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Porirua City Emissions Inventory 2021/22

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Porirua City Emissions Inventory 2021/22

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Executive Summary

Greenhouse Gas (GHG) emissions for the Porirua City Territorial Area (that is covered by the Porirua City Council) have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture and Forestry sectors. This document reports greenhouse gas emissions produced in or resulting from activity or consumption within the geographic boundaries of the Porirua City Territorial Area for the 2021/22 financial reporting year and examines greenhouse gas emissions produced from 2018/19 to 2021/22.

The Porirua City Territorial Area is referred to hereafter as Porirua for ease. Greenhouse gas emissions are generally reported in this document in units of carbon dioxide equivalents (CO₂e) and are referred to as 'emissions'.

Major findings of the project include:

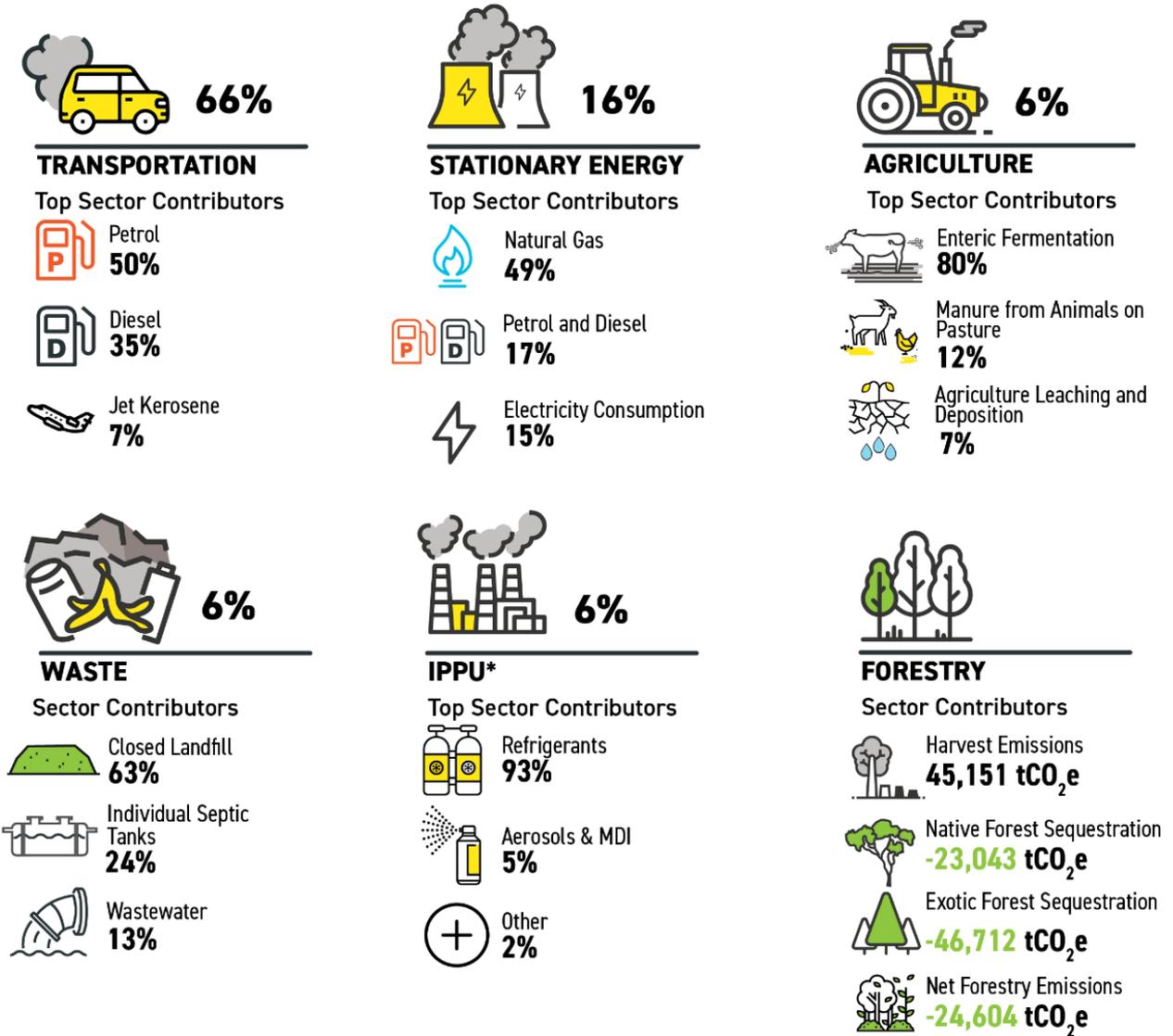
2021/22 Emissions Inventory

- In the 2021/22 reporting year (1st July 2021 to 30th June 2022), **Total Gross Emissions** in Porirua were 265,960 tCO₂e.
- **Transport** (e.g. emissions from road and air travel) is by far the largest emitting sector in Porirua, representing 66% of total gross emissions, with on-road petrol and diesel use accounting for 51% of Porirua's total gross emissions.
- **Stationary Energy** (e.g. emissions relating to electricity and natural gas consumption) is the second-highest emitting sector in the region, accounting for 17% of total gross emissions.
- **Industrial Processes and Product Use (IPPU)** (e.g. refrigerant use) produced 6.4% of Porirua's total gross emissions. **Waste** and **Agriculture** represented 6.3% and 6.0% of Porirua's total gross emissions respectively.
- **Net Forestry** emissions were -24,604 in 2021/22 as carbon sequestration (carbon captured and stored in plants or soil by forests) was higher than emissions from forest harvesting (e.g., the release of carbon from timber, roots and organic matter following harvesting). Net Forestry emissions are not included in total gross emissions but in total net emissions.
- **Total Net Emissions** in Porirua were 241,356 tCO₂e. Total net emissions includes sequestration and emissions release from forestry.

Changes in Annual Emissions, 2018/19 to 2021/22

- Between 2018/19 and 2021/22, **Total Gross Emissions** in Porirua decreased from 301,404 tCO₂e to 265,960 tCO₂e, a decrease of 12% (35,444 tCO₂e), largely due to a reduction in transport emissions.
- Over this time the population of the city increased by 3.4%, resulting in **Per Capita Gross Emissions** in Porirua decreasing by 15% between 2018/19 and 2021/22, from 5.1 to 4.3 tCO₂e per person per year.
- Emissions from **Transport** decreased by 15%, between 2018/19 and 2021/22 (31,030 tCO₂e), driven by a reduction in air travel emissions and on-road petrol and diesel consumption.
- Emissions from **Waste** decreased by 21% between 2019/20 and 2021/22 (4,367 tCO₂e), due to an increase in landfill gas capture efficiency.
- Emissions from **Stationary Energy** increased by 2% between 2018/19 and 2021/22 (896 tCO₂e), due to increased natural gas consumption, partly offset by decreased use of fossil fuel electricity generation in the national grid.
- **Total Net Emissions** decreased by 19% (57,847 tCO₂e) between 2018/19 and 2021/22. This was caused by the 35,444 tCO₂e reduction in total gross emissions combined with a 20,598 tCO₂e decrease in emissions released by forest harvesting in these years.

Porirua Emissions Inventory for 2021/22



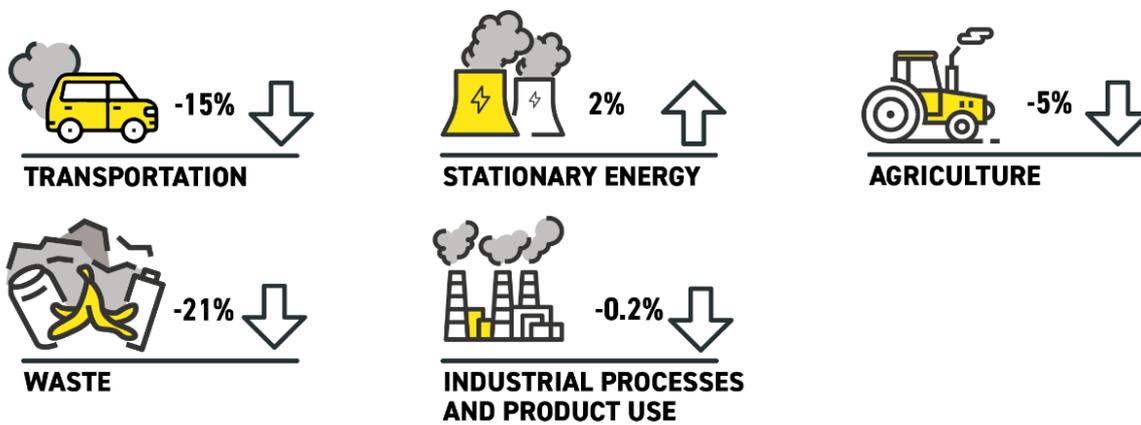
**Total Gross Emissions
(excluding Forestry): 265,960 tCO₂e**

**Total Net Emissions
(including Forestry): 241,356 tCO₂e**

*IPPU = Industrial Processes and Product Use

Figure 1: Porirua 2021/22 Emissions Inventory

Porirua Emissions Change 2018/19-2021/22



Change in Gross Emissions between 2018/19 and 2021/22: -12%

Figure 2: Change in Porirua Emissions Inventory between 2018/19 and 2021/22

1.0 Introduction

AECOM New Zealand Limited (AECOM) was commissioned by the Greater Wellington Regional Council to assist in the development of community-scale greenhouse gas (GHG) footprints for the Porirua City Territorial Area for the 2018/19 to 2021/22 financial years. As part of this work, AECOM recalculated emissions for the 2018/19 financial year, previously calculated by AECOM, using current best-practice methods, updated data, and additional emission sources to enable direct comparison to the other reported years.

This is part of a wider study to develop emissions inventories for each district within the Greater Wellington region. Emissions are reported for the financial year period from 1 July to 30 June for the respective years. The study boundary reported in the following pages incorporates the jurisdiction of the Porirua City Council.

The Porirua City Territorial Area is referred to hereafter as Porirua for ease. Greenhouse gas emissions are generally reported in this document in units of carbon dioxide equivalents (CO₂e) and are referred to as 'emissions'.

2.0 Approach and Limitations

The methodological approach used to calculate emissions follows the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory v1.1 (GPC) published by the World Resources Institute (WRI) 2021. The GPC includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture, and Forestry activities within the district's boundary. The sector calculations for Agriculture, Forestry and Waste are based on Intergovernmental Panel on Climate Change (IPCC) workbooks and guidance for emissions measurement. The sector calculators also use methods consistent with GHG Protocol standards published by the WRI for emissions measurement when needed.

The same methodology has been used for other community-scale GHG footprints around New Zealand, (e.g. the Bay of Plenty region, Hawke's Bay region, Auckland, Christchurch, Dunedin, and the Waikato region) and internationally. The GPC methodology¹ represents international best practice for city and regional level GHG emissions reporting and offers a robust, established method, which enables comparisons between different studies.

This emissions inventory assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the location of consumption. An example of indirect emissions is those associated with the consumption of electricity, which is supplied by the national grid (these are classed as Scope 2). All other indirect emissions such as cross-boundary travel (e.g. flights) and energy transportation and distribution losses fit into Scope 3.

All major assumptions made during data collection and analysis have been detailed within **Appendix A – Assumptions**. The following aspects are worth noting in reviewing the emissions inventory:

- Emissions are calculated by collecting or estimating data for each emissions source and then converting that data into emissions (tCO₂e) using an emission factor. Emission factors enable an estimate of emissions from a unit of activity data (e.g. litres of fuel used)². This inventory uses applicable emission factors predominantly from the New Zealand Ministry of the Environment (MfE).
- Emissions are expressed on a carbon dioxide-equivalent basis (CO₂e) including climate change feedback using the 100-year Global Warming Potential (GWP) values³. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the

¹ <http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities>

² <https://environment.govt.nz/publications/measuring-emissions-a-guide-for-organisations-2022-quick-guide/>

³ https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (Table 8.7)

<https://aecomaus.sharepoint.com/sites/CCF/Shared Documents/GWRC CCF FY22/3.>

Reports/GWRC_EmissionsInventory_2022_Porirua_230619_Final.docx

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atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs.

