Prepared for
Wellington City Council
Co No.: N/A

AECOM

Wellington City GHG Emissions Inventory 2023

(1st July 2022 – 30th June 2023)

08-Dec-2023

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Client: Wellington City Council

Co No.: N/A

Prepared by

,

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1.3	08-Dec-2023	Final	Anthony Hume Associate Director - Practice Leader Sustainability & Resilience	

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Executive Summary

This report details the Greenhouse Gas (GHG) emissions within the geographic boundaries for the Wellington City Territorial Area (administered by the Wellington City Council). The emissions have been measured and reported using the production-based Global Protocol for Community-Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This document reports GHG emissions produced in or resulting from activity or consumption for the FY23 government financial year (1st July 2022 to 30th June 2023).

Every three years Greater Wellington Regional Council (GWRC) compiles a complete emissions inventory to the GPC for the whole Wellington region. Between these reporting years, Wellington City Council will assess emissions in Wellington City annually and have engaged AECOM to produce a streamlined inventory for FY23. Data covering 90% of Wellington City's emissions incorporating the largest emission sources has been collected. The remaining 10% of Wellington City's emissions have been estimated based on the FY22 inventory previously completed by AECOM for Wellington City Council[1]. The remaining 10% of emission sources do not significantly vary year to year.

Major findings of the FY23 inventory include:

- **Total gross emissions** in Wellington City were 887,155 tCO_2e.
- **Transport** (e.g. emissions resulting from road, marine, and air travel) represented 56% of Wellington City's total gross emissions, with on-road petrol and diesel consumption accounting for 39% of total gross emissions.
- **Stationary Energy** (e.g. emissions relating to electricity and natural gas consumption) was the second-highest emitting sector in the city, producing 28% of total gross emissions.
- **Waste** (e.g. emissions from landfill and wastewater treatment) were responsible for 7% of Wellington City's total gross emissions.
- **Industrial Processes and Product Use** (IPPU) (e.g. emissions from refrigerant gasses and aerosols) represented 7% of Wellington City's total gross emissions.
- **Agriculture** represented 2% of Wellington City's total gross emissions.
- **Net Forestry** emissions totaled -79,908 tCO_2e. This represents that carbon sequestrated (carbon captured and stored in plants or soil by forests) was greater 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. Therefore the **total net emissions** (gross emissions minus forestry) in Wellington City were 807,247 tCO_2e.
- **Annual total gross emissions decreased by 1.4% from FY22 to FY23[2]** driven by a reduction in the emissions intensity of national electricity generation which meant that electricity was 44% less carbon intensive per unit consumed than in FY22. The decrease in electricity emissions was somewhat balanced by a rebound in transport fuel use after the impacts of Covid-19 (particularly aviation and on-road fuel).
- Key changes from FY22 to FY23:
    - On-road transport emissions increased 13%.
    - Electricity consumption emissions decreased 44%, with consumption unchanged (<0.5%).
    - Air travel emissions increased 61%, particularly due to an increase in international passengers.
    - Landfill waste emissions decreased 14%, with a 31% decrease in emissions from operating landfill sites (Southern Landfill and Spicer Landfill).

[1] https://wellington.govt.nz/climate-change-sustainability-environment/climate-change/what-were-doing-about-climate-change/tracking-city-emissions

[2] The previously published FY22 inventory for Wellington City was updated as part of the Greater Wellington Region FY22 Emissions Inventory based on more accurate fuel sales data, see Section 5.

1.0 Introduction

Wellington City Council commissioned AECOM New Zealand Limited (AECOM) to assist in developing a production-based community-scale greenhouse gas (GHG) emissions footprint for the Wellington City Territorial Area for the 2023 financial year (FY23). The FY23 year covers the period from 1st July 2022 to 30th June 2023 (Government financial year). The study boundary incorporates the jurisdiction of the Wellington City Council. The Wellington City Territorial Area (as shown in **Figure 1**) is hereafter referred to as Wellington City for ease.

