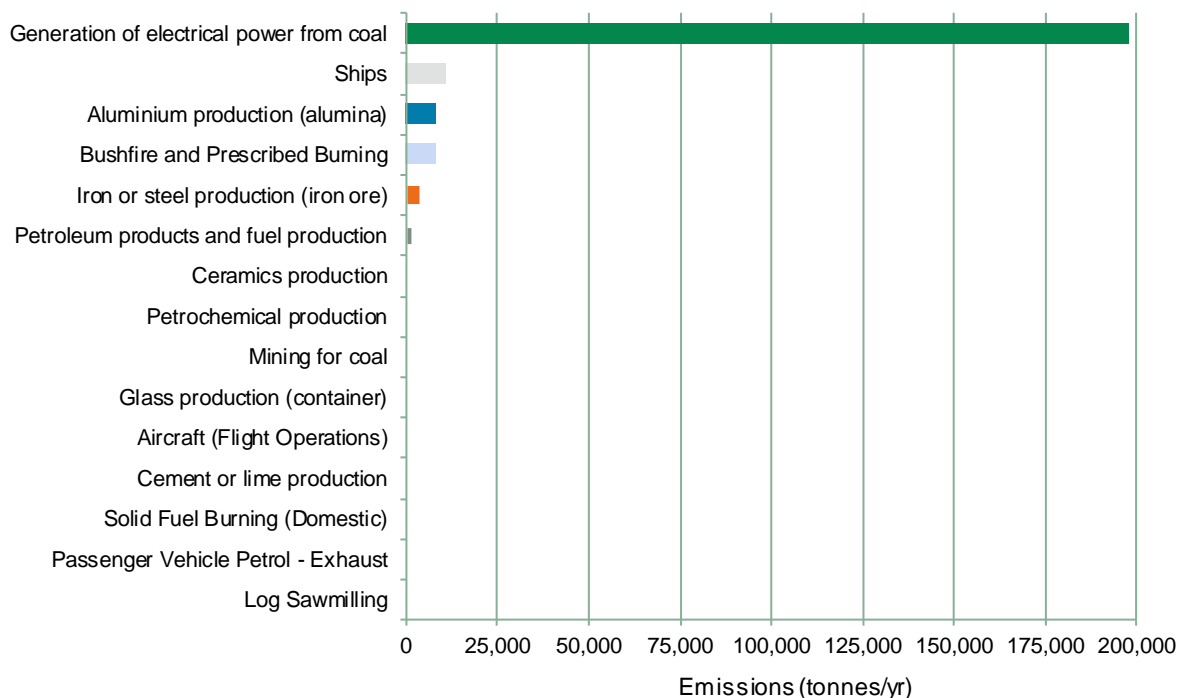


Figure 3-46: GMR: top 15 natural and human-made sources of sulfur dioxide

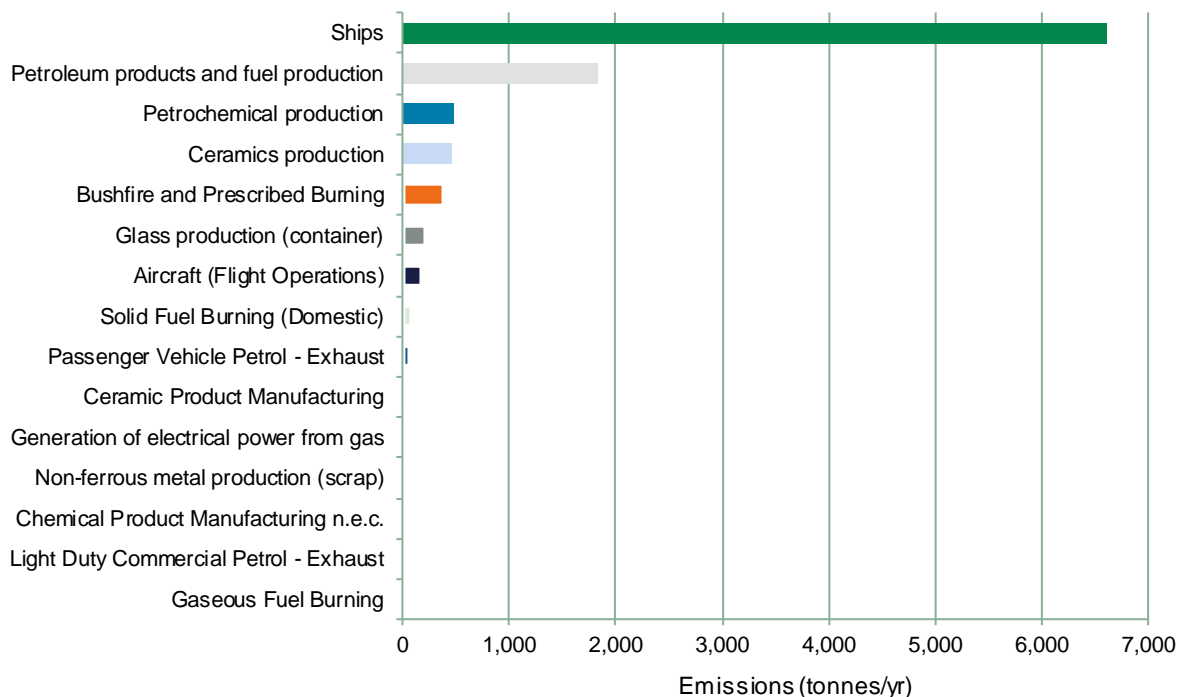


Figure 3-47: Sydney region: top 15 natural and human-made sources of sulfur dioxide

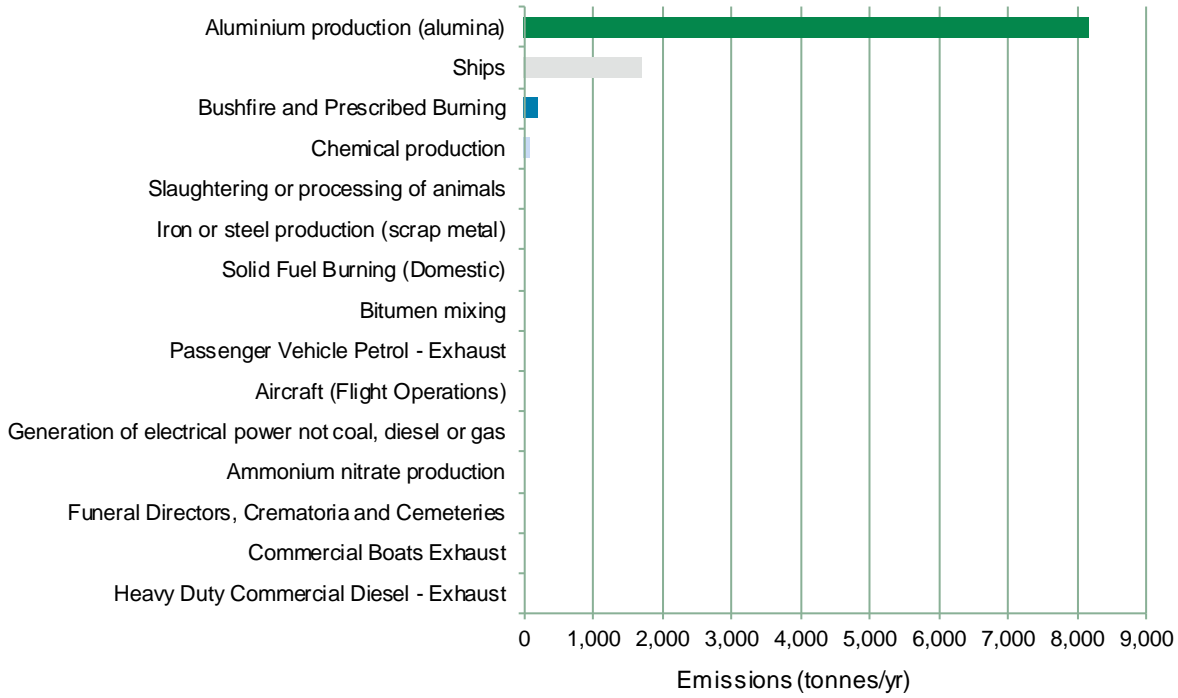


Figure 3-48: Newcastle region: top 15 natural and human-made sources of sulfur dioxide

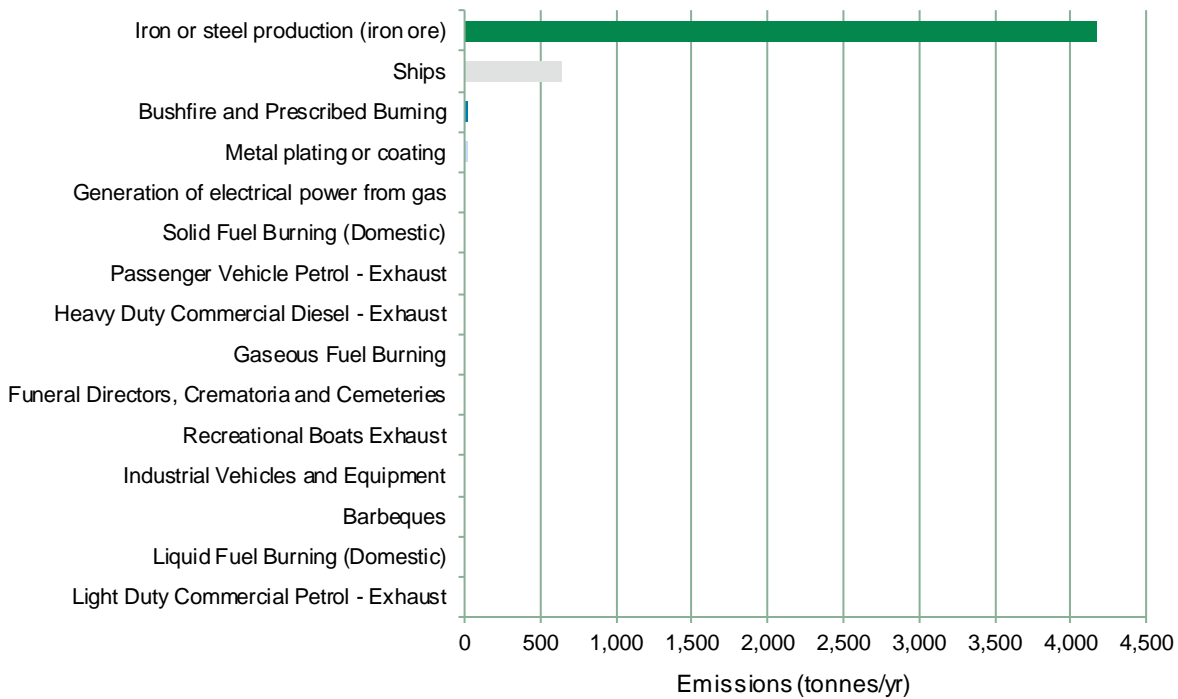


Figure 3-49: Wollongong region: top 15 natural and human-made sources of sulfur dioxide

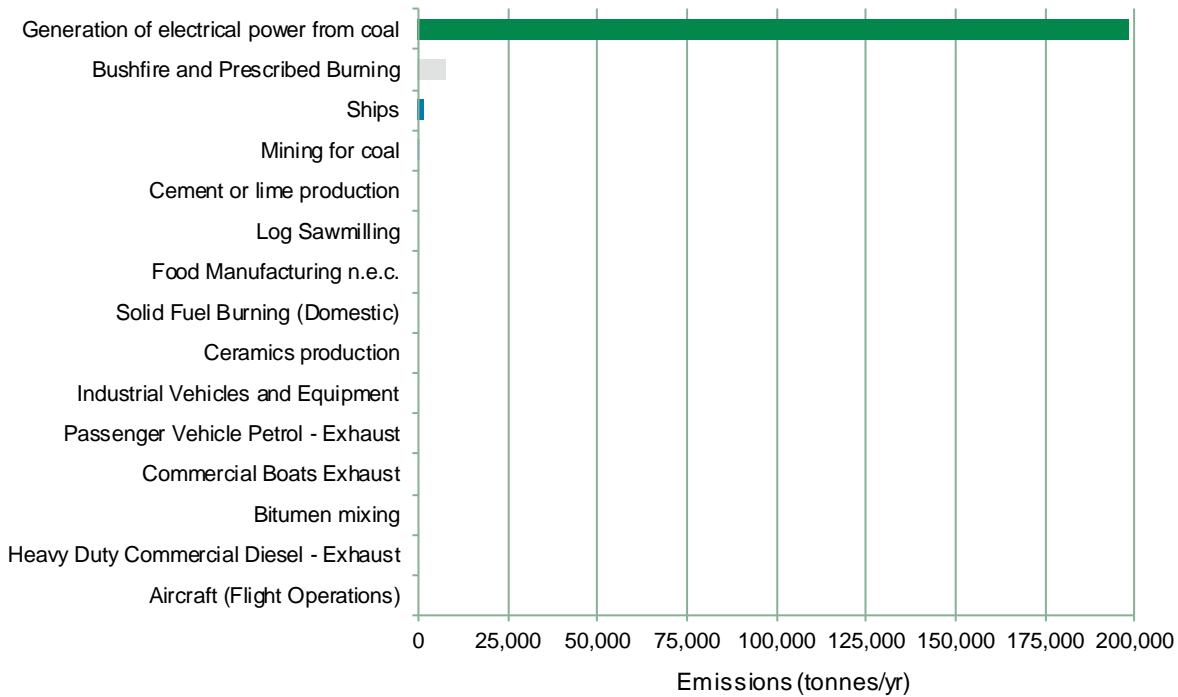


Figure 3-50: Non-urban region: top 15 natural and human-made sources of sulfur dioxide

## 3.6. Total volatile organic compounds

### 3.6.1. Natural and human-made emissions

Table 3-16 presents total estimated annual emissions of VOC by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 3-16: Total estimated annual emissions of VOC by natural and human-made source type in each region

Substance	Region	Emissions (tonnes/year)						Total <sup>43</sup>
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Total volatile organic compounds	Sydney	31,785	9,561	57,399	9,369	7,552	12,641	128,306
	Newcastle	4,376	108	3,933	1,194	1,466	952	12,029
	Wollongong	3,055	79.91	2,750	362	612	497	7,355
	Non-urban	165,805	580	9,746	1,703	11,670	2,034	191,539
	GMR <sup>43</sup>	205,021	10,330	73,828	12,628	21,300	16,124	339,230

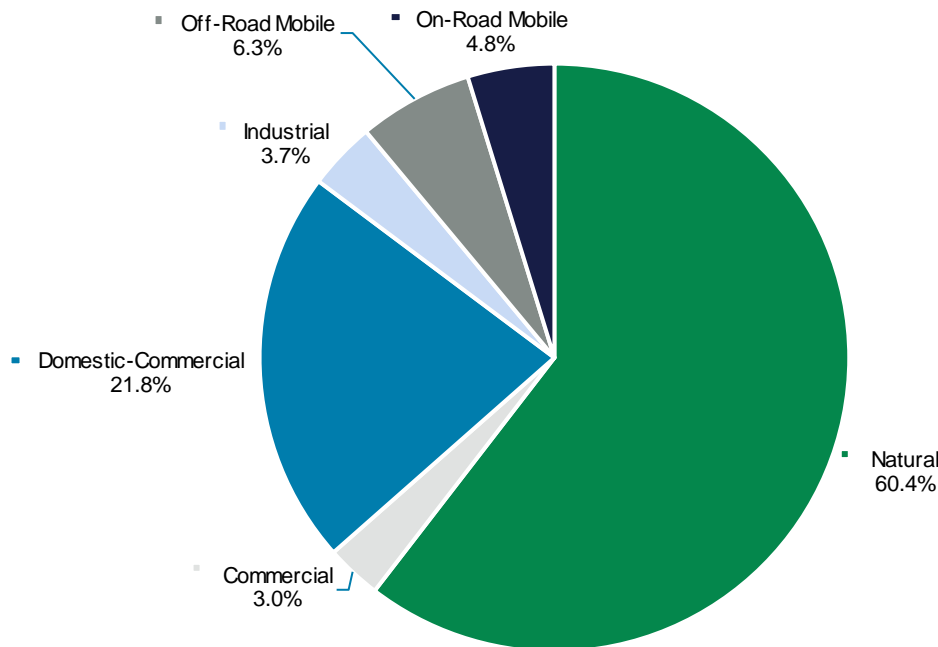
Table 3-17 presents the proportions of total estimated annual emissions of VOC by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

<sup>43</sup> The totals may differ from the sum of the addends due to rounding.

**Table 3-17: Proportions of total estimated annual emissions of VOC by natural and human-made source type in each region**

Substance	Region	Proportion (%)					
		Natural	Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Total volatile organic compounds	Sydney	24.8	7.45	44.7	7.30	5.89	9.85
	Newcastle	36.4	0.90	32.7	9.93	12.2	7.91
	Wollongong	41.5	1.09	37.4	4.92	8.32	6.76
	Non-urban	86.6	0.30	5.09	0.89	6.09	1.06
	GMR	60.4	3.04	21.8	3.72	6.28	4.75

Figure 3-51, Figure 3-52, Figure 3-53, Figure 3-54 and Figure 3-55 show the estimated annual emissions of VOC by natural and human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.



**Figure 3-51: GMR: proportions of total estimated annual emissions of VOC by natural and human-made source type**

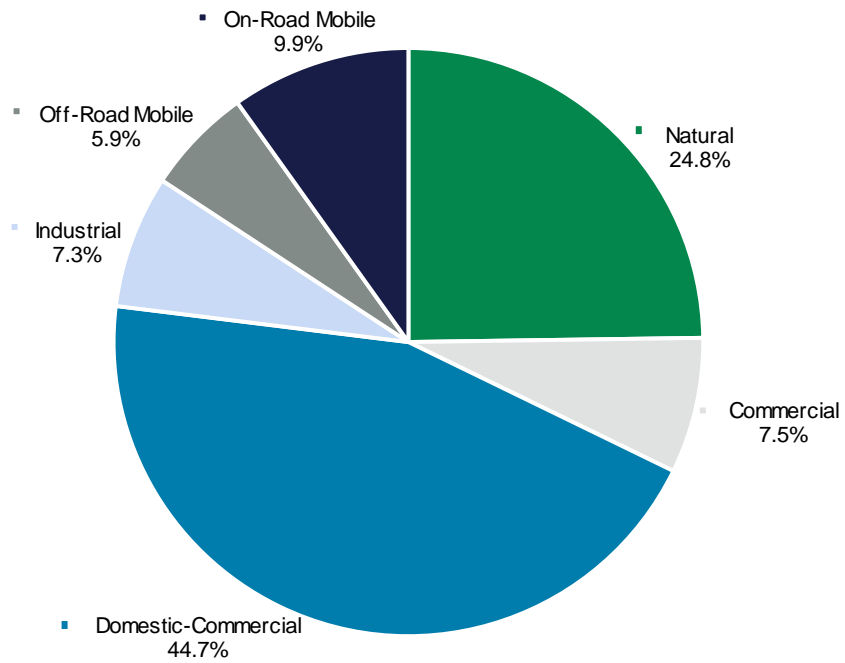


Figure 3-52: Sydney region: proportions of total estimated annual emissions of VOC by natural and human-made source type

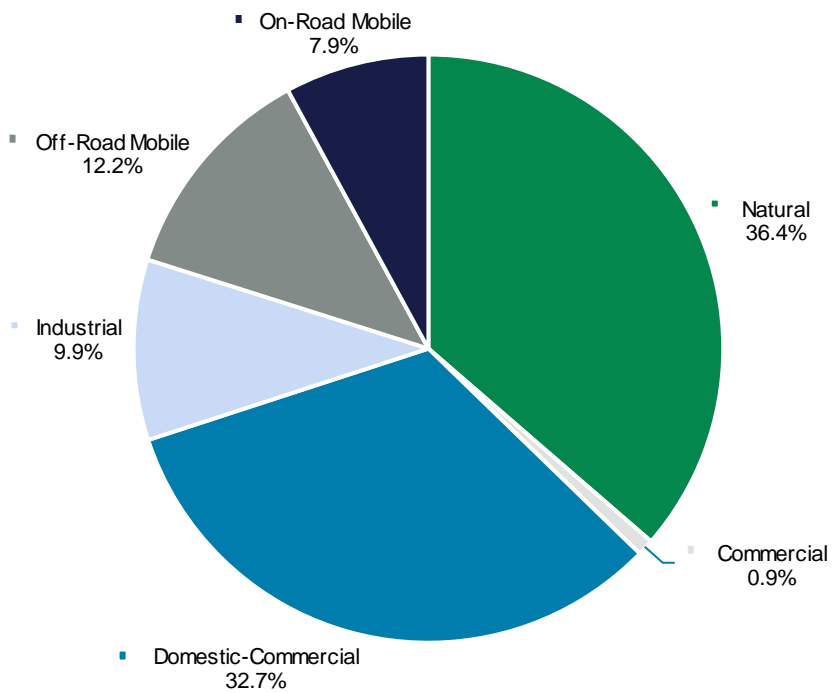


Figure 3-53: Newcastle region: proportions of total estimated annual emissions of VOC by natural and human-made source type

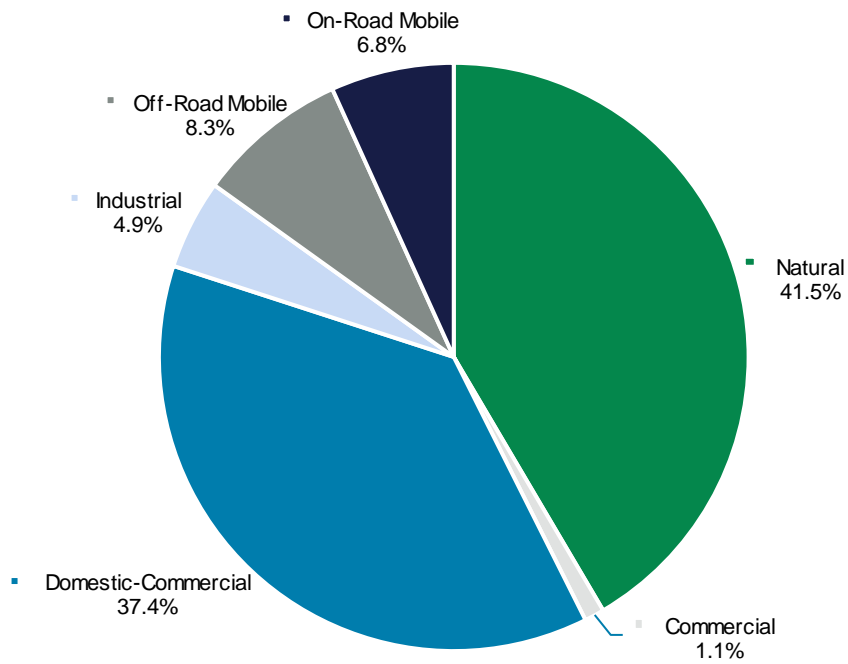


Figure 3-54: Wollongong region: proportions of total estimated annual emissions of VOC by natural and human-made source type

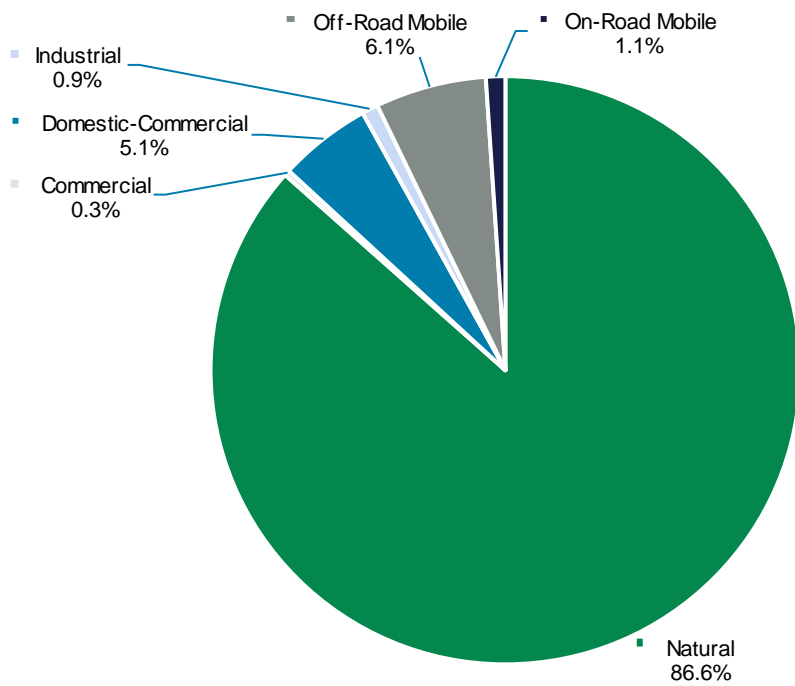


Figure 3-55: Non-urban region: proportions of total estimated annual emissions of VOC by natural and human-made source type

### 3.6.2. Priority natural and human-made emissions

Table 3-18 presents total estimated annual emissions, proportions and cumulative proportions of natural and human-made sources of VOC in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 3-18: Natural and human-made sources of VOC in each region**

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
<b>Total volatile organic compounds in the GMR</b>				
Natural	Vegetation	142,465	42.0	42.0
Natural	Bushfire and Prescribed Burning	61,167	18.0	60.0
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	27,715	8.17	68.2
Off-Road Mobile	Commercial Boats Exhaust	10,778	3.18	71.4
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	10,277	3.03	74.4
Domestic-Commercial	Surface Coatings	9,728	2.87	77.3
Domestic-Commercial	Solid Fuel Burning (Domestic)	8,239	2.43	79.7
On-Road Mobile	All - Evaporative	6,956	2.05	81.8
Commercial	Automotive Fuel Retailing	6,646	1.96	83.7
Off-Road Mobile	Recreational Boats Exhaust	6,266	1.85	85.6
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	5,803	1.71	87.3
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	5,590	1.65	88.9
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	4,152	1.22	90.1
Domestic-Commercial	Graphic Arts	3,811	1.12	91.3
Domestic-Commercial	Natural/Town Gas Leakage	3,075	0.91	92.2
Off-Road Mobile	Industrial Vehicles and Equipment	2,237	0.66	92.8
Industrial	Printing, packaging and visual media production	1,756	0.52	93.3
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1,706	0.50	93.8
Industrial	Petroleum products storage	1,682	0.50	94.3
Industrial	Petroleum products and fuel production	1,488	0.44	94.8
Industrial	Composting	1,440	0.42	95.2
Natural	Marine Aerosol	1,365	0.40	95.6

<sup>44</sup> n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006).

<sup>45</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g.  $9.46 \times 10^{-2} = 0.0946$ ).

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	986	0.29	95.9
Industrial	Waste disposal (application to land)	919	0.27	96.2
Industrial	Metal plating or coating	861	0.25	96.4
Off-Road Mobile	Recreational Boats Evaporative	853	0.25	96.7
Industrial	Generation of electrical power from coal	840	0.25	96.9
Commercial	Printing	763	0.23	97.2
Commercial	Laundries and Dry-Cleaners	690	0.20	97.4
Commercial	Smash Repairing	578	0.17	97.5
Domestic-Commercial	Lawn Mowing Evaporative (Public Open Spaces)	560	0.17	97.7
On-Road Mobile	Others - Exhaust	503	0.15	97.8
Industrial	Petrochemical production	454	0.13	98.0
Industrial	Generation of electrical power from gas	444	0.13	98.1
On-Road Mobile	Light Duty Diesel - Exhaust	384	0.11	98.2
Off-Road Mobile	Aircraft (Flight Operations)	368	0.11	98.3
Off-Road Mobile	Locomotives	334	$9.85 \times 10^{-2}$	98.4
Industrial	Iron or steel production (scrap metal)	327	$9.64 \times 10^{-2}$	98.5
Industrial	Chemical production	302	$8.89 \times 10^{-2}$	98.6
Industrial	Cement or lime handling	293	$8.65 \times 10^{-2}$	98.7
Off-Road Mobile	Ships	251	$7.39 \times 10^{-2}$	98.8
Industrial	Non-thermal treatment of waste	227	$6.68 \times 10^{-2}$	98.8
Commercial	Chemical Product Manufacturing n.e.c.	203	$5.99 \times 10^{-2}$	98.9
Commercial	Bread Manufacturing	189	$5.59 \times 10^{-2}$	99.0
Domestic-Commercial	Barbeques	183	$5.39 \times 10^{-2}$	99.0
Domestic-Commercial	Cutback Bitumen	160	$4.72 \times 10^{-2}$	99.1
Commercial	Wine Manufacturing	159	$4.68 \times 10^{-2}$	99.1
Commercial	Petroleum Product Wholesaling	148	$4.36 \times 10^{-2}$	99.1
Industrial	Ammonium nitrate production	136	$4.02 \times 10^{-2}$	99.2
Commercial	Log Sawmilling	127	$3.74 \times 10^{-2}$	99.2
Domestic-Commercial	Gaseous Fuel Burning	125	$3.67 \times 10^{-2}$	99.3
Off-Road Mobile	Commercial Boats Evaporative	116	$3.41 \times 10^{-2}$	99.3
Industrial	Paints/polishes/adhesives production	114	$3.37 \times 10^{-2}$	99.3



Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	General agricultural processing	112	3.31×10 <sup>-2</sup>	99.4
Commercial	Chemical Wholesaling	111	3.27×10 <sup>-2</sup>	99.4
Industrial	Solid waste landfilling	106	3.11×10 <sup>-2</sup>	99.4
Commercial	Synthetic Resin Manufacturing	105	3.10×10 <sup>-2</sup>	99.5
Commercial	Paint Manufacturing	104	3.08×10 <sup>-2</sup>	99.5
Industrial	Metal processing	90.94	2.68×10 <sup>-2</sup>	99.5
Industrial	Sewage treatment - large plants	90.41	2.67×10 <sup>-2</sup>	99.5
Industrial	Generation of electrical power not coal, diesel or gas	88.78	2.62×10 <sup>-2</sup>	99.6
Industrial	Mining for coal	86.48	2.55×10 <sup>-2</sup>	99.6
Industrial	Iron or steel production (iron ore)	78.16	2.30×10 <sup>-2</sup>	99.6
Off-Road Mobile	Aircraft (Ground Operations)	77.79	2.29×10 <sup>-2</sup>	99.6
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	76.59	2.26×10 <sup>-2</sup>	99.7
Industrial	Plastics resins production	74.80	2.20×10 <sup>-2</sup>	99.7
Commercial	Spirit Manufacturing	63.53	1.87×10 <sup>-2</sup>	99.7
Industrial	Pharmaceutical and veterinary products production	63.24	1.86×10 <sup>-2</sup>	99.7
Industrial	Soap and detergent production	59.30	1.75×10 <sup>-2</sup>	99.7
Commercial	Electric Cable and Wire Manufacturing	55.86	1.65×10 <sup>-2</sup>	99.7
Commercial	Waste Disposal Services	51.59	1.52×10 <sup>-2</sup>	99.8
Industrial	Bitumen mixing	46.26	1.36×10 <sup>-2</sup>	99.8
Commercial	Services to Air Transport	43.46	1.28×10 <sup>-2</sup>	99.8
Industrial	Boat construction/ maintenance (general)	42.78	1.26×10 <sup>-2</sup>	99.8
Industrial	Container reconditioning	40.30	1.19×10 <sup>-2</sup>	99.8
Industrial	Boat construction/ maintenance (dry/float)	35.13	1.04×10 <sup>-2</sup>	99.8
Commercial	Solid Paperboard Container Manufacturing	31.35	9.24×10 <sup>-3</sup>	99.8
Industrial	Glass production (container)	28.76	8.48×10 <sup>-3</sup>	99.8
Industrial	Ceramics production	27.80	8.19×10 <sup>-3</sup>	99.9
Industrial	Sewage treatment - small plants	27.76	8.18×10 <sup>-3</sup>	99.9
Industrial	Slaughtering or processing of animals	25.94	7.65×10 <sup>-3</sup>	99.9
Natural	Agricultural Burning	24.87	7.33×10 <sup>-3</sup>	99.9
Industrial	Rubber products/ tyre production	24.86	7.33×10 <sup>-3</sup>	99.9