- GPC reporting is predominately production-based (as opposed to consumption-based) and focused on emissions released within the geographic boundary but includes indirect emissions from energy consumption and cross boundary travel from sources such as air travel. Production-based approaches exclude globally produced emissions relating to consumption (e.g., embodied emissions relating to products produced elsewhere but consumed within the geographic area, such as imported food products, cars, phones, clothes etc.).
- Total emissions are reported as both gross emissions (excluding Forestry) and net emissions (including Forestry).
- Emissions for individual main greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
- Where location specific data were not accessible, information was calculated based on national or regional level data.
- Transport emissions:
 - Transport emissions associated with air travel, rail, and marine fuel were calculated by working out the emissions relating to each journey arriving or departing the area based on data provided by the relevant operators. Emissions for these sources are then split equally between the destination and origin. Emissions relating to a particular point source (e.g. an airport or port) are allocated to the expected users of that source, not just the area that it is located in. For example, in the Greater Wellington region, the Wellington Airport is treated as a regional airport where it is expected that all territorial authorities will use Wellington Airport for air travel. Therefore, emissions from this source have been allocated to all regional territorial authorities based on population. This is also applicable to marine freight and inter-island marine journeys.
 - All other transport emissions are calculated using the fuel sold in the area (e.g. petrol, diesel, LPG). Fuel sold in an area does not always mean that the fuel is used in that area, however this approach is considered to be a robust and comparable estimate of fuel consumption in a geographic area.
- Solid waste emissions:
 - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day, as per the GPC reporting requirements. This method accounts for the gradual release of emissions from waste over a long period of time, and so calculates the emissions produced per year from waste in landfill (including emissions from closed landfill sites).
 - Emissions are calculated for waste produced within the geographic boundary, even if they are transported outside the boundary to be entered into landfill. Landfill waste for Porirua is understood to have been disposed at Spicer Landfill since 1976. From 1954 until 1976, Porirua's waste was disposed of at Sievers Grove Landfill, Porirua East (now closed).
- Wastewater emissions:
 - Wastewater treatment plant emissions have been calculated following WaterNZ (2021) guidance. Wastewater emissions include those released directly from wastewater treatment, flaring of captured gas, and discharge onto land/water. Emissions relating to biosolid waste from wastewater treatment sent to landfill have been included in the solid waste emissions source category.
 - Wastewater emissions from populations not connected to centralised wastewater treatment plants have been estimated by assuming that these populations use septic tank systems.
- Industrial Processes and Product Use (IPPU) emissions:

- IPPU emissions are estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2020 report (MfE 2022). Emissions are estimated on a per capita basis applying a national average per person.
- Forestry emissions:
 - This emissions inventory accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e. it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
 - The emissions inventory considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.

Overall sector data and results for the emissions inventory have been provided to Porirua City Council in calculation table spreadsheets. All assumptions made during data collection and analysis have been detailed within **Appendix A – Assumptions**.

Uncertainty

It is important to consider the level of uncertainty associated with the results, particularly given the different datasets used. Depending on data availability, national, regional, and local datasets are used across the different calculators. At the national level, New Zealand's Greenhouse Gas Inventory shows that for 2020 (the most recent nationwide inventory) an estimate of gross emissions uncertainty was $\pm 8.8\%$, whereas a net emissions uncertainty estimate was $\pm 26.9\%$ and uncertainty in the gross trend was $\pm 6.4\%$. These levels of uncertainty should be considered when interpreting the results of this emissions inventory (MfE, 2022⁴).

StatsNZ Regional Inventory

Emissions reported using the GPC method (as reported here) differ from the regional emissions estimates produced by StatsNZ. The differences are due to differences in scope, coverage, data sources, emission factors, and methods⁵.

Main differences:

- The StatsNZ approach is entirely based on production, while the GPC approach includes elements of consumption (e.g. where emissions from electricity are allocated to where the electricity is consumed, not where it is generated).
- The StatsNZ method uses a residence approach, while GPC is based on the territory approach.
- This report uses global warming potentials from the IPCC Fifth Assessment Report with climate change feedbacks, while the StatsNZ estimates use those from the Fourth Assessment Report, without climate change feedbacks.
- The StatsNZ estimates also don't include the scope 3 emissions reported here, such as cross boundary air travel and marine freight, or sequestration from forestry.

⁴ <https://environment.govt.nz/assets/publications/GhG-Inventory/New-Zealand-Greenhouse-Gas-Inventory-1990-2020-Chapters-1-15.pdf>

⁵ <https://www.stats.govt.nz/methods/about-regional-greenhouse-gas-emissions-statistics/>

<https://aecomaus.sharepoint.com/sites/CCF/Shared Documents/GWRC CCF FY22/3.>

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3.0 Emissions Inventory for 2021/22

The paragraphs, figures and tables below outline Porirua’s greenhouse gas emissions, referred to as ‘emissions’ in this assessment. This includes Porirua’s total emissions, emissions from each sector, and major emissions sources within each sector. The focus of emissions reporting is on gross emissions.

During the 2021/22 reporting period, Porirua emitted **Total Gross Emissions** of 265,960 tCO₂e. Transport emissions are by far the city’s most significant contributors to total gross emissions. Note that gross emissions do not account for Forestry sequestration and harvesting emissions. A breakdown of net emissions (i.e. including results from Forestry resources) is reported separately in section 3.7.

The population of Porirua in 2021/22 was approximately 61,350 people, resulting in per capita gross emissions of 4.3 tCO₂e/person. Discussion of per capita emissions is limited to when it is useful for comparing emission figures against other territorial authorities.

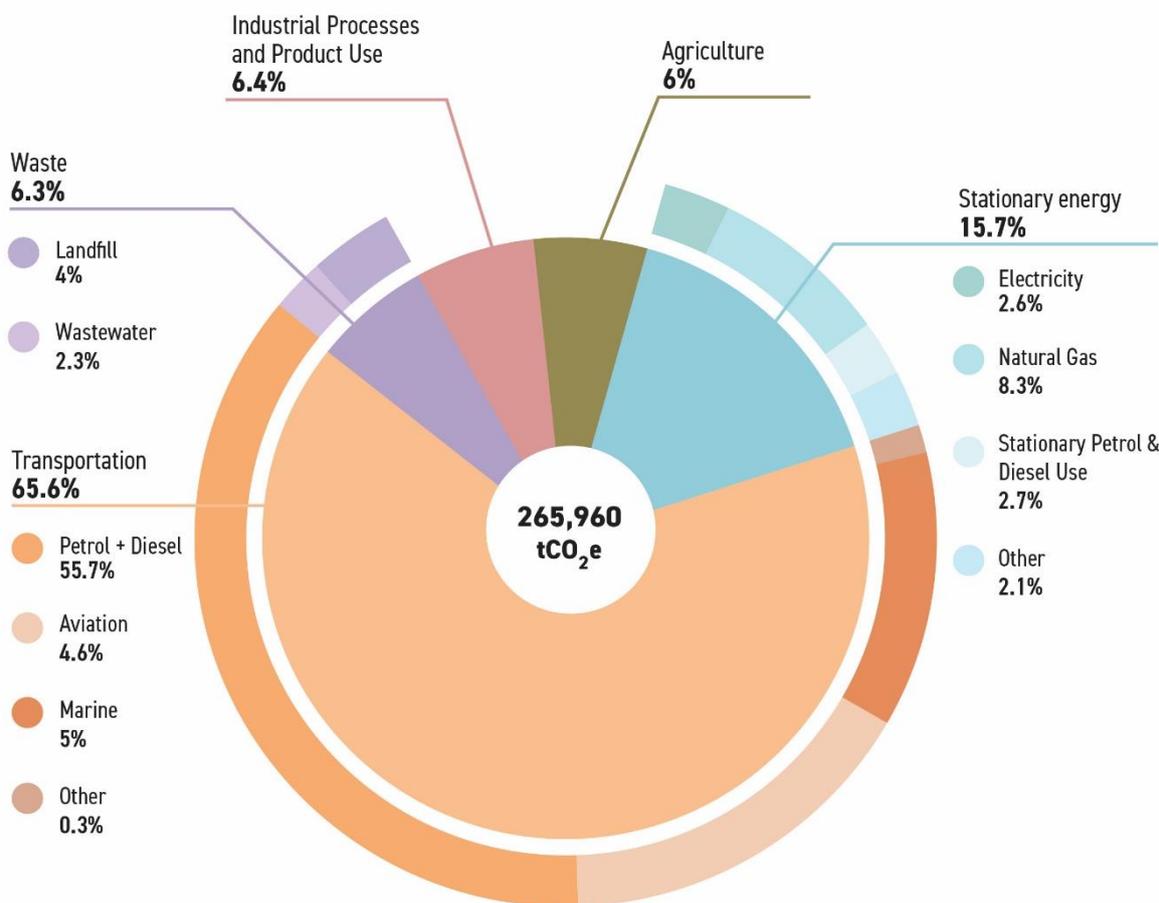


Figure 3: Porirua City’s total gross GHG emissions split by sector (tCO₂e).

The emissions inventory comprises emissions from six different sectors, summarised below. Due to rounding, there may be discrepancies between the sum of reported figures and reported totals.

The change in emissions from each emission source between 2018/19 and 2021/22 is presented in section 4.0. This includes analysis of notable changes in emissions.

3.1 Transport

The highest emitting sector in Porirua, Transport, produced 174,520 tCO₂e in 2021/22 (66% of Porirua's gross total emissions). Table 1 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source. Air travel and marine travel emissions relating to the Wellington Airport and CentrePort have been split between all territorial authority areas in the region (see below).

Table 1 Transport energy emissions by emission source

Sector / Emissions Source	tCO ₂ e	% of Total Gross Emissions	% of Sector Total
Petrol	87,039	32.7%	49.9%
Diesel	61,042	23.0%	35.0%
Jet Kerosene (Air Travel)	12,383	4.7%	7.1%
Marine Freight	7,613	2.9%	4.4%
Marine (Inter-Island Ferries)	5,559	2.1%	3.2%
LPG	520	0.2%	0.3%
Rail (Electric)	298	0.1%	0.2%
Aviation Gas (Air Travel)	65	<0.1%	<0.1%
Rail (Diesel)	1	<0.1%	<0.1%
Total	174,520	65.6%	100%

Most of the Transport emissions in 2021/22 can be attributed to petrol and diesel, which produced 87,039 tCO₂e and 61,042 tCO₂e respectively (collectively 85% of the sector's emissions and 56% of total gross emissions). Diesel and petrol transport emissions are broken down into on-road and off-road use. On-road transport consists of all standard road vehicles used on public roads (cars, trucks, buses, etc.). Off-road transport consists of all fuel used for vehicle movement off roads (agricultural tractors and vehicles, forklifts, etc.). On-road transport produced 135,601 tCO₂e in 2021/22 (78% of Transport emissions and 51% of total gross emissions) and off-road transport produced 12,999 tCO₂e (7% of Transport emissions).

An additional breakdown of on-road emissions by vehicle type is provided in the Appendix attached to this report.