The purpose of the GHG emissions inventory for FY23 is to estimate the relative scale of GHG emissions produced in the Wellington City area and the relative contribution of different emission sources to Wellington City's total emissions. The results of this inventory can be used to assess trends and changes in the emissions produced in Wellington City over time.

This inventory is part of Wellington City Council's Te Atakura - First to Zero climate action plan[3] regarding measuring the city's emissions and tracking progress towards Wellington City's 2050 net-zero target.

Figure 1 Map of the Wellington City territorial area (sourced from VectorStock)

[3] https://Wellington.govt.nz/climate-change-sustainability-environment/climate-change/what-were-doing-about-climate-change/te-atakura-first-to-zero-climate-action-plan

2.0 Approach

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 methodology follows a production-based approach and allocates emissions to industries as opposed to final users. Production-based approaches exclude global emissions relating to consumption (i.e., embodied emissions relating to products produced elsewhere but consumed within the geographic area, such as imported food products, cars, phones, clothes etc.).

This emissions footprint 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 consumption location. An example of indirect emissions is those associated with electricity consumption, which is supplied by the national grid (Scope 2). All other indirect emissions, such as cross-boundary travel (e.g., flights) and energy transportation and distribution losses, are Scope 3.

The calculation method for the FY23 GHG emission inventory differs from previous GHG emission inventories completed for Wellington City by AECOM. Data for this GHG emissions inventory has been collected for a short-list of emission sources, which cover approximately 90% of Wellington City's emissions. Short-listed sources were calculated as per previous inventories, and remaining sources have been estimated based on the FY22 (1st July 2021 to 30th June 2022) inventory.

The inventory is based on data and reporting guidance available at the time of calculation, using reasonable assumptions in line with the GPC reporting guidance, and may need to be updated in the future to account for changes in data availability or changes to reporting guidance.

Greenhouse gas emissions are generally reported in this document in Carbon Dioxide Equivalent (CO_2e) units and are referred to as 'emissions'.

2.1 Data Collection Approach

The data collection approach for the FY23 GHG emissions inventory is shown in Figure 2. This figure details for each emission source whether data has been collected, adjusted based on a population changed between FY22 and FY23, or not adjusted from FY22.

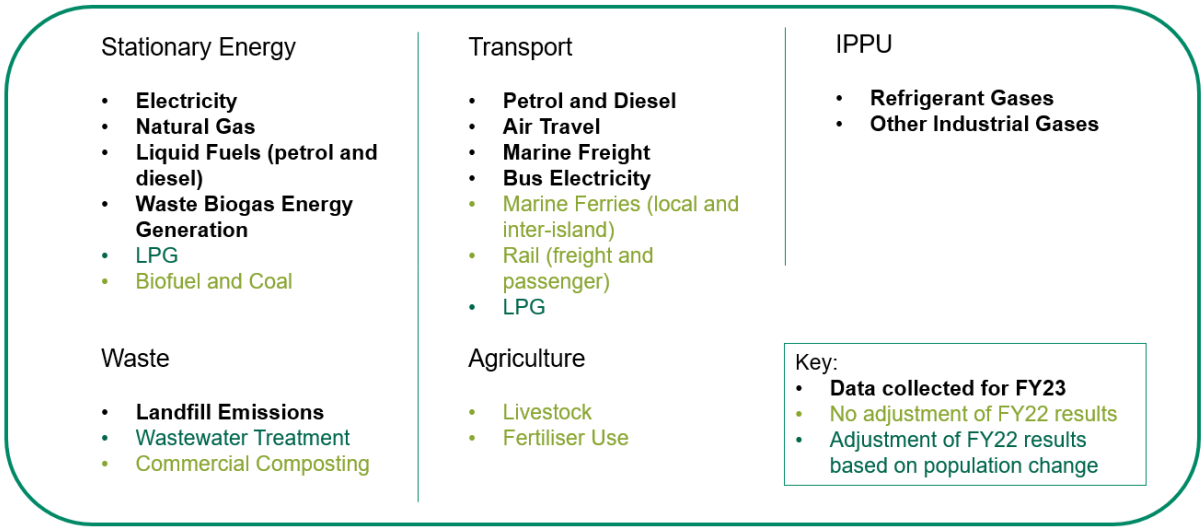

Figure 2 Data Collection Approach for each Emission Source

All major assumptions made during data collection and analysis have been detailed within **Appendix A – Assumptions**.