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	Shipping in bulk	24.77	7.30×10 <sup>-3</sup>	99.9
Industrial	Concrete works	23.55	6.94×10 <sup>-3</sup>	99.9
Industrial	Brewing and distilling	23.47	6.92×10 <sup>-3</sup>	99.9
Industrial	Railway systems activities	22.04	6.50×10 <sup>-3</sup>	99.9
Commercial	Beer and Malt Manufacturing	20.81	6.13×10 <sup>-3</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	20.40	6.01×10 <sup>-3</sup>	99.9
Commercial	Metal Coating and Finishing	20.10	5.93×10 <sup>-3</sup>	99.9
Industrial	Coal works	19.55	5.76×10 <sup>-3</sup>	99.9
Industrial	Inert waste landfilling	18.32	5.40×10 <sup>-3</sup>	99.9
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	16.96	5.0×10 <sup>-3</sup>	99.9
Commercial	Cake and Pastry Manufacturing	16.25	4.79×10 <sup>-3</sup>	99.9
Commercial	Port Operators	13.39	3.95×10 <sup>-3</sup>	100.0
Commercial	Food Manufacturing n.e.c.	13.24	3.90×10 <sup>-3</sup>	100.0
Commercial	Basic Iron and Steel Manufacturing	12.00	3.54×10 <sup>-3</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	11.13	3.28×10 <sup>-3</sup>	100.0
Industrial	Pesticides and related products production	10.43	3.07×10 <sup>-3</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	9.29	2.74×10 <sup>-3</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	7.63	2.25×10 <sup>-3</sup>	100.0
Industrial	Aluminium production (alumina)	7.23	2.13×10 <sup>-3</sup>	100.0
Industrial	Land-based extractive activity	6.89	2.03×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste	5.85	1.72×10 <sup>-3</sup>	100.0
Industrial	Paper or pulp production	5.58	1.64×10 <sup>-3</sup>	100.0
Industrial	Cement or lime production	5.25	1.55×10 <sup>-3</sup>	100.0
Commercial	Plastic Bag and Film Manufacturing	4.31	1.27×10 <sup>-3</sup>	100.0
Industrial	Crushing, grinding or separating	4.21	1.24×10 <sup>-3</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	4.18	1.23×10 <sup>-3</sup>	100.0
Commercial	Ink Manufacturing	4.16	1.23×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	3.95	1.16×10 <sup>-3</sup>	100.0
Industrial	General animal products production	3.49	1.03×10 <sup>-3</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	2.78	8.20×10 <sup>-4</sup>	100.0

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	General chemicals storage	2.51	7.40×10 <sup>-4</sup>	100.0
Commercial	Plaster Product Manufacturing	2.47	7.29×10 <sup>-4</sup>	100.0
Commercial	Structural Metal Product Manufacturing n.e.c.	2.43	7.15×10 <sup>-4</sup>	100.0
Industrial	Rendering or fat extraction	2.37	6.99×10 <sup>-4</sup>	100.0
Commercial	Industrial Gas Manufacturing	2.27	6.70×10 <sup>-4</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	2.22	6.53×10 <sup>-4</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	2.13	6.29×10 <sup>-4</sup>	100.0
Industrial	Dairy processing	2.13	6.27×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	1.91	5.64×10 <sup>-4</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	1.77	5.22×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	1.25	3.69×10 <sup>-4</sup>	100.0
Commercial	Gas Supply	1.12	3.30×10 <sup>-4</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	1.02	3.01×10 <sup>-4</sup>	100.0
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	0.94	2.77×10 <sup>-4</sup>	100.0
Industrial	Non-ferrous metal production (scrap)	0.89	2.64×10 <sup>-4</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	0.85	2.51×10 <sup>-4</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	0.77	2.26×10 <sup>-4</sup>	100.0
Commercial	Ice Cream Manufacturing	0.75	2.23×10 <sup>-4</sup>	100.0
Industrial	Water-based extractive activity	0.75	2.21×10 <sup>-4</sup>	100.0
Industrial	Paper production using recycled materials	0.68	2.00×10 <sup>-4</sup>	100.0
Commercial	Biscuit Manufacturing	0.60	1.78×10 <sup>-4</sup>	100.0
Commercial	Lifting and Material Handling Equipment Manufacturing	0.50	1.46×10 <sup>-4</sup>	100.0
Commercial	Ceramic Product Manufacturing	0.49	1.44×10 <sup>-4</sup>	100.0
Commercial	Corrugated Paperboard Container Manufacturing	0.47	1.40×10 <sup>-4</sup>	100.0
Industrial	Glass production	0.47	1.39×10 <sup>-4</sup>	100.0
Commercial	Confectionery Manufacturing	0.43	1.26×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	0.37	1.09×10 <sup>-4</sup>	100.0
Industrial	Waste storage	0.37	1.08×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	0.31	9.24×10 <sup>-5</sup>	100.0

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	Aluminium production (scrap metal)	0.30	8.75×10 <sup>-5</sup>	100.0
Industrial	Chemical storage	0.26	7.77×10 <sup>-5</sup>	100.0
Industrial	Bird accommodation	0.25	7.30×10 <sup>-5</sup>	100.0
Commercial	Oil and Fat Manufacturing	0.20	5.84×10 <sup>-5</sup>	100.0
Commercial	Wooden Furniture and Upholstered Seat Manufacturing	0.19	5.55×10 <sup>-5</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	0.17	5.08×10 <sup>-5</sup>	100.0
Commercial	Milk and Cream Processing	0.12	3.42×10 <sup>-5</sup>	100.0
Commercial	Fruit and Vegetable Processing	0.12	3.41×10 <sup>-5</sup>	100.0
Commercial	Aircraft Manufacturing	0.10	3.02×10 <sup>-5</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	9.80×10 <sup>-2</sup>	2.89×10 <sup>-5</sup>	100.0
Commercial	Scientific Research	8.96×10 <sup>-2</sup>	2.64×10 <sup>-5</sup>	100.0
Industrial	Boat mooring and storage	8.21×10 <sup>-2</sup>	2.42×10 <sup>-5</sup>	100.0
Industrial	Sterilisation activities	8.08×10 <sup>-2</sup>	2.38×10 <sup>-5</sup>	100.0
Industrial	Explosives production	7.69×10 <sup>-2</sup>	2.27×10 <sup>-5</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	7.25×10 <sup>-2</sup>	2.14×10 <sup>-5</sup>	100.0
Commercial	Gravel and Sand Quarrying	5.72×10 <sup>-2</sup>	1.69×10 <sup>-5</sup>	100.0
Industrial	Animal accommodation	5.41×10 <sup>-2</sup>	1.59×10 <sup>-5</sup>	100.0
Industrial	Dairy animal accommodation	5.17×10 <sup>-2</sup>	1.52×10 <sup>-5</sup>	100.0
Industrial	Other land-based extraction	4.63×10 <sup>-2</sup>	1.36×10 <sup>-5</sup>	100.0
Industrial	Pig accommodation	4.58×10 <sup>-2</sup>	1.35×10 <sup>-5</sup>	100.0
Commercial	Railway Equipment Manufacturing	3.86×10 <sup>-2</sup>	1.14×10 <sup>-5</sup>	100.0
Industrial	Contaminated soil treatment	3.62×10 <sup>-2</sup>	1.07×10 <sup>-5</sup>	100.0
Industrial	Helicopter-related activity	2.17×10 <sup>-2</sup>	6.39×10 <sup>-6</sup>	100.0
Commercial	Road and Bridge Construction	1.47×10 <sup>-2</sup>	4.35×10 <sup>-6</sup>	100.0
Commercial	Soap and Other Detergent Manufacturing	1.13×10 <sup>-2</sup>	3.33×10 <sup>-6</sup>	100.0
Commercial	Explosive Manufacturing	8.33×10 <sup>-3</sup>	2.46×10 <sup>-6</sup>	100.0
Commercial	Non-Building Construction n.e.c.	4.09×10 <sup>-3</sup>	1.21×10 <sup>-6</sup>	100.0
Commercial	Construction Material Mining n.e.c.	3.31×10 <sup>-3</sup>	9.75×10 <sup>-7</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	2.68×10 <sup>-3</sup>	7.90×10 <sup>-7</sup>	100.0
Commercial	Rail Transport	1.73×10 <sup>-3</sup>	5.11×10 <sup>-7</sup>	100.0
Industrial	Scrap metal processing	1.50×10 <sup>-3</sup>	4.43×10 <sup>-7</sup>	100.0

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Commercial	Steel Pipe and Tube Manufacturing	1.20×10 <sup>-3</sup>	3.53×10 <sup>-7</sup>	100.0
Industrial	Mining for minerals	8.10×10 <sup>-4</sup>	2.39×10 <sup>-7</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	6.51×10 <sup>-4</sup>	1.92×10 <sup>-7</sup>	100.0
Commercial	Non-Ferrous Metal Casting	6.24×10 <sup>-4</sup>	1.84×10 <sup>-7</sup>	100.0
Commercial	Agricultural Machinery Manufacturing	1.53×10 <sup>-4</sup>	4.51×10 <sup>-8</sup>	100.0
<b>Total volatile organic compounds in the Sydney region</b>				
Natural	Vegetation	28,679	22.4	22.4
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	21,929	17.1	39.4
Domestic-Commercial	Surface Coatings	7,682	5.99	45.4
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	7,673	5.98	51.4
Commercial	Automotive Fuel Retailing	6,646	5.18	56.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	6,093	4.75	61.3
On-Road Mobile	All - Evaporative	5,289	4.12	65.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	4,652	3.63	69.1
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	4,492	3.50	72.6
Off-Road Mobile	Recreational Boats Exhaust	3,196	2.49	75.1
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	3,109	2.42	77.5
Domestic-Commercial	Graphic Arts	3,015	2.35	79.9
Off-Road Mobile	Commercial Boats Exhaust	2,982	2.32	82.2
Natural	Bushfire and Prescribed Burning	2,939	2.29	84.5
Domestic-Commercial	Natural/Town Gas Leakage	2,428	1.89	86.4
Industrial	Printing, packaging and visual media production	1,686	1.31	87.7
Industrial	Petroleum products and fuel production	1,487	1.16	88.8
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1,432	1.12	89.9
Industrial	Composting	1,237	0.96	90.9
Industrial	Petroleum products storage	1,089	0.85	91.8
Commercial	Printing	740	0.58	92.3
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	716	0.56	92.9
Industrial	Metal plating or coating	629	0.49	93.4
Commercial	Laundries and Dry-Cleaners	541	0.42	93.8

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	Waste disposal (application to land)	507	0.39	94.2
Industrial	Petrochemical production	454	0.35	94.6
Commercial	Smash Repairing	453	0.35	94.9
Domestic-Commercial	Lawn Mowing Evaporative (Public Open Spaces)	449	0.35	95.3
Off-Road Mobile	Recreational Boats Evaporative	435	0.34	95.6
On-Road Mobile	Others - Exhaust	404	0.31	95.9
Industrial	Generation of electrical power from gas	361	0.28	96.2
Off-Road Mobile	Aircraft (Flight Operations)	347	0.27	96.5
On-Road Mobile	Light Duty Diesel - Exhaust	309	0.24	96.7
Industrial	Cement or lime handling	293	0.23	96.9
Industrial	Iron or steel production (scrap metal)	293	0.23	97.2
Off-Road Mobile	Industrial Vehicles and Equipment	251	0.20	97.4
Industrial	Non-thermal treatment of waste	226	0.18	97.5
Industrial	Chemical production	203	0.16	97.7
Commercial	Chemical Product Manufacturing n.e.c.	199	0.16	97.8
Commercial	Bread Manufacturing	176	0.14	98.0
Natural	Marine Aerosol	165	0.13	98.1
Off-Road Mobile	Ships	146	0.11	98.2
Domestic-Commercial	Barbeques	144	0.11	98.3
Domestic-Commercial	Cutback Bitumen	125	9.74×10 <sup>-2</sup>	98.4
Industrial	Paints/polishes/adhesives production	114	8.92×10 <sup>-2</sup>	98.5
Commercial	Chemical Wholesaling	111	8.63×10 <sup>-2</sup>	98.6
Commercial	Synthetic Resin Manufacturing	105	8.17×10 <sup>-2</sup>	98.7
Commercial	Paint Manufacturing	104	8.14×10 <sup>-2</sup>	98.8
Domestic-Commercial	Gaseous Fuel Burning	98.44	7.67×10 <sup>-2</sup>	98.9
Commercial	Non-Metallic Mineral Product Manufacturing n.e.c.	76.59	5.97×10 <sup>-2</sup>	98.9
Industrial	Plastics resins production	74.80	5.83×10 <sup>-2</sup>	99.0
Industrial	Solid waste landfilling	73.43	5.72×10 <sup>-2</sup>	99.0
Off-Road Mobile	Aircraft (Ground Operations)	70.49	5.49×10 <sup>-2</sup>	99.1
Off-Road Mobile	Commercial Boats Evaporative	65.87	5.13×10 <sup>-2</sup>	99.1
Commercial	Spirit Manufacturing	63.53	4.95×10 <sup>-2</sup>	99.2

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Commercial	Petroleum Product Wholesaling	62.71	4.89×10 <sup>-2</sup>	99.2
Industrial	Sewage treatment - large plants	62.23	4.85×10 <sup>-2</sup>	99.3
Industrial	Pharmaceutical and veterinary products production	60.28	4.70×10 <sup>-2</sup>	99.3
Industrial	Soap and detergent production	59.30	4.62×10 <sup>-2</sup>	99.4
Industrial	General agricultural processing	48.46	3.78×10 <sup>-2</sup>	99.4
Off-Road Mobile	Locomotives	48.25	3.76×10 <sup>-2</sup>	99.4
Industrial	Generation of electrical power not coal, diesel or gas	45.79	3.57×10 <sup>-2</sup>	99.5
Commercial	Services to Air Transport	43.46	3.39×10 <sup>-2</sup>	99.5
Industrial	Container reconditioning	38.47	3.00×10 <sup>-2</sup>	99.5
Industrial	Boat construction/maintenance (dry/float)	35.13	2.74×10 <sup>-2</sup>	99.6
Industrial	Boat construction/maintenance (general)	33.16	2.58×10 <sup>-2</sup>	99.6
Commercial	Solid Paperboard Container Manufacturing	31.35	2.44×10 <sup>-2</sup>	99.6
Industrial	Glass production (container)	28.76	2.24×10 <sup>-2</sup>	99.6
Industrial	Bitumen mixing	28.27	2.20×10 <sup>-2</sup>	99.7
Commercial	Waste Disposal Services	26.82	2.09×10 <sup>-2</sup>	99.7
Industrial	Ceramics production	25.53	1.99×10 <sup>-2</sup>	99.7
Industrial	Rubber products/tyre production	24.86	1.94×10 <sup>-2</sup>	99.7
Industrial	Brewing and distilling	23.47	1.83×10 <sup>-2</sup>	99.7
Commercial	Wine Manufacturing	22.42	1.75×10 <sup>-2</sup>	99.8
Industrial	Concrete works	22.05	1.72×10 <sup>-2</sup>	99.8
Industrial	Railway systems activities	22.04	1.72×10 <sup>-2</sup>	99.8
Industrial	Slaughtering or processing of animals	21.76	1.70×10 <sup>-2</sup>	99.8
Commercial	Beer and Malt Manufacturing	20.81	1.62×10 <sup>-2</sup>	99.8
Commercial	Metal Coating and Finishing	19.53	1.52×10 <sup>-2</sup>	99.8
Industrial	Metal processing	17.86	1.39×10 <sup>-2</sup>	99.9
Commercial	Cake and Pastry Manufacturing	16.25	1.27×10 <sup>-2</sup>	99.9
Commercial	Port Operators	13.39	1.04×10 <sup>-2</sup>	99.9
Commercial	Food Manufacturing n.e.c.	12.21	9.52×10 <sup>-3</sup>	99.9
Commercial	Basic Iron and Steel Manufacturing	11.68	9.10×10 <sup>-3</sup>	99.9
Commercial	Fabricated Metal Product Manufacturing n.e.c.	10.98	8.55×10 <sup>-3</sup>	99.9

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	Pesticides and related products production	10.43	8.13×10 <sup>-3</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	10.11	7.88×10 <sup>-3</sup>	99.9
Commercial	Automotive Component Manufacturing n.e.c.	8.47	6.60×10 <sup>-3</sup>	99.9
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	7.95	6.20×10 <sup>-3</sup>	99.9
Industrial	Mining for coal	5.69	4.44×10 <sup>-3</sup>	99.9
Industrial	Paper or pulp production	5.58	4.35×10 <sup>-3</sup>	100.0
Commercial	Plastic Bag and Film Manufacturing	4.31	3.36×10 <sup>-3</sup>	100.0
Industrial	Crushing, grinding or separating	4.19	3.27×10 <sup>-3</sup>	100.0
Commercial	Ink Manufacturing	4.16	3.24×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - small plants	3.66	2.85×10 <sup>-3</sup>	100.0
Industrial	General animal products production	3.15	2.46×10 <sup>-3</sup>	100.0
Commercial	Electrical and Equipment Manufacturing n.e.c.	2.78	2.17×10 <sup>-3</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	2.76	2.15×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	2.75	2.14×10 <sup>-3</sup>	100.0
Commercial	Plaster Product Manufacturing	2.47	1.93×10 <sup>-3</sup>	100.0
Commercial	Structural Metal Product Manufacturing n.e.c.	2.43	1.89×10 <sup>-3</sup>	100.0
Commercial	Industrial Gas Manufacturing	2.27	1.77×10 <sup>-3</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	2.22	1.73×10 <sup>-3</sup>	100.0
Natural	Agricultural Burning	2.16	1.68×10 <sup>-3</sup>	100.0
Commercial	Soft Drink, Cordial and Syrup Manufacturing	2.13	1.66×10 <sup>-3</sup>	100.0
Industrial	Rendering or fat extraction	1.97	1.54×10 <sup>-3</sup>	100.0
Industrial	Dairy processing	1.81	1.41×10 <sup>-3</sup>	100.0
Commercial	Organic Industrial Chemical Manufacturing n.e.c.	1.77	1.38×10 <sup>-3</sup>	100.0
Industrial	General chemicals storage	1.43	1.12×10 <sup>-3</sup>	100.0
Industrial	Cement or lime production	1.41	1.10×10 <sup>-3</sup>	100.0
Commercial	Gas Supply	1.12	8.74×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.99	7.70×10 <sup>-4</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	0.96	7.51×10 <sup>-4</sup>	100.0



Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Commercial	Basic Non-Ferrous Metal Manufacturing n.e.c.	0.94	7.33×10 <sup>-4</sup>	100.0
Industrial	Non-ferrous metal production (scrap)	0.89	6.97×10 <sup>-4</sup>	100.0
Commercial	Ice Cream Manufacturing	0.75	5.88×10 <sup>-4</sup>	100.0
Industrial	Paper production using recycled materials	0.68	5.29×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	0.66	5.14×10 <sup>-4</sup>	100.0
Commercial	Biscuit Manufacturing	0.60	4.71×10 <sup>-4</sup>	100.0
Commercial	Lifting and Material Handling Equipment Manufacturing	0.50	3.86×10 <sup>-4</sup>	100.0
Commercial	Corrugated Paperboard Container Manufacturing	0.47	3.69×10 <sup>-4</sup>	100.0
Industrial	Glass production	0.47	3.66×10 <sup>-4</sup>	100.0
Commercial	Confectionery Manufacturing	0.43	3.33×10 <sup>-4</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	0.30	2.35×10 <sup>-4</sup>	100.0
Industrial	Waste storage	0.29	2.25×10 <sup>-4</sup>	100.0
Industrial	Chemical storage	0.26	2.05×10 <sup>-4</sup>	100.0
Commercial	Oil and Fat Manufacturing	0.20	1.54×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	0.20	1.53×10 <sup>-4</sup>	100.0
Industrial	Land-based extractive activity	0.19	1.52×10 <sup>-4</sup>	100.0
Commercial	Wooden Furniture and Upholstered Seat Manufacturing	0.19	1.47×10 <sup>-4</sup>	100.0
Industrial	Bird accommodation	0.18	1.39×10 <sup>-4</sup>	100.0
Commercial	Plastic Injection Moulded Product Manufacturing	0.17	1.34×10 <sup>-4</sup>	100.0
Commercial	Ceramic Product Manufacturing	0.12	9.25×10 <sup>-5</sup>	100.0
Commercial	Milk and Cream Processing	0.12	9.05×10 <sup>-5</sup>	100.0
Commercial	Fruit and Vegetable Processing	0.12	9.02×10 <sup>-5</sup>	100.0
Commercial	Aircraft Manufacturing	0.10	7.98×10 <sup>-5</sup>	100.0
Commercial	Scientific Research	8.96×10 <sup>-2</sup>	6.98×10 <sup>-5</sup>	100.0
Industrial	Sterilisation activities	8.08×10 <sup>-2</sup>	6.30×10 <sup>-5</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	5.91×10 <sup>-2</sup>	4.61×10 <sup>-5</sup>	100.0
Industrial	Dairy animal accommodation	5.17×10 <sup>-2</sup>	4.03×10 <sup>-5</sup>	100.0
Industrial	Boat mooring and storage	4.55×10 <sup>-2</sup>	3.55×10 <sup>-5</sup>	100.0
Commercial	Railway Equipment Manufacturing	3.86×10 <sup>-2</sup>	3.01×10 <sup>-5</sup>	100.0
Commercial	Gravel and Sand Quarrying	2.66×10 <sup>-2</sup>	2.08×10 <sup>-5</sup>	100.0

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	Pig accommodation	2.66×10 <sup>-2</sup>	2.07×10 <sup>-5</sup>	100.0
Industrial	Helicopter-related activity	2.11×10 <sup>-2</sup>	1.64×10 <sup>-5</sup>	100.0
Commercial	Soap and Other Detergent Manufacturing	1.13×10 <sup>-2</sup>	8.79×10 <sup>-6</sup>	100.0
Industrial	Shipping in bulk	4.77×10 <sup>-3</sup>	3.72×10 <sup>-6</sup>	100.0
Commercial	Non-Building Construction n.e.c.	2.86×10 <sup>-3</sup>	2.23×10 <sup>-6</sup>	100.0
Industrial	Other land-based extraction	2.56×10 <sup>-3</sup>	2.00×10 <sup>-6</sup>	100.0
Industrial	Recovery of waste	2.52×10 <sup>-3</sup>	1.97×10 <sup>-6</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	2.34×10 <sup>-3</sup>	1.83×10 <sup>-6</sup>	100.0
Industrial	Scrap metal processing	1.50×10 <sup>-3</sup>	1.17×10 <sup>-6</sup>	100.0
Commercial	Steel Pipe and Tube Manufacturing	1.20×10 <sup>-3</sup>	9.34×10 <sup>-7</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	4.93×10 <sup>-4</sup>	3.84×10 <sup>-7</sup>	100.0
Commercial	Agricultural Machinery Manufacturing	1.53×10 <sup>-4</sup>	1.19×10 <sup>-7</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	1.10×10 <sup>-4</sup>	8.60×10 <sup>-8</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	4.61×10 <sup>-5</sup>	3.59×10 <sup>-8</sup>	100.0
<b>Total volatile organic compounds in the Newcastle region</b>				
Natural	Vegetation	2,929	24.3	24.3
Natural	Bushfire and Prescribed Burning	1,418	11.8	36.1
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	1,364	11.3	47.5
Off-Road Mobile	Commercial Boats Exhaust	1,016	8.45	55.9
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	644	5.35	61.3
Industrial	Petroleum products storage	567	4.71	66.0
Domestic-Commercial	Surface Coatings	514	4.27	70.3
Domestic-Commercial	Solid Fuel Burning (Domestic)	460	3.83	74.1
On-Road Mobile	All - Evaporative	446	3.71	77.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	325	2.70	80.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	286	2.38	82.9
Off-Road Mobile	Recreational Boats Exhaust	280	2.32	85.2
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	263	2.18	87.4
Domestic-Commercial	Graphic Arts	188	1.56	88.9
Domestic-Commercial	Natural/Town Gas Leakage	162	1.35	90.3

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	Ammonium nitrate production	136	1.13	91.4
Industrial	Chemical production	98.45	0.82	92.2
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	75.63	0.63	92.9
Industrial	Metal processing	72.12	0.60	93.5
Industrial	Printing, packaging and visual media production	69.72	0.58	94.0
Industrial	General agricultural processing	61.53	0.51	94.6
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	57.87	0.48	95.0
Off-Road Mobile	Ships	44.09	0.37	95.4
Off-Road Mobile	Locomotives	40.98	0.34	95.7
Off-Road Mobile	Recreational Boats Evaporative	38.05	0.32	96.1
Industrial	Waste disposal (application to land)	36.96	0.31	96.4
Industrial	Iron or steel production (scrap metal)	33.99	0.28	96.7
Commercial	Laundries and Dry-Cleaners	32.52	0.27	96.9
Commercial	Smash Repairing	30.61	0.25	97.2
Off-Road Mobile	Industrial Vehicles and Equipment	29.39	0.24	97.4
Natural	Marine Aerosol	28.49	0.24	97.7
Domestic-Commercial	Lawn Mowing Evaporative (Public Open Spaces)	27.61	0.23	97.9
On-Road Mobile	Others - Exhaust	27.22	0.23	98.1
Commercial	Waste Disposal Services	24.77	0.21	98.3
Industrial	Generation of electrical power not coal, diesel or gas	20.95	0.17	98.5
On-Road Mobile	Light Duty Diesel - Exhaust	19.73	0.16	98.7
Industrial	Coal works	19.25	0.16	98.8
Industrial	Shipping in bulk	16.04	0.13	99.0
Commercial	Bread Manufacturing	13.65	0.11	99.1
Industrial	Sewage treatment - large plants	12.84	0.11	99.2
Industrial	Bitumen mixing	12.29	0.10	99.3
Industrial	Generation of electrical power from gas	11.02	9.16×10 <sup>-2</sup>	99.4
Domestic-Commercial	Barbeques	9.65	8.02×10 <sup>-2</sup>	99.4
Domestic-Commercial	Cutback Bitumen	8.95	7.44×10 <sup>-2</sup>	99.5
Industrial	Boat construction/ maintenance (general)	8.67	7.20×10 <sup>-2</sup>	99.6

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Off-Road Mobile	Commercial Boats Evaporative	8.23	6.84×10 <sup>-2</sup>	99.7
Industrial	Aluminium production (alumina)	7.23	6.01×10 <sup>-2</sup>	99.7
Off-Road Mobile	Aircraft (Flight Operations)	6.60	5.49×10 <sup>-2</sup>	99.8
Domestic-Commercial	Gaseous Fuel Burning	6.58	5.47×10 <sup>-2</sup>	99.8
Industrial	Slaughtering or processing of animals	4.18	3.48×10 <sup>-2</sup>	99.9
Commercial	Chemical Product Manufacturing n.e.c.	2.47	2.06×10 <sup>-2</sup>	99.9
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	2.07	1.72×10 <sup>-2</sup>	99.9
Off-Road Mobile	Aircraft (Ground Operations)	2.07	1.72×10 <sup>-2</sup>	99.9
Industrial	Pharmaceutical and veterinary products production	1.46	1.21×10 <sup>-2</sup>	99.9
Off-Road Mobile	Commercial Vehicles and Equipment	1.20	1.00×10 <sup>-2</sup>	99.9
Industrial	Petroleum products and fuel production	1.13	9.43×10 <sup>-3</sup>	100.0
Industrial	Metal plating or coating	0.88	7.34×10 <sup>-3</sup>	100.0
Industrial	Mining for coal	0.83	6.86×10 <sup>-3</sup>	100.0
Commercial	Metal Coating and Finishing	0.58	4.79×10 <sup>-3</sup>	100.0
Natural	Agricultural Burning	0.47	3.90×10 <sup>-3</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	0.46	3.79×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.39	3.24×10 <sup>-3</sup>	100.0
Industrial	Dairy processing	0.32	2.68×10 <sup>-3</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	0.32	2.63×10 <sup>-3</sup>	100.0
Industrial	Land-based extractive activity	0.25	2.04×10 <sup>-3</sup>	100.0
Commercial	Wine Manufacturing	0.23	1.90×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste	0.15	1.27×10 <sup>-3</sup>	100.0
Commercial	Petroleum Product Wholesaling	0.11	8.81×10 <sup>-4</sup>	100.0
Industrial	Waste storage	7.67×10 <sup>-2</sup>	6.37×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	6.60×10 <sup>-2</sup>	5.49×10 <sup>-4</sup>	100.0
Industrial	General chemicals storage	6.58×10 <sup>-2</sup>	5.47×10 <sup>-4</sup>	100.0
Industrial	Non-thermal treatment of waste	4.93×10 <sup>-2</sup>	4.10×10 <sup>-4</sup>	100.0
Industrial	Other land-based extraction	4.32×10 <sup>-2</sup>	3.60×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	3.83×10 <sup>-2</sup>	3.19×10 <sup>-4</sup>	100.0
Industrial	Contaminated soil treatment	3.62×10 <sup>-2</sup>	3.01×10 <sup>-4</sup>	100.0

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	Cement or lime handling	2.33×10 <sup>-2</sup>	1.93×10 <sup>-4</sup>	100.0
Commercial	Road and Bridge Construction	6.97×10 <sup>-3</sup>	5.79×10 <sup>-5</sup>	100.0
Industrial	Concrete works	6.06×10 <sup>-3</sup>	5.03×10 <sup>-5</sup>	100.0
Commercial	Gravel and Sand Quarrying	4.93×10 <sup>-3</sup>	4.10×10 <sup>-5</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	2.62×10 <sup>-3</sup>	2.18×10 <sup>-5</sup>	100.0
Commercial	Construction Material Mining n.e.c.	2.32×10 <sup>-3</sup>	1.93×10 <sup>-5</sup>	100.0
Industrial	Crushing, grinding or separating	1.11×10 <sup>-3</sup>	9.25×10 <sup>-6</sup>	100.0
Commercial	Ceramic Product Manufacturing n.e.c.	6.51×10 <sup>-4</sup>	5.41×10 <sup>-6</sup>	100.0
Industrial	Sewage treatment - small plants	6.23×10 <sup>-4</sup>	5.18×10 <sup>-6</sup>	100.0
Industrial	Helicopter-related activity	5.83×10 <sup>-4</sup>	4.85×10 <sup>-6</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	9.85×10 <sup>-5</sup>	8.19×10 <sup>-7</sup>	100.0
<b>Total volatile organic compounds in the Wollongong region</b>				
Natural	Vegetation	2,963	40.3	40.3
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	997	13.6	53.8
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	430	5.85	59.7
Off-Road Mobile	Recreational Boats Exhaust	397	5.40	65.1
Domestic-Commercial	Surface Coatings	370	5.04	70.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	274	3.73	73.9
On-Road Mobile	All - Evaporative	235	3.19	77.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	213	2.89	79.9
Industrial	Waste disposal (application to land)	193	2.62	82.6
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	173	2.35	84.9
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	171	2.32	87.2
Domestic-Commercial	Graphic Arts	137	1.86	89.1
Domestic-Commercial	Natural/Town Gas Leakage	117	1.59	90.7
Industrial	Iron or steel production (iron ore)	78.16	1.06	91.7
Natural	Bushfire and Prescribed Burning	75.79	1.03	92.8
Off-Road Mobile	Commercial Boats Exhaust	70.29	0.96	93.7
Off-Road Mobile	Industrial Vehicles and Equipment	66.70	0.91	94.6