Table 2 Petrol and diesel emissions – on-road and off-road

Sector / Emissions Source	tCO ₂ e	% of Total Gross Emissions	% of Sector Total
Petrol - On-Road	86,240	32.4%	49.4%
Diesel - On-Road	49,361	18.6%	28.3%
Diesel - Off-Road	11,680	4.4%	6.7%
Petrol - Off-Road	799	0.3%	0.5%
Petrol and Diesel Total	148,081	55.7%	84.9%

The next largest emission source for Porirua in 2021/22 is jet kerosene (aircraft jet fuel), contributing 7% of the sector's emissions and 5% of total gross emissions (12,448 tCO₂e). Jet kerosene emissions are based on the fuel consumed by aircraft journeys to and from Wellington, with emissions split equally between the origin and destination location. The Wellington Airport has been considered to be a

regional airport so emissions from jet kerosene have been split between all territorial authorities in the Greater Wellington Region based on population. It is important to note that jet kerosene emissions for Porirua in 2021/22 were 59% lower than in 2018/19, largely due to the restriction on international travel through Wellington Airport due to the COVID-19 pandemic (see section 7.0), it is likely that this will increase in 2022/23.

The remaining Transport emissions are attributed to marine freight, inter-island ferries, rail (both freight and electric commuter trains), aviation gas (used by small aircraft), and LPG use for transport (e.g., forklifts).

Emissions from marine freight have been divided between all territorial authorities in the Greater Wellington region based on relative population sizes. It is understood that imports and exports through this port are not exclusively related to activities in the Greater Wellington region; however, to ensure that these emissions are reflected in community carbon footprints as per the GPC requirements, this approach is appropriate. A similar consideration has been applied to aircraft emissions relating to Wellington Airport and inter-island ferry journeys. All assumptions have been detailed in the appendix.

3.2 Stationary Energy

Producing 41,754 tCO₂e in 2021/22, Stationary Energy was Porirua's second-highest emitting sector (16% of total gross emissions). Table 3 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 3 Stationary Energy emissions by emission source

Emissions Source	tCO ₂ e	% of Total Gross Emissions	% of Sector Total
Natural Gas	20,388	7.7%	48.8%
Stationary Petrol & Diesel Use	7,117	2.7%	17.0%
Electricity Consumption	6,406	2.4%	15.3%
LPG	4,118	1.5%	9.9%
Natural Gas Transmission & Distribution Losses	1,648	0.6%	3.9%
Biofuel / Wood	851	0.3%	2.0%
Electricity Transmission & Distribution Losses	679	0.3%	1.6%
Coal	548	0.2%	1.3%
Total:	41,754	15.7%	100%

Natural gas consumption was the cause of 49% of Stationary Energy emissions in 2021/22 (20,388 tCO₂e) and 8% of Porirua's total gross emissions (22,036 tCO₂e when including transmission and distribution losses related to the consumption).

Stationary petrol and diesel use accounted for 17% of Stationary Energy emissions in 2021/22 (7,117 tCO₂e). Electricity consumption was the cause of 15% of Stationary Energy emissions in 2021/22 (6,406 tCO₂e) and 2% of Porirua's total gross emissions (7,085 tCO₂e when including transmission and distribution losses related to the consumption).

Use of LPG generated 10% of Stationary Energy emissions in 2021/22 (4,118 tCO₂e). The burning of coal and biofuels produced the remaining Stationary Energy emissions.

Biogenic CO₂ emissions from biofuels have not been included in these totals and are reported separately in section 3.10.

3.3 Industrial Processes and Product Use (IPPU)

IPPU in Porirua produced 16,987 tCO₂e in 2021/22, contributing 6.4% to Porirua's total gross emissions. This sector includes emissions associated with the consumption of industrial products and synthetic gases containing GHGs for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and Sulphur Hexafluoride for electrical insulation and equipment production. No known industrial processes (as defined in the GPC requirements) are present in Porirua (e.g., aluminum manufacture).

IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g., coal, electricity and/or petrol and diesel). These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to particular geographic locations. Addressing IPPU emissions is typically a national policy issue.

Table 4 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source. The most significant contributor to IPPU emissions is refrigerants, which produced 93% of IPPU emissions (15,804 tCO₂e).

Table 4 Industrial processes and product use emissions by emission source

Sector / Emissions Source	tCO ₂ e	% of Total Gross Emissions	% of Sector Total
Refrigerants and Air Conditioning	15,804	5.9%	93.0%
Aerosols	881	0.3%	5.2%
SF6 - Electrical Equipment	172	0.1%	1.0%
Foam Blowing	69	<0.1%	0.4%
SF6 - Other	34	<0.1%	0.2%
Fire Extinguishers	27	<0.1%	0.2%
Total	16,987	6.4%	100%

3.4 Waste

Waste originating in Porirua (solid waste and wastewater) produced 16,658 tCO₂e in 2021/22. Table 5 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 5 Waste emissions by emission source

Sector / Emissions Source	tCO ₂ e	% of Total Gross Emissions	% of Sector Total
Solid Waste	10,508	4.0%	63.1%
Individual Septic Tanks	4,016	1.5%	24.1%
Wastewater Treatment Plants	2,135	0.8%	12.8%
Total:	16,658	6.3%	100%

Landfill waste produced the bulk of waste emissions (10,508 tCO₂e in 2021/22), making up 63% of total waste emissions. Solid waste emissions include emissions from open (operating) landfill sites and closed landfill sites. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill.

Landfill emissions are those that are the result of waste produced in Porirua and emitted in the reporting year, calculated based on all the waste sent to landfill over time.

Wastewater treatment (treatment plants and individual septic tanks) accounted for 37% of total waste emissions in 2021/22 (6,150 tCO₂e). The majority of households in Porirua (79%) are connected to wastewater treatment plants, producing total emissions of 2,135 tCO₂e in wastewater emissions. Households not connected to centralised wastewater treatment plants (i.e., using individual septic tanks) produced 4,016 tCO₂e in wastewater emissions. Septic tanks have a higher emissions intensity per quantity of wastewater compared to the wastewater treatment plants in Porirua.

3.5 Agriculture

Agriculture emitted 16,041 tCO₂e in 2021/22 (6% of Porirua's gross emissions). Table 6 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emissions source.

Agricultural emissions are the result of both livestock and crop farming within the geographic area. Enteric fermentation from livestock produced 80% of Porirua's agricultural emissions (12,757 tCO₂e). Enteric fermentation GHG emissions are produced by methane (CH₄) released from the digestive process of ruminant animals (e.g., cattle and sheep). The second highest source of Agricultural emissions was produced by unmanaged manure from grazing animals on pasture (1,919 tCO₂e).

Table 6 Agriculture emissions by emission source

Sector / Emissions Source	tCO ₂ e	% of Total Gross Emissions	% of Sector Total
Enteric Fermentation	12,757	4.8%	79.5%
Unmanaged Manure on Pasture	1,919	0.7%	12.0%
Agricultural Leaching and Deposition (manure, urine, and fertiliser)	1,167	0.4%	7.3%
Managed Manure	179	0.1%	1.1%
Fertilisers on Land	18	<0.1%	0.1%
Total	16,041	6.0%	100%

Livestock was responsible for the majority of the Agriculture sector's GHG emissions. Sheep account for 63% of agricultural emissions in Porirua, with non-dairy cattle accounting for 34%. In 2021/22, there were an estimated 18,347 sheep in Porirua and 2,126 non-dairy cattle.

Table 7 Agriculture emissions by emission source

Sector / Emissions Source	tCO ₂ e	% of Total Gross Emissions	% of Sector Total
Sheep	10,057	3.8%	63%
Non-Dairy Cattle	5,453	2.1%	34%
Other Livestock	515	0.2%	3%
Fertiliser	16	<0.1%	0.1%
Total	16,041	6.0%	100%

3.6 Forestry

Net Forestry emissions include:

- Sequestration of carbon from the atmosphere from native forests (e.g. mānuka and kānuka) and exotic forest (e.g. pine) sequesters (captures) while the trees are growing to maturity and,
- emissions released due to harvesting of forests via the release of carbon from organic matter and soils following harvesting.

When forest sequestration exceeds emissions from harvesting in a particular year, the extra carbon sequestered by forest results in net-negative Forestry emissions. Conversely, when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then Forestry emissions will be a net-positive source of emissions.

Total sequestration in 2021/22 was 69,755 tCO₂e (mostly from exotic forests), while harvesting emissions were 45,151 tCO₂e. This meant that Forestry in Porirua was a net negative source of emissions in 2021/22 (rather than a positive source of emissions, where harvesting emissions exceed sequestration). Total Forestry emissions in 2021/22 were therefore -24,604 tCO₂e. It is noted that the harvesting of exotic forests can be cyclical in nature. Some years will have higher sequestration, and some years will have higher harvesting emissions determined by the age of forests, commercial operators, and the global market.

Table 8 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO ₂ e
Harvest Emissions	45,151
Native Forest Sequestration	-23,043
Exotic Forest Sequestration	-46,712
Total	-24,604

3.7 Net Emissions

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting emissions and sequestration). The cyclical nature of harvesting and planting regimes influences the observed forestry emissions, which in 2021/22 were a net-negative source of emissions. During the 2021/22 reporting period, Porirua emitted total net emissions of 241,356 tCO₂e.

Figure 4 shows total gross emissions and total net emissions in 2021/22, and the impact of forestry sequestration and harvesting.

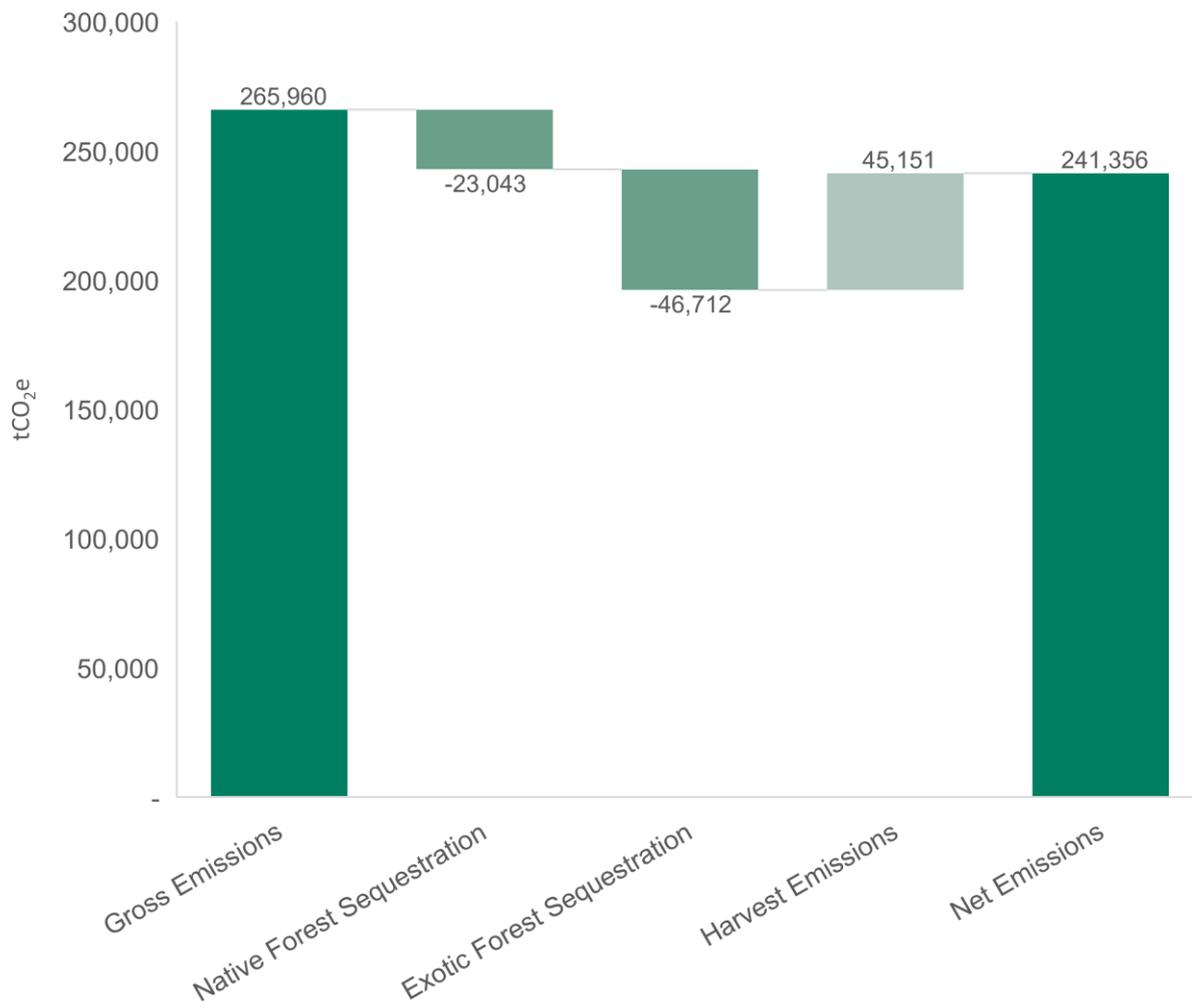


Figure 4 Total gross emissions and total net emissions in 2021/22, showing the impact of forestry sequestration and harvesting

3.8 Territorial Authorities in the Greater Wellington Region

The Greater Wellington regional area contains several territorial authorities including Wellington City Council, Porirua City Council, Kāpiti Coast District Council, Hutt City Council, Upper Hutt City Council, Masterton District Council, Carterton District Council, and South Wairarapa District Council.