It is essential to consider the uncertainty associated with the results, particularly given the different datasets used. At the national level, New Zealand's Greenhouse Gas Inventory the estimate of gross emissions uncertainty was ±8.8%, with a net emissions uncertainty estimate of ±26.9% (MfE, 2022).

3.0 Wellington City Emissions Inventory for FY23

3.1 Total Emissions (Gross and Net)

Total emissions are reported as both gross emissions (excluding forestry harvesting and sequestration) and net emissions (including forestry harvesting and sequestration).

During FY23, Wellington City emitted **total gross emissions** of 887,155 tCO_2e. Transport and Stationary Energy emissions are Wellington City's most significant contributors to total gross emissions.

The population of Wellington City in FY23 was approximately 213,100 people, resulting in per capita gross emissions of 4.2 tCO_2e/person.

The total net emissions in Wellington City were 807,247 tCO_2e.

Table 1 Total net and gross emissions

Total emissions	Emissions (tCO_2e)
Total Gross emissions (excluding Forestry)	887,155
Total Net Emissions (including Forestry)	807,247

3.2 Emission Sectors and Sources

Figure 3 and Table 2 illustrate the six different sectors that comprise the emissions inventory. A discussion of each sector follows in Sections 3.3 through Section 3.8. Section 4.0 details the change in Wellington City's emissions since FY22. Due to rounding, there may be some discrepancy between totals and the sum of results in the tables.