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Off-Road Mobile	Recreational Boats Evaporative	54.03	0.73	95.4
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	36.74	0.50	95.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	31.11	0.42	96.3
Commercial	Laundries and Dry-Cleaners	25.74	0.35	96.6
Industrial	Petroleum products storage	25.59	0.35	97.0
Industrial	Metal plating or coating	25.07	0.34	97.3
Commercial	Smash Repairing	22.27	0.30	97.6
Industrial	Generation of electrical power from gas	21.41	0.29	97.9
Domestic-Commercial	Lawn Mowing Evaporative (Public Open Spaces)	20.54	0.28	98.2
Natural	Marine Aerosol	16.84	0.23	98.4
Off-Road Mobile	Ships	16.35	0.22	98.7
On-Road Mobile	Others - Exhaust	13.81	0.19	98.8
Commercial	Printing	12.63	0.17	99.0
Commercial	Petroleum Product Wholesaling	12.50	0.17	99.2
On-Road Mobile	Light Duty Diesel - Exhaust	10.06	0.14	99.3
Industrial	Shipping in bulk	8.73	0.12	99.4
Domestic-Commercial	Barbeques	6.96	9.46×10 <sup>-2</sup>	99.5
Off-Road Mobile	Locomotives	5.95	8.09×10 <sup>-2</sup>	99.6
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	5.24	7.12×10 <sup>-2</sup>	99.7
Domestic-Commercial	Cutback Bitumen	5.08	6.91×10 <sup>-2</sup>	99.8
Domestic-Commercial	Gaseous Fuel Burning	4.75	6.45×10 <sup>-2</sup>	99.8
Industrial	Sewage treatment - large plants	4.22	5.73×10 <sup>-2</sup>	99.9
Industrial	Container reconditioning	1.83	2.49×10 <sup>-2</sup>	99.9
Industrial	General chemicals storage	1.01	1.37×10 <sup>-2</sup>	99.9
Industrial	Metal processing	0.96	1.31×10 <sup>-2</sup>	99.9
Industrial	Concrete works	0.81	1.10×10 <sup>-2</sup>	99.9
Industrial	Bitumen mixing	0.69	9.36×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Boats Evaporative	0.59	7.97×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Flight Operations)	0.58	7.95×10 <sup>-3</sup>	100.0
Commercial	Automotive Component Manufacturing n.e.c.	0.54	7.29×10 <sup>-3</sup>	100.0
Commercial	Ceramic Product Manufacturing	0.37	5.02×10 <sup>-3</sup>	100.0

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Commercial	Basic Iron and Steel Manufacturing	0.33	4.43×10 <sup>-3</sup>	100.0
Industrial	Coal works	0.30	4.14×10 <sup>-3</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	0.15	2.01×10 <sup>-3</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.14	1.87×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	0.12	1.66×10 <sup>-3</sup>	100.0
Industrial	Chemical production	5.72×10 <sup>-2</sup>	7.78×10 <sup>-4</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	4.76×10 <sup>-2</sup>	6.47×10 <sup>-4</sup>	100.0
Industrial	Cement or lime handling	4.28×10 <sup>-2</sup>	5.83×10 <sup>-4</sup>	100.0
Industrial	Non-thermal treatment of waste	3.80×10 <sup>-2</sup>	5.16×10 <sup>-4</sup>	100.0
Industrial	Mining for coal	1.88×10 <sup>-2</sup>	2.55×10 <sup>-4</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	1.26×10 <sup>-2</sup>	1.71×10 <sup>-4</sup>	100.0
Commercial	Gravel and Sand Quarrying	1.97×10 <sup>-3</sup>	2.68×10 <sup>-5</sup>	100.0
Commercial	Rubber Product Manufacturing n.e.c.	3.38×10 <sup>-4</sup>	4.60×10 <sup>-6</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	1.02×10 <sup>-4</sup>	1.39×10 <sup>-6</sup>	100.0
Commercial	Synthetic Resin Manufacturing	3.78×10 <sup>-5</sup>	5.14×10 <sup>-7</sup>	100.0
<b>Total volatile organic compounds in the Non-urban region</b>				
Natural	Vegetation	107,893	56.3	56.3
Natural	Bushfire and Prescribed Burning	56,735	29.6	86.0
Off-Road Mobile	Commercial Boats Exhaust	6,710	3.50	89.5
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	3,425	1.79	91.2
Off-Road Mobile	Recreational Boats Exhaust	2,393	1.25	92.5
Off-Road Mobile	Industrial Vehicles and Equipment	1,890	0.99	93.5
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1,530	0.80	94.3
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,412	0.74	95.0
Domestic-Commercial	Surface Coatings	1,161	0.61	95.6
Natural	Marine Aerosol	1,155	0.60	96.2
On-Road Mobile	All - Evaporative	987	0.52	96.7
Industrial	Generation of electrical power from coal	840	0.44	97.2
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	653	0.34	97.5

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	607	0.32	97.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	602	0.31	98.1
Domestic-Commercial	Graphic Arts	471	0.25	98.4
Domestic-Commercial	Natural/Town Gas Leakage	367	0.19	98.6
Off-Road Mobile	Recreational Boats Evaporative	326	0.17	98.8
Off-Road Mobile	Locomotives	239	0.12	98.9
Industrial	Metal plating or coating	207	0.11	99.0
Industrial	Composting	203	0.11	99.1
Industrial	Waste disposal (application to land)	183	9.55×10 <sup>-2</sup>	99.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	181	9.47×10 <sup>-2</sup>	99.3
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	162	8.44×10 <sup>-2</sup>	99.4
Commercial	Wine Manufacturing	136	7.10×10 <sup>-2</sup>	99.4
Commercial	Log Sawmilling	127	6.62×10 <sup>-2</sup>	99.5
Commercial	Laundries and Dry-Cleaners	90.74	4.74×10 <sup>-2</sup>	99.6
Industrial	Mining for coal	79.95	4.17×10 <sup>-2</sup>	99.6
Commercial	Petroleum Product Wholesaling	72.59	3.79×10 <sup>-2</sup>	99.6
Commercial	Smash Repairing	71.75	3.75×10 <sup>-2</sup>	99.7
Domestic-Commercial	Lawn Mowing Evaporative (Public Open Spaces)	63.03	3.29×10 <sup>-2</sup>	99.7
On-Road Mobile	Others - Exhaust	57.58	3.01×10 <sup>-2</sup>	99.7
Commercial	Electric Cable and Wire Manufacturing	55.86	2.92×10 <sup>-2</sup>	99.8
Industrial	Generation of electrical power from gas	50.16	2.62×10 <sup>-2</sup>	99.8
On-Road Mobile	Light Duty Diesel - Exhaust	44.73	2.34×10 <sup>-2</sup>	99.8
Off-Road Mobile	Ships	44.29	2.31×10 <sup>-2</sup>	99.8
Off-Road Mobile	Commercial Boats Evaporative	41.13	2.15×10 <sup>-2</sup>	99.9
Industrial	Solid waste landfilling	32.19	1.68×10 <sup>-2</sup>	99.9
Industrial	Sewage treatment - small plants	24.10	1.26×10 <sup>-2</sup>	99.9
Natural	Agricultural Burning	22.24	1.16×10 <sup>-2</sup>	99.9
Industrial	Generation of electrical power not coal, diesel or gas	22.04	1.15×10 <sup>-2</sup>	99.9
Domestic-Commercial	Barbeques	21.81	1.14×10 <sup>-2</sup>	99.9
Domestic-Commercial	Cutback Bitumen	21.14	1.10×10 <sup>-2</sup>	99.9
Industrial	Inert waste landfilling	18.32	9.56×10 <sup>-3</sup>	99.9



Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Domestic-Commercial	Gaseous Fuel Burning	14.88	7.77×10 <sup>-3</sup>	99.9
Off-Road Mobile	Aircraft (Flight Operations)	13.23	6.91×10 <sup>-3</sup>	100.0
Industrial	Sewage treatment - large plants	11.12	5.81×10 <sup>-3</sup>	100.0
Commercial	Printing	10.37	5.41×10 <sup>-3</sup>	100.0
Off-Road Mobile	Commercial Vehicles and Equipment	8.96	4.68×10 <sup>-3</sup>	100.0
Commercial	Wood Product Manufacturing n.e.c.	7.63	3.99×10 <sup>-3</sup>	100.0
Industrial	Land-based extractive activity	6.45	3.37×10 <sup>-3</sup>	100.0
Industrial	Recovery of waste	5.69	2.97×10 <sup>-3</sup>	100.0
Off-Road Mobile	Aircraft (Ground Operations)	5.23	2.73×10 <sup>-3</sup>	100.0
Industrial	Bitumen mixing	5.01	2.61×10 <sup>-3</sup>	100.0
Industrial	Cement or lime production	3.84	2.00×10 <sup>-3</sup>	100.0
Industrial	General agricultural processing	2.41	1.26×10 <sup>-3</sup>	100.0
Industrial	Ceramics production	2.27	1.18×10 <sup>-3</sup>	100.0
Commercial	Plastic Product, Rigid Fibre Reinforced, Manufacturing	1.70	8.86×10 <sup>-4</sup>	100.0
Commercial	Chemical Product Manufacturing n.e.c.	1.59	8.28×10 <sup>-4</sup>	100.0
Industrial	Pharmaceutical and veterinary products production	1.50	7.84×10 <sup>-4</sup>	100.0
Commercial	Medicinal and Pharmaceutical Product Manufacturing	1.42	7.41×10 <sup>-4</sup>	100.0
Industrial	Recovery of waste oil	1.25	6.55×10 <sup>-4</sup>	100.0
Commercial	Food Manufacturing n.e.c.	1.03	5.38×10 <sup>-4</sup>	100.0
Industrial	Boat construction/maintenance (general)	0.95	4.98×10 <sup>-4</sup>	100.0
Industrial	Water-based extractive activity	0.75	3.92×10 <sup>-4</sup>	100.0
Industrial	Concrete works	0.69	3.60×10 <sup>-4</sup>	100.0
Commercial	Hospitals (Except Psychiatric Hospitals)	0.67	3.49×10 <sup>-4</sup>	100.0
Commercial	Mining and Construction Machinery Manufacturing	0.54	2.80×10 <sup>-4</sup>	100.0
Commercial	Synthetic Resin Manufacturing	0.51	2.64×10 <sup>-4</sup>	100.0
Industrial	Rendering or fat extraction	0.40	2.08×10 <sup>-4</sup>	100.0
Commercial	Spring and Wire Product Manufacturing	0.37	1.94×10 <sup>-4</sup>	100.0
Industrial	General animal products production	0.34	1.77×10 <sup>-4</sup>	100.0
Industrial	Aluminium production (scrap metal)	0.30	1.55×10 <sup>-4</sup>	100.0

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Commercial	Automotive Component Manufacturing n.e.c.	0.28	1.49×10 <sup>-4</sup>	100.0
Industrial	Petroleum products and fuel production	0.18	9.45×10 <sup>-5</sup>	100.0
Domestic-Commercial	Liquid Fuel Burning (Domestic)	0.15	7.79×10 <sup>-5</sup>	100.0
Industrial	Chemical production	0.11	5.94×10 <sup>-5</sup>	100.0
Commercial	Prepared Animal and Bird Feed Manufacturing	9.79×10 <sup>-2</sup>	5.11×10 <sup>-5</sup>	100.0
Industrial	Explosives production	7.69×10 <sup>-2</sup>	4.01×10 <sup>-5</sup>	100.0
Industrial	Bird accommodation	6.86×10 <sup>-2</sup>	3.58×10 <sup>-5</sup>	100.0
Commercial	Funeral Directors, Crematoria and Cemeteries	6.68×10 <sup>-2</sup>	3.49×10 <sup>-5</sup>	100.0
Commercial	Paper Product Manufacturing n.e.c.	5.64×10 <sup>-2</sup>	2.95×10 <sup>-5</sup>	100.0
Industrial	Animal accommodation	5.41×10 <sup>-2</sup>	2.82×10 <sup>-5</sup>	100.0
Industrial	Non-thermal treatment of waste	3.72×10 <sup>-2</sup>	1.94×10 <sup>-5</sup>	100.0
Industrial	Boat mooring and storage	3.65×10 <sup>-2</sup>	1.91×10 <sup>-5</sup>	100.0
Commercial	Gravel and Sand Quarrying	2.37×10 <sup>-2</sup>	1.24×10 <sup>-5</sup>	100.0
Industrial	Pig accommodation	1.92×10 <sup>-2</sup>	1.00×10 <sup>-5</sup>	100.0
Industrial	Crushing, grinding or separating	1.82×10 <sup>-2</sup>	9.51×10 <sup>-6</sup>	100.0
Industrial	Miscellaneous licensed discharges to waters (at any time)	1.33×10 <sup>-2</sup>	6.93×10 <sup>-6</sup>	100.0
Commercial	Furniture Manufacturing n.e.c.	1.11×10 <sup>-2</sup>	5.82×10 <sup>-6</sup>	100.0
Industrial	Cement or lime handling	9.89×10 <sup>-3</sup>	5.16×10 <sup>-6</sup>	100.0
Commercial	Explosive Manufacturing	8.33×10 <sup>-3</sup>	4.35×10 <sup>-6</sup>	100.0
Commercial	Road and Bridge Construction	7.78×10 <sup>-3</sup>	4.06×10 <sup>-6</sup>	100.0
Commercial	Fabricated Metal Product Manufacturing n.e.c.	6.22×10 <sup>-3</sup>	3.25×10 <sup>-6</sup>	100.0
Industrial	General chemicals storage	1.84×10 <sup>-3</sup>	9.61×10 <sup>-7</sup>	100.0
Commercial	Rail Transport	1.73×10 <sup>-3</sup>	9.04×10 <sup>-7</sup>	100.0
Industrial	Waste storage	1.42×10 <sup>-3</sup>	7.39×10 <sup>-7</sup>	100.0
Commercial	Non-Building Construction n.e.c.	1.23×10 <sup>-3</sup>	6.43×10 <sup>-7</sup>	100.0
Commercial	Construction Material Mining n.e.c.	9.87×10 <sup>-4</sup>	5.15×10 <sup>-7</sup>	100.0
Industrial	Mining for minerals	8.10×10 <sup>-4</sup>	4.23×10 <sup>-7</sup>	100.0
Commercial	Glass and Glass Product Manufacturing	7.41×10 <sup>-4</sup>	3.87×10 <sup>-7</sup>	100.0
Commercial	Non-Ferrous Metal Casting	6.24×10 <sup>-4</sup>	3.26×10 <sup>-7</sup>	100.0
Industrial	Other land-based extraction	4.95×10 <sup>-4</sup>	2.59×10 <sup>-7</sup>	100.0

Module	Activity <sup>44</sup>	Emissions (tonnes/year)	Proportion (%) <sup>45</sup>	Cumulative proportion (%)
Industrial	Pesticides and related products production	3.34×10 <sup>-4</sup>	1.74×10 <sup>-7</sup>	100.0
Industrial	Coal works	1.06×10 <sup>-4</sup>	5.53×10 <sup>-8</sup>	100.0

Figure 3-56, Figure 3-57, Figure 3-58, Figure 3-59 and Figure 3-60 show the estimated annual emissions for the top 15 natural and human-made sources of VOC in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

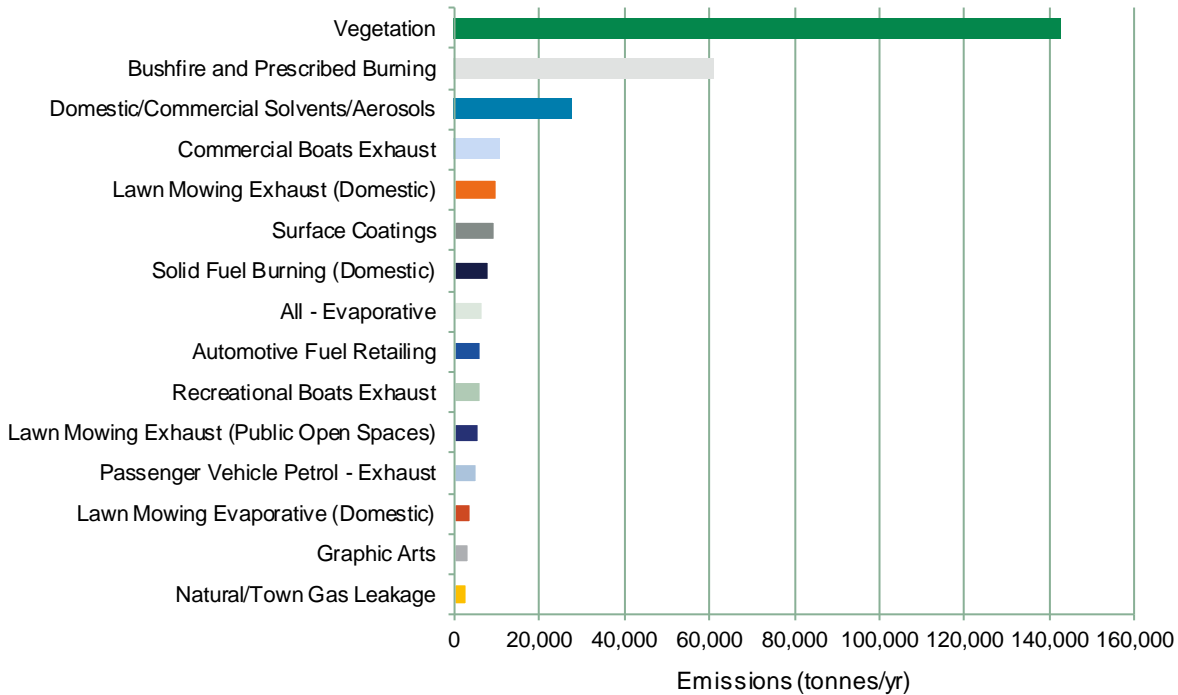


Figure 3-56: GMR: top 15 natural and human-made sources of VOC

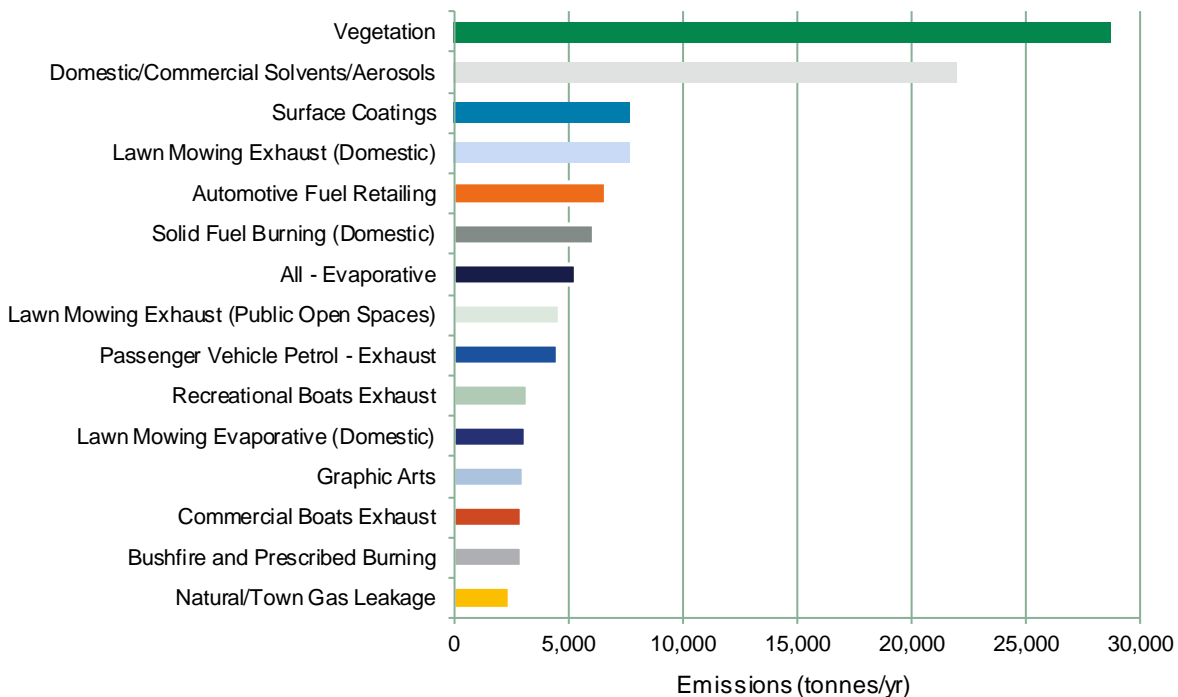


Figure 3-57: Sydney region: top 15 natural and human-made sources of VOC

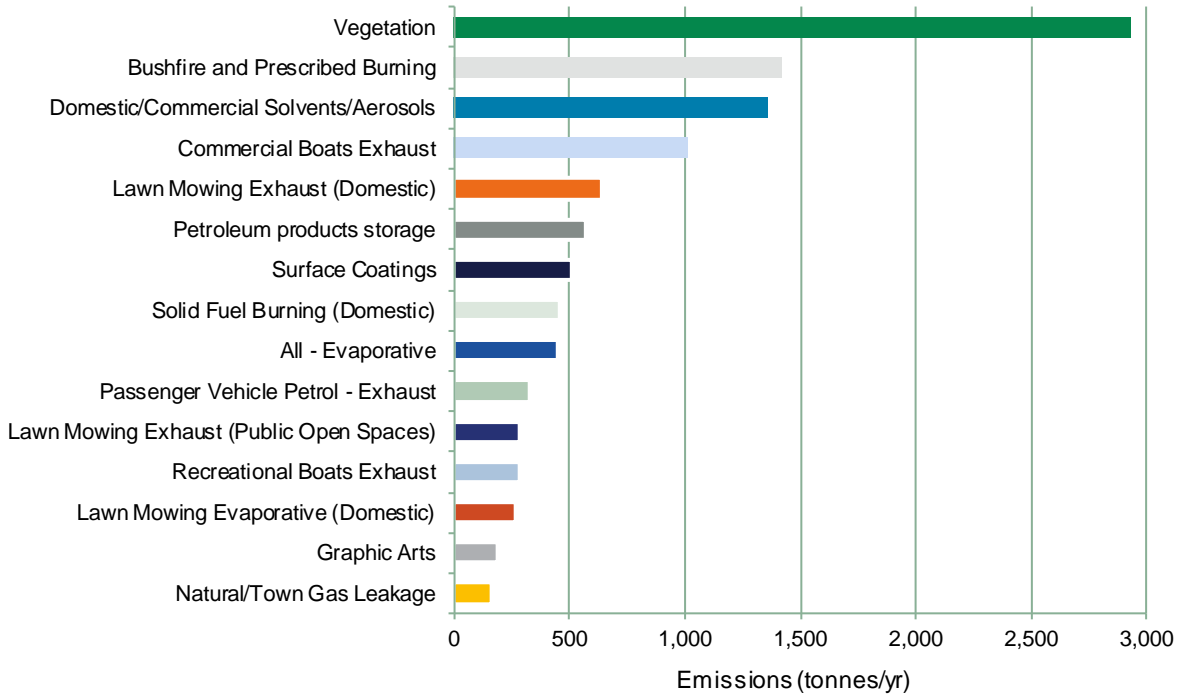


Figure 3-58: Newcastle region: top 15 natural and human-made sources of VOC

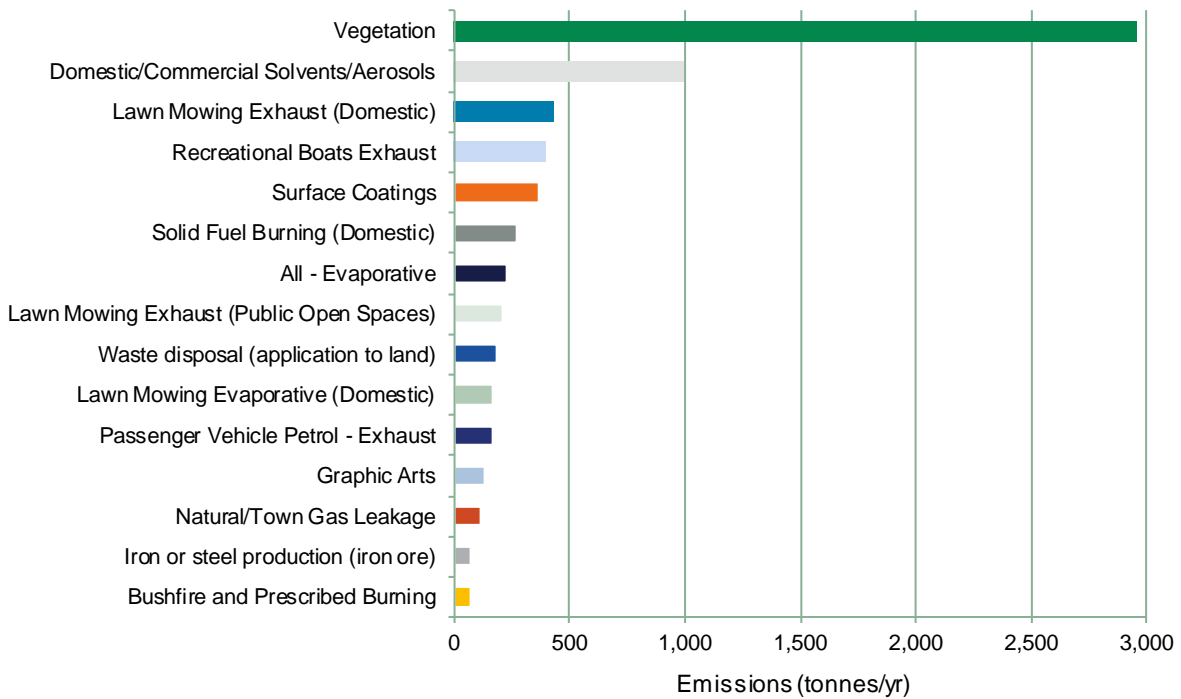
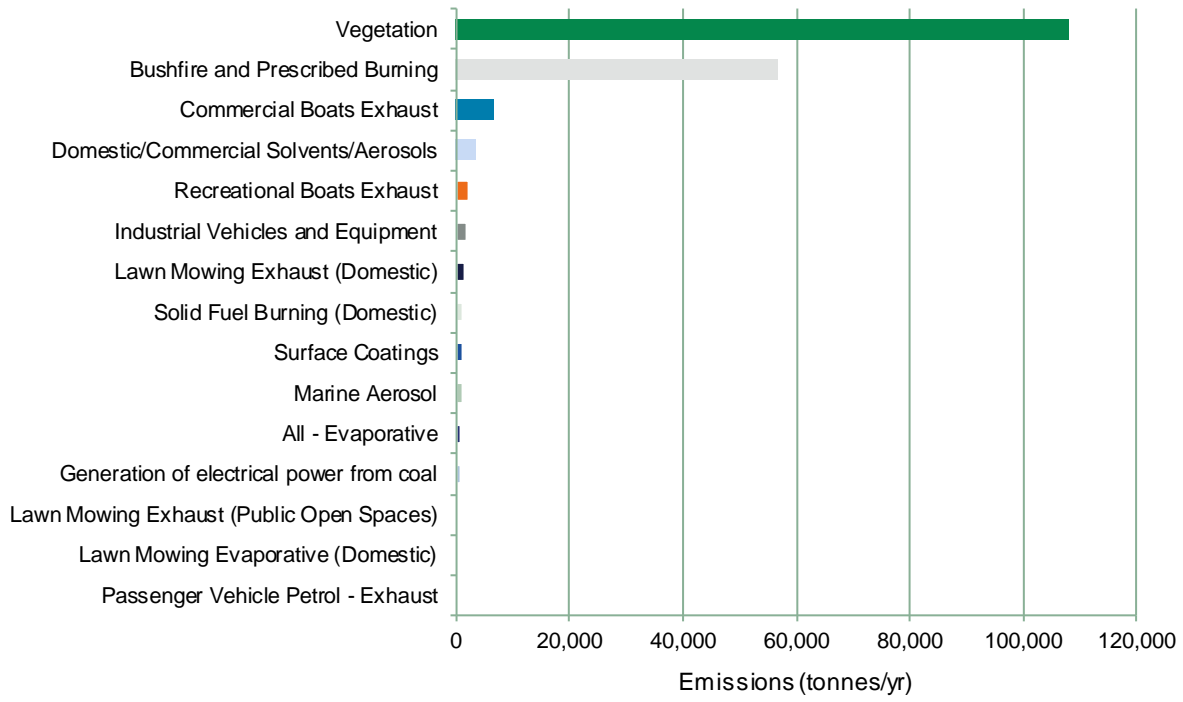


Figure 3-59: Wollongong region: top 15 natural and human-made sources of VOC



**Figure 3-60: Non-urban region: top 15 natural and human-made sources of VOC**

## 4. Emissions summary

The air emissions inventory has been developed for the 2013 calendar year, which incorporates an area covering the greater Sydney, Newcastle and Wollongong regions, known collectively as the Greater Metropolitan Region (GMR).

The air emissions inventory includes emissions from biogenic (natural living organisms), geogenic (natural non-living) and anthropogenic (human-made) sources as follows:

- **Natural** – biogenic and geogenic (e.g. bushfires, marine aerosol and vegetation)
- **Commercial** – non-EPA licensed<sup>46</sup> premises (e.g. printers, quarries and service stations)
- **Domestic-Commercial** – domestic activities (e.g. residential lawn mowing, wood heaters and portable fuel containers) and non-premises based commercial activities (e.g. public open space lawn mowing)
- **Industrial** – EPA-licensed<sup>47</sup> premises (e.g. coal mines, oil refineries and power stations)
- **Off-Road Mobile** – unregistered non-road vehicles and equipment (e.g. dump trucks, bulldozers, locomotives and marine vessels)
- **On-Road Mobile** – road registered vehicles (e.g. registered cars, trucks and buses).

The pollutants inventoried include criteria pollutants specified in the Ambient Air Quality NEPM (NEPC, 2016), air toxics associated with the National Pollutant Inventory NEPM (NEPC, 2008) and the Air Toxics NEPM (NEPC, 2004), and any other pollutants associated with state-specific programs, i.e. Load Based Licensing (Protection of the Environment Operations (General) Regulation 2009 (PCO, 2010b)) and the Protection of the Environment Operations (Clean Air) Regulation 2010 (PCO, 2011).

This report presents emissions of criteria pollutants referred to in the Ambient Air Quality NEPM (NEPC, 2016), including<sup>48</sup>:

- carbon monoxide (CO)
- oxides of nitrogen (NO<sub>x</sub>)
- particulate matter ≤ 10µm (PM<sub>10</sub>)
- particulate matter ≤ 2.5µm (PM<sub>2.5</sub>)
- sulfur dioxide (SO<sub>2</sub>) and
- total volatile organic compounds (VOC).

---

<sup>46</sup> Not a scheduled activity or scheduled development work as defined in the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>47</sup> An activity listed in Schedule 1 of the *Protection of the Environment (Operations) Act 1997* (PCO, 2010a).

<sup>48</sup> VOC is not included in the Ambient Air Quality NEPM but is included in this report due to its importance as a precursor to the formation of secondary pollution in the atmosphere. Lead is an AAQ NEPM pollutant but is not included in this report as monitoring for lead ceased in 2005 with NSW annual average ambient levels having fallen to less than 10% of the NEPM standard (OEH, 2019).

Table 4-1 presents total estimated annual emissions of criteria pollutants from natural and human-made sources in the Sydney, Newcastle and Wollongong regions, and the whole GMR. Total estimated annual emissions are also presented for the region defined as Non-urban. This region is the area of the GMR minus the combined areas of the Sydney, Newcastle and Wollongong regions.

**Table 4-1: Total estimated annual emissions from natural and human-made sources in each region**

Substance	Region <sup>49</sup>	Emissions (tonnes/year)		
		Human-made	Natural	Total <sup>49</sup>
Carbon monoxide	Sydney	210,291	42,008	252,299
	Newcastle	60,789	20,261	81,050
	Wollongong	114,170	1,083	115,253
	Non-urban	82,829	810,795	893,625
	GMR	468,079	874,147	1,342,226
Oxides of nitrogen	Sydney	58,676	2,605	61,282
	Newcastle	9,133	739	9,872
	Wollongong	9,863	110	9,973
	Non-urban	191,334	32,466	223,800
	GMR	269,007	35,920	304,927
Particulate matter ≤ 10µm	Sydney	15,415	5,786	21,200
	Newcastle	4,969	2,300	7,269
	Wollongong	1,790	239	2,029
	Non-urban	79,038	95,222	174,260
	GMR	101,211	103,547	204,758
Particulate matter ≤ 2.5µm	Sydney	9,945	3,816	13,761
	Newcastle	2,093	1,769	3,862
	Wollongong	942	111	1,054
	Non-urban	16,248	71,269	87,517
	GMR	29,228	76,965	106,194
Sulfur dioxide	Sydney	10,148	382	10,530
	Newcastle	9,988	184	10,172
	Wollongong	4,840	9.85	4,850
	Non-urban	200,376	7,378	207,754
	GMR	225,351	7,955	233,306
Total volatile organic compounds	Sydney	96,521	31,785	128,306
	Newcastle	7,653	4,376	12,029
	Wollongong	4,300	3,055	7,355
	Non-urban	25,734	165,805	191,539
	GMR	134,209	205,021	339,230

<sup>49</sup> The total for the GMR may differ from the sum of the regions due to rounding.