Figure 5 shows the Greater Wellington Region total gross emissions divided by territorial authority. Figure 6 shows total gross emissions for the territorial authorities in the Greater Wellington Region, split by sector.

Wellington City is the highest emitting territorial authority in the region, representing 23% of Greater Wellington’s total gross emissions. Wellington City’s emissions inventory is predominantly transport-related emissions with the next largest emitting territorial authorities; Masterton and South Wairarapa containing significant agricultural emissions. Of the eight territorial authorities within the Greater Wellington region, Upper Hutt has the lowest total gross emissions, with emissions mostly from Transport and Stationary Energy. Porirua has the second lowest total gross emissions, with emissions also mostly from Transport and Stationary Energy.

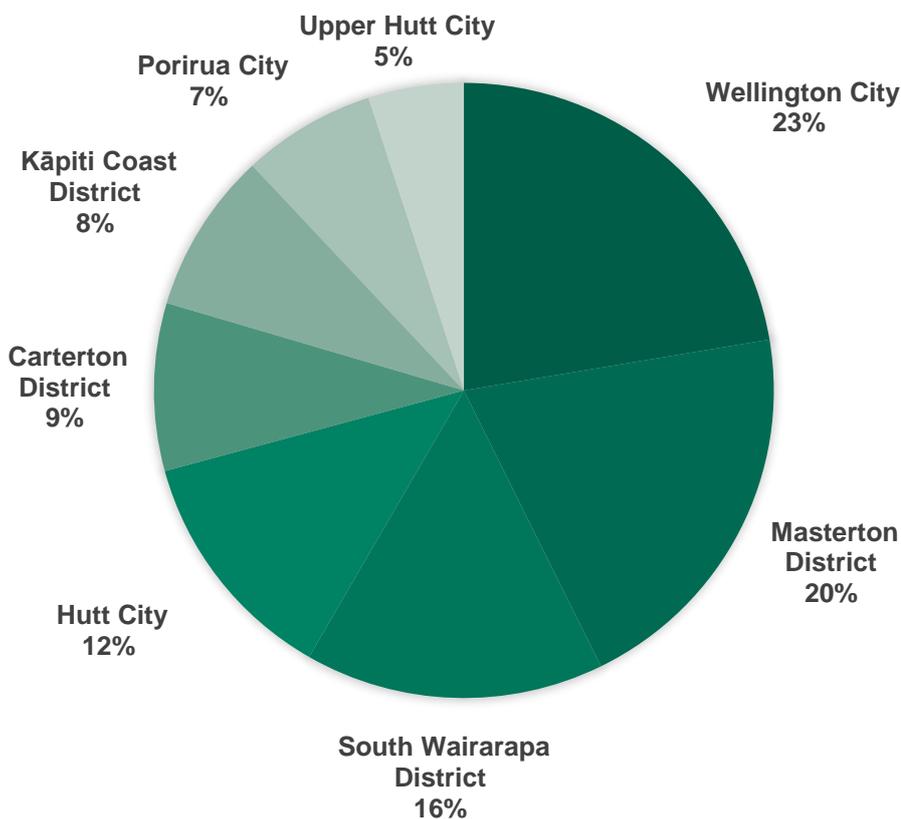


Figure 5 Greater Wellington’s total gross emissions divided by territorial authority (tCO₂e).

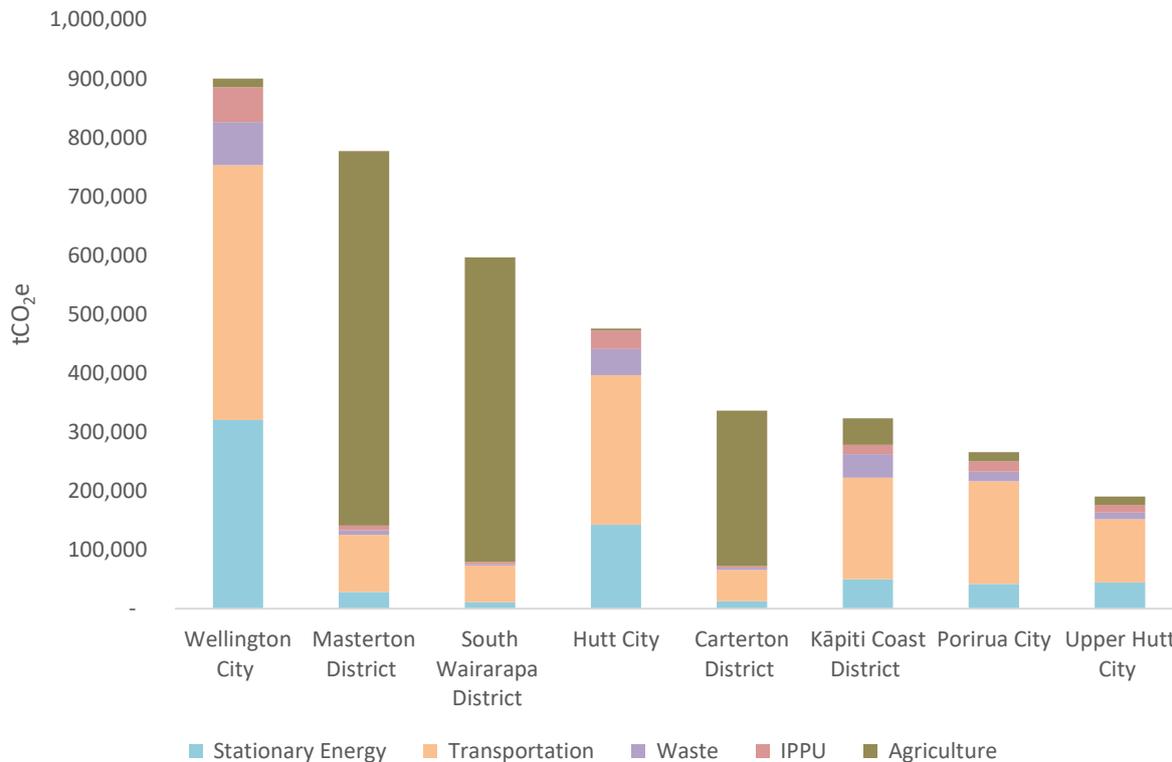


Figure 6 Total gross emissions by territorial authority in the Greater Wellington region (tCO₂e).

When comparing emissions inventories from different areas, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. Figure 7 shows emissions per capita for the territorial authorities within the Greater Wellington Region.

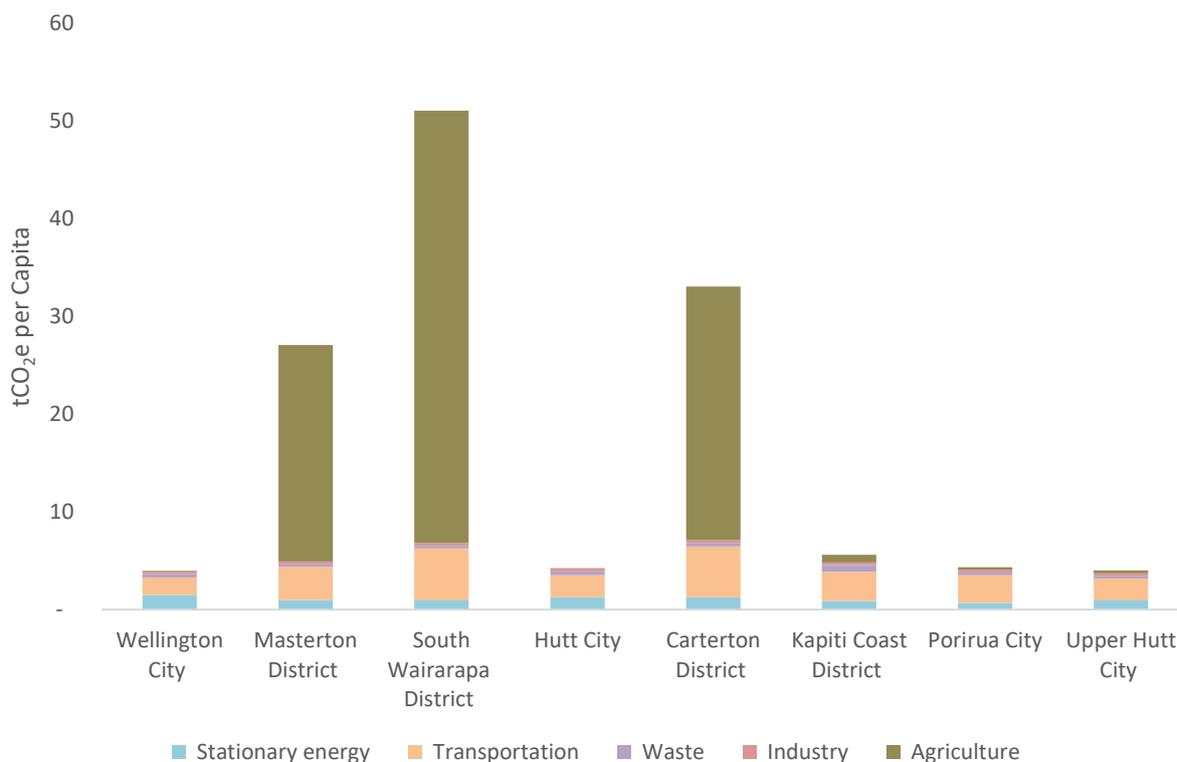


Figure 7 Total gross emissions per capita for the territorial authorities within the Greater Wellington Region (tCO₂e).

The Greater Wellington region has a 7.1 tCO₂e/per capita figure for total gross emissions which is lower than the national value of 15.7 tCO₂e/per capita. Upper Hutt has the lowest per capita total emissions at 4.0 tCO₂e/per capita. South Wairarapa and Carterton have the largest per capita total gross emissions at 51.4 tCO₂e/per capita and 33.3 tCO₂e/per capita respectively, both due to high Agriculture emissions in the district. Masterton has the third highest per capita emissions at 27.4 tCO₂e/per capita, again due to Agriculture emissions in the district. South Wairarapa, Carterton and Masterton also have the highest per capita transport emissions in the region (5.3 tCO₂e/per capita, 5.2 tCO₂e/per capita and 3.4 tCO₂e/per capita, respectively). Wellington City has the highest Stationary Energy emissions per capita in the region (1.5 tCO₂e/per capita).

Porirua has 4.3 tCO₂e/per capita for total gross emissions in 2021/22, similar to that of Wellington City and Hutt City. Porirua has the lowest Stationary Energy per capita emissions in the Region, at 0.7 tCO₂e/per capita, and relatively small Agriculture emissions per capita.