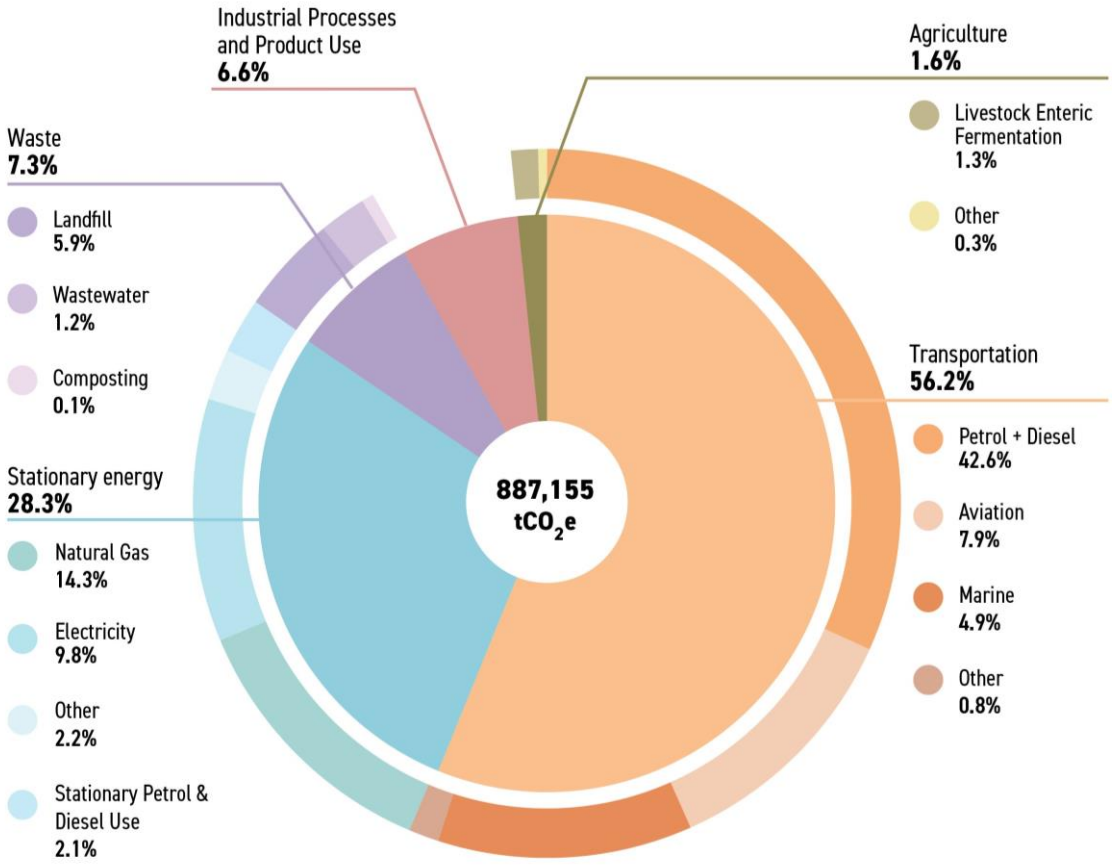

Figure 3: Wellington City's total gross GHG emissions split by sector (tCO_2e)

Table 2 Wellington City FY23 emissions by sector

Emissions Source	Emissions (tCO_2e)	Percentage of Total Gross Emissions (%)
Transportation	498,182	56.2%
Stationary Energy	251,441	28.3%
Waste (incl. wastewater)	64,451	7.3%
Industrial Processes and Product Use	58,631	6.6%
Agriculture	14,450	1.6%
Total Gross Emissions	**887,155**	**100%**

Table 3 shows the emission sources from largest to lowest emission source. Full breakdowns of emissions are presented in **Appendix B.**

Table 3 Wellington City FY23 emissions by source

Emissions Source	Emissions (tCO_2e)	Percentage of Total Gross Emissions (%)
On-Road Transport	345,782	39.0%
Natural Gas (including transmission and distribution losses)	126,801	14.3%
Electricity Consumption (including transmission and distribution losses)	87,084	9.8%
Air Travel	69,892	7.9%
Refrigerant and Air Conditioning Gasses (IPPU)	54,837	6.2%
Solid Waste	52,705	5.9%
Marine Transport	43,571	4.9%
Off-Road Transport	34,071	3.8%
Stationary Diesel and Petrol Use	18,390	2.1%
LPG (Stationary Energy and Transportation)	14,305	1.6%
Enteric Fermentation from Livestock	11,484	1.3%
Wastewater Treatment (incl. household septic tanks)	10,763	1.2%
Rail Transport	4,867	0.5%
Other Industrial Gasses (IPPU)	3,794	0.4%
Other Agriculture Emissions	2,966	0.3%
Biofuel and Biogas	2,948	0.3%
Coal	1,914	0.2%
Composting (Green Waste)	983	0.1%
Total Gross Emissions	**887,155**	**100%**

3.3 Transport

Transport was the highest emitting sector estimated in Wellington City, producing a total of 498,182 tCO_2e (56% of total gross emissions). Petrol and diesel use represented 76% of the transport emissions in Wellington City (219,730 tCO_2e and 158,083 tCO_2e respectively).

Diesel and petrol transport emissions are split into on-road and off-road use. On-road transport, consisting of all standard road vehicles (cars, trucks, buses, etc.), was responsible for 69% of transport emissions and 39% of total gross emissions. Off-road transport, consisting of all fuel used for off road vehicles (agricultural tractors and vehicles, forklifts, etc.), was responsible for 7% of transport emissions. A further breakdown of on-road emissions by vehicle type and class is included as **Appendix C**.

The next largest emission source in the transport sector was air travel, contributing 14% of the sector's emissions and 8% of total gross emissions. Air travel emissions are based on the fuel consumed by aircraft journeys to and from Wellington City, with emissions split equally between the origin and destination location. Wellington Airport is a regional airport so emissions from air travel have been split between all territorial authorities in the Greater Wellington Region based on population.

Marine transport emissions (from local ferries, inter-island ferries, and freight vessels) produced 9% of transport emissions and 5% of total gross emissions. As with air travel, emissions are split equally between the origin and destination location. For marine freight, the emissions related to the journeys to and from Wellington have been split between the territorial authorities in the Greater Wellington Region. This ensures that the emissions are captured as per the GPC requirements. It is acknowledged that marine transport and air travel hubs in Wellington City support an area wider that the immediate Wellington Region.