Table 4-2 presents the proportions of total estimated annual emissions of criteria pollutants from natural and human-made sources in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 4-2: Proportions of total estimated annual emissions from natural and human-made sources in each region**

Substance	Region	Proportion (%)	
		Human-made	Natural
Carbon monoxide	Sydney	83.3	16.7
	Newcastle	75.0	25.0
	Wollongong	99.1	0.94
	Non-urban	9.27	90.7
	GMR	34.9	65.1
Oxides of nitrogen	Sydney	95.7	4.25
	Newcastle	92.5	7.49
	Wollongong	98.9	1.11
	Non-urban	85.5	14.5
	GMR	88.2	11.8
Particulate matter $\leq 10\mu\text{m}$	Sydney	72.7	27.3
	Newcastle	68.4	31.6
	Wollongong	88.2	11.8
	Non-urban	45.4	54.6
	GMR	49.4	50.6
Particulate matter $\leq 2.5\mu\text{m}$	Sydney	72.3	27.7
	Newcastle	54.2	45.8
	Wollongong	89.4	10.6
	Non-urban	18.6	81.4
	GMR	27.5	72.5
Sulfur dioxide	Sydney	96.4	3.63
	Newcastle	98.2	1.81
	Wollongong	99.8	0.20
	Non-urban	96.4	3.55
	GMR	96.6	3.41
Total volatile organic compounds	Sydney	75.2	24.8
	Newcastle	63.6	36.4
	Wollongong	58.5	41.5
	Non-urban	13.4	86.6
	GMR	39.6	60.4



Figure 4-1, Figure 4-2, Figure 4-3, Figure 4-4 and Figure 4-5 show the proportions of total estimated annual emissions of criteria pollutants from natural and human-made sources in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

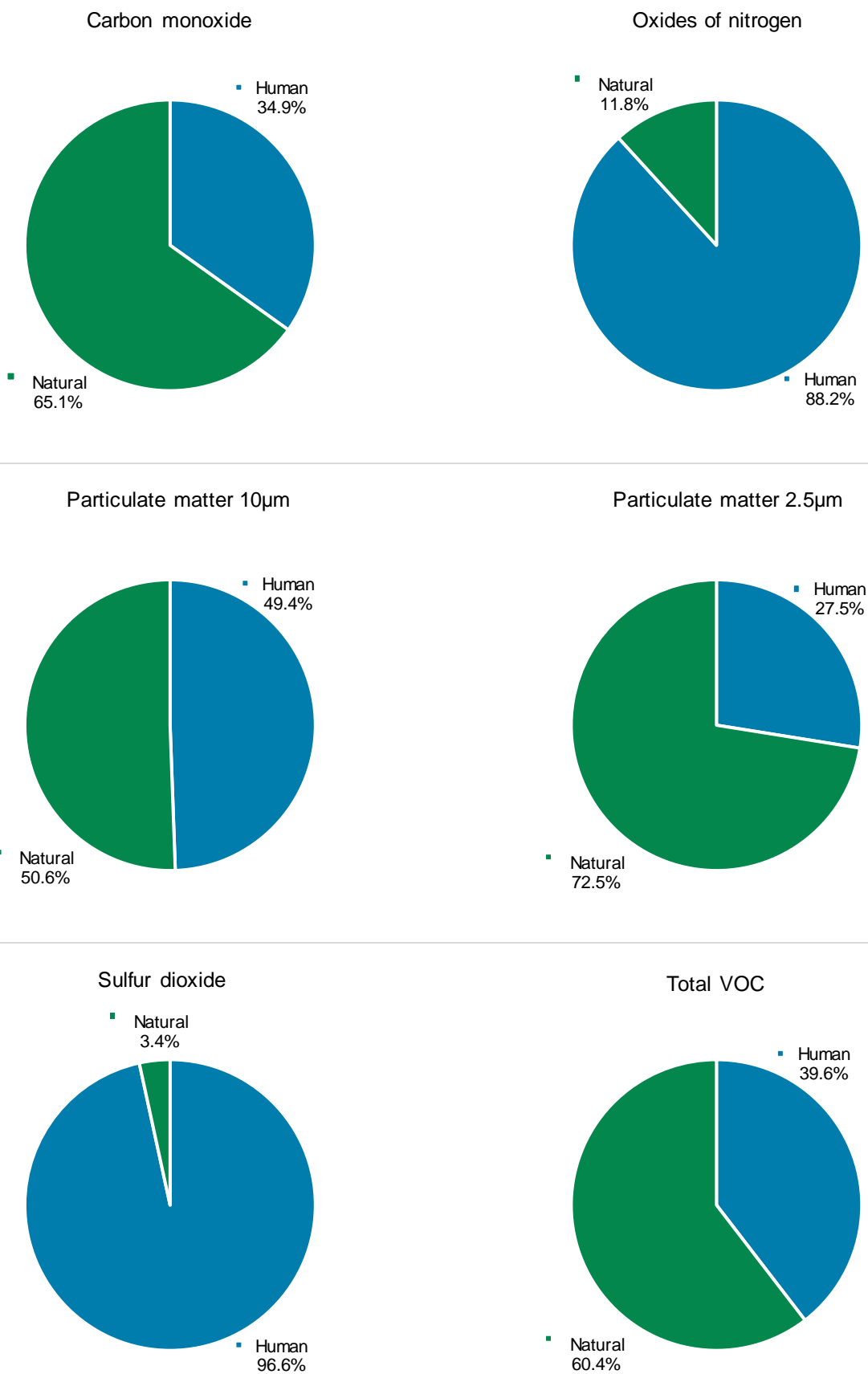


Figure 4-1: GMR: proportions of total estimated annual emissions from natural and human-made sources

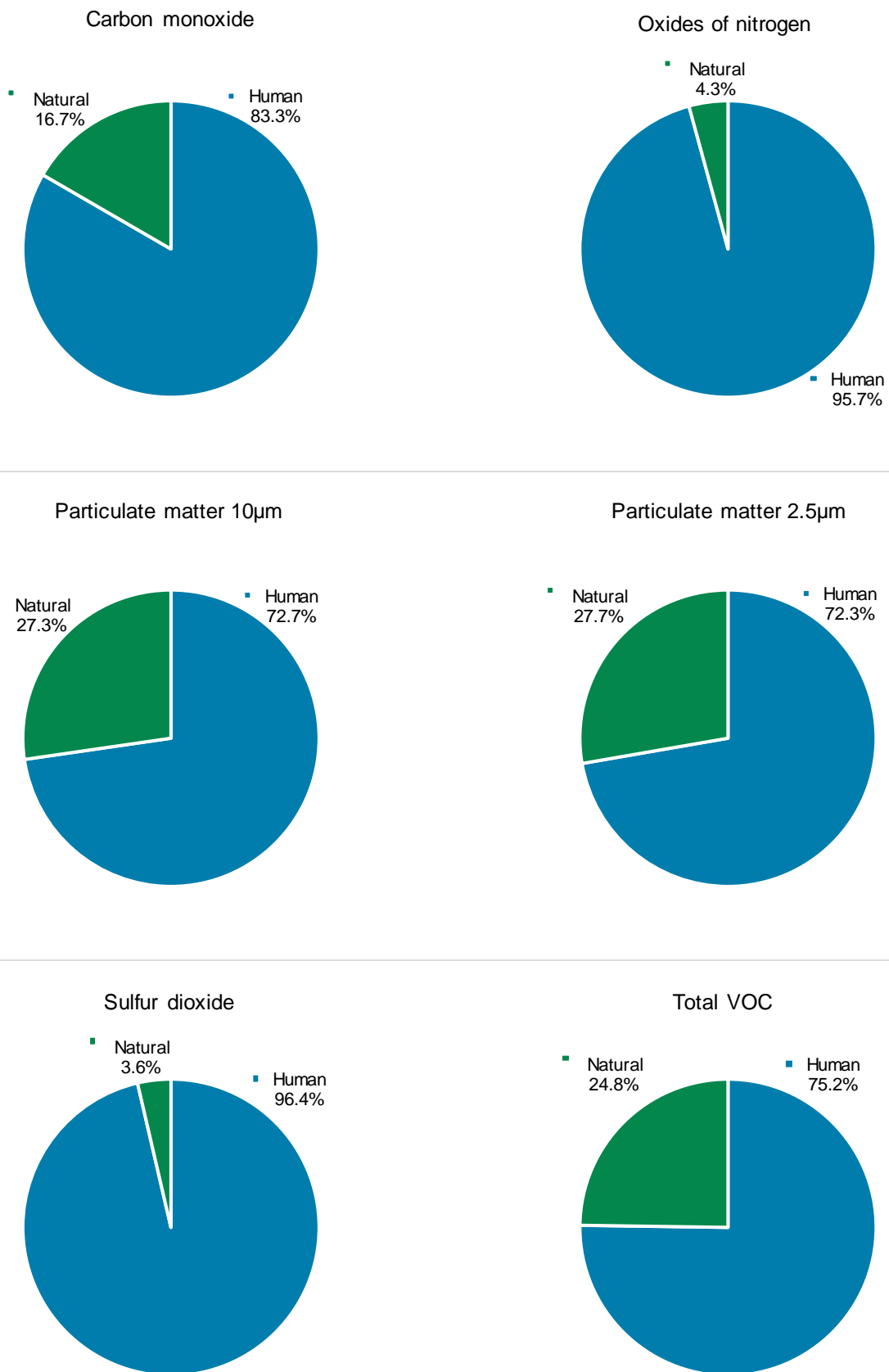


Figure 4-2: Sydney region: proportions of total estimated annual emissions from natural and human-made sources

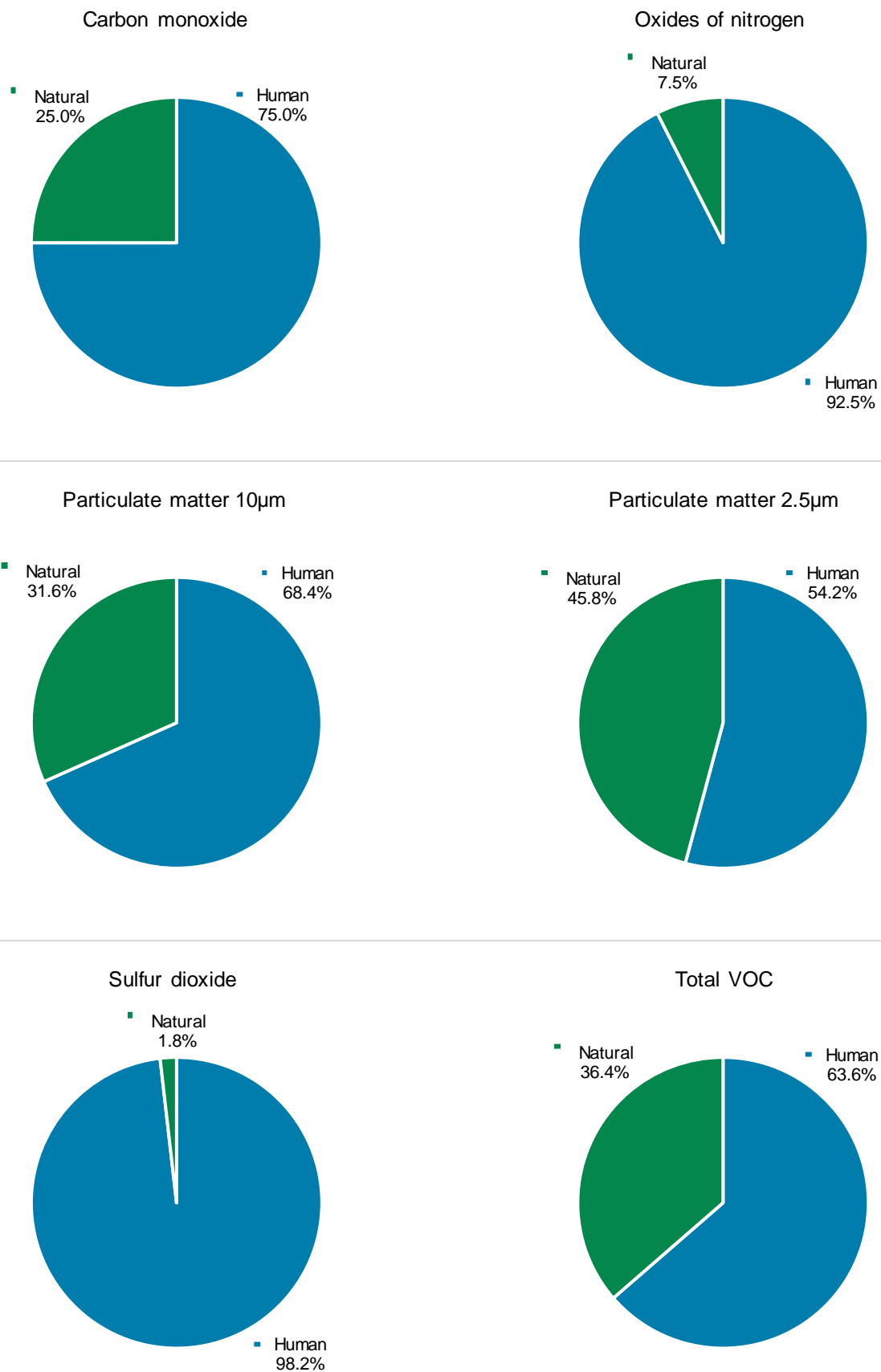


Figure 4-3: Newcastle region: proportions of total estimated annual emissions from natural and human-made sources

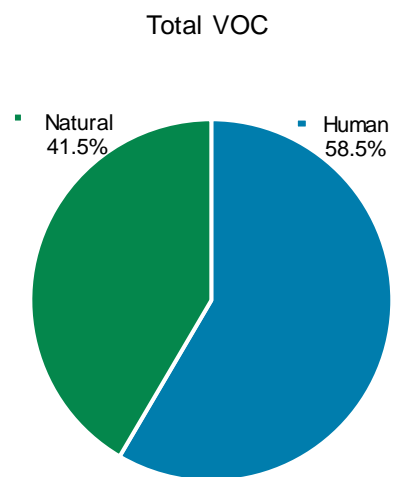
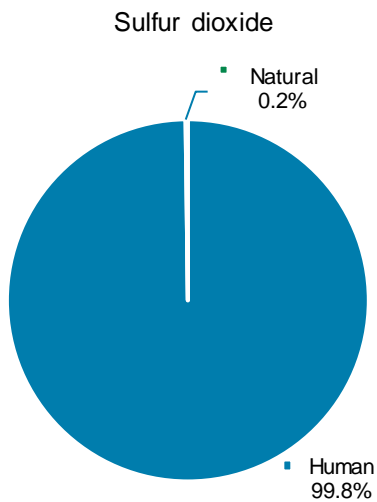
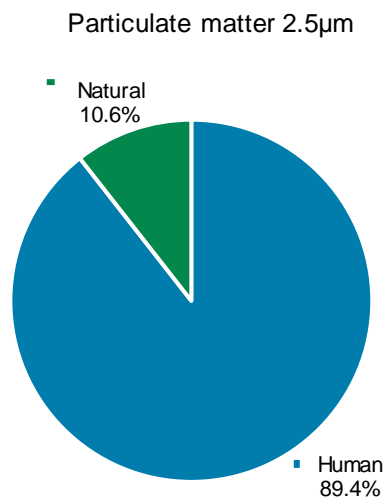
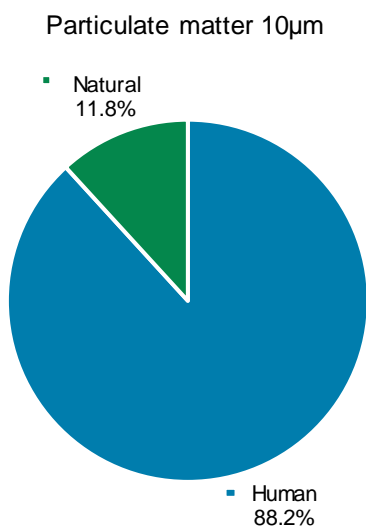
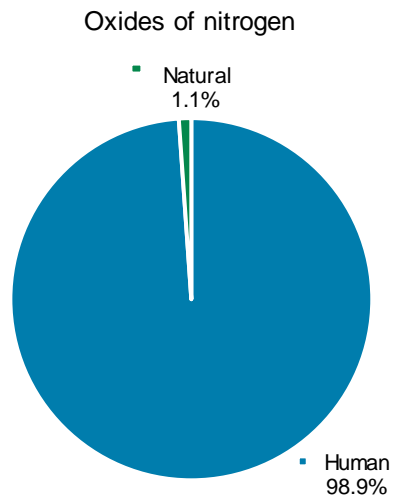
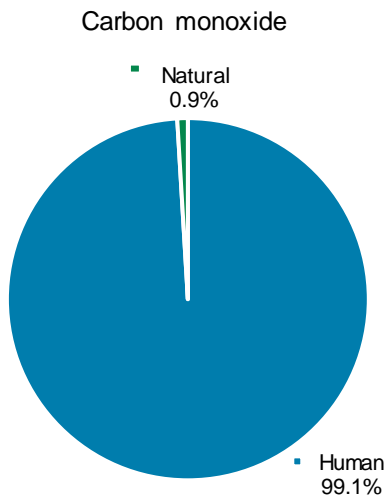
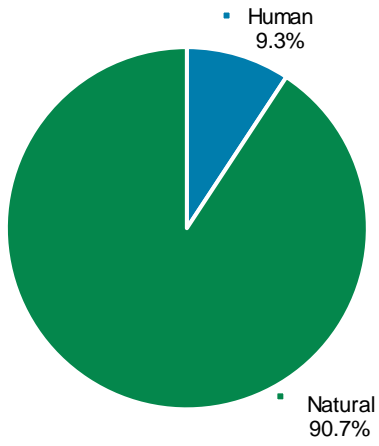
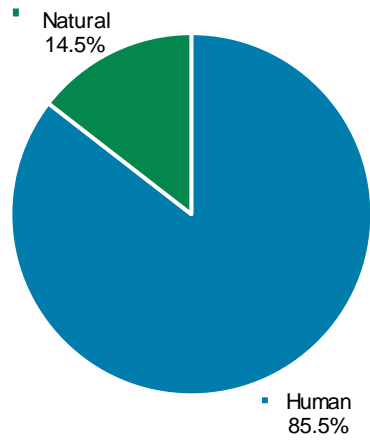


Figure 4-4: Wollongong region: proportions of total estimated annual emissions from natural and human-made sources

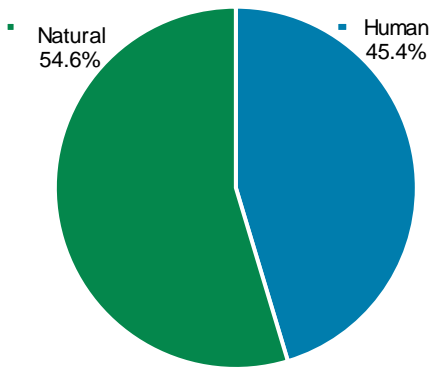
Carbon monoxide



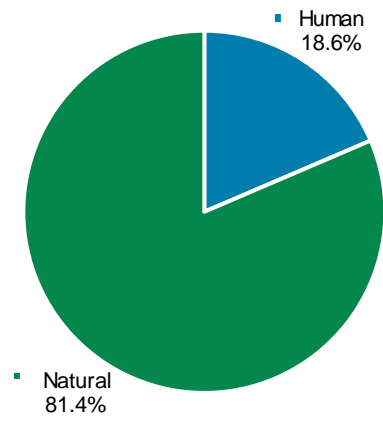
Oxides of nitrogen



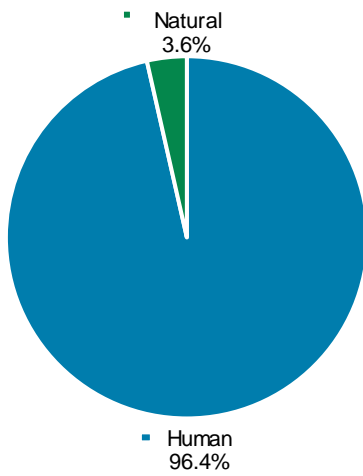
Particulate matter 10µm



Particulate matter 2.5µm



Sulfur dioxide



Total VOC

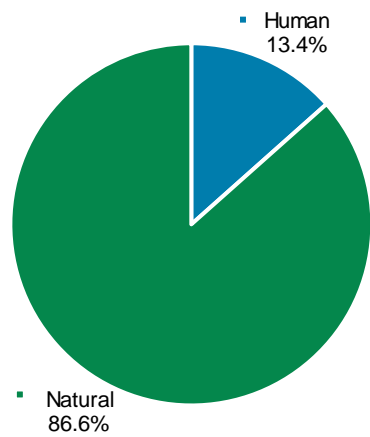


Figure 4-5: Non-urban region: proportions of total estimated annual emissions from natural and human-made sources

Table 4-3 presents total estimated annual emissions of criteria pollutants by human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 4-3: Total estimated annual emissions by human-made source type in each region**

Substance	Region <sup>50</sup>	Emissions (tonnes/year)					Total <sup>50</sup>
		Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile	
Carbon monoxide	Sydney	320	90,299	5,968	22,465	91,239	210,291
	Newcastle	9.68	6,838	43,489	3,802	6,649	60,789
	Wollongong	16.69	4,456	104,510	1,640	3,547	114,170
	Non-urban	31.26	18,072	17,179	33,720	13,827	82,829
	GMR	378	119,664	171,147	61,628	115,262	468,079
Oxides of nitrogen	Sydney	359	2,701	7,387	15,734	32,496	58,676
	Newcastle	38.13	187	2,016	4,104	2,788	9,133
	Wollongong	11.12	129	6,166	1,946	1,610	9,863
	Non-urban	154	457	145,396	37,136	8,191	191,334
	GMR	562	3,473	160,966	58,920	45,085	269,007
Particulate matter ≤ 10µm	Sydney	682	5,744	6,040	1,111	1,838	15,415
	Newcastle	82.44	432	4,016	283	156	4,969
	Wollongong	30.41	262	1,280	133	85.34	1,790
	Non-urban	492	1,296	75,087	1,736	427	79,038
	GMR	1,287	7,734	86,422	3,263	2,505	101,211
Particulate matter ≤ 2.5µm	Sydney	291	5,517	1,824	1,034	1,279	9,945
	Newcastle	19.28	415	1,289	263	107	2,093
	Wollongong	10.03	251	497	125	59.43	942
	Non-urban	112	1,245	12,921	1,665	305	16,248
	GMR	433	7,429	16,530	3,086	1,750	29,228
Sulfur dioxide	Sydney	78.95	124	3,057	6,790	97.36	10,148
	Newcastle	1.76	9.12	8,261	1,709	7.12	9,988
	Wollongong	0.74	5.75	4,190	640	4.06	4,840
	Non-urban	110	25.81	198,604	1,618	17.43	200,376
	GMR	192	165	214,112	10,757	126	225,351
Total volatile organic compounds	Sydney	9,561	57,399	9,369	7,552	12,641	96,521
	Newcastle	108	3,933	1,194	1,466	952	7,653
	Wollongong	79.91	2,750	362	612	497	4,300
	Non-urban	580	9,746	1,703	11,670	2,034	25,734
	GMR	10,330	73,828	12,628	21,300	16,124	134,209

<sup>50</sup> The totals may differ from the sum of the addends due to rounding.

Table 4-4 presents the proportions of total estimated annual emissions of criteria pollutants by human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 4-4: Proportions of total estimated annual emissions by human-made source type in each region**

Substance	Region	Proportion (%) <sup>51</sup>				
		Commercial	Domestic-Commercial	Industrial	Off-Road Mobile	On-Road Mobile
Carbon monoxide	Sydney	0.15	42.9	2.84	10.7	43.4
	Newcastle	1.59×10 <sup>-2</sup>	11.2	71.5	6.26	10.9
	Wollongong	1.46×10 <sup>-2</sup>	3.90	91.5	1.44	3.11
	Non-urban	3.77×10 <sup>-2</sup>	21.8	20.7	40.7	16.7
	GMR	8.08×10 <sup>-2</sup>	25.6	36.6	13.2	24.6
Oxides of nitrogen	Sydney	0.61	4.60	12.6	26.8	55.4
	Newcastle	0.42	2.04	22.1	44.9	30.5
	Wollongong	0.11	1.31	62.5	19.7	16.3
	Non-urban	8.06×10 <sup>-2</sup>	0.24	76.0	19.4	4.28
	GMR	0.21	1.29	59.8	21.9	16.8
Particulate matter ≤ 10µm	Sydney	4.43	37.3	39.2	7.21	11.9
	Newcastle	1.66	8.70	80.8	5.70	3.13
	Wollongong	1.70	14.6	71.5	7.44	4.77
	Non-urban	0.62	1.64	95.0	2.20	0.54
	GMR	1.27	7.64	85.4	3.22	2.48
Particulate matter ≤ 2.5µm	Sydney	2.93	55.5	18.3	10.4	12.9
	Newcastle	0.92	19.8	61.6	12.5	5.12
	Wollongong	1.06	26.6	52.7	13.2	6.31
	Non-urban	0.69	7.66	79.5	10.2	1.88
	GMR	1.48	25.4	56.6	10.6	5.99
Sulfur dioxide	Sydney	0.78	1.22	30.1	66.9	0.96
	Newcastle	1.76×10 <sup>-2</sup>	9.13×10 <sup>-2</sup>	82.7	17.1	7.13×10 <sup>-2</sup>
	Wollongong	1.53×10 <sup>-2</sup>	0.12	86.6	13.2	8.38×10 <sup>-2</sup>
	Non-urban	5.50×10 <sup>-2</sup>	1.29×10 <sup>-2</sup>	99.1	0.81	8.70×10 <sup>-3</sup>
	GMR	8.50×10 <sup>-2</sup>	7.31×10 <sup>-2</sup>	95.0	4.77	5.59×10 <sup>-2</sup>
Total volatile organic compounds	Sydney	9.91	59.5	9.71	7.82	13.1
	Newcastle	1.41	51.4	15.6	19.2	12.4
	Wollongong	1.86	63.9	8.41	14.2	11.6
	Non-urban	2.25	37.9	6.62	45.3	7.90
	GMR	7.70	55.0	9.41	15.9	12.0

<sup>51</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10<sup>-2</sup> = 0.0946).

Figure 4-6, Figure 4-7, Figure 4-8, Figure 4-9 and Figure 4-10 show the proportions of total estimated annual emissions of criteria pollutants by human-made source type in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

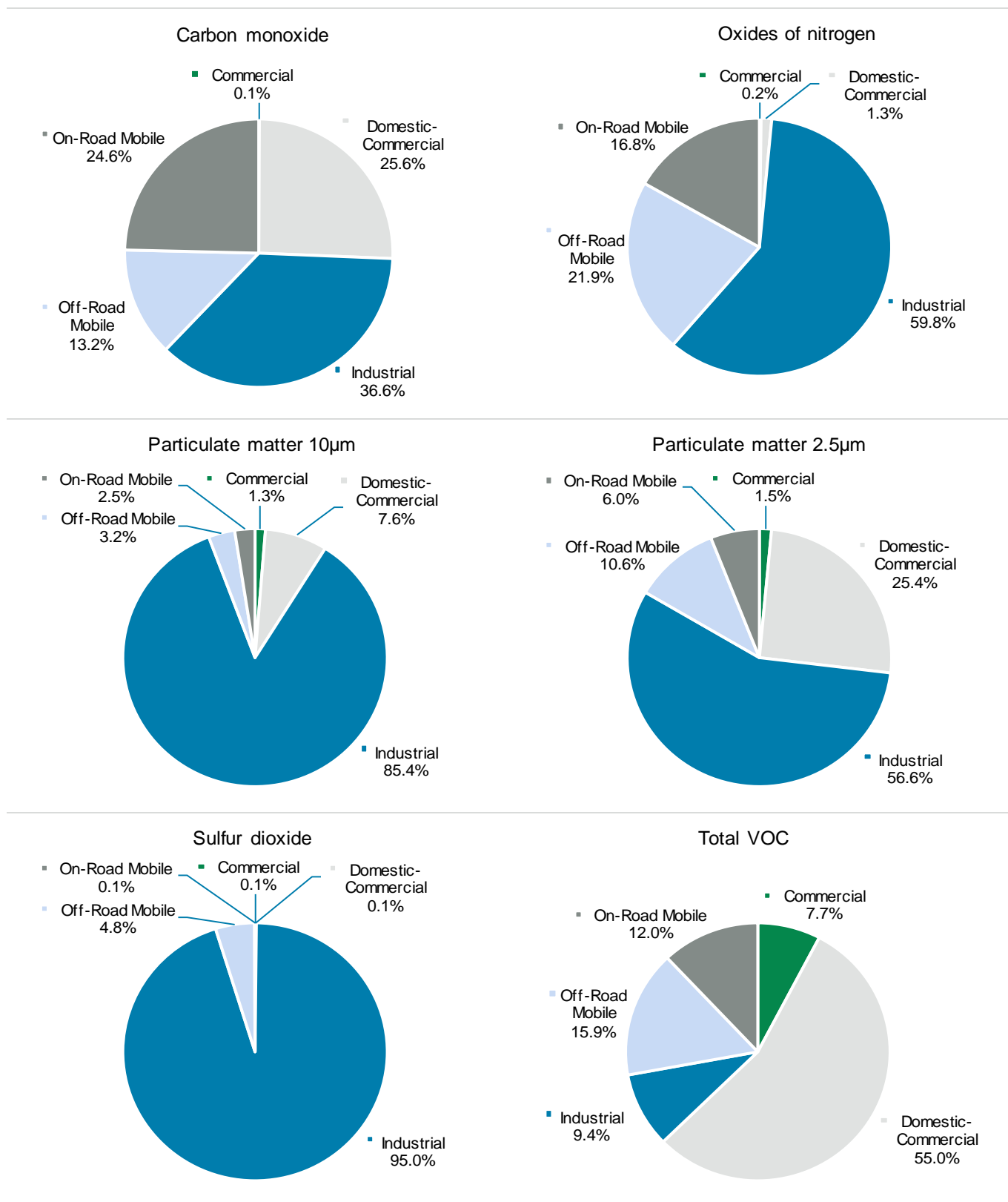


Figure 4-6: GMR: proportions of total estimated annual emissions by human-made source type