3.9 Total Gross Emissions by Greenhouse Gas

Each greenhouse gas has a different level of impact on climate change, this is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO₂e).

Table 9: Porirua total gross emissions, by greenhouse gas

Greenhouse Gas	Tonnes	Tonnes of CO ₂ e
Carbon Dioxide (CO ₂)	207,609	207,609
Biogenic Methane (CH ₄)	827	28,102
Non-biogenic Methane (CH ₄)	110	3,749
Nitrous Oxide (N ₂ O)	28	8,208
Other / Unknown Gas (in CO ₂ e)	18,291	18,291
Total	226,865	265,960

By far the largest source of emissions in tonnes is carbon dioxide (CO₂) at 207,609 tonnes. Due to the greater global warming impact of methane per tonne, methane represents 0.4% of the total tonnage of GHG emissions from Porirua but represents 11% of CO₂e. Nitrous oxide represents 0.01% of the total tonnage of GHG emissions from Porirua but represents 3% of CO₂e.

3.10 Biogenic Emissions

Biogenic carbon dioxide and methane emissions are stated in Table 10 and Table 11, respectively.

Biogenic CO₂ emissions result from the combustion of biomass materials that store and sequester CO₂, including materials used to make biofuels (e.g., trees, crops, vegetable oils, or animal fats). Biogenic CO₂ emissions from plants and animals are excluded from gross and net emissions as they are considered to be part of the natural carbon cycle.

Table 10: Biogenic CO₂ in Porirua (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO ₂) (Excluded from gross emissions)		
Biofuel	8,698	t CO ₂
Landfill Gas	6,934	t CO ₂
Total Biogenic CO₂	15,633	t CO₂

Biogenic CH₄ emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large impact on global warming relative to biogenic CO₂. Biogenic methane represents 0.4% of the gross total tonnage of GHG emissions in Porirua but represents 11% of total gross GHG emissions when expressed in CO₂e. This is caused by the higher global warming impact of methane per tonne, compared to carbon dioxide. The total tonnage of each GHG and the contribution of each GHG to total gross emissions when expressed in CO₂e is shown in Table 9.

The importance of biogenic CH₄ is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes specific targets to reduce biogenic CH₄ by between 24% and 47% below 2017 levels by 2050, and by 10% below 2017 levels by 2030. More information on the Act is available here: <https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act>.

Table 11: Biogenic Methane in Porirua (Included in gross emissions)

Biogenic Methane (CH₄) (Included in gross emissions)		
Enteric Fermentation (Livestock)	375	t CH ₄
Landfill Gas	308	t CH ₄
Wastewater Treatment	127	t CH ₄
Biofuel	12	t CH ₄
Manure Management (Livestock)	5	t CH ₄
Total Biogenic CH₄	827	t CH₄

4.0 Annual Emissions Change from 2018/19 to 2021/22

Alongside calculating Porirua’s emissions inventory for 2021/22, Porirua’s emissions inventory for 2019/20 and 2020/21 has been calculated, and the previously published 2018/19 inventory has been recalculated. The 2018/19 inventory has been updated to account for updates in data and calculation best-practice and to align with the other reporting years. This section displays the results of the 2018/19, 2019/20, 2020/21 and 2021/22 emissions inventories with a focus on gross emissions and documents the change in emissions from 2018/19 to 2021/22.

An analysis of the impact of the COVID-19 pandemic on Porirua’s emissions is found in Section 6.0. This section is cautious in examining the interpretation of changes, due to the inventory only assessing one financial year (2018/19) prior to the COVID-19 pandemic disruptions.

Table 12 Change in Porirua total gross and net emissions from 2018/19 to 2021/22

	2018/19 (tCO ₂ e)	2019/20 (tCO ₂ e)	2020/21 (tCO ₂ e)	2021/22 (tCO ₂ e)	% Change (2018/19 to 2021/22)
Total Net Emissions (including Forestry)	299,203	261,781	249,889	241,356	-19%
Total Gross Emissions (excluding Forestry)	301,404	282,078	274,493	265,960	-12%

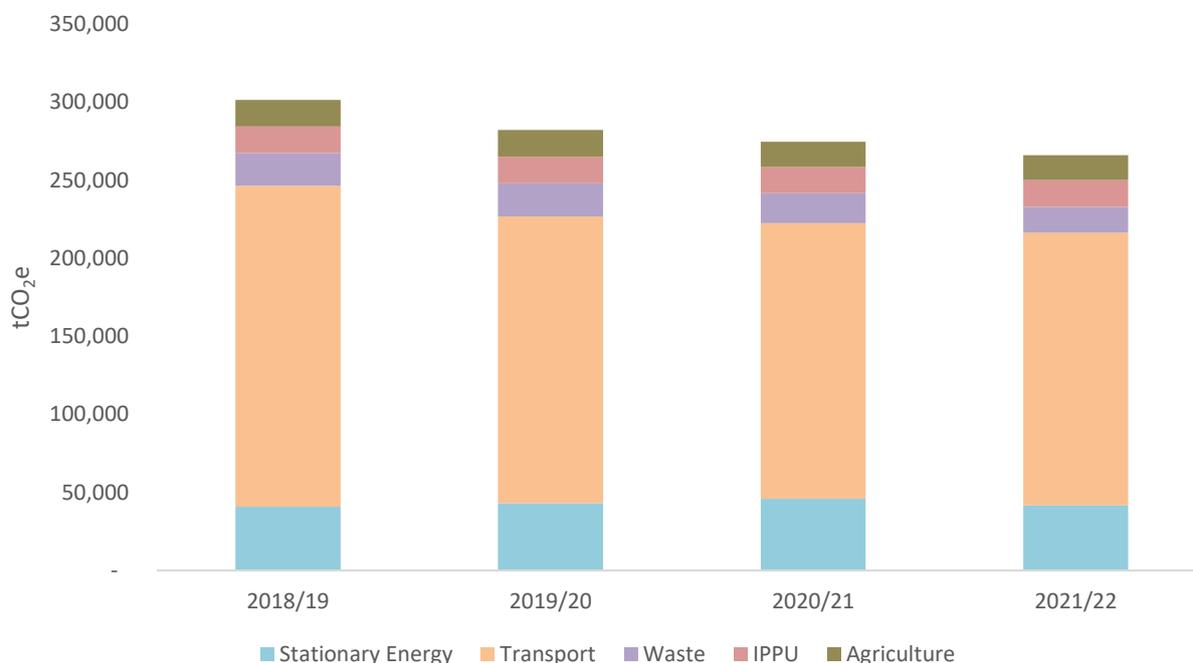


Figure 8 Change in Porirua total gross emissions from 2018/19 to 2021/22

Annual total gross emissions decreased by 12% from 301,404 tCO₂e in 2018/19 to 265,960 tCO₂e in 2021/22. Annual total net emissions in Porirua decreased by 19% from 299,203 in 2018/19 to 241,356 tCO₂e. The decrease in both gross and net emissions was driven by a reduction in Transport emissions primarily related to air travel and on-road fuel use. The impact of COVID-19 pandemic restrictions can be especially seen in air travel emissions where emissions were 59% lower in 2021/22 compared to 2018/19.

The population of Porirua remained steady between 2018/19 and 2021/22 (increasing by 3.4%). Owing to the decrease in total gross emissions, per capita emissions between 2018/19 and 2021/22 decreased from 5.1 to 4.3 tCO₂e per person per year. A discussion of the decoupling of gross emissions from population growth and GDP is found in Section 5.0.

The sections below outline the change in emissions between 2018/19 and 2021/22 for each sector and emissions source, highlighting the changes that have had the largest impact on total gross emissions. Due to rounding, there may be discrepancies between the sum of reported figures and reported totals.

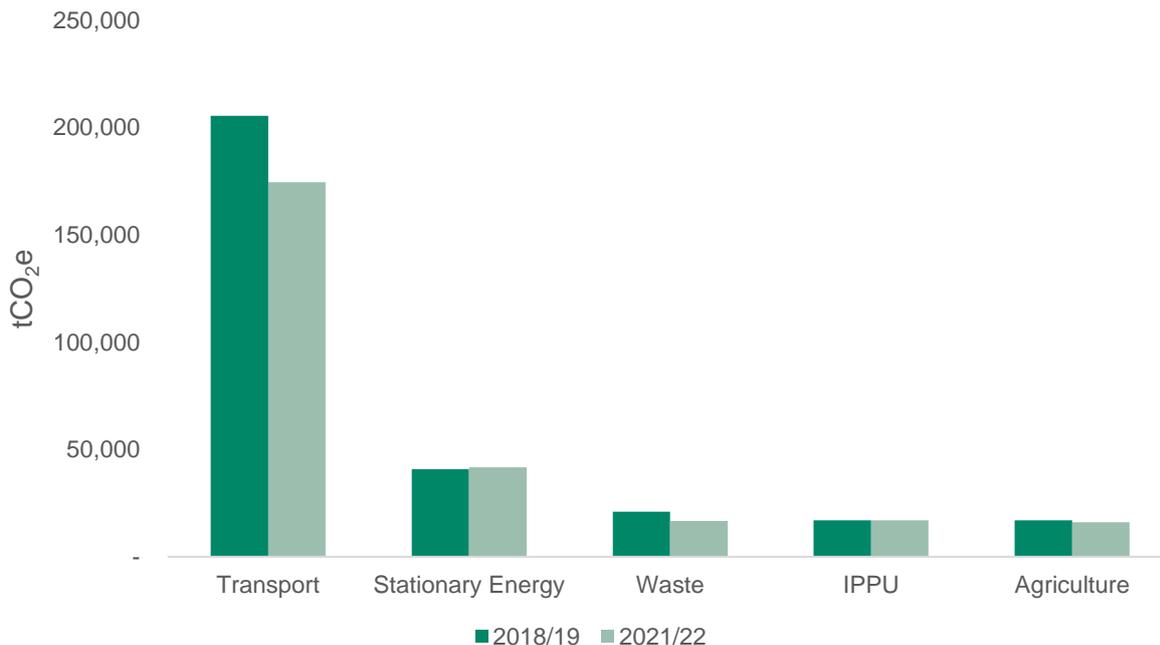


Figure 9 Emissions for each sector of Porirua gross emissions inventory for 2018/19 and 2021/22

4.1 Transport

Table 13 Change in Porirua Transport emissions from 2018/19 to 2021/22

Sector / Emissions Source	2018/19 (tCO ₂ e)	2019/20 (tCO ₂ e)	2020/21 (tCO ₂ e)	2021/22 (tCO ₂ e)	% Change (2018/19 to 2021/22)
Petrol	94,370	85,922	90,438	87,039	-8%
Diesel	64,399	60,641	61,890	61,042	-5%
Jet Kerosene (Air Travel)	30,016	22,131	8,197	12,383	-59%
Marine Freight	8,499	6,386	7,204	7,613	-10%
Marine (Inter-Island Ferries)	7,314	7,396	7,553	5,559	-24%
LPG	499	502	521	520	4%
Rail (Electric)	388	395	537	298	-23%
Aviation Gas (Air Travel)	65	65	65	65	0%
Total	205,550	183,437	176,405	174,520	-15%

Transport emissions decreased by 15% between 2018/19 and 2021/22 (31,030 tCO₂e). This was driven by a 17,633 tCO₂e decrease in Jet Kerosene (aircraft fuel) emissions and a 9,979 tCO₂e reduction in on-road fuel use emissions.

Jet Kerosene emissions decreased by 59% due to a reduction in flights, especially of international flights through Wellington Airport, with international passenger numbers down 91% and domestic passenger numbers down 39% between 2019/20 and 2021/22⁶. This is likely the impact of COVID-19-related restrictions on travel and the slow pace of recovery of the aviation industry. It is expected that emissions from this source will increase in 2022/23.

On-road fuel use emissions (petrol and diesel) decreased by 7%, with an 8% decrease in on-road petrol emissions. This is partly due to the impacts of COVID-19 with restrictions on travel in both 2019/20 and 2021/22 in Greater Wellington. Improvements in the efficiency of private, commercial, and public transport vehicles may have also contributed to this decrease.

Emissions related to the inter-island ferries decreased by 24% between 2018/19 and 2021/22 (1,755 tCO₂e), this is due to a change in fuel use for some journeys by one of the operators of this service, from heavy fuel oil to diesel, which has a lower emissions impact.

Marine freight emissions decreased by 10% between 2018/19 and 2021/22 (886 tCO₂e). It is, however, important to note that maritime freight emissions for Wellington tend to fluctuate year-to-year based on distance travelled by vessels, size of vessels, and the number of visits in a particular year (for example, emissions from marine freight in 2021/22 are 19% higher than in 2019/20).

Rail electricity emissions decreased due to a 13% decrease in electricity consumption, and a reduction in fossil fuel electricity generation in the national grid.

⁶ <https://www.wellingtonairport.co.nz/business/investor-services/traffic-reports/>

<https://aecomaus.sharepoint.com/sites/CCF/Shared Documents/GWRC CCF FY22/3.>

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4.2 Stationary Energy

Table 14 Change in Porirua's Stationary Energy emissions from 2018/19 to 2021/22

Sector / Emissions Source	2018/19 (tCO ₂ e)	2019/20 (tCO ₂ e)	2020/21 (tCO ₂ e)	2021/22 (tCO ₂ e)	% Change (2018/19 to 2021/22)
Natural Gas	18,213	20,585	21,315	20,388	12%
Stationary Petrol & Diesel Use	7,527	7,066	7,232	7,117	-5%
Electricity Consumption	7,258	7,264	9,382	6,406	-12%
LPG	3,955	3,977	4,131	4,118	4%
Natural Gas Transmission and Distribution Losses	1,472	1,664	1,723	1,648	12%
Coal	946	1,177	570	548	-42%
Biofuel / Wood	853	849	846	851	-0.3%
Electricity Transmission and Distribution Losses	634	635	872	679	7%
Total:	40,859	43,217	46,070	41,754	2%

Emissions from Stationary Energy increased by 2% between 2018/19 and 2021/22 (896 tCO₂e). This was driven by an increase in natural gas consumption which increased by 12% between 2018/19 and 2021/22 and a decrease in electricity consumption emissions due to changes in the emissions intensity of the national grid.

Electricity consumption in Porirua (in kWh) increased by 1% between 2018/19 and 2021/22. However, emissions from this source decreased by 12% due to a decrease in the emissions intensity of the national electricity grid (tCO₂e/kWh). The emissions intensity of the national grid decreased due to a reduction in coal and gas generation as renewable generation sources made up a greater proportion of national generation (especially hydropower). It is important to note that the emissions intensity of New Zealand's national grid fluctuates year on year, primarily driven by water levels in the hydropower system (as can be seen in the increase in emissions from 2019/20 to 2020/21 and subsequent decrease again in 2021/22).

Other notable changes can be seen in stationary petrol and diesel use which decreased by 5% (410 tCO₂e) between 2018/19 and 2021/22, and coal use, which reduced 42% (by 398 tCO₂e). The decrease in coal use represents transitions away from coal use for energy to lower emission options.

4.3 Waste

Table 15 Change in Porirua Waste emissions from 2018/19 to 2021/22

Sector / Emissions Source	2018/19 (tCO ₂ e)	2019/20 (tCO ₂ e)	2020/21 (tCO ₂ e)	2021/22 (tCO ₂ e)	% Change (2018/19 to 2021/22)
Landfill Sites	14,908	15,084	12,802	10,508	-30%
Individual Septic Tanks	3,885	3,940	3,983	4,016	3%
Wastewater Treatment Plants	2,233	2,265	2,289	2,135	-4%
Total	21,025	21,289	19,074	16,658	-21%

Total Waste emissions reduced by 21% between 2018/19 and 2021/22 (4,367 tCO₂e); this was driven by improvements in landfill gas capture at Spicer Landfill.

Emissions from Individual Septic Tanks are determined based on an estimate of the population of Porirua not connected to centralised wastewater treatment plants. Emissions from this source increased by 3% due to an increase in the estimate of the population not connected to centralised wastewater treatment, in line with population growth.

Wastewater treatment plant emissions decreased 4% between 2018/19 and 2021/22 (98 tCO₂e).

4.4 Industrial Processes and Product Use (IPPU)

Table 16 Change in Porirua IPPU emissions from 2018/19 to 2021/22

Sector / Emissions Source	2018/19 (tCO ₂ e)	2019/20 (tCO ₂ e)	2020/21 (tCO ₂ e)	2021/22 (tCO ₂ e)	% Change (2018/19 to 2021/22)
Refrigerants and Air Conditioning	15,743	15,739	15,725	15,804	0.4%
Aerosols	991	919	876	881	-11%
SF6 - Electrical Equipment	156	168	171	172	10%
Foam Blowing	69	72	69	69	0%
SF6 - Other	34	34	34	34	0%
Fire Extinguishers	27	27	27	27	0%
Total	17,020	16,958	16,902	16,987	-0.2%

IPPU emissions remained relatively unchanged between 2018/19 and 2021/22. The only notable change is a decrease in aerosol emissions which may be due to a decrease in the quantity used or an increase in the use of lower emissions-impacting aerosols. Note that national-level data is used for this sector and is portioned out using a population approach; actual emissions for Porirua are unknown.

4.5 Agriculture

Table 17 Change in Porirua's Agriculture emissions from 2018/19 to 2021/22

Sector / Emissions Source	2018/19 (tCO ₂ e)	2019/20 (tCO ₂ e)	2020/21 (tCO ₂ e)	2021/22 (tCO ₂ e)	% Change (2018/19 to 2021/22)
Livestock Enteric Fermentation	13,459	13,644	12,757	12,757	-5%
Unmanaged Manure on Pasture	2,038	2,063	1,919	1,919	-6%
Agricultural Leaching and Deposition (Manure, Urine, and Fertiliser)	1,240	1,255	1,167	1,167	-6%
Managed Manure	194	195	179	179	-8%
Fertilisers on Land	20	20	18	18	-6%
Total	16,951	17,177	16,041	16,041	-5%

The Agriculture sector's emissions decreased by 5% between 2018/19 and 2021/22 (910 tCO₂e). This decrease is driven by a reduction in total livestock numbers, especially sheep.

Sheep represent 87% of total livestock in Porirua in 2021/22 and 63% of agricultural emissions. Emissions related to sheep decreased by 10% (1,121 tCO₂e) due to a 10% reduction in the number of sheep (from 20,392 sheep to 18,347 sheep).

Non-dairy cattle represent 10% of total livestock in Porirua in 2021/22 and 34% of agricultural emissions, this is due to their greater emissions footprint compared to sheep. Emissions related to non-dairy cattle increased by 4% (214 tCO₂e) due to an increase in the number of non-dairy cattle (from 2,075 cattle to 2,126 cattle).

4.6 Forestry

Table 18 Change in Porirua Forestry emissions from 2018/19 to 2021/22

Sector / Emissions Source	2018/19 (tCO ₂ e)	2019/20 (tCO ₂ e)	2020/21 (tCO ₂ e)	2021/22 (tCO ₂ e)	% Change (2018/19 to 2021/22)
Total Harvest Emissions	65,750	49,851	45,151	45,151	-31%
Native Forest Sequestration	-23,043	-23,043	-23,043	-23,043	0%
Exotic Forest Sequestration	-44,908	-47,105	-46,712	-46,712	4%
Total	-2,201	-20,297	-24,604	-24,604	

Net Forestry sequestration (emissions released minus sequestration) increased by 22,403 tCO₂e between 2018/19 and 2021/22, from -2,201 tCO₂e to -24,604 tCO₂e. While sequestration from native and exotic forestry remained stable, harvesting emissions decreased by 31% (20,598 tCO₂e).

Forestry harvesting emissions decreased due to a decrease in Porirua's proportion of Greater Wellington's land area covered by exotic trees of harvestable age (used to estimate Porirua's proportion

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of the Greater Wellington region's commercial harvesting) and a region-wide decrease in harvesting. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes, where some years will have higher sequestration and some years will have higher harvesting emission. This depends on the age of forests and the demand for lumber and timber. Improved and updated data sources may impact the estimation of emissions from this source in the future.

Sequestration by native forests remained unchanged during this time as the same data has been used for each year; however, it is unlikely that there have been significant changes.

5.0 Decoupling of GHG emissions from population growth and GDP

Decoupling of emissions is when emissions grow less rapidly than the growth of an economy (measured in Gross Domestic Product (GDP)). The term decoupling expresses the desire to mitigate emissions without harming economic well-being. The exact drivers for the decoupling of emissions from GDP are generally difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transportation, and housing will all contribute. Both direct local actions (e.g. landfill gas reductions) and indirect national trends (e.g. changes to emissions from electricity generation) can contribute to emissions decoupling. A complete discussion of the decoupling of emissions is beyond this project’s scope.

Figure 10 shows the changes in gross emissions when compared to changes in other metrics of interest between 2018/19 and 2021/22. For example, total gross emissions have decreased by 12%, whilst the population in Porirua has increased by 3%, resulting in a 15% reduction in total gross emissions per capita. Similarly, Gross Domestic Product (GDP) in Porirua has increased by around 16%, resulting in a 24% decrease in the GHG emissions ratio to GDP. The data suggests that potentially a high-level, decoupling of the emissions covered by this assessment from economic growth has occurred between 2018/19 and 2021/22 in Porirua. However, it is noted that emissions calculated as part of this assessment are based on production-based emissions. Emissions calculated as part of a consumption-based assessment may present a different outcome.

Porirua Changes from 2018/19 to 2021/22

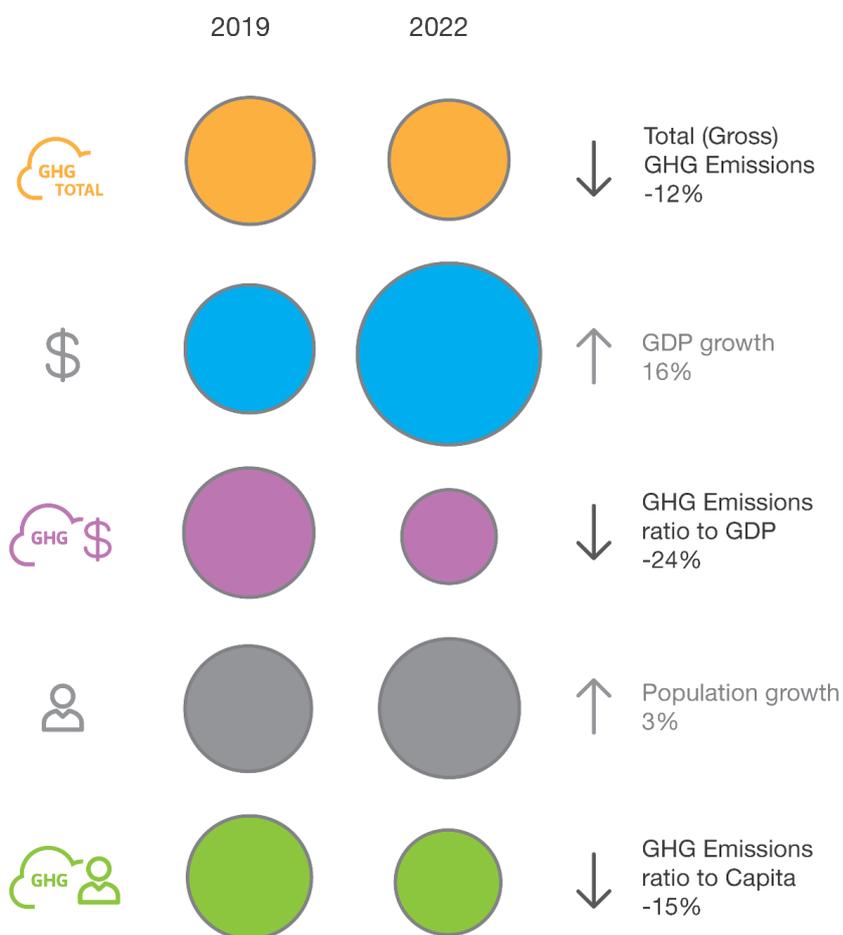


Figure 10 Change in total gross emissions compared to other metrics of interest

6.0 Update to the 2018/19 Emissions Inventory

Improvements to the methodology, improvements in available data, and updates to emission factors since the 2018/19 Community Carbon Footprint (Emissions Inventory) was first published in 2020, have meant that the 2018/19 inventory results are required to be updated to allow direct comparison with the 2019/20, 2020/21, and 2021/22 inventories.