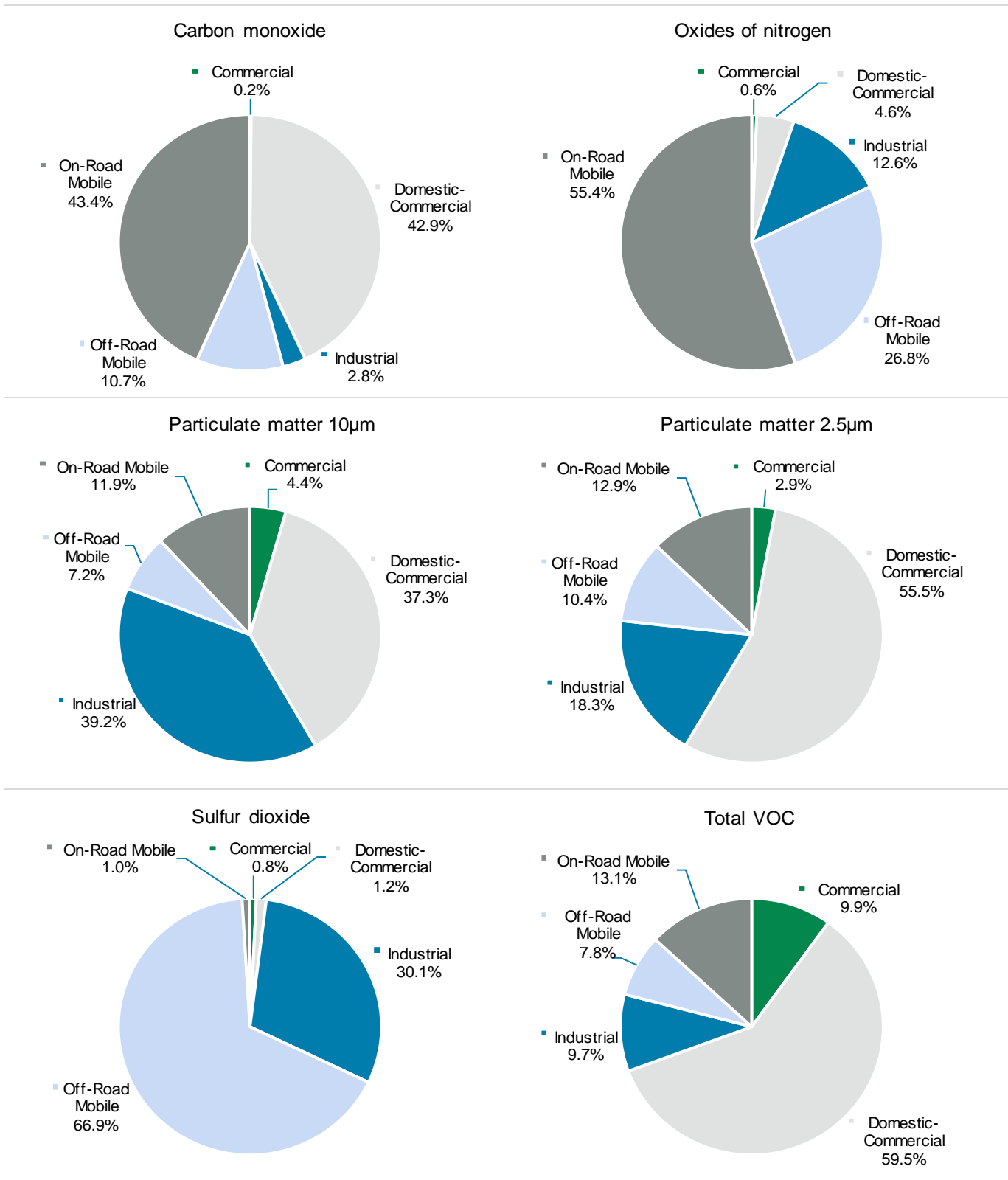


Figure 4-7: Sydney region: proportions of total estimated annual emissions by human-made source type

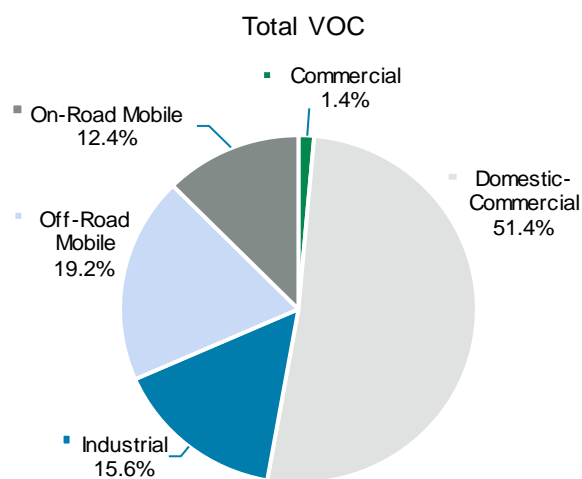
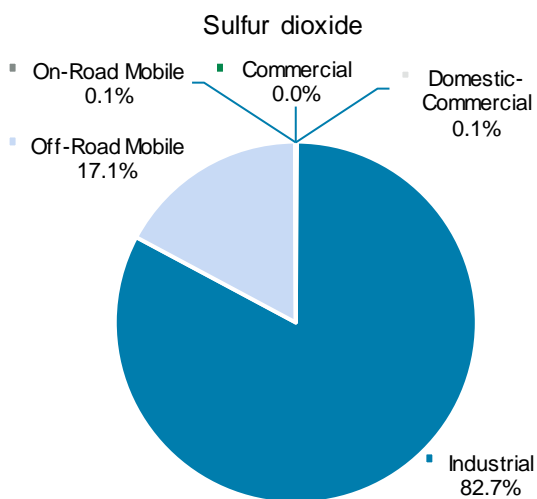
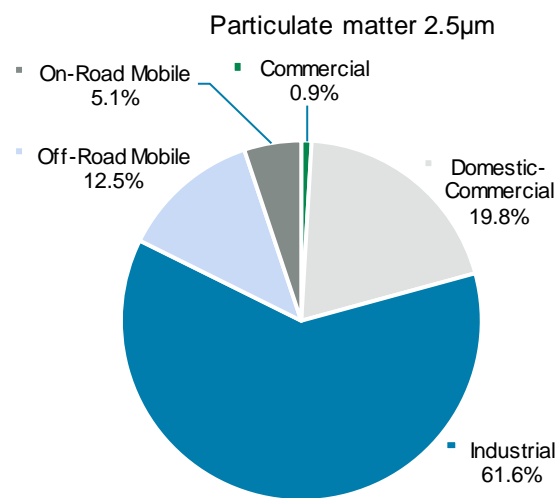
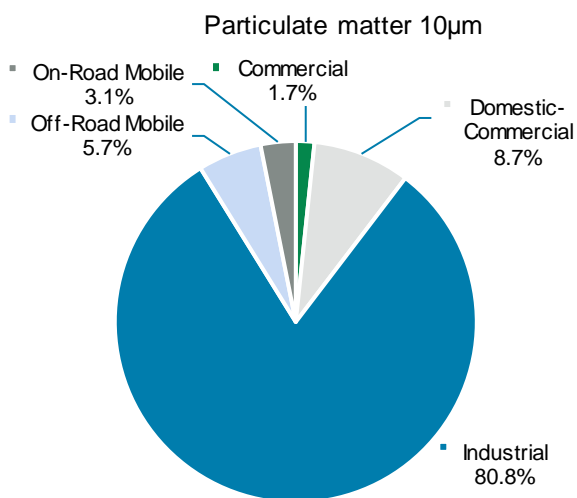
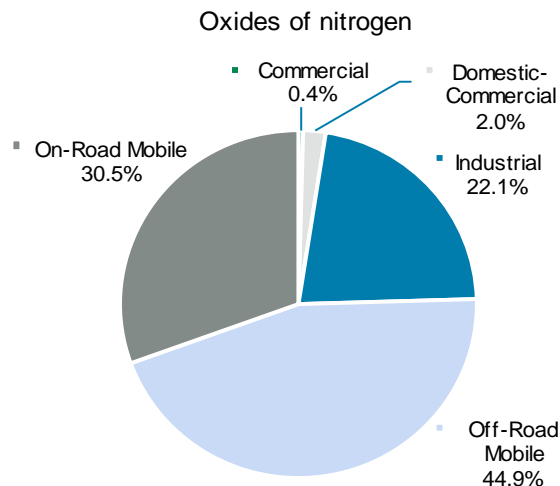
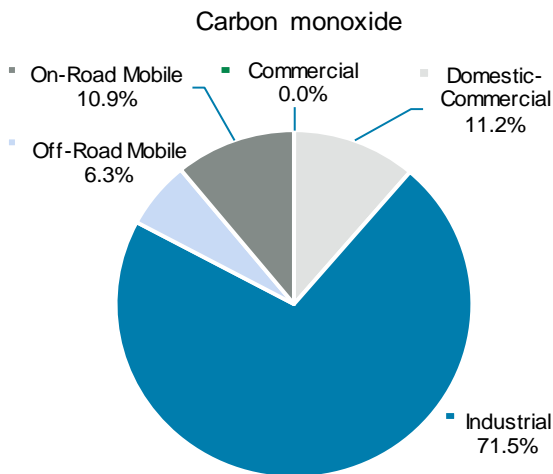


Figure 4-8: Newcastle region: proportions of total estimated annual emissions by human-made source type

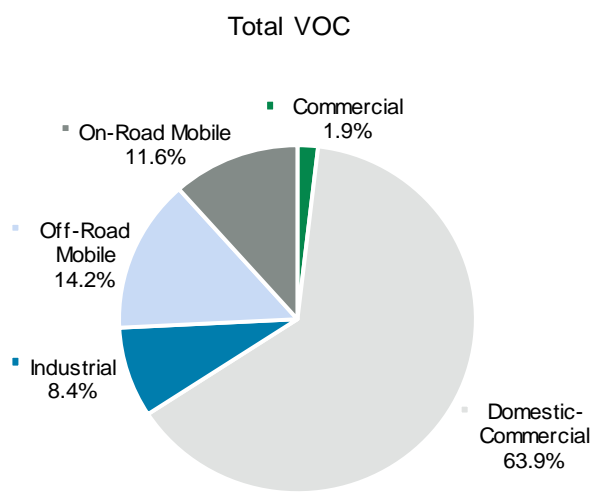
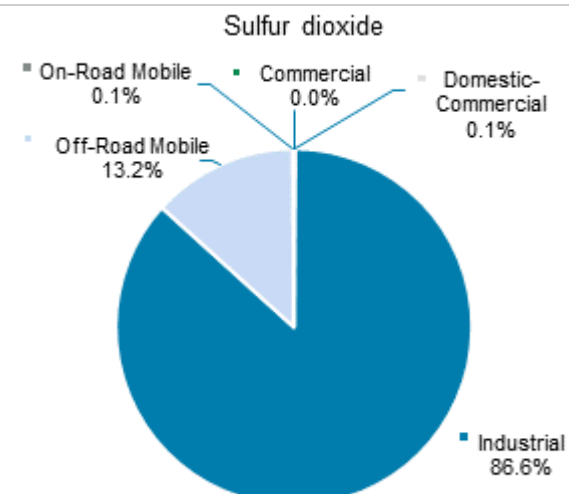
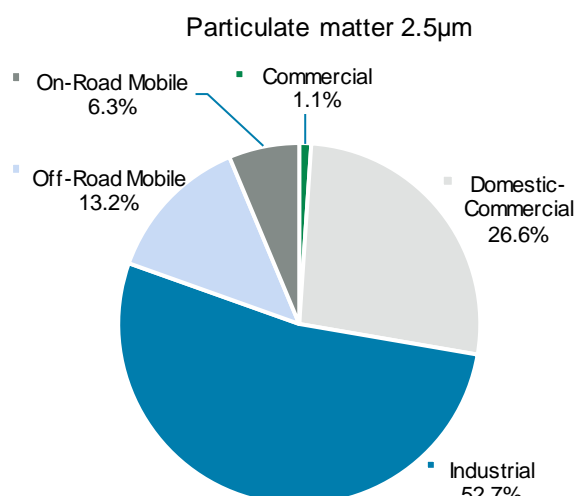
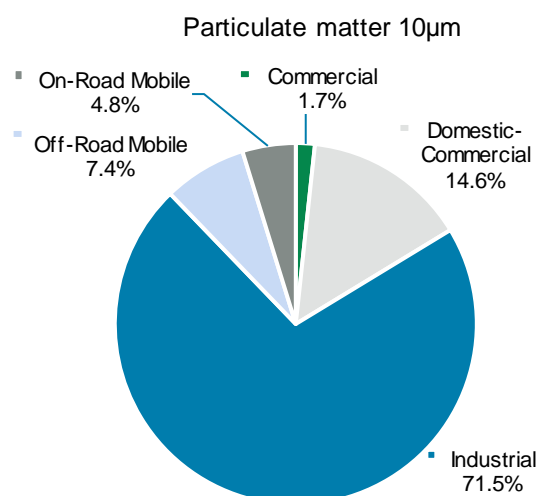
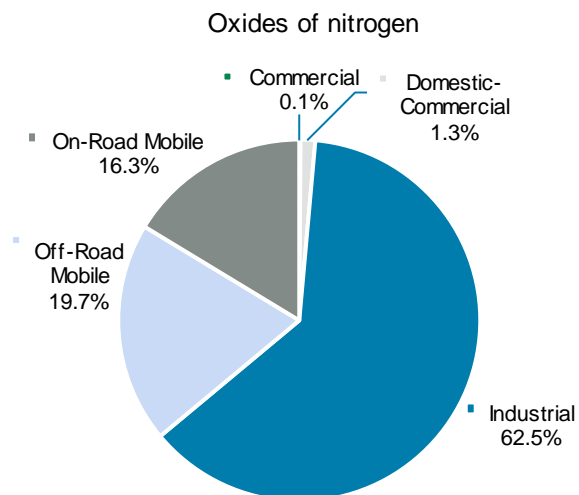
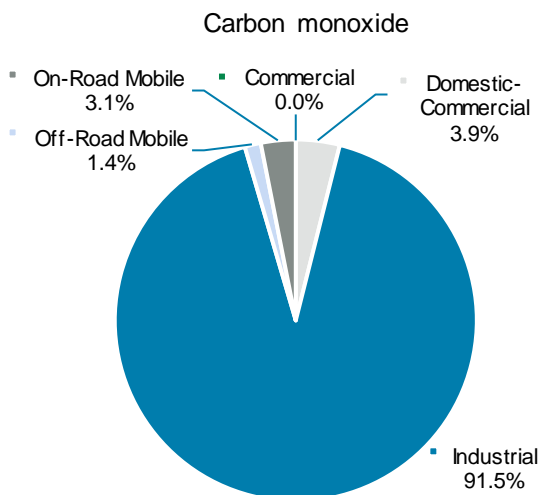


Figure 4-9: Wollongong region: proportions of total estimated annual emissions by human-made source type

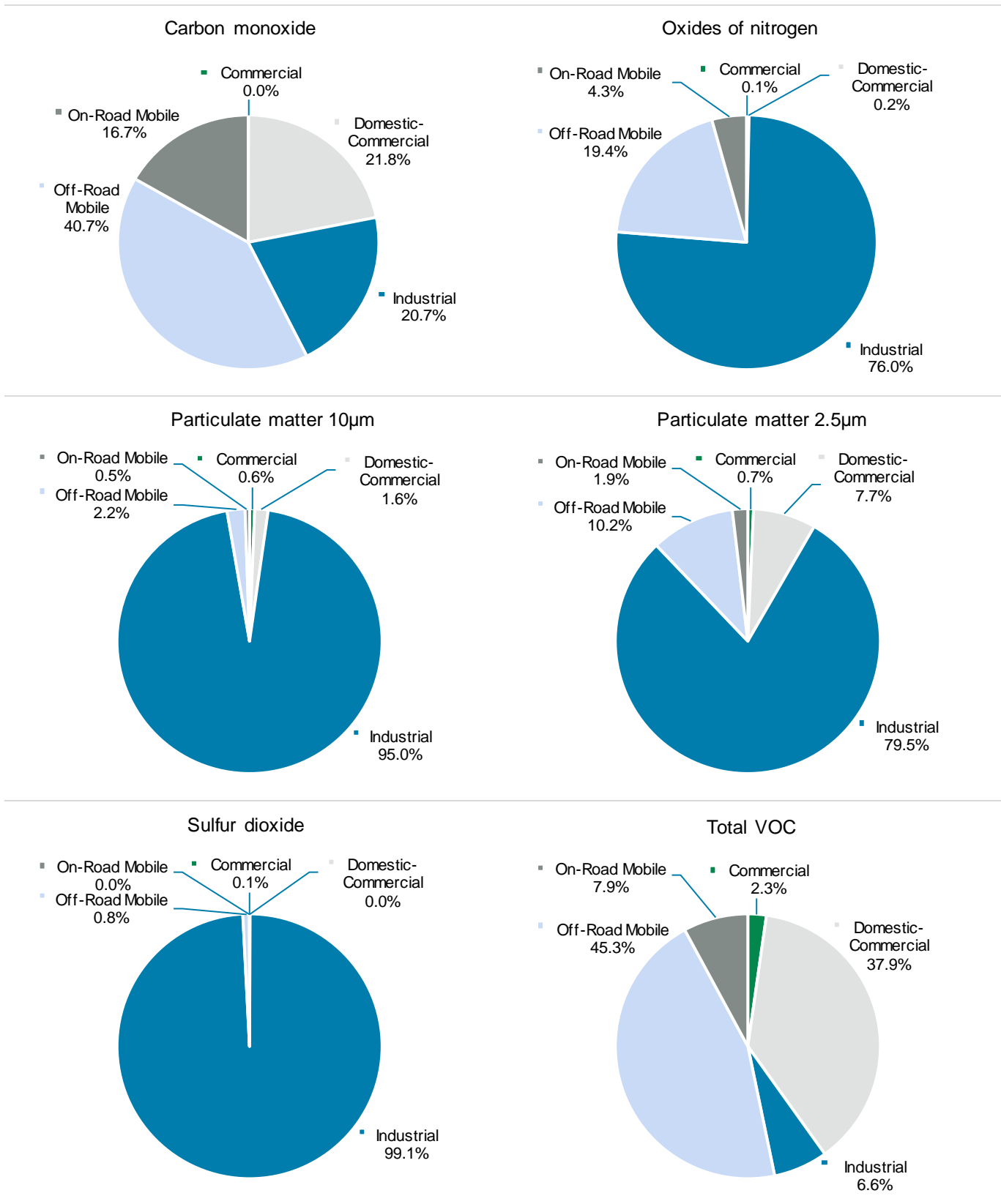


Figure 4-10: Non-urban region: proportions of total estimated annual emissions by human-made source type

Table 4-5 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of carbon monoxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 4-5: Top 10 human-made sources of carbon monoxide in each region**

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made carbon monoxide sources in the GMR</b>				
Industrial	Iron or steel production (iron ore)	103,354	22.1	22.1
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	79,074	16.9	39.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	50,117	10.7	49.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	45,363	9.69	59.4
Industrial	Aluminium production (alumina)	40,709	8.70	68.1
Off-Road Mobile	Commercial Boats Exhaust	27,225	5.82	73.9
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	23,995	5.13	79.0
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	22,657	4.84	83.9
Off-Road Mobile	Recreational Boats Exhaust	16,490	3.52	87.4
Off-Road Mobile	Industrial Vehicles and Equipment	11,822	2.53	89.9
Human-made	Other	47,273	10.1	100.0
<b>Top 10 human-made carbon monoxide sources in the Sydney region</b>				
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	62,708	29.8	29.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	37,063	17.6	47.4
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	33,868	16.1	63.5
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	19,688	9.36	72.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	18,161	8.64	81.5
Off-Road Mobile	Recreational Boats Exhaust	8,411	4.00	85.5
Off-Road Mobile	Commercial Boats Exhaust	7,616	3.62	89.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	3,706	1.76	90.9
Off-Road Mobile	Aircraft (Flight Operations)	2,936	1.40	92.3
On-Road Mobile	Others - Exhaust	2,897	1.38	93.7
Human-made	Other	13,236	6.29	100.0
<b>Top 10 human-made carbon monoxide sources in the Newcastle region</b>				
Industrial	Aluminium production (alumina)	40,709	67.0	67.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	4,776	7.86	74.8
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	2,840	4.67	79.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	2,800	4.61	84.1
Off-Road Mobile	Commercial Boats Exhaust	2,560	4.21	88.3

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Industrial	Iron or steel production (scrap metal)	2,038	3.35	91.7
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	1,126	1.85	93.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	1,116	1.84	95.4
Off-Road Mobile	Recreational Boats Exhaust	736	1.21	96.6
Industrial	Ammonium nitrate production	411	0.68	97.2
Human-made	Other	1,674	2.75	100.0
<b>Top 10 human-made carbon monoxide sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	103,354	90.5	90.5
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2,541	2.23	92.8
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1,899	1.66	94.4
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,668	1.46	95.9
Off-Road Mobile	Recreational Boats Exhaust	1,045	0.92	96.8
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	831	0.73	97.5
Industrial	Generation of electrical power from gas	820	0.72	98.2
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	586	0.51	98.8
Off-Road Mobile	Industrial Vehicles and Equipment	333	0.29	99.0
Industrial	Metal plating or coating	289	0.25	99.3
Human-made	Other	804	0.70	100.0
<b>Top 10 human-made carbon monoxide sources in the Non-urban region</b>				
Off-Road Mobile	Commercial Boats Exhaust	16,871	20.4	20.4
Off-Road Mobile	Industrial Vehicles and Equipment	9,309	11.2	31.6
Industrial	Mining for coal	9,122	11.0	42.6
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	9,050	10.9	53.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	8,586	10.4	63.9
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	6,755	8.16	72.1
Off-Road Mobile	Recreational Boats Exhaust	6,298	7.60	79.7
Industrial	Generation of electrical power from coal	6,093	7.36	87.0
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	2,594	3.13	90.2
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	2,549	3.08	93.2
Human-made	Other	5,602	6.76	100.0

Figure 4-11, Figure 4-12, Figure 4-13, Figure 4-14 and Figure 4-15 show the proportions of total estimated annual emissions for the top 10 human-made sources of carbon monoxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

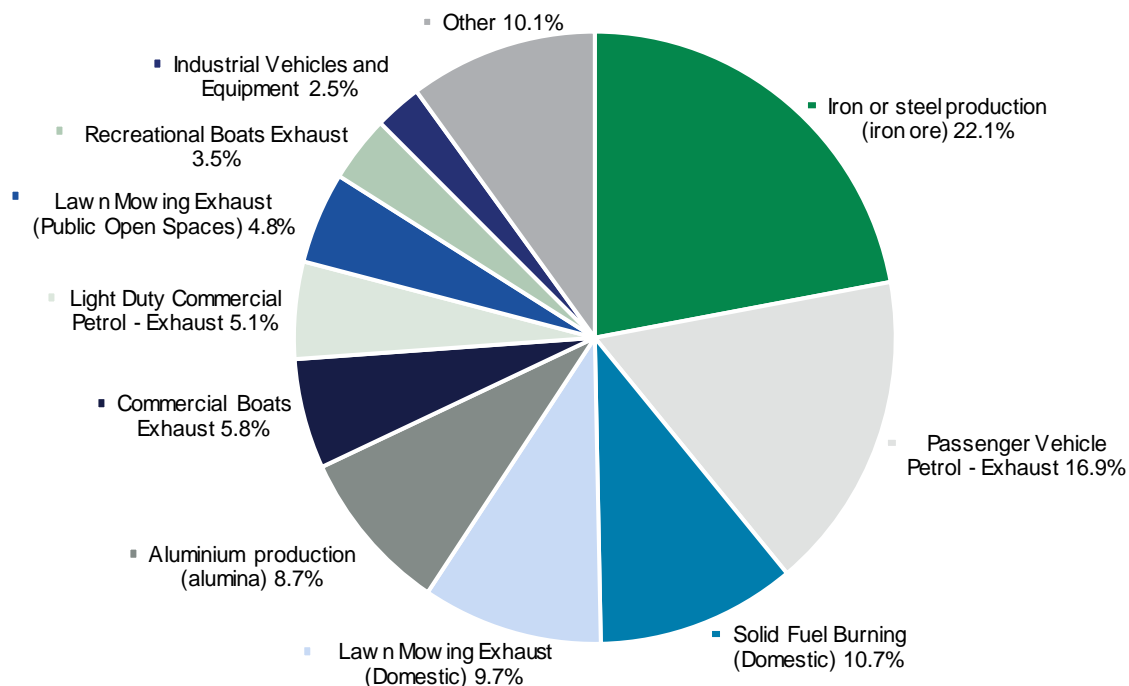


Figure 4-11: GMR: top 10 human-made sources of carbon monoxide

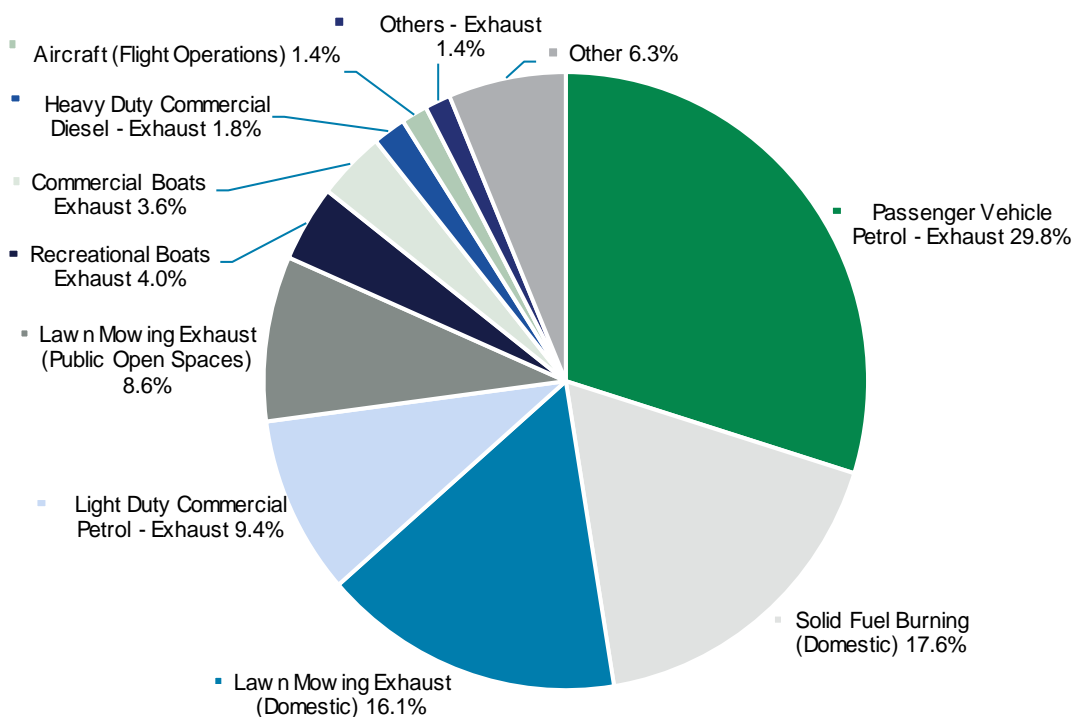


Figure 4-12: Sydney region: top 10 human-made sources of carbon monoxide

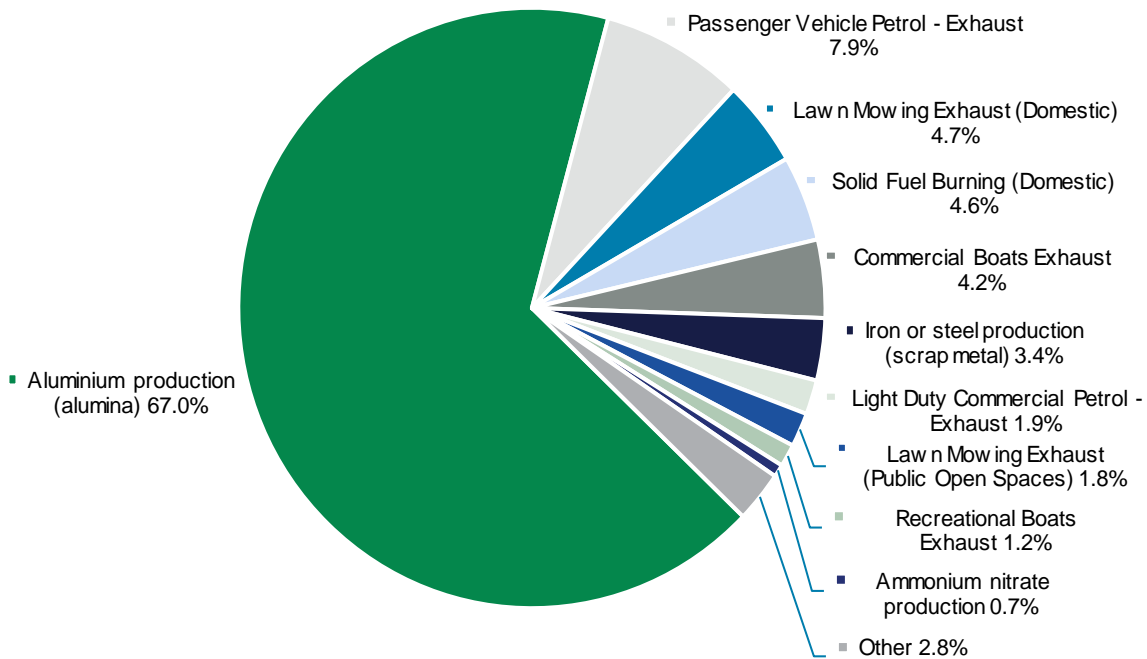


Figure 4-13: Newcastle region: top 10 human-made sources of carbon monoxide

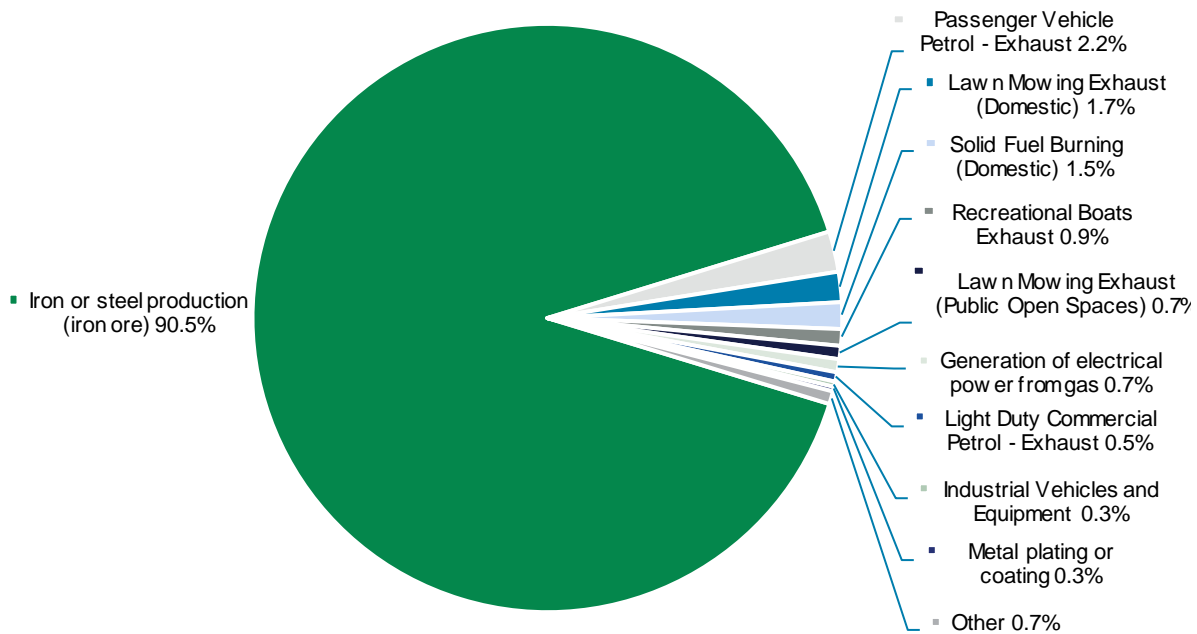


Figure 4-14: Wollongong region: top 10 human-made sources of carbon monoxide



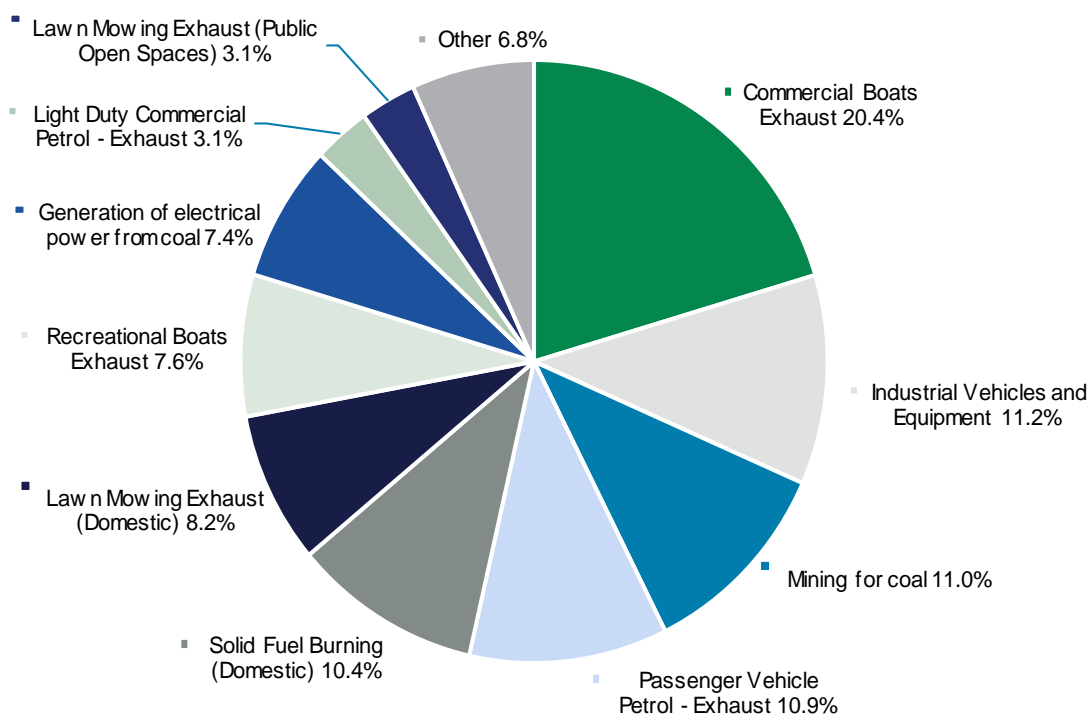


Figure 4-15: Non-urban region: top 10 human-made sources of carbon monoxide

Table 4-6 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of oxides of nitrogen in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 4-6: Top 10 human-made sources of oxides of nitrogen in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made oxides of nitrogen sources in the GMR</b>				
Industrial	Generation of electrical power from coal	139,246	51.8	51.8
Off-Road Mobile	Industrial Vehicles and Equipment	30,767	11.4	63.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	20,564	7.64	70.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	13,273	4.93	75.8
Off-Road Mobile	Ships	12,373	4.60	80.4
Off-Road Mobile	Locomotives	9,093	3.38	83.8
On-Road Mobile	Light Duty Diesel - Exhaust	6,631	2.47	86.2
Industrial	Iron or steel production (iron ore)	5,772	2.15	88.4
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	4,490	1.67	90.0
Industrial	Cement or lime production	3,985	1.48	91.5
Human-made	Other	22,812	8.48	100.0
<b>Top 10 human-made oxides of nitrogen sources in the Sydney region</b>				
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	13,694	23.3	23.3
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	10,039	17.1	40.4
Off-Road Mobile	Ships	6,874	11.7	52.2

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
On-Road Mobile	Light Duty Diesel - Exhaust	5,230	8.91	61.1
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	3,443	5.87	66.9
Off-Road Mobile	Industrial Vehicles and Equipment	2,840	4.84	71.8
Off-Road Mobile	Commercial Boats Exhaust	2,154	3.67	75.5
Off-Road Mobile	Aircraft (Flight Operations)	1,966	3.35	78.8
Industrial	Generation of electrical power from gas	1,905	3.25	82.1
Domestic-Commercial	Gaseous Fuel Burning	1,705	2.91	85.0
Human-made	Other	8,827	15.0	100.0
<b>Top 10 human-made oxides of nitrogen sources in the Newcastle region</b>				
Off-Road Mobile	Ships	2,293	25.1	25.1
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	1,339	14.7	39.8
Industrial	Ammonium nitrate production	1,301	14.2	54.0
Off-Road Mobile	Locomotives	1,115	12.2	66.2
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	857	9.38	75.6
Off-Road Mobile	Industrial Vehicles and Equipment	360	3.94	79.5
On-Road Mobile	Light Duty Diesel - Exhaust	344	3.77	83.3
Off-Road Mobile	Commercial Boats Exhaust	251	2.74	86.1
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	240	2.62	88.7
Industrial	Iron or steel production (scrap metal)	186	2.04	90.7
Human-made	Other	848	9.29	100.0
<b>Top 10 human-made oxides of nitrogen sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	5,772	58.5	58.5
Off-Road Mobile	Industrial Vehicles and Equipment	935	9.48	68.0
Off-Road Mobile	Ships	781	7.92	75.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	774	7.85	83.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	504	5.11	88.9
Industrial	Generation of electrical power from gas	328	3.33	92.2
On-Road Mobile	Light Duty Diesel - Exhaust	190	1.93	94.1
Off-Road Mobile	Locomotives	163	1.65	95.8
On-Road Mobile	Light Duty Commercial Petrol - Exhaust	136	1.38	97.2
Domestic-Commercial	Gaseous Fuel Burning	82.22	0.83	98.0
Human-made	Other	197	1.99	100.0
<b>Top 10 human-made oxides of nitrogen sources in the Non-urban region</b>				
Industrial	Generation of electrical power from coal	139,246	72.8	72.8
Off-Road Mobile	Industrial Vehicles and Equipment	26,632	13.9	86.7
Off-Road Mobile	Locomotives	6,513	3.40	90.1

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	4,757	2.49	92.6
Industrial	Cement or lime production	3,104	1.62	94.2
Industrial	Mining for coal	2,481	1.30	95.5
Off-Road Mobile	Ships	2,425	1.27	96.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	1,874	0.98	97.8
Off-Road Mobile	Commercial Boats Exhaust	1,205	0.63	98.4
On-Road Mobile	Light Duty Diesel - Exhaust	867	0.45	98.8
Human-made	Other	2,231	1.17	100.0

Figure 4-16, Figure 4-17, Figure 4-18, Figure 4-19 and Figure 4-20 show the proportions of total estimated annual emissions for the top 10 human-made sources of oxides of nitrogen in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

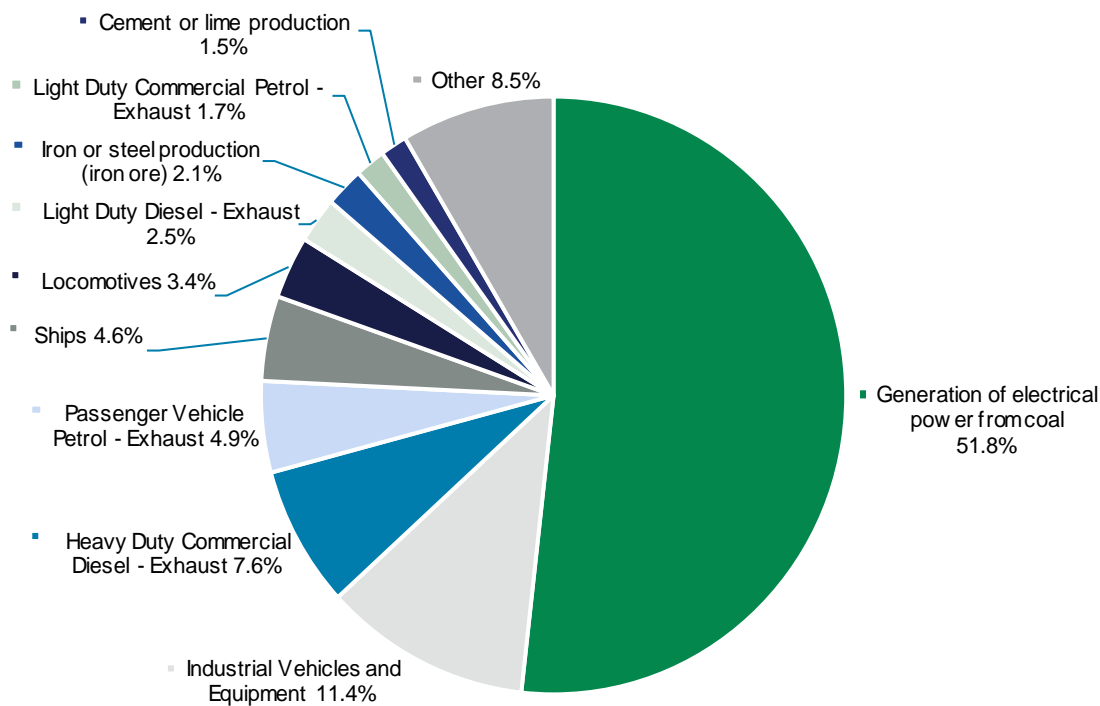


Figure 4-16: GMR: top 10 human-made sources of oxides of nitrogen

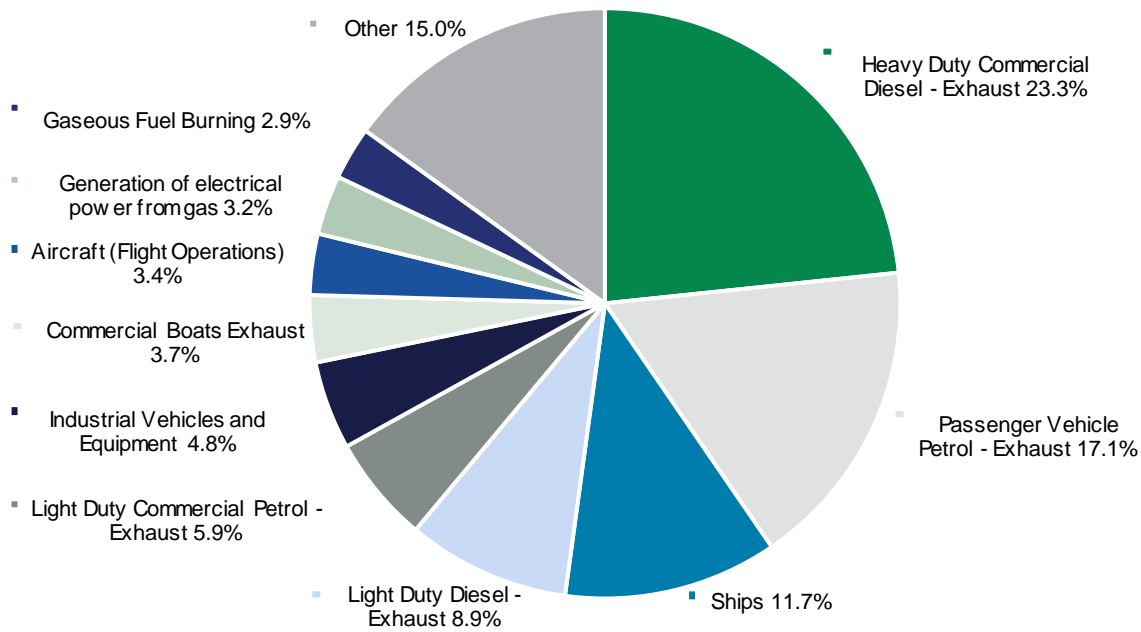


Figure 4-17: Sydney region: top 10 human-made sources of oxides of nitrogen

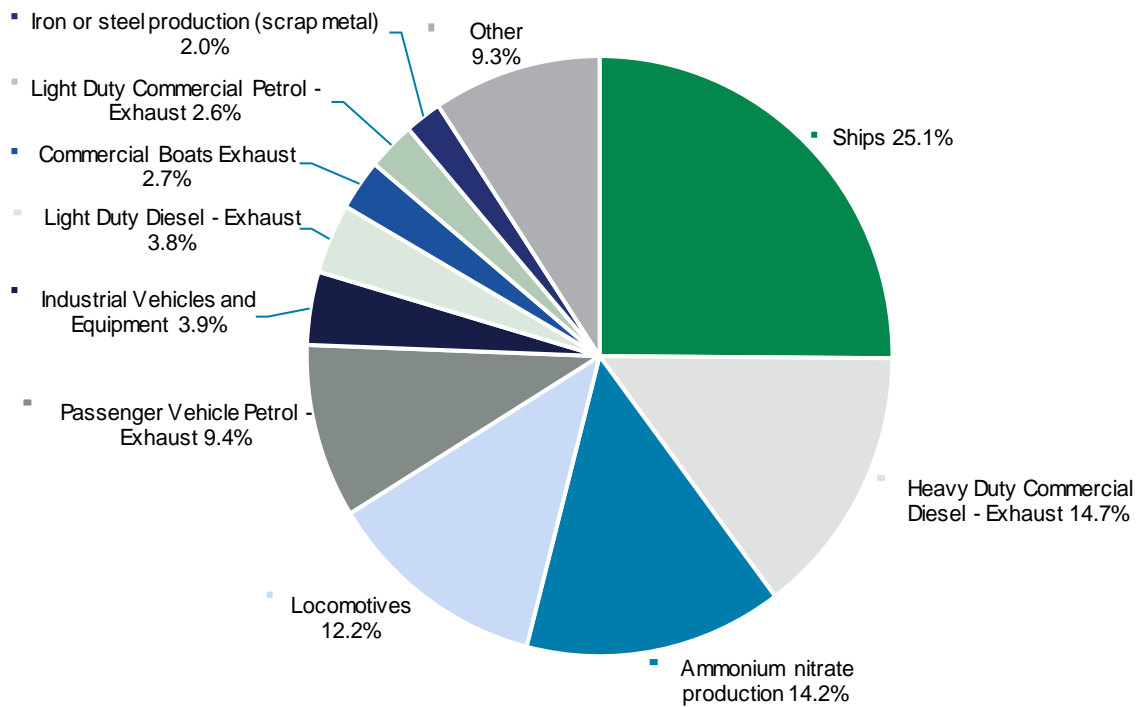


Figure 4-18: Newcastle region: top 10 human-made sources of oxides of nitrogen

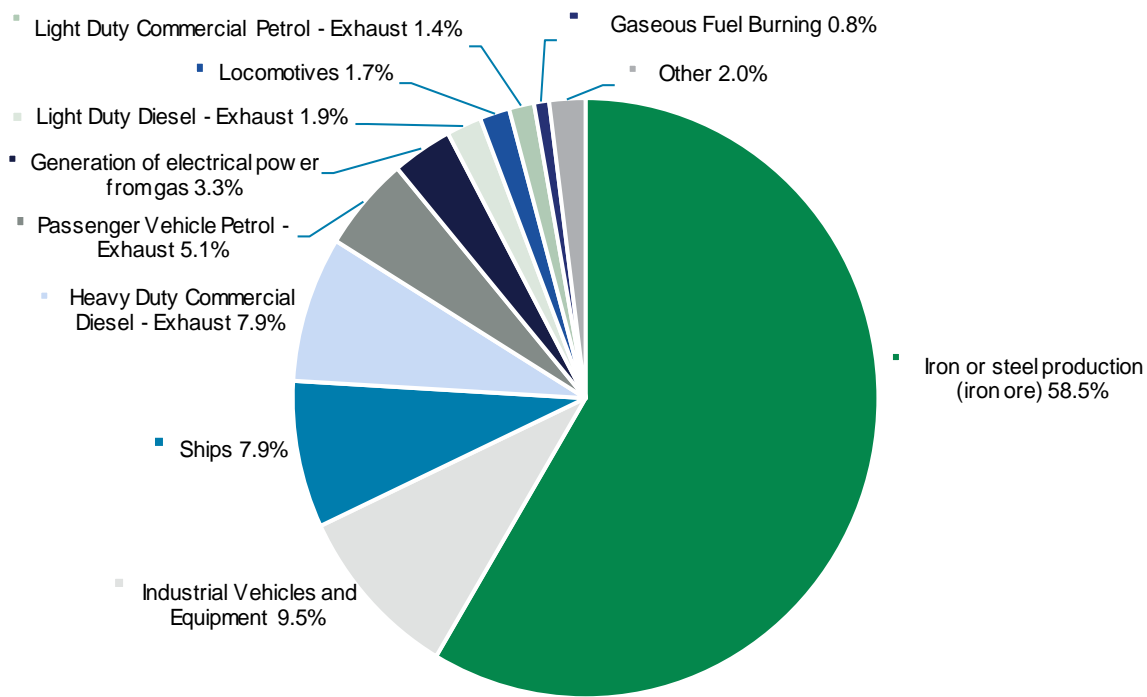


Figure 4-19: Wollongong region: top 10 human-made sources of oxides of nitrogen

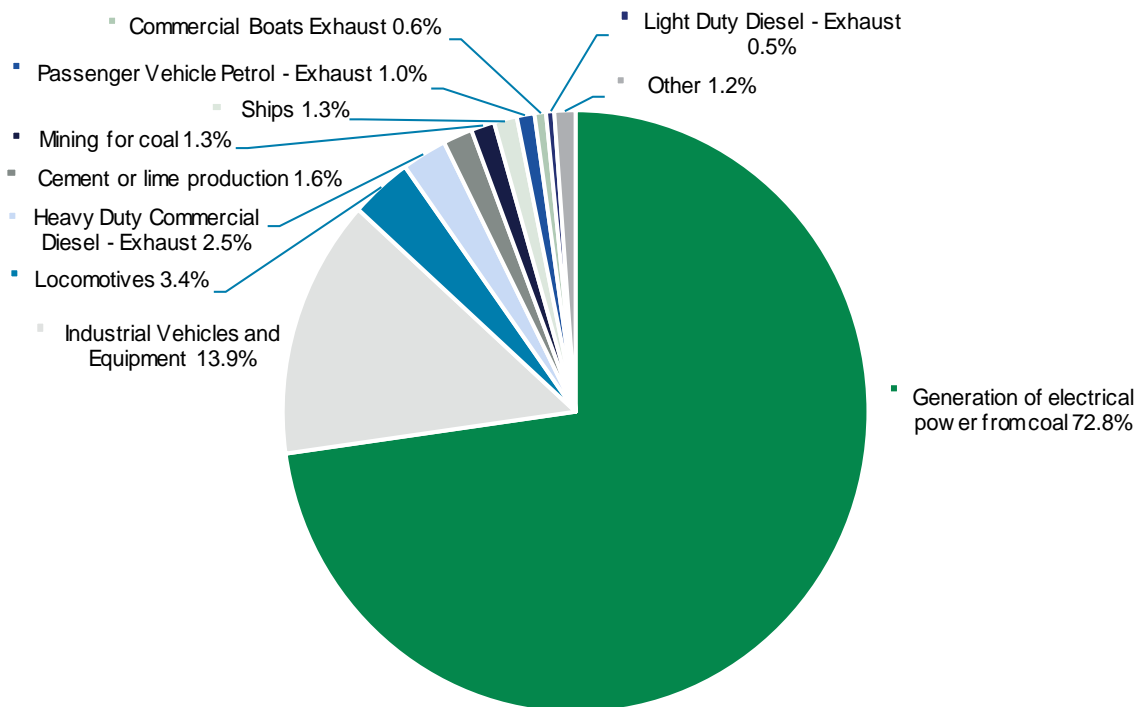


Figure 4-20: Non-urban region: top 10 human-made sources of oxides of nitrogen

Table 4-7 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 4-7: Top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$  in each region**

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made particulate matter <math>\leq 10\mu\text{m}</math> sources in the GMR</b>				
Industrial	Mining for coal	68,020	67.2	67.2
Domestic-Commercial	Solid Fuel Burning (Domestic)	7,036	6.95	74.2
Industrial	Generation of electrical power from coal	3,623	3.58	77.7
Industrial	Land-based extractive activity	3,071	3.03	80.8
Industrial	Ceramics production	1,580	1.56	82.3
Industrial	Waste disposal (application to land)	1,563	1.54	83.9
On-Road Mobile	All - Non-Exhaust PM	1,548	1.53	85.4
Off-Road Mobile	Industrial Vehicles and Equipment	1,371	1.35	86.8
Off-Road Mobile	Ships	1,275	1.26	88.0
Industrial	Coal works	1,169	1.15	89.2
Human-made	Other	10,955	10.8	100.0
<b>Top 10 human-made particulate matter <math>\leq 10\mu\text{m}</math> sources in the Sydney region</b>				
Domestic-Commercial	Solid Fuel Burning (Domestic)	5,203	33.8	33.8
Industrial	Waste disposal (application to land)	1,221	7.92	41.7
On-Road Mobile	All - Non-Exhaust PM	1,148	7.44	49.1
Industrial	Ceramics production	890	5.78	54.9
Off-Road Mobile	Ships	774	5.02	59.9
Industrial	Crushing, grinding or separating	666	4.32	64.2
Industrial	Mining for coal	479	3.11	67.3
Industrial	Land-based extractive activity	451	2.92	70.3
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	431	2.79	73.1
Commercial	Gravel and Sand Quarrying	342	2.22	75.3
Human-made	Other	3,810	24.7	100.0
<b>Top 10 human-made particulate matter <math>\leq 10\mu\text{m}</math> sources in the Newcastle region</b>				
Industrial	Mining for coal	1,480	29.8	29.8
Industrial	Coal works	901	18.1	47.9
Industrial	Aluminium production (alumina)	506	10.2	58.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	393	7.91	66.0
Industrial	Ammonium nitrate production	328	6.61	72.6
Industrial	Land-based extractive activity	225	4.53	77.2
Off-Road Mobile	Ships	215	4.32	81.5
Industrial	Waste disposal (application to land)	121	2.43	83.9
On-Road Mobile	All - Non-Exhaust PM	99.69	2.01	85.9

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Industrial	Non-thermal treatment of waste	87.42	1.76	87.7
Human-made	Other	612	12.3	100.0
<b>Top 10 human-made particulate matter ≤ 10µm sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	915	51.1	51.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	234	13.1	64.2
Industrial	Coal works	131	7.30	71.5
Industrial	Mining for coal	113	6.32	77.8
Off-Road Mobile	Ships	78.06	4.36	82.2
Industrial	Generation of electrical power from gas	65.58	3.66	85.9
On-Road Mobile	All - Non-Exhaust PM	53.21	2.97	88.8
Off-Road Mobile	Industrial Vehicles and Equipment	41.95	2.34	91.2
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	22.13	1.24	92.4
Industrial	Waste disposal (application to land)	20.03	1.12	93.5
Human-made	Other	116	6.47	100.0
<b>Top 10 human-made particulate matter ≤ 10µm sources in the Non-urban region</b>				
Industrial	Mining for coal	65,948	83.4	83.4
Industrial	Generation of electrical power from coal	3,623	4.58	88.0
Industrial	Land-based extractive activity	2,395	3.03	91.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,205	1.53	92.6
Off-Road Mobile	Industrial Vehicles and Equipment	1,196	1.51	94.1
Industrial	Boat mooring and storage	945	1.20	95.3
Industrial	Ceramics production	689	0.87	96.2
Industrial	Cement or lime production	482	0.61	96.8
Commercial	Gravel and Sand Quarrying	336	0.43	97.2
On-Road Mobile	All - Non-Exhaust PM	248	0.31	97.5
Human-made	Other	1,969	2.49	100.0

Figure 4-21, Figure 4-22, Figure 4-23, Figure 4-24 and Figure 4-25 show the proportions of total estimated annual emissions for the top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

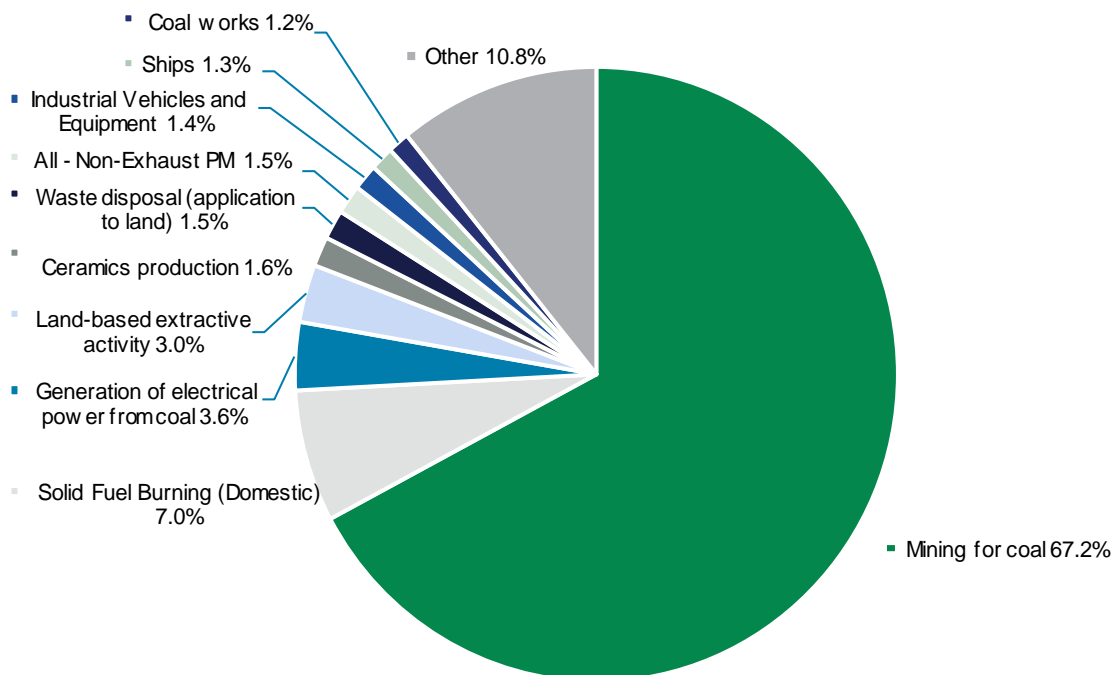


Figure 4-21: GMR: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$

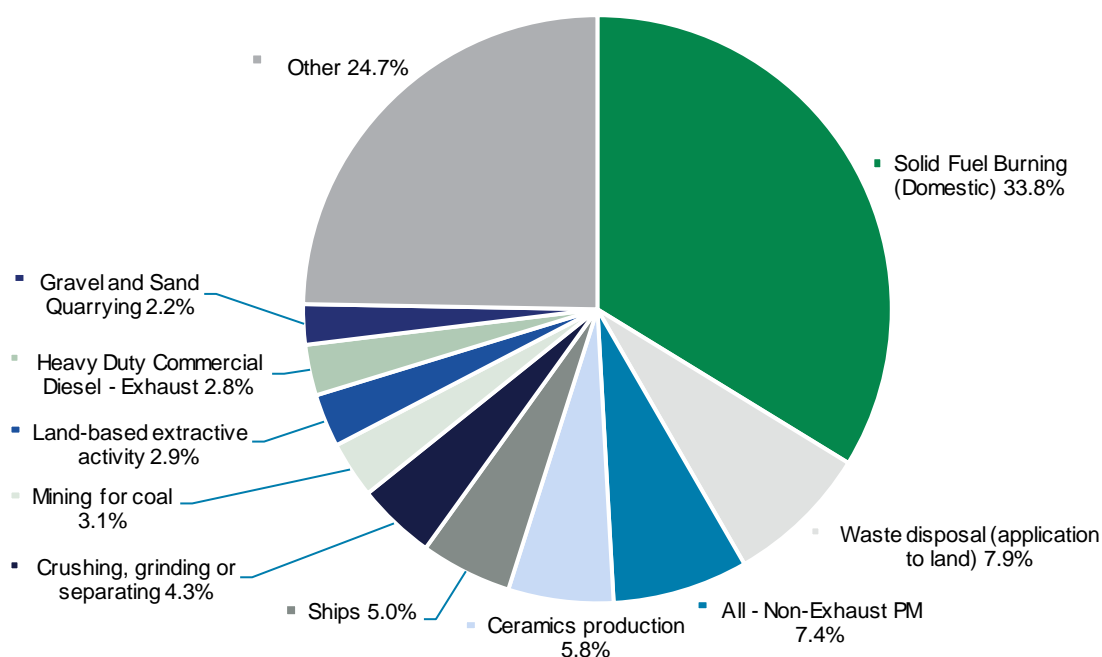


Figure 4-22: Sydney region: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$



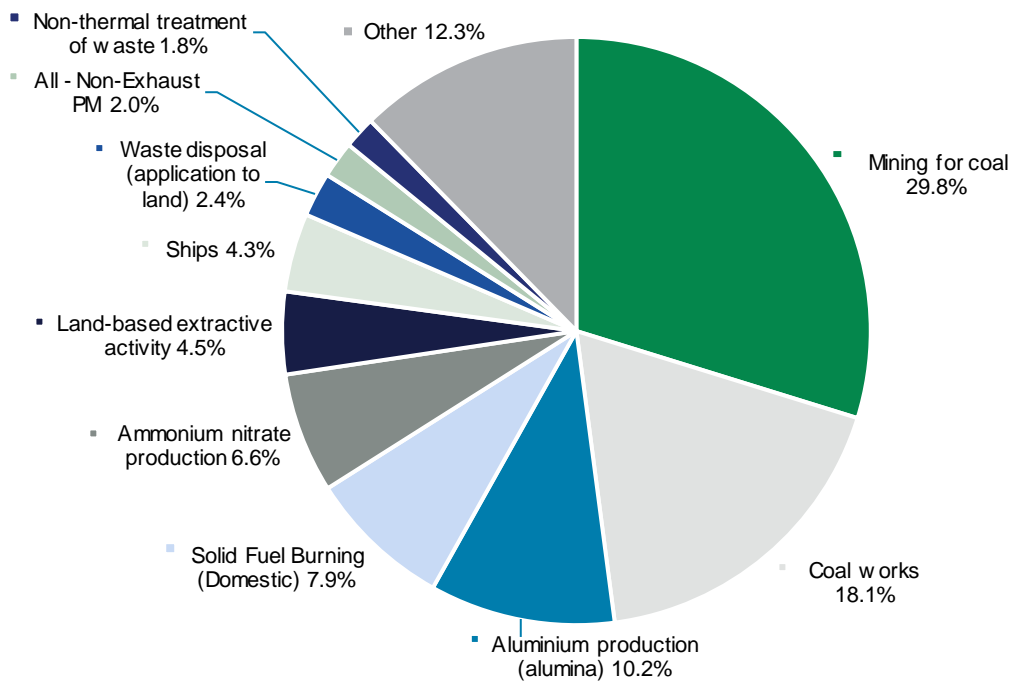


Figure 4-23: Newcastle region: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$

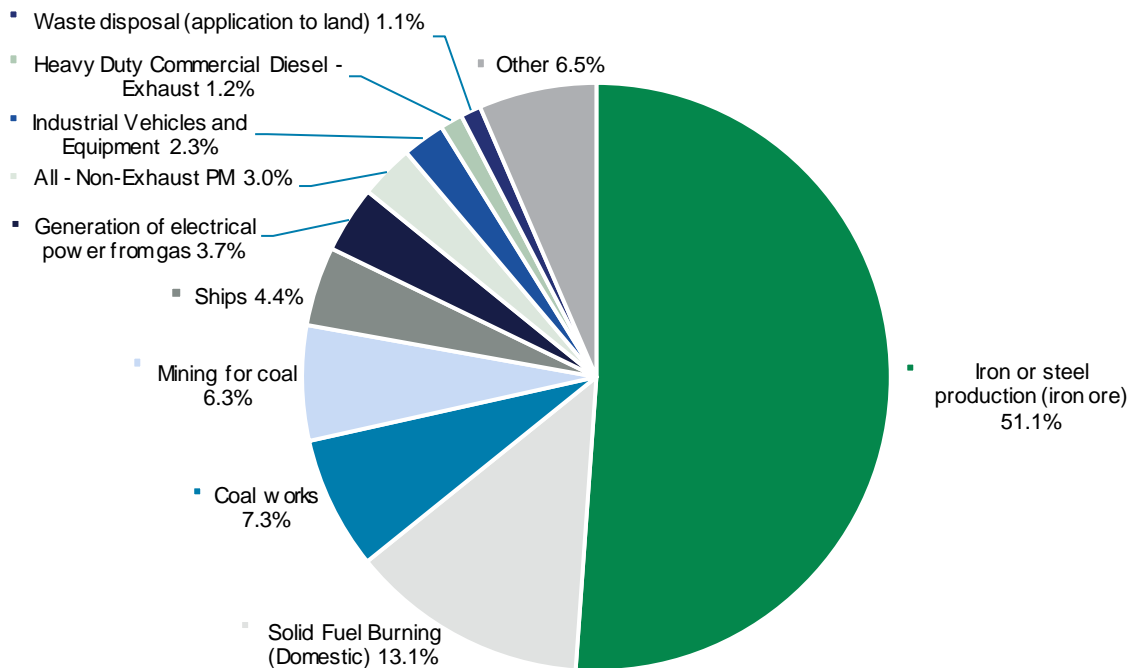


Figure 4-24: Wollongong region: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$