The previous 2018/19 inventory results and updated 2018/19 inventory results are presented in Table 19.

Critical reasons for the change to results between these inventories are outlined below:

- Stationary Energy emissions have been adjusted due to improvements in data and methodology changes, notably the natural gas and electricity data and emission factors, and a difference in the allocation of diesel and petrol sales to stationary energy purposes.
- Transportation emissions have been adjusted due to data improvements and methodology changes, most notably in how the Wellington Region's petrol and diesel sales have been allocated to the territorial authorities within the Region (from a population approach to a vehicle kilometre travelled approach). The marine freight and inter-island ferry calculations have also been updated based on best-practice guidance for cross-boundary transport emissions.
- Waste emissions have been adjusted due to updates to the estimate of landfill gas capture system efficiency at the open landfill sites, the estimate of historical waste (1950-1999), and the population not connected to centralised wastewater treatment. Wastewater treatment plant emissions calculations have been updated to align with WaterNZ guidance (2021).
- IPPU emissions have been adjusted due to a change in data and emission factors provided by the Ministry for the Environment (MfE).
- Agriculture emissions have been adjusted due to improvements in data based on regional trends since the 2017 territorial authority-level census and changes in MfE emission factors.
- Forestry emissions have been adjusted due to improvements in published data and emission factors.

Table 19 Reported GHG emissions in Porirua for 2018/19, showing the change in emissions between those previously reported (2020) and the updated results (2023)

	2018/19 previous inventory (2020) – tCO ₂ e	2018/19 updated inventory (2023) – tCO ₂ e
Stationary Energy	45,816	40,859
Transportation	204,211	205,550
Waste	21,221	21,025
IPPU	17,658	17,020
Agriculture	15,525	16,951
Forestry	-7,616	-2,201
Total Net Emissions (incl. forestry)	296,815	299,203
Total Gross Emissions (excl. forestry)	304,431	301,404

Future emissions inventories for Porirua may also require adjustments to the emission results reported here due to improvements to the inventory process.

7.0 Impact of the COVID-19 pandemic on GHG Emissions

COVID-19 impacted New Zealand and the entire world during 2020 and 2021; causing widespread government-imposed restrictions on businesses and individuals and huge shifts in behaviours and economic markets. Restrictions in New Zealand relating to COVID-19 began in mid-March 2020 with many personal and business restrictions continuing past the end of 2019/20 and throughout 2021/22.⁷

Globally, carbon dioxide emissions from fossil fuels (the largest contributor to greenhouse gas emissions) in 2020 decreased by 7% compared to 2019⁸. Emissions from the transportation sector account for the largest share of this decrease. Surface transport, e.g. car journeys, fell by approximately half at the peak of COVID-19 restrictions in April 2020 (when restrictions were at their maximum, particularly across Europe and the U.S. Globally, emissions recovered to near 2019 levels and are expected to continue to increase.

In New Zealand, national daily carbon dioxide emissions are estimated to have fallen by up to 41% during the level 4 lockdown in April 2020⁹. National gross emissions decreased by 3% from 2018/19 to 2019/20, which was largely driven by a decrease in fuel use in road transport due to COVID-19 pandemic restrictions, a decrease in fuel use in manufacturing industries and construction due to COVID-19 restrictions, and a decrease in fuel use from domestic aviation also due to COVID-19 restrictions.

Total gross emissions in Porirua decreased by 35,444 tCO₂e (12%) between 2018/19 (pre-COVID-19) and 2021/22. A 15% decrease in Transport emissions (31,030 tCO₂e) accounts for the vast majority of this change. Notably, Transport emissions reduced by 11% between 2018/19 and 2019/20, driven by reduced road and air transport fuel use (see Figure 10). Air travel emissions in particular have been impacted by COVID-19 with emissions 73% lower in 2020/21 than in 2018/19 especially due to a reduction in international flights. It is expected that air travel emissions will rise to near pre-COVID-19 levels in 2022/23 in the Wellington Region. On-road transport emissions were also impacted by COVID-19, especially through restrictions on travel for periods of time in 2019/20 and 2021/22.

Despite changes in Stationary Energy, Agriculture, Waste, and IPPU emissions, these sectors are not judged to have been significantly affected by COVID-19. Of note, electricity consumption has increased during this time with annual emissions affected by the sources of national generation of electricity in each year. We cannot say with confidence whether energy consumption, or other changes have been significantly affected by COVID-19.

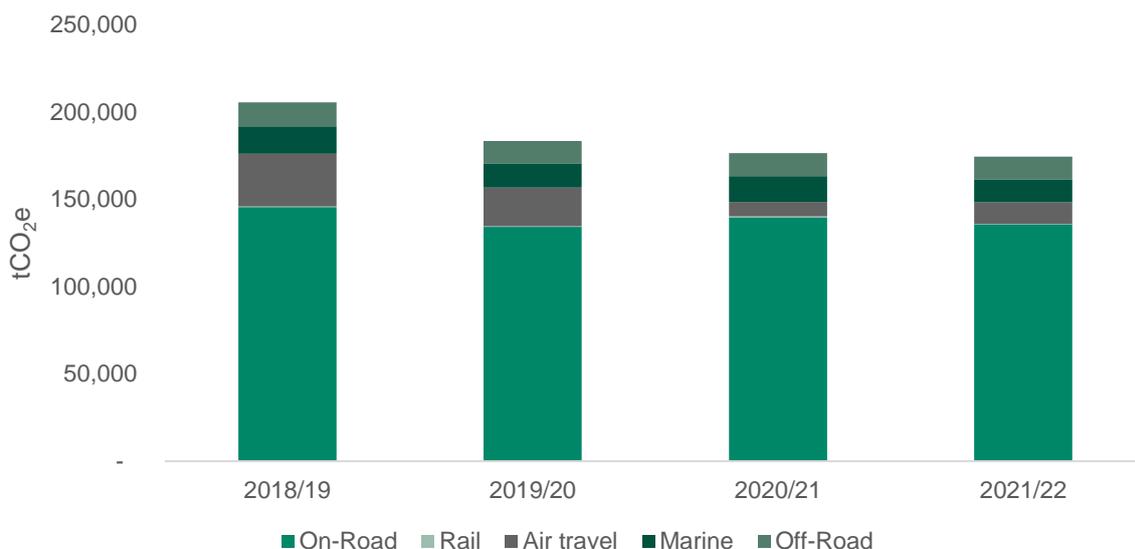


Figure 11 Porirua Transport emissions for 2018/19, 2019/20, 2020/21 and 2021/22 (tCO₂e)

⁷ <https://covid19.govt.nz/alert-system/history-of-the-covid-19-alert-system/>

⁸ Pierre Friedlingstein et al. - Global Carbon Budget 2020 (2020)

⁹ Corinne Le Quere et al. – Temporary Reduction in Daily Global CO₂ Emissions During the COVID-19 Forced Confinement

https://aecomaus.sharepoint.com/sites/CCF/Shared Documents/GWRC CCF FY22/3. Reports/GWRC_EmissionsInventory_2022_Porirua_230619_Final.docx

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8.0 Closing Statement

Porirua GHG emissions inventory provides information for decision-making and action by the council, Porirua stakeholders, and the wider community. We encourage the council to use the results of this study to update current climate actions plans and set emission reduction targets.

The emissions inventory developed for Porirua covers emissions produced in the Stationary Energy, Transport, Waste, IPPU, Agriculture, and Forestry sectors using the GPC reporting framework. Sector-level data allows Porirua to target and work with the sectors that contribute the most emissions to the inventory.

Understanding of the extensive and long-lasting effects of climate change is improving all the time. It is recommended that this full emissions inventory be updated regularly (every two or three years) to inform ongoing positive decision making to address climate change issues. Use of real-time data for major emissions sources and consideration of consumption-based emissions, can also add to understanding of emissions across the region.

The accuracy of any emissions inventory is limited by the availability, quality, and applicability of data. Areas where data could be improved for future inventories include forestry (forest cover and harvesting), agriculture (especially livestock numbers), wastewater, and on and off-road transport fuel use.

9.0 Limitations

Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in the Report. AECOM assumes no liability for any inaccuracies in or omissions to that information. This Report was prepared between January 2023 and May 2023 and is based on the information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time. This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice.

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Appendix A

Assumptions and Data Sources

Sector / Category	Assumption and Data Sources
General	
Geographical Boundary	<p>LGNZ local council mapping boundaries have been applied.</p> <p>The emissions inventory for each territorial authority covers the entirety of the territorial authority area.</p>
Population	<p>Population figures are provided by StatsNZ.</p> <p>Financial year populations have been used, these are based on the average population from the two calendar years (e.g. the average of 2020 and 2021 calendar year populations for 2020/21).</p>
Climate Change Feedback	<p>Emissions are expressed on a carbon dioxide-equivalent basis (CO₂e) including climate change feedback using the 100-year Global Warming Potential (GWP) values.</p> <p>Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs.</p> <p>Emissions for individual main greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.</p>
GPC Production Approach	<p>GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption.</p> <p>Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g., embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.).</p> <p>A breakdown of emissions by scope (1, 2 and 3) is included in the supplementary spreadsheet information supplied with this report.</p>
Emission Factors	<p>All emission factors have detailed source information in the calculation tables within which they are used. Where possible, the most up to date, NZ-specific emission factors have been applied.</p> <p>AR5 Global Warming Potential (GWP) figures for greenhouse gases have been used accounting for climate change feedbacks.</p>
Transport Emissions	
Petrol and Diesel:	<p>Total petrol and diesel sales data was provided by Wellington City Council for Wellington City Council, Porirua City Council, Kāpiti Coast District Council, Hutt City Council and Upper Hutt City Council. Total petrol and diesel sales data was provided by Masterton District Council for South Wairarapa District Council, Masterton District Council and Carterton District Council.</p> <p>Sales data have then been then apportioned out to the territorial authorities within the region based on the total distance travelled by vehicles in each territorial authority in the financial year (known as Vehicle Kilometres Travelled or VKT).</p> <p>Allocating fuel consumption across a region based on VKT does not account for the likely makeup of the vehicle fleet of a particular geographic area (e.g. where a more rural area</p>