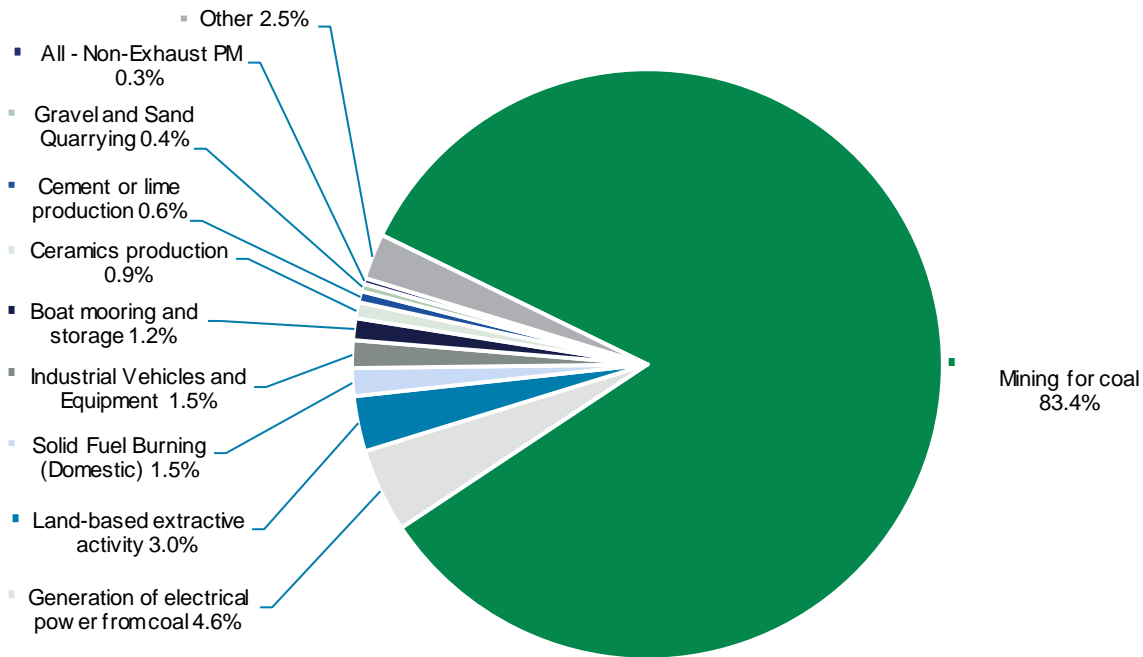


Figure 4-25: Non-urban region: top 10 human-made sources of particulate matter  $\leq 10\mu\text{m}$

Table 4-8 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 4-8: Top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$  in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made particulate matter <math>\leq 2.5\mu\text{m}</math> sources in the GMR</b>				
Industrial	Mining for coal	10,238	35.0	35.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	6,773	23.2	58.2
Industrial	Generation of electrical power from coal	1,477	5.05	63.3
Off-Road Mobile	Industrial Vehicles and Equipment	1,330	4.55	67.8
Off-Road Mobile	Ships	1,173	4.01	71.8
Industrial	Land-based extractive activity	837	2.86	74.7
On-Road Mobile	All - Non-Exhaust PM	824	2.82	77.5
Industrial	Ceramics production	621	2.13	79.6
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	604	2.07	81.7
Industrial	Cement or lime production	392	1.34	83.0
Human-made	Other	4,960	17.0	100.0
<b>Top 10 human-made particulate matter <math>\leq 2.5\mu\text{m}</math> sources in the Sydney region</b>				
Domestic-Commercial	Solid Fuel Burning (Domestic)	5,009	50.4	50.4
Off-Road Mobile	Ships	712	7.16	57.5
On-Road Mobile	All - Non-Exhaust PM	610	6.14	63.7

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Industrial	Ceramics production	504	5.07	68.7
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	418	4.20	72.9
Industrial	Waste disposal (application to land)	232	2.33	75.3
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	200	2.01	77.3
On-Road Mobile	Light Duty Diesel - Exhaust	185	1.86	79.1
Industrial	Crushing, grinding or separating	149	1.50	80.6
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	142	1.43	82.1
Human-made	Other	1,784	17.9	100.0
<b>Top 10 human-made particulate matter <math>\leq 2.5\mu\text{m}</math> sources in the Newcastle region</b>				
Domestic-Commercial	Solid Fuel Burning (Domestic)	378	18.1	18.1
Industrial	Aluminium production (alumina)	363	17.4	35.4
Industrial	Ammonium nitrate production	322	15.4	50.8
Industrial	Mining for coal	240	11.4	62.2
Off-Road Mobile	Ships	197	9.43	71.7
Industrial	Coal works	107	5.11	76.8
Industrial	Land-based extractive activity	61.02	2.92	79.7
On-Road Mobile	All - Non-Exhaust PM	53.04	2.53	82.2
Industrial	Iron or steel production (scrap metal)	44.28	2.12	84.4
Industrial	Agricultural fertiliser (phosphate) production	40.87	1.95	86.3
Human-made	Other	287	13.7	100.0
<b>Top 10 human-made particulate matter <math>\leq 2.5\mu\text{m}</math> sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	378	40.1	40.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	225	23.9	64.0
Off-Road Mobile	Ships	71.81	7.62	71.6
Industrial	Generation of electrical power from gas	65.58	6.96	78.6
Off-Road Mobile	Industrial Vehicles and Equipment	40.69	4.32	82.9
On-Road Mobile	All - Non-Exhaust PM	28.31	3.00	85.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	21.47	2.28	88.2
Industrial	Coal works	20.52	2.18	90.4
Industrial	Mining for coal	16.02	1.70	92.1
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	11.20	1.19	93.3
Human-made	Other	63.55	6.74	100.0
<b>Top 10 human-made particulate matter <math>\leq 2.5\mu\text{m}</math> sources in the Non-urban region</b>				
Industrial	Mining for coal	9,898	60.9	60.9
Industrial	Generation of electrical power from coal	1,477	9.09	70.0
Off-Road Mobile	Industrial Vehicles and Equipment	1,160	7.14	77.2
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,160	7.14	84.3

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Industrial	Land-based extractive activity	683	4.20	88.5
Industrial	Cement or lime production	337	2.08	90.6
Off-Road Mobile	Ships	192	1.18	91.8
Industrial	Boat mooring and storage	183	1.12	92.9
Off-Road Mobile	Commercial Boats Exhaust	138	0.85	93.7
On-Road Mobile	All - Non-Exhaust PM	132	0.81	94.5
Human-made	Other	887	5.46	100.0

Figure 4-26, Figure 4-27, Figure 4-28, Figure 4-29 and Figure 4-30 show the proportions of total estimated annual emissions for the top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$  in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

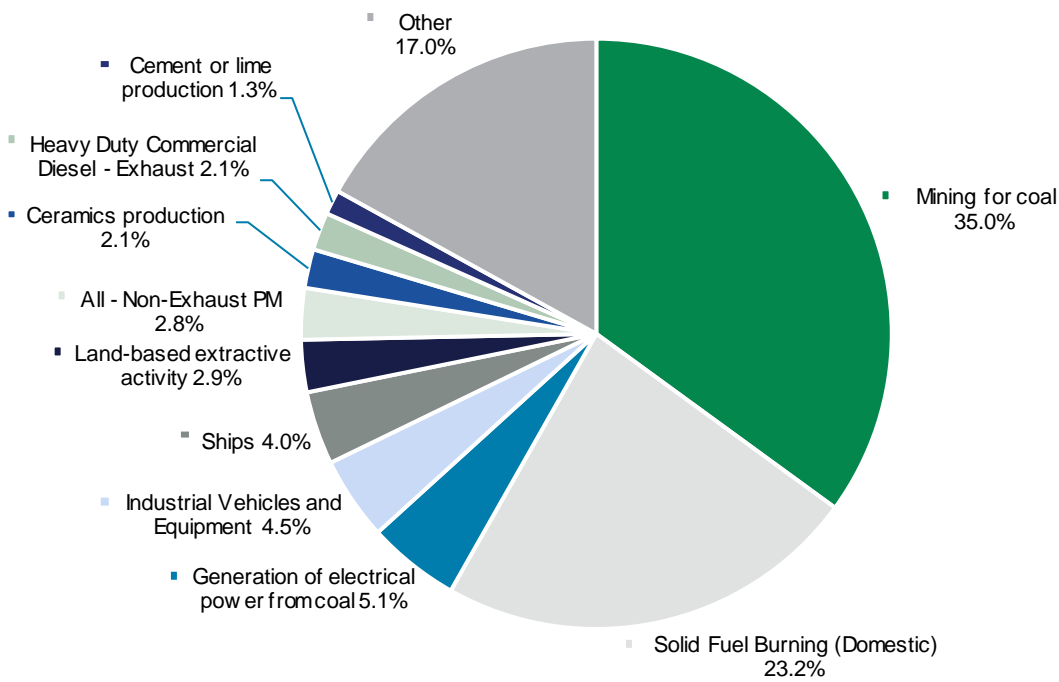


Figure 4-26: GMR: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

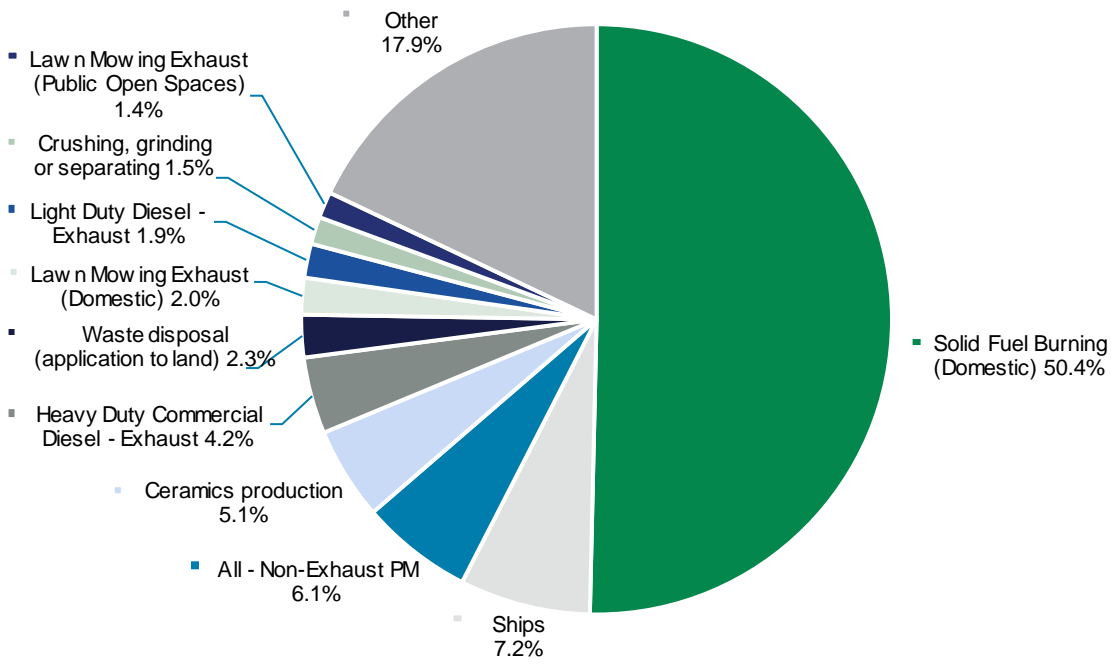


Figure 4-27: Sydney region: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

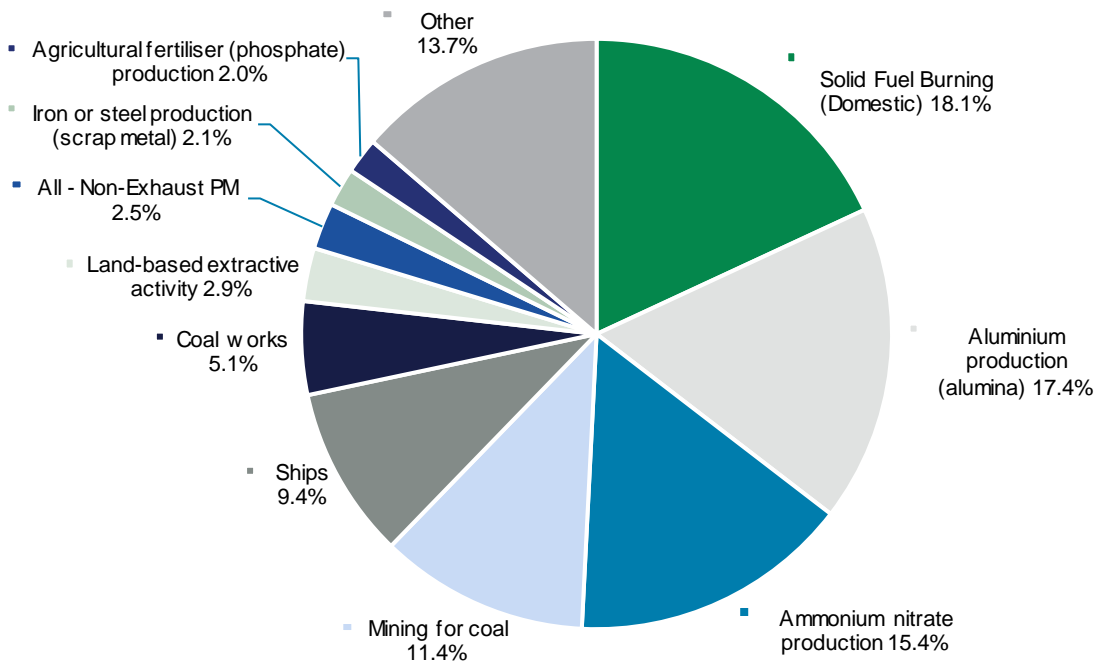


Figure 4-28: Newcastle region: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

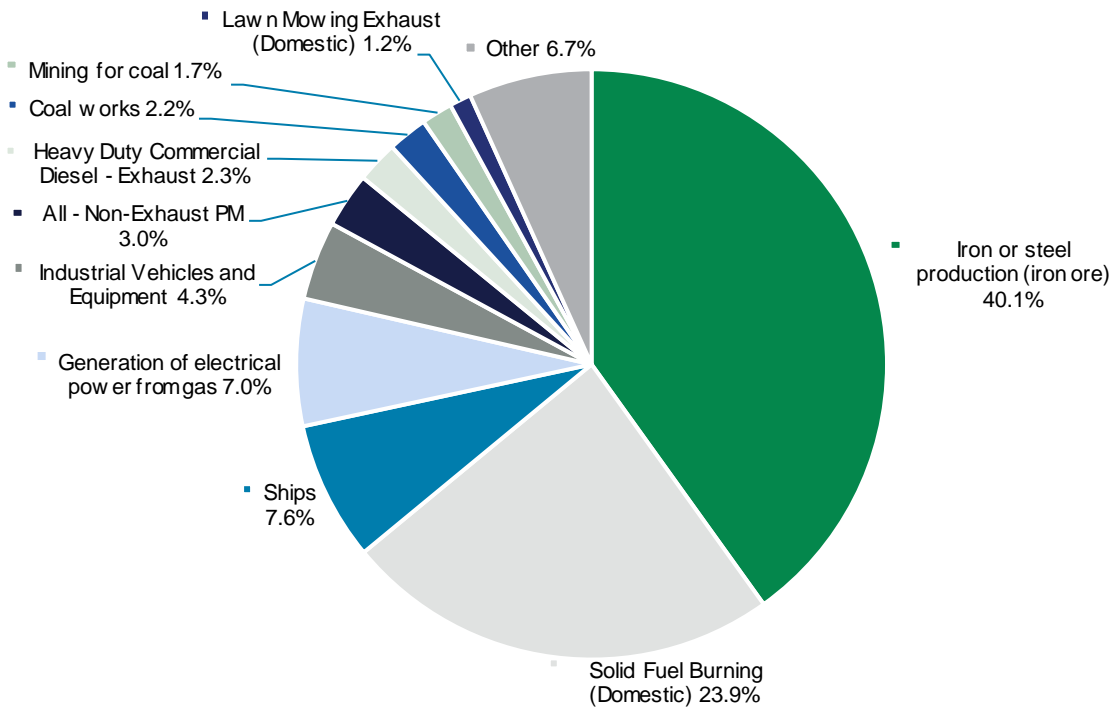


Figure 4-29: Wollongong region: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

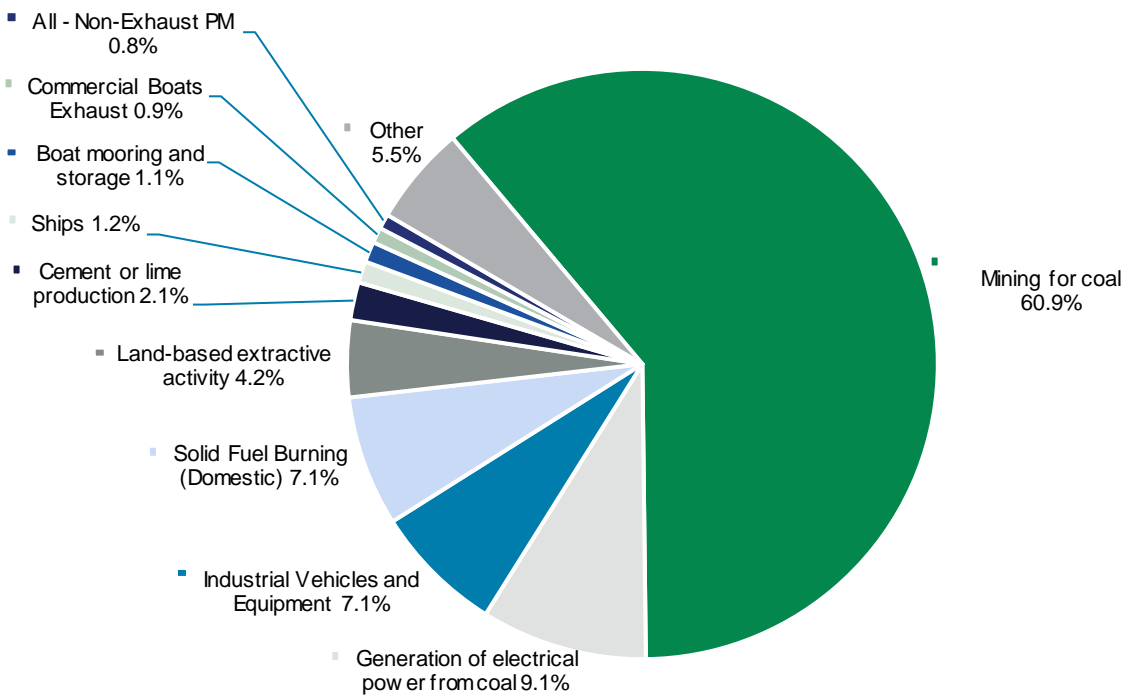


Figure 4-30: Non-urban region: top 10 human-made sources of particulate matter  $\leq 2.5\mu\text{m}$

Table 4-9 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of sulfur dioxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

**Table 4-9: Top 10 human-made sources of sulfur dioxide in each region**

Module	Activity <sup>52</sup>	Emissions (tonnes/year)	Proportion (%) <sup>53</sup>	Cumulative proportion (%)
<b>Top 10 human-made sulfur dioxide sources in the GMR</b>				
Industrial	Generation of electrical power from coal	198,191	87.9	87.9
Off-Road Mobile	Ships	10,536	4.68	92.6
Industrial	Aluminium production (alumina)	8,168	3.62	96.2
Industrial	Iron or steel production (iron ore)	4,176	1.85	98.1
Industrial	Petroleum products and fuel production	1,841	0.82	98.9
Industrial	Ceramics production	477	0.21	99.1
Industrial	Petrochemical production	473	0.21	99.3
Industrial	Mining for coal	264	0.12	99.5
Industrial	Glass production (container)	213	9.46×10 <sup>-2</sup>	99.6
Off-Road Mobile	Aircraft (Flight Operations)	180	7.97×10 <sup>-2</sup>	99.6
Human-made	Other	833	0.37	100.0
<b>Top 10 human-made sulfur dioxide sources in the Sydney region</b>				
Off-Road Mobile	Ships	6,606	65.1	65.1
Industrial	Petroleum products and fuel production	1,840	18.1	83.2
Industrial	Petrochemical production	473	4.67	87.9
Industrial	Ceramics production	458	4.52	92.4
Industrial	Glass production (container)	213	2.10	94.5
Off-Road Mobile	Aircraft (Flight Operations)	173	1.70	96.2
Domestic-Commercial	Solid Fuel Burning (Domestic)	84.16	0.83	97.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	70.01	0.69	97.7
Commercial	Ceramic Product Manufacturing	36.80	0.36	98.1
Industrial	Generation of electrical power from gas	23.07	0.23	98.3
Human-made	Other	169	1.67	100.0
<b>Top 10 human-made sulfur dioxide sources in the Newcastle region</b>				
Industrial	Aluminium production (alumina)	8,168	81.8	81.8
Off-Road Mobile	Ships	1,703	17.1	98.8
Industrial	Chemical production	64.36	0.64	99.5
Industrial	Slaughtering or processing of animals	9.32	9.33×10 <sup>-2</sup>	99.6
Industrial	Iron or steel production (scrap metal)	9.06	9.07×10 <sup>-2</sup>	99.7

<sup>52</sup> n.e.c. in the activity stands for not elsewhere classified, a general industry code in the Australia and New Zealand Standard Industrial Classification (ABS, 2006).

<sup>53</sup> Proportions less than 0.1% are expressed in scientific notation to three significant figures (e.g. 9.46×10<sup>-2</sup> = 0.0946).

Module	Activity <sup>52</sup>	Emissions (tonnes/year)	Proportion (%) <sup>53</sup>	Cumulative proportion (%)
Domestic-Commercial	Solid Fuel Burning (Domestic)	6.36	6.37×10 <sup>-2</sup>	99.7
Industrial	Bitumen mixing	6.04	6.04×10 <sup>-2</sup>	99.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	5.03	5.04×10 <sup>-2</sup>	99.8
Off-Road Mobile	Aircraft (Flight Operations)	3.41	3.41×10 <sup>-2</sup>	99.9
Industrial	Generation of electrical power not coal, diesel or gas	2.17	2.17×10 <sup>-2</sup>	99.9
Human-made	Other	11.01	0.11	100.0
<b>Top 10 human-made sulfur dioxide sources in the Wollongong region</b>				
Industrial	Iron or steel production (iron ore)	4,176	86.3	86.3
Off-Road Mobile	Ships	639	13.2	99.5
Industrial	Metal plating or coating	8.09	0.17	99.6
Industrial	Generation of electrical power from gas	5.09	0.11	99.8
Domestic-Commercial	Solid Fuel Burning (Domestic)	3.79	7.82×10 <sup>-2</sup>	99.8
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	2.89	5.98×10 <sup>-2</sup>	99.9
On-Road Mobile	Heavy Duty Commercial Diesel - Exhaust	0.56	1.15×10 <sup>-2</sup>	99.9
Domestic-Commercial	Gaseous Fuel Burning	0.53	1.10×10 <sup>-2</sup>	99.9
Commercial	Funeral Directors, Crematoria and Cemeteries	0.53	1.09×10 <sup>-2</sup>	99.9
Off-Road Mobile	Recreational Boats Exhaust	0.51	1.05×10 <sup>-2</sup>	99.9
Human-made	Other	3.23	6.67×10 <sup>-2</sup>	100.0
<b>Top 10 human-made sulfur dioxide sources in the Non-urban region</b>				
Industrial	Generation of electrical power from coal	198,191	98.9	98.9
Off-Road Mobile	Ships	1,589	0.79	99.7
Industrial	Mining for coal	263	0.13	99.8
Industrial	Cement or lime production	121	6.04×10 <sup>-2</sup>	99.9
Commercial	Log Sawmilling	69.71	3.48×10 <sup>-2</sup>	99.9
Commercial	Food Manufacturing n.e.c.	37.47	1.87×10 <sup>-2</sup>	99.9
Domestic-Commercial	Solid Fuel Burning (Domestic)	19.50	9.73×10 <sup>-3</sup>	100.0
Industrial	Ceramics production	18.19	9.08×10 <sup>-3</sup>	100.0
Off-Road Mobile	Industrial Vehicles and Equipment	13.99	6.98×10 <sup>-3</sup>	100.0
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	11.22	5.60×10 <sup>-3</sup>	100.0
Human-made	Other	41.82	2.09×10 <sup>-2</sup>	100.0



Figure 4-31, Figure 4-32, Figure 4-33, Figure 4-34 and Figure 4-35 show the proportions of total estimated annual emissions for the top 10 human-made sources of sulfur dioxide in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

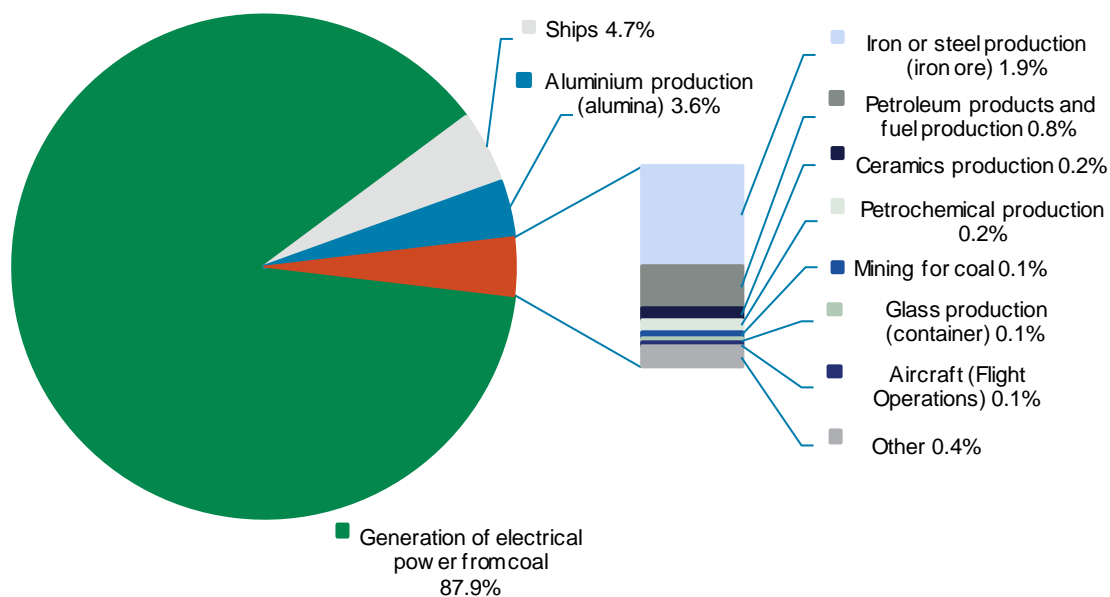


Figure 4-31: GMR: top 10 human-made sources of sulfur dioxide

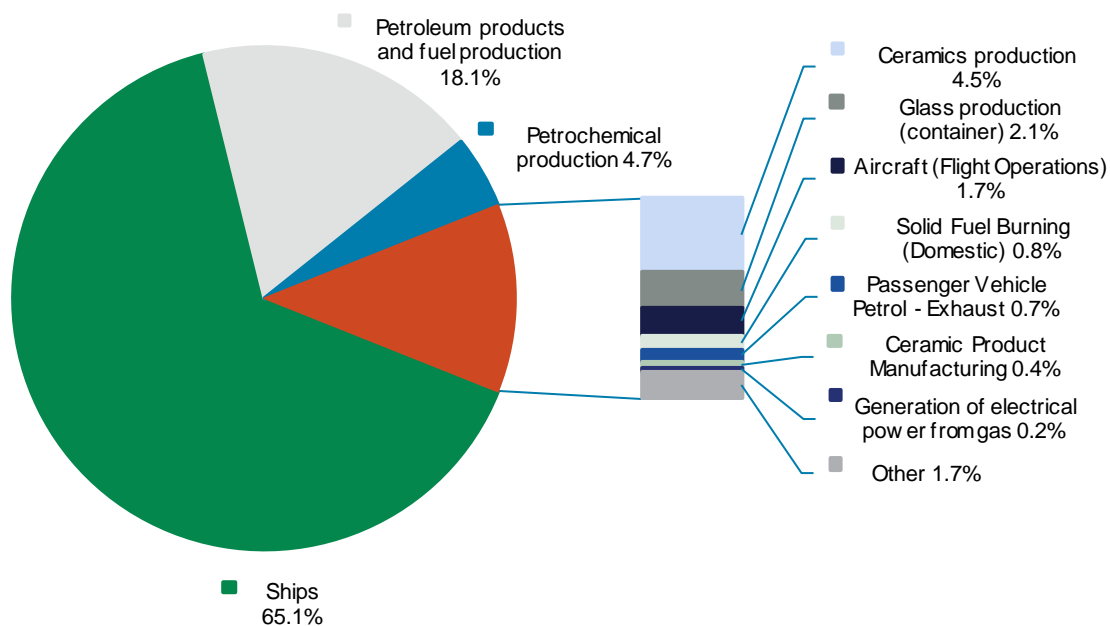


Figure 4-32: Sydney region: top 10 human-made sources of sulfur dioxide

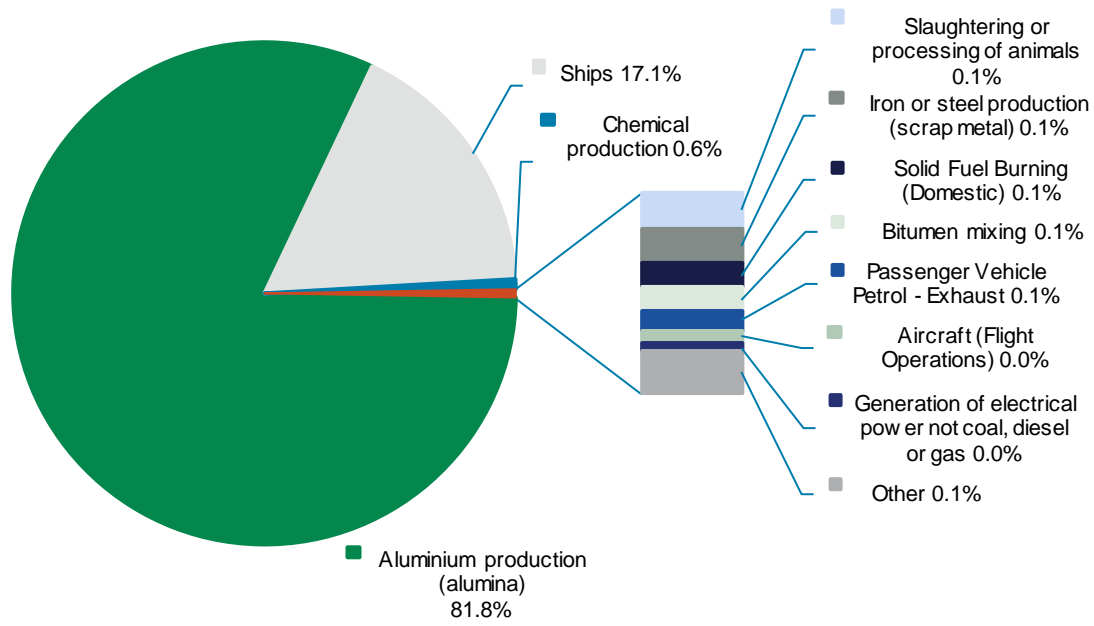


Figure 4-33: Newcastle region: top 10 human-made sources of sulfur dioxide

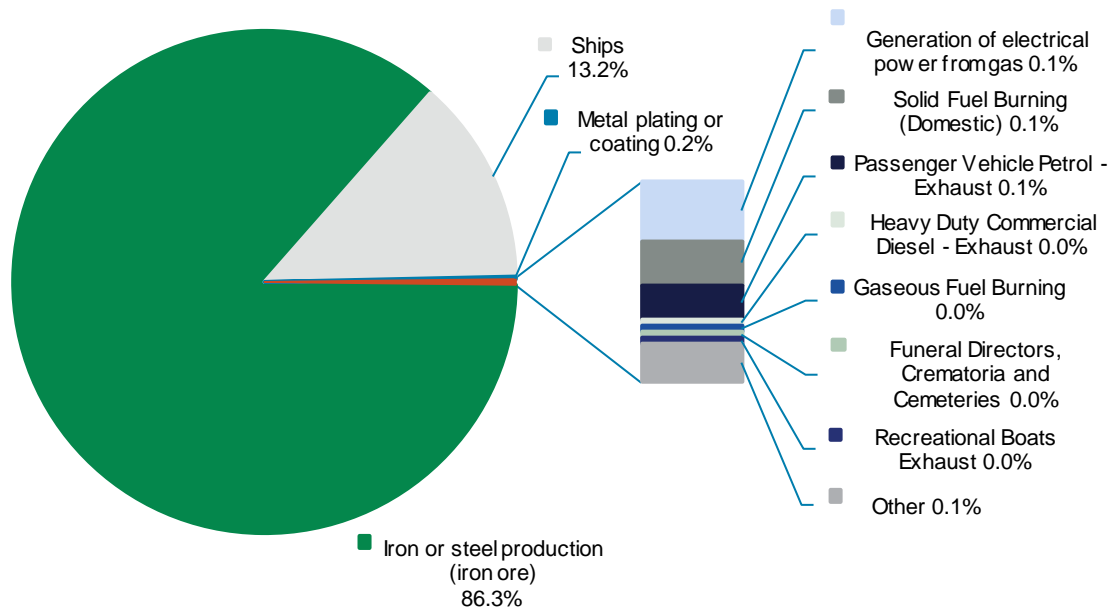


Figure 4-34: Wollongong region: top 10 human-made sources of sulfur dioxide

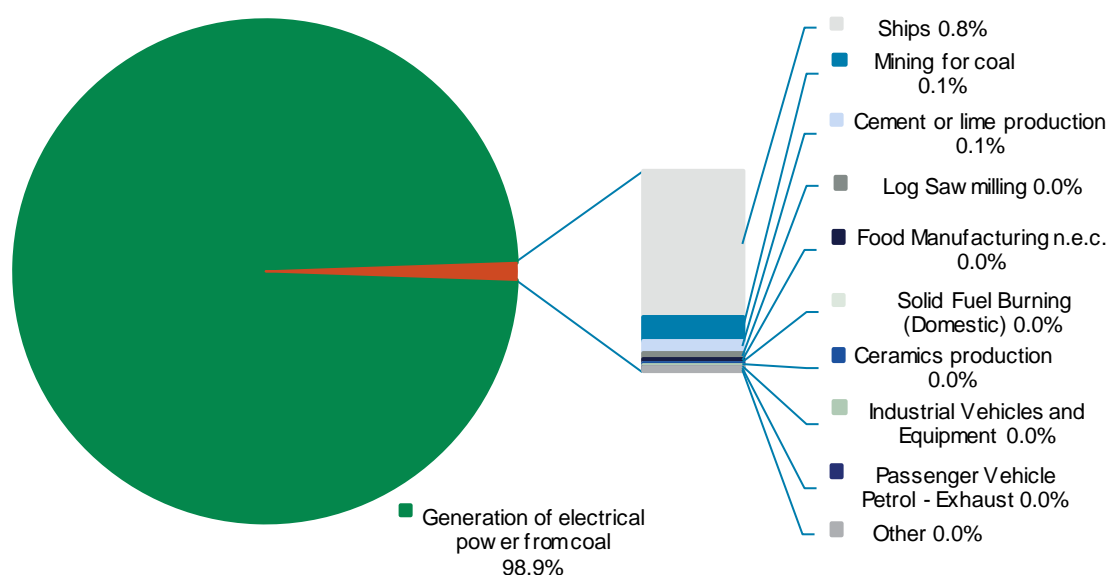


Figure 4-35: Non-urban region: top 10 human-made sources of sulfur dioxide

Table 4-10 presents total estimated annual emissions, proportions and cumulative proportions for the top 10 human-made sources of VOC in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions.

Table 4-10: Top 10 human-made sources of VOC in each region

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
<b>Top 10 human-made total volatile organic compounds sources in the GMR</b>				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	27,715	20.7	20.7
Off-Road Mobile	Commercial Boats Exhaust	10,778	8.03	28.7
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	10,277	7.66	36.3
Domestic-Commercial	Surface Coatings	9,728	7.25	43.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	8,239	6.14	49.7
On-Road Mobile	All - Evaporative	6,956	5.18	54.9
Commercial	Automotive Fuel Retailing	6,646	4.95	59.9
Off-Road Mobile	Recreational Boats Exhaust	6,266	4.67	64.5
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	5,803	4.32	68.9
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	5,590	4.16	73.0
Human-made	Other	36,211	27.0	100.0
<b>Top 10 human-made total volatile organic compounds sources in the Sydney region</b>				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	21,929	22.7	22.7
Domestic-Commercial	Surface Coatings	7,682	7.96	30.7

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	7,673	7.95	38.6
Commercial	Automotive Fuel Retailing	6,646	6.89	45.5
Domestic-Commercial	Solid Fuel Burning (Domestic)	6,093	6.31	51.8
On-Road Mobile	All - Evaporative	5,289	5.48	57.3
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	4,652	4.82	62.1
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	4,492	4.65	66.8
Off-Road Mobile	Recreational Boats Exhaust	3,196	3.31	70.1
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	3,109	3.22	73.3
Human-made	Other	25,761	26.7	100.0
<b>Top 10 human-made total volatile organic compounds sources in the Newcastle region</b>				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	1,364	17.8	17.8
Off-Road Mobile	Commercial Boats Exhaust	1,016	13.3	31.1
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	644	8.41	39.5
Industrial	Petroleum products storage	567	7.41	46.9
Domestic-Commercial	Surface Coatings	514	6.71	53.6
Domestic-Commercial	Solid Fuel Burning (Domestic)	460	6.02	59.6
On-Road Mobile	All - Evaporative	446	5.83	65.5
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	325	4.25	69.7
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	286	3.74	73.5
Off-Road Mobile	Recreational Boats Exhaust	280	3.65	77.1
Human-made	Other	1,752	22.9	100.0
<b>Top 10 human-made total volatile organic compounds sources in the Wollongong region</b>				
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	997	23.2	23.2
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	430	10.0	33.2
Off-Road Mobile	Recreational Boats Exhaust	397	9.23	42.4
Domestic-Commercial	Surface Coatings	370	8.61	51.1
Domestic-Commercial	Solid Fuel Burning (Domestic)	274	6.38	57.4
On-Road Mobile	All - Evaporative	235	5.46	62.9
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	213	4.95	67.8
Industrial	Waste disposal (application to land)	193	4.48	72.3
Domestic-Commercial	Lawn Mowing Evaporative (Domestic)	173	4.03	76.3
On-Road Mobile	Passenger Vehicle Petrol - Exhaust	171	3.97	80.3
Human-made	Other	847	19.7	100.0
<b>Top 10 human-made total volatile organic compounds sources in the Non-urban region</b>				
Off-Road Mobile	Commercial Boats Exhaust	6,710	26.1	26.1

Module	Activity	Emissions (tonnes/year)	Proportion (%)	Cumulative proportion (%)
Domestic-Commercial	Domestic/Commercial Solvents/Aerosols	3,425	13.3	39.4
Off-Road Mobile	Recreational Boats Exhaust	2,393	9.30	48.7
Off-Road Mobile	Industrial Vehicles and Equipment	1,890	7.34	56.0
Domestic-Commercial	Lawn Mowing Exhaust (Domestic)	1,530	5.95	62.0
Domestic-Commercial	Solid Fuel Burning (Domestic)	1,412	5.49	67.5
Domestic-Commercial	Surface Coatings	1,161	4.51	72.0
On-Road Mobile	All - Evaporative	987	3.83	75.8
Industrial	Generation of electrical power from coal	840	3.26	79.1
Domestic-Commercial	Lawn Mowing Exhaust (Public Open Spaces)	653	2.54	81.6
Human-made	Other	4,734	18.4	100.0

Figure 4-36, Figure 4-37, Figure 4-38, Figure 4-39 and Figure 4-40 show the proportions of total estimated annual emissions for the top 10 human-made sources of VOC in the whole GMR and the Sydney, Newcastle, Wollongong and Non-urban regions, respectively.

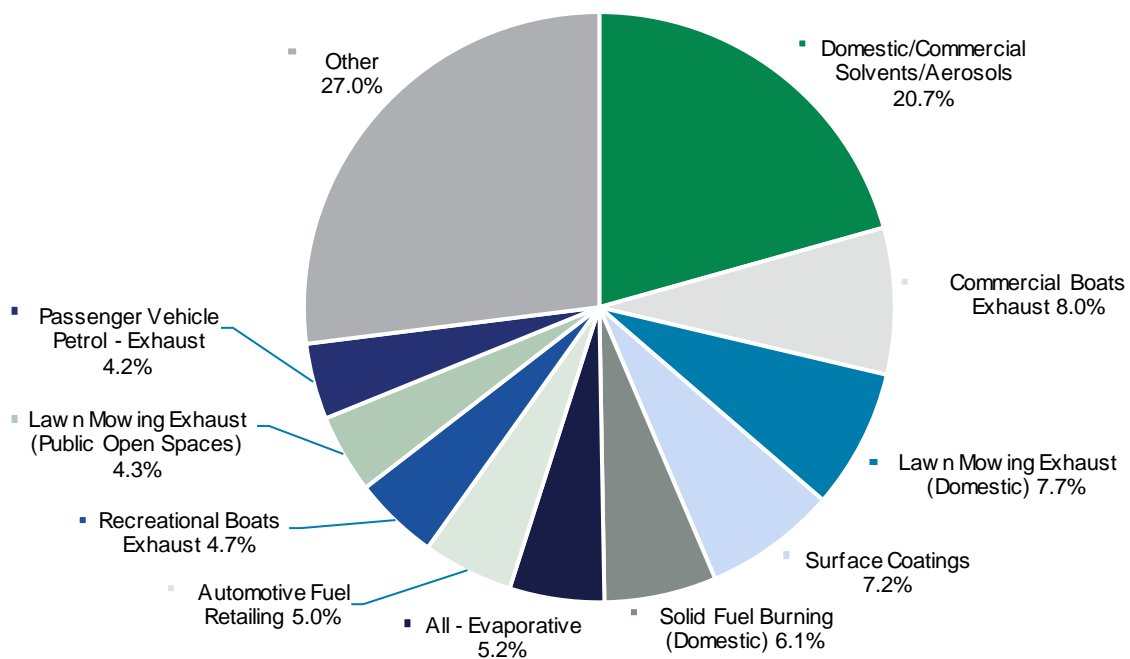


Figure 4-36: GMR: top 10 human-made sources of VOC

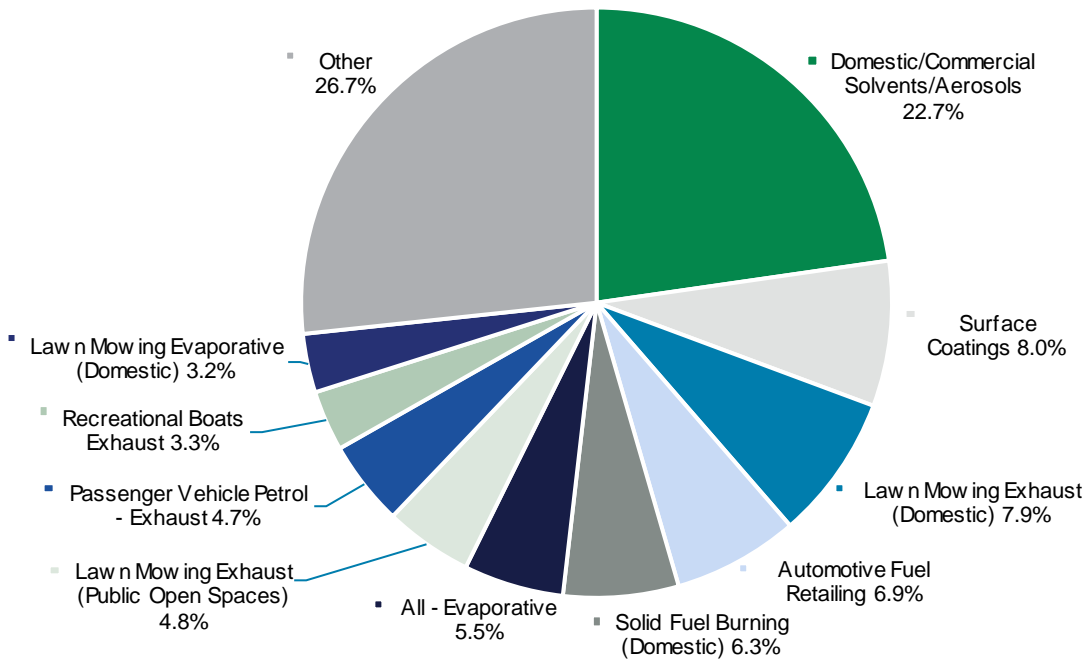


Figure 4-37: Sydney region: top 10 human-made sources of VOC

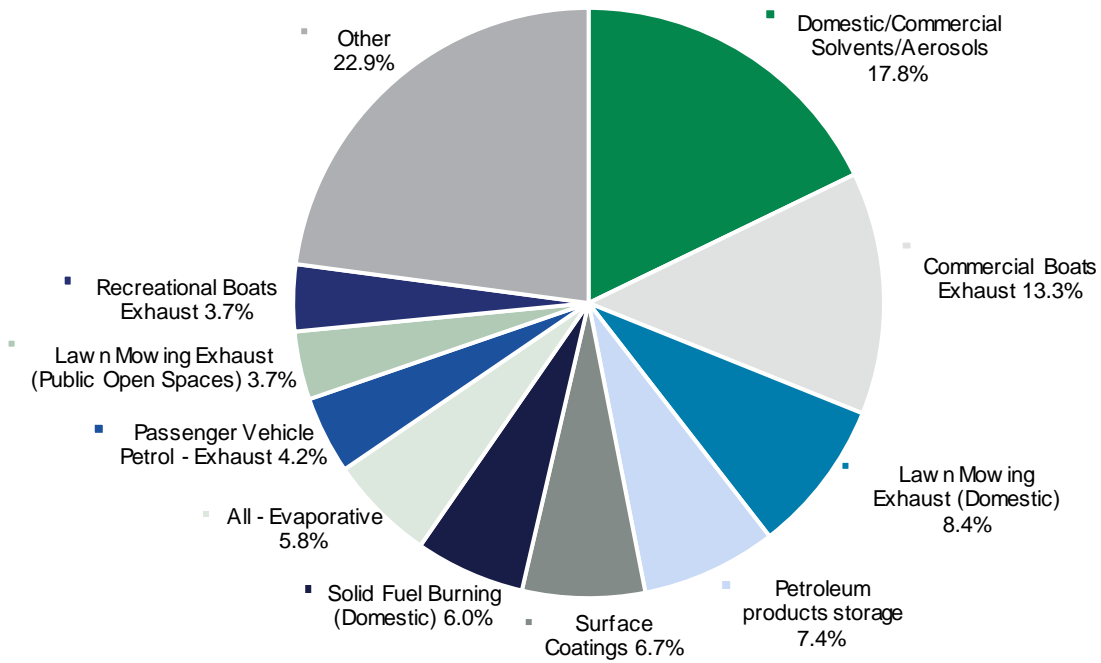


Figure 4-38: Newcastle region: top 10 human-made sources of VOC

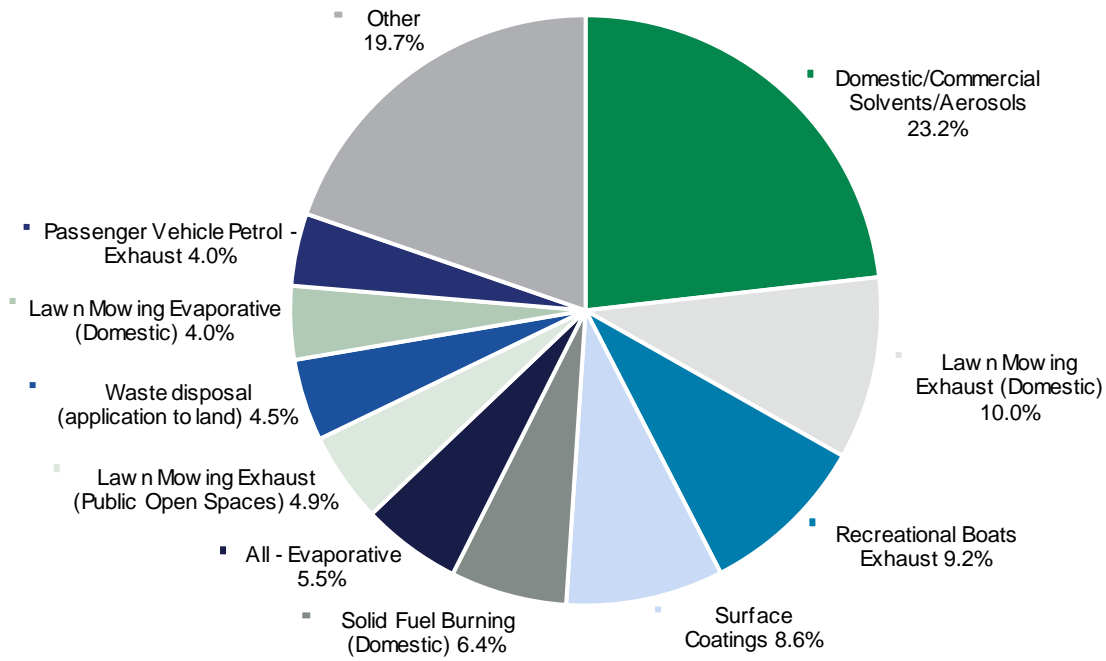


Figure 4-39: Wollongong region: top 10 human-made sources of VOC

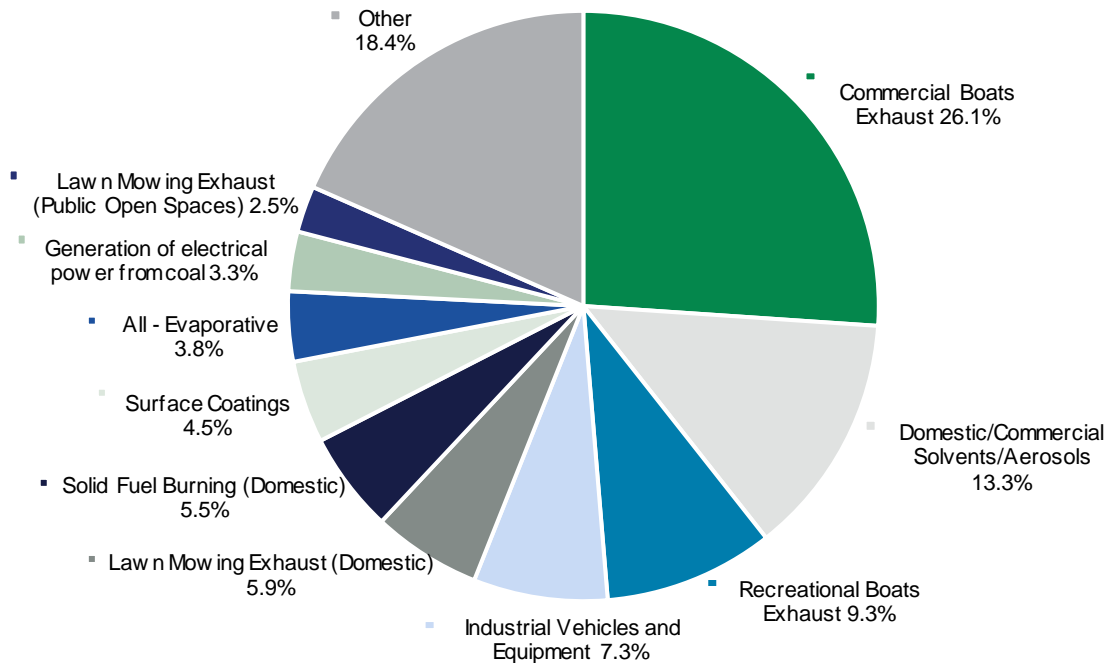


Figure 4-40: Non-urban region: top 10 human-made sources of VOC

## 5. References

- ABS 2006, 1292.0 – *Australia and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0)*, Australian Bureau of Statistics, Canberra, [www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/1292.0?OpenDocument](http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/1292.0?OpenDocument)
- Agapides NG 2017, NO<sub>x</sub> emissions from lightning based on observational data during electrical storms and the physical properties of lightning strokes, *Air Quality and Climate Journal*, Clean Air Society of Australia and New Zealand, vol.51, no.3, December 2017.
- Agapides NG 2018, DMS emissions from the ocean using sea surface observations, weather predictions and physical properties in a two-layer mass transfer model, *Air Quality and Climate Journal*, Clean Air Society of Australia and New Zealand, vol.52, no.1, January 2018.
- BTS 2014, *Population and Household Forecasts for the Greater Metropolitan Region in NSW*, Bureau of Transport Statistics, Transport for NSW, Sydney, May 2014.
- BTS 2016, *Vehicle Kilometres Travelled for the Greater Metropolitan Region in NSW for 2011 to 2041*, Bureau of Transport Statistics, Transport for NSW, Sydney, April 2016.
- CARB 2008, *ARB's Emissions Inventory, Area-Wide Source Methodologies, Index of Methodologies by Major Category*, California Air Resources Board, Sacramento, CA, USA, [www.arb.ca.gov/ei/areasrc/index0.htm](http://www.arb.ca.gov/ei/areasrc/index0.htm)
- CARB 2011, *Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values*, California Air Resources Board, Sacramento, CA, USA, [www.arb.ca.gov/toxics/healthval/contable.pdf](http://www.arb.ca.gov/toxics/healthval/contable.pdf)
- CARB 2014, *California Emission Inventory and Reporting System (CEIDARS): Particulate Matter (PM) Speciation Profiles*, Californian Air Resources Board, Sacramento, CA, USA, [www.arb.ca.gov/ei/speciate/speciate.htm](http://www.arb.ca.gov/ei/speciate/speciate.htm), [www.arb.ca.gov/ei/speciate/pmchemprofile20aug14.zip](http://www.arb.ca.gov/ei/speciate/pmchemprofile20aug14.zip)
- CARB 2015, *California Emission Inventory and Reporting System (CEIDARS): Organic Gas Speciation Profiles*, Californian Air Resources Board, Sacramento, CA, USA, [www.arb.ca.gov/ei/speciate/speciate.htm](http://www.arb.ca.gov/ei/speciate/speciate.htm), [www.arb.ca.gov/ei/speciate/orgprofile11feb15.zip](http://www.arb.ca.gov/ei/speciate/orgprofile11feb15.zip)
- Carter W 2010, *Development of the SAPRC-07 Chemical Mechanism and Updated Ozone Reactivity Scales, Report to the California Air Resources Board Contracts Nos 03-318, 06-408 and 07-730*, College of Engineering, Center for Environmental Research and Technology (CE-CERT), University of California, CA, USA, [www.engr.ucr.edu/~carter/SAPRC/saprc07.pdf](http://www.engr.ucr.edu/~carter/SAPRC/saprc07.pdf)
- DEC 2005, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, Department of Environment and Conservation, Sydney, [www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf](http://www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf)
- DEE 2017, *National Greenhouse Accounts Factors*, Department of Environment and Energy, Canberra, [www.environment.gov.au/system/files/resources/5a169bfb-f417-4b00-9b70-6ba328ea8671/files/national-greenhouse-accounts-factors-july-2017.pdf](http://www.environment.gov.au/system/files/resources/5a169bfb-f417-4b00-9b70-6ba328ea8671/files/national-greenhouse-accounts-factors-july-2017.pdf)
- DEWHA 2009, *Second National In-Service Emissions Study (NISE2) Light Duty Petrol Vehicle Emissions Testing, RTA.07.2828.0309 – Final Report*, Department of the Environment, Water, Heritage and the Arts, Canberra, March 2009, [www.environment.gov.au/archive/transport/publications/pubs/nise2-report-09.pdf](http://www.environment.gov.au/archive/transport/publications/pubs/nise2-report-09.pdf)
- EA 2001, *State of Knowledge Report: Air Toxics and Indoor Air Quality in Australia*, Environment Australia, Canberra, [www.environment.gov.au/archive/atmosphere/airquality/publications/sok/index.html](http://www.environment.gov.au/archive/atmosphere/airquality/publications/sok/index.html)
- EEA 2016, *EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016*, European Environment Agency, Copenhagen, Denmark, [www.eea.europa.eu/publications/emep-eea-guidebook-2016](http://www.eea.europa.eu/publications/emep-eea-guidebook-2016)
- EEA 2017, *EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 1.A.3.b.i-iv*, European Environment Agency, Copenhagen, Denmark, July 2017, [www.eea.europa.eu/publications/emep-eea-guidebook-2016](http://www.eea.europa.eu/publications/emep-eea-guidebook-2016)
- EPA 2012a, *2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, Biogenic-Geogenic Emissions: Results*, Environment Protection Authority, Sydney, [www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008](http://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008)
- EPA 2012b, *2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, Commercial Emissions: Results*, Environment Protection Authority, Sydney, [www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008](http://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008)
- EPA 2012c, *2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, Domestic-Commercial Emissions: Results*, Environment Protection Authority, Sydney, [www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008](http://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008)
- EPA 2012d, *2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, Industrial Emissions: Results*, Environment Protection Authority, Sydney, [www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008](http://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008)
- EPA 2012e, *2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, Off-Road Mobile Emissions: Results*, Environment Protection Authority, Sydney, [www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008](http://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008)



EPA 2012f, *2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, On-Road Mobile Emissions: Results*, Environment Protection Authority, Sydney, [www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008](http://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2008)

EPA 2016a, *Diesel Locomotive Emissions Upgrade Kit Demonstration Project: Fuel Efficiency, Emissions and Noise Testing*, Environment Protection Authority, Sydney, February 2016, [www.epa.nsw.gov.au/your-environment/air/non-road-diesel-marine-emissions/reducing-diesel-emissions-locomotives](http://www.epa.nsw.gov.au/your-environment/air/non-road-diesel-marine-emissions/reducing-diesel-emissions-locomotives)

EPA 2016b, *Diesel Locomotive: Fuel Efficiency and Emissions Testing*, Environment Protection Authority, Sydney, November 2016, [www.epa.nsw.gov.au/your-environment/air/non-road-diesel-marine-emissions/reducing-diesel-emissions-locomotives](http://www.epa.nsw.gov.au/your-environment/air/non-road-diesel-marine-emissions/reducing-diesel-emissions-locomotives)

EPAV 1999, *Hazardous Air Pollutants: A Review of Studies Performed in Australia and New Zealand*, Environment Protection Authority of Victoria, Melbourne.

FAA 2015, *Emissions and Dispersion Modelling System (EDMS) v5.1.4.1*, US Department of Transportation, Federal Aviation Administration, Washington, DC, USA, [www.faa.gov/about/office\\_org/headquarters\\_offices/aep/models/edms\\_model](http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model)

ICSM 2014, *Geocentric Datum of Australia Technical Manual Version 2.4*, Intergovernmental Committee on Surveying and Mapping, Canberra, [www.icsm.gov.au/sites/default/files/2017-09/gda-v\\_2.4\\_0.pdf](http://www.icsm.gov.au/sites/default/files/2017-09/gda-v_2.4_0.pdf)

Keith LH & Telliard WA 1979, Priority pollutants part 1: A perspective view, *Environmental Science and Technology*, vol.13, no.4, April 1979, pp.416–24, American Chemical Society, Washington, DC, USA.

NEPC 2004, *National Environment Protection (Air Toxics) Measure – As made 3 December 2004*, National Environment Protection Council, Adelaide, [www.nepc.gov.au/nepms/air-toxics](http://www.nepc.gov.au/nepms/air-toxics)

NEPC 2008, *National Environment Protection (National Pollutant Inventory) Measure – As varied 13 November 2008*, National Environment Protection Council, Adelaide, [www.nepc.gov.au/nepms/national-pollutant-inventory](http://www.nepc.gov.au/nepms/national-pollutant-inventory)

NEPC 2016, *National Environment Protection (Ambient Air Quality) Measure – As varied 25 February 2016*, National Environment Protection Council, Adelaide, [www.nepc.gov.au/nepms/ambient-air-quality](http://www.nepc.gov.au/nepms/ambient-air-quality)

OEH 2019, *New South Wales Annual Compliance Report 2017: National Environment Protection Measure (Ambient Air Quality) Measure*, Office of Environment and Heritage, Sydney, [www.environment.nsw.gov.au/research-and-publications/publications-search/new-south-wales-annual-compliance-report-2017](http://www.environment.nsw.gov.au/research-and-publications/publications-search/new-south-wales-annual-compliance-report-2017)

PCO 2010a, *Protection of the Environment Operations Act 1997*, New South Wales Parliamentary Counsel's Office, Sydney, [www.legislation.nsw.gov.au/#/view/act/1997/156](http://www.legislation.nsw.gov.au/#/view/act/1997/156)

PCO 2010b, *Protection of the Environment Operations (General) Regulation 2009*, New South Wales Parliamentary Counsel's Office, Sydney, [www.legislation.nsw.gov.au/#/view/regulation/2009/211](http://www.legislation.nsw.gov.au/#/view/regulation/2009/211)

PCO 2011, *Protection of the Environment Operations (Clean Air) Regulation 2010*, New South Wales Parliamentary Counsel's Office, Sydney, [www.legislation.nsw.gov.au/#/view/regulation/2010/428](http://www.legislation.nsw.gov.au/#/view/regulation/2010/428)

TR 2014a, *Survey of Domestic Air Polluting Activities in NSW GMA, Project Reference: 4778*, Taverner Research, Sydney, October 2014.

TR 2014b, *Survey of Service Station Progress in Implementing VR Regulations in NSW GMA, Project Reference: 4732*, Taverner Research, Sydney, December 2014.

UMWELT 2015, *Industrial Survey 2013 Calendar Year Air Emissions Inventory for the NSW Greater Metropolitan Region*, Umwelt (Australia), Teralba, June 2015.

USEPA 1995, *AP 42, Fifth Edition, Compilation of Air Pollutant Emissions Factors, Volume 1: Stationary Point and Area Sources*, Technology Transfer Network, Clearinghouse for Inventories and Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, USA, [www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors](http://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors)

USEPA 2003, *Inventory Preparation for Emissions Modeling, Emission Inventory Conference Training Session, April 28, 2003*, 12<sup>th</sup> International Emission Inventory Conference: Clearinghouse for Inventories and Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, USA (No longer available on USEPA website)

USEPA 2007, *Air Emissions Inventory Improvement Program, EIIP Technical Report Series, Volumes 1–10*, Technology Transfer Network, Clearinghouse for Inventories and Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, USA, [www.epa.gov/air-emissions-inventories/air-emissions-inventory-improvement-program-eiip](http://www.epa.gov/air-emissions-inventories/air-emissions-inventory-improvement-program-eiip)

USEPA 2009, *Emission Factors for Locomotives, EPA-420-F-09-025*, United States Environmental Protection Agency, Office of Transportation and Air Quality, Ann Arbor, MI, USA, <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P100500B.pdf>

USEPA 2010, *The Clean Air Act Amendments of 1990 List of Hazardous Air Pollutants*, Technology Transfer Network, Air Toxics Website, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, USA, [www.epa.gov/ttnatw01/orig189.html](http://www.epa.gov/ttnatw01/orig189.html)

USEPA 2011a, *2008 National Emissions Inventory Data*, Technology Transfer Network, Clearinghouse for Inventories and Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, USA, [www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-data](http://www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-data)

USEPA 2011b, Nonroad Engines, Equipment, and Vehicles, Transportation and Air Quality, United States Environmental Protection Agency, Office of Transportation and Air Quality, Washington, DC, USA, [www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-emissions-nonroad-vehicles-and-engines](http://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-emissions-nonroad-vehicles-and-engines)

USEPA 2016, *Fuel Effects on Exhaust Emissions from On-road Vehicles in MOVES2014: Final Report*, EPA-420-R-16-001, Assessments and Standards Division, US Environment Protection Agency, Office of Transportation and Air Quality, February 2016, <https://nepis.epa.gov>

Van den Berg M, Birnbaum L, Bosveld A, Brunström B, Cook P, Feeley M, Giesy J, Hanberg A, Hasegawa R, Kennedy S, Kubiak T, Larsen J, van Leeuwen F, Liem A, Nolt C, Peterson R, Poellinger L, Safe S, Schrenk D, Tillitt D, Tysklind M., Younes, M, Wærn F & Zacharewski T 1998, Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife, *Environmental Health Perspectives*, vol.106, no.12, December 1998, pp.775–92, Cary, NC, USA.