	<p>may use more diesel, or a more urban area may have more hybrid or electric vehicles travelling).</p> <p>Fuel sold in an area does not always mean that the fuel is used in that area, however this approach is considered to be a robust and comparable estimate of fuel consumption in a geographic area.</p> <p>Total petrol and diesel fuel use was then divided by likely end use. The division into transport and stationary energy end use (and within transport, on-road and off-road) was calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) in April 2020.</p> <ul style="list-style-type: none"> - On-road transport is defined as all standard transportation vehicles used on roads e.g. cars, bikes, buses. - Off-road transport is defined as machinery for agriculture, construction and other industry used off-roads. - Stationary energy petrol and diesel use is defined as fuel not used for transport either on or off roads. Petrol and diesel used for stationary energy has been reported in the Stationary Energy sector.
Rail Diesel	<p>Consumption was calculated by KiwiRail using the Induced Activity method for system boundaries. The following assumptions were made:</p> <ul style="list-style-type: none"> - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried, multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. <p>Using the induced activity method, the trans-boundary routes were determined, and the number of stops taken along the way derived. The total litres of diesel consumed per route was then split between the departure territorial authority, arrival territorial authority and any territorial authority the freight stopped at along the way. If the freight travelled through but did not stop within a territorial authority, no emissions were allocated.</p> <p>Data was not available for 2021/22 therefore the 2020/21 value has been used for 2021/22.</p> <p>This data is subject to commercial confidentiality.</p>
Jet Kerosene (Scheduled Flights)	<p>Calculated using the Induced Activity method as per rail diesel.</p> <p>An estimate of fuel use was calculated for flights arriving and departing from Wellington Airport:</p> <ul style="list-style-type: none"> - The schedule of flights arriving and departing from Wellington Airport containing details on the aircraft used for each flight was used to calculate fuel consumption. - Flight distances and aircraft fuel burn rates were used for these calculations. - As per the induced activity method, only 50% of emissions calculated per one-way arrival and departure were allocated to Wellington Airport. The remaining 50% of each leg was allocated to the originating or destination airport. <p>An estimation of fuel use from military, freight, private, and other flights for 2020/21 and 2021/22 have been estimated based on data provided in 2020.</p> <p>Wellington Airport has been treated as a regional airport, so emissions have been split between the territorial authorities in the region on a population basis.</p>

	<p>Fuel use by aircraft using Kāpiti Coast Airport has also been accounted for using the same methodology, with all emissions allocated to Kāpiti Coast District.</p>
Aviation Gas (General Aviation)	<p>Aviation gas is mostly used by small aircraft for relatively short flights.</p> <p>Data for Wellington Airport was not available at the time of writing, so an assumption has been made based on similar sized airports in New Zealand. This is the same assumption used in the previous 2019/20 inventory.</p> <p>Wellington Airport has been treated as a regional airport, so emissions have been split between the territorial authorities in the region on a population basis.</p> <p>Fuel use by aircraft using Kāpiti Coast Airport has also been accounted for using the same methodology, with all emissions allocated to Kāpiti Coast District.</p> <p>There are a number of small aerodromes and runways across the region. Due to the difficulty of obtaining data, emissions related to flights from these locations have been excluded. It is likely that these emissions would have been very small in relation to other sources, and so would fit below the materiality threshold.</p>
Marine Fuels - Freight	<p>Calculated using the Induced Activity method as per rail diesel and jet kerosene.</p> <p>An estimate of fuel use was calculated for flights arriving and departing from CentrePort (Wellington Port):</p> <ul style="list-style-type: none"> - The schedule of vessels arriving and departing from Wellington Port containing details on size of the vessel was used to calculate fuel consumption. - Shipping distances and vessel fuel burn rates were used for these calculations. - As per the induced activity method, only 50% of emissions calculated per one-way arrival and departure were allocated to Wellington Port. The remaining 50% of each leg was allocated to the originating or destination Port. <p>International shipping passing through CentrePort was split by weight of cargo into 'Logs' and 'All other cargo'. Emissions generated by 'All other cargo' has been allocated on a per capita basis between all territorial authorities in the Wellington Region. Emissions generated by 'logs' was split between territorial authorities, proportionally, by the percentage share of district forest area of harvest age (>26 years old).</p>
Marine Fuels (Local)	<p>Port operational vessels:</p> <ul style="list-style-type: none"> - Fuel use has been provided directly from Wellington Port (CPL) for 2020/21 - The 2020/21 figure has also been used for 2019/20 and 2021/22 - All emissions from this source have been allocated to Wellington City <p>Local ferries:</p> <ul style="list-style-type: none"> - Diesel fuel use has been provided directly by the ferry operator - Electricity use has been provided directly by the ferry operator (beginning in 2021/22) - All emissions from this source have been allocated to Wellington City <p>Private use, other commercial operators, and commercial fishing:</p> <ul style="list-style-type: none"> - Most small private boats use fuel purchased at vehicle gas stations so this consumption will be included in off-road transport petrol and diesel emissions. - No data was available to determine emissions from other commercial operators, and commercial fishing

Marine Fuels – Inter-island Ferries	Data has been provided by the ferry operators in commercial confidence. Assumptions of fuel use have been used where data was not provided.
Cruise Ships	No reliable data was available to determine the emissions from cruise ships (only relevant to 2019/20 as there were no cruise ship visits in 2020/21 and 2021/22).
LPG	Total North Island consumption data was used and then split on a per capita basis to determine the territorial authority's consumption. National LPG end use data has been used to breakdown consumption into stationary energy and transport usage, these are then reported separately in their respective categories.
Stationary Energy Emissions	
Consumer Energy End Use	Stationary energy demand (e.g. electricity use, natural gas, etc.) is broken down by the sector in which they are consumed. We report stationary energy demand in the following categories: industrial (which includes agriculture, forestry, and fishing); commercial; and residential. These sectors follow the Australia New Zealand Standard Industrial Classification 2006 definitions. In addition to agriculture, forestry and fishing, the industrial sector includes mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities. Emissions from petrol and diesel used for stationary energy are not broken down into these sectors. Energy demand used for transport is reported in the transport sector.
Electricity Consumption	Electricity demand has been calculated using grid demand trends from the EMI website (www.emi.ea.govt.nz) to obtain raw grid exit point data for each territorial authority area. Reconciled demand has been used as per EMI's confirmation. The breakdown into sectors is based on NZ average consumption per sector (residential, commercial, and industrial).
Public Transport Electricity	Electricity used in the public transport system is included in the Transport sector (where known).
Private Transport Electricity	Electricity used for private transport (e.g. electric cars, electric bikes, electric micro-mobility) has not been separated from other stationary energy electricity consumption due to a lack of reliable data.
Coal Consumption	National coal consumption data has been provided by MBIE for all years (2022). Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis. Regional industrial coal consumption has been divided between territorial authorities on a per capita basis, where relevant.

<p>Biofuel and Wood Consumption</p>	<p>National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE 2021).</p> <p>Biofuel consumption has been divided between territorial authorities on a per capita basis.</p> <p>Biofuel emissions are broken down into Biogenic emissions (CO₂) and Non-Biogenic emissions (CH₄ and N₂O).</p> <p>The latest year's data available is for 2019. 2019/20, 2020/21, and 2021/22 use the 2019 figure, adjusted for population change.</p>
<p>LPG Consumption</p>	<p>North Island LPG sales data (tonnes) has been provided by the LPG Association for 2020 and 2021. Data interpolated between known data points or copied from the most recent data point where data is not available.</p> <p>'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG.</p> <p>Sales have been divided between territorial authorities on a per capita basis.</p> <p>The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.</p>
<p>Petrol and Diesel (Stationary Energy End Use)</p>	<p>Total petrol and diesel sales data was provided by Wellington City Council for Wellington City Council, Porirua City Council, Kāpiti Coast District Council, Hutt City Council and Upper Hutt City Council. Total petrol and diesel sales data was provided by Masterton District Council for South Wairarapa District Council, Masterton District Council and Carterton District Council.</p> <p>Sales data have then been then apportioned out to the territorial authorities within the region based on the total distance travelled by vehicles in each territorial authority in the financial year (known as Vehicle Kilometres Travelled or VKT).</p> <p>Allocating fuel consumption across a region based on VKT does not account for the likely makeup of the vehicle fleet of a particular geographic area (e.g. where a more rural area may use more diesel, or a more urban area may have more hybrid or electric vehicles travelling).</p> <p>Fuel sold in an area does not always mean that the fuel is used in that area, however this approach is considered to be a robust and comparable estimate of fuel consumption in a geographic area.</p> <p>Total petrol and diesel fuel use was then divided by likely end use. The division into transport and stationary energy end use (and within transport, on-road and off-road) was calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) in April 2020.</p> <ul style="list-style-type: none"> - On-road transport is defined as all standard transportation vehicles used on roads e.g. cars, bikes, buses. - Off-road transport is defined as machinery for agriculture, construction and other industry used off-roads. - Stationary energy petrol and diesel use is defined as fuel not used for transport either on or off roads. Petrol and diesel used for stationary energy has been reported in the Stationary Energy sector.
<p>Natural Gas Consumption</p>	<p>Natural gas consumption data has been provided by FirstGas. Territorial Authorities supplied by gas from each Point of Connection (POC) have been confirmed by FirstGas.</p>

Biogenic Emissions (CO ₂)	Some carbon dioxide (CO ₂) emissions are considered to be biogenic. These are CO ₂ emissions where the carbon has been recently derived from CO ₂ present in the atmosphere (for example, some agricultural and waste emissions). These emissions are not included in calculating total CO ₂ e.
Agricultural Emissions	
Agriculture	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ). The last territorial authority census was in 2017. Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use since 2017. Due to the gap in data for 2021/22, the 2020/21 figure has been used for 2021/22.
Solid Waste Emissions	
Landfill Emissions	<p>Landfill waste volume and landfill gas capture system information has been provided by the respective council departments.</p> <p>Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day, as per the GPC reporting requirements. This method accounts for the gradual release of emissions from waste over a long period of time, and so calculates the emissions produced per year from waste in landfill (including emissions from closed landfill sites).</p> <p>Waste volume:</p> <ul style="list-style-type: none"> - Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis. <p>Landfill gas capture system efficiency:</p> <ul style="list-style-type: none"> - Efficiency and coverage of the system used in the emissions calculations has been provided by the respective councils based on recorded or estimated data. <p>Landfill gas flaring / burning for energy generation:</p> <ul style="list-style-type: none"> - There is biogas energy generation at Southern Landfill which is a site used by some councils in the Wellington Region. The percentage of landfill gas flared or burned for energy generation used in the calculations has been taken from data provided by WCC in relation to the calculation of Southern Landfill's Unique Emissions Factor (UEF) for 2019/20 and 2021/22. - Emissions relating to burning of landfill gas for energy generation have been included in the Stationary Energy sector. <p>Emissions are allocated to territorial authorities based on where the waste was produced, even if the waste is disposed in landfill outside the territorial authority:</p> <ul style="list-style-type: none"> - Information on the origin and destination of waste produced in each territorial area has been provided by the respective councils based on recorded or estimated data.
Wastewater Emissions	
Wastewater Treatment	<p>All wastewater emissions have been calculated following the WaterNZ (2021) guidance.</p> <p>Wastewater Treatment Plants:</p> <ul style="list-style-type: none"> - Calculation of emissions includes emissions released directly from wastewater treatment, flaring of captured gas and from discharge onto land/water. - Where data was not available assumed values have been used based on the WaterNZ (2021) guidance - Emissions relating to discharge of biosolids sent to landfill (if present) have been included in the Solid Waste emissions source.

	<ul style="list-style-type: none"> - Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority. <p>Individual Septic Tanks:</p> <ul style="list-style-type: none"> - Populations not connected to known centralised wastewater treatment plants are assumed to be using septic tanks.
Industrial Emissions	
Industrial Processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the Region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g., fire extinguishers, refrigerants) have been estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2020 report (MfE 2022). Emissions are estimated on a per capita basis applying a national average per person.
Forestry Emissions	
Exotic Forestry Harvested and Exotic Forest coverage	<p>Harvested forestry, and forest cover information for each territorial authority has been derived from Landcare Research data.</p> <p>This emissions inventory accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e., it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.</p> <p>The emissions inventory considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.</p>
Native Forest	Native forest land area for each territorial authority has been provided by Landcare Research.