Rail emissions produced 1% of the sector's emissions. Rail emissions were calculated from both national freight and public commuter electric trains.

3.4 Stationary Energy

Natural gas consumption including transmission and distribution losses from the reticulated gas system accounted for 50% of stationary energy emissions (14% of total gross emissions) and was Wellington City's second highest emission source, behind on-road transport.

Electricity consumption (including transmission and distribution losses) accounted for 35% of stationary energy emissions and 10% of Wellington City's total gross emissions. Electricity consumption emissions depend upon the amount of consumption (in kWh), and the emissions intensity of the national grid (tCO_2e/kWh), which changes annually. The emissions intensity of the grid was low in FY23 relative to recent years, resulting in lower than usual emissions from this source regardless of consumption.

The use of LPG, petrol, diesel, coal, biofuels, and landfill biogas used for energy generation, produced the remaining stationary energy emissions.

Biogenic CO_2 emissions from biofuels and landfill gas flaring have not been included in these totals and are reported separately in section 3.10.

3.5 Waste

Waste processed in Wellington City (solid waste, wastewater, and compost) comprised 7% of Wellington City's total gross emissions.

Solid waste produced the bulk of waste emissions making up 82% of total waste emissions. Solid waste emissions include emissions from open (operating) landfill sites (13,467 tCO_2e) and closed landfill sites (39,238 tCO_2e). 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. The reported emissions here relate to the emissions produced in FY23 from all waste produced in Wellington City that has entered landfill sites over the last 50+ years, as per the GPC guidance for city-level reporting. This approach differs from other reporting methods which estimate the future emissions related to waste entering the landfill in the reporting year.

Open landfill emissions relate to emissions from waste produced in Wellington City and sent to Southern Landfill and Spicer Landfill. Both Southern Landfill and Spicer Landfill have landfill gas capture systems that reduce emissions being released into the atmosphere. The Southern Landfill gas capture system was upgraded in FY23 leading to further emissions capture and use of landfill gas for energy production. Owing to the lack of gas capture systems at closed landfill sites, emissions from closed landfill sites were greater than those from currently open sites. It is noted that the annual emissions from closed landfill sites will continue to decrease over time as no new waste enters these sites.

Wastewater treatment (both treatment plants and individual septic tanks) accounted for 17% of total waste emissions. The vast majority of households in Wellington City (94%) are connected to wastewater treatment plants, with resulting emissions of 7,735 tCO_2e from wastewater treatment and processing. Households not connected to wastewater treatment plants (i.e., using individual septic tanks) produced 3,028 tCO_2e in wastewater emissions. Due to methane production, septic tanks have a higher emissions intensity per quantity of wastewater compared to the wastewater treatment plants in Wellington City.

Waste diverted from landfill for composting in Wellington City includes horticultural, animal waste products, green waste, bark, and sawdust. Composting of this organic waste produces lower emissions than if sent to a landfill. Diverted organic waste, composted at Southern Landfill produced 983 tCO_2e.

3.6 Industrial Processes and Product Use (IPPU)

IPPU 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 Wellington City (e.g., aluminium manufacture).

IPPU contributed 7% to total gross emissions. The most significant contributor to IPPU emissions was refrigerant gasses, which produced 94% of IPPU emissions.

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.

3.7 Agriculture

Agricultural emissions from both livestock and crop farming were responsible for 2% of Wellington City's total gross emissions. Enteric fermentation represented 80% of agricultural emissions. Enteric fermentation is the methane (CH_4) released from the digestive process of cattle and sheep. The second highest source of agricultural emissions was produced from nitrous oxide (N_2O) released by unmanaged manure from grazing animals on pasture. These results have not been updated since the FY22 inventory as they represent a small proportion of Wellington City's emissions and are unlikely to have changed significantly since FY22.

It is important to note that these agricultural results do not include emissions related to the consumption of agricultural products supplied to Wellington City as per the GPC methodology.

3.8 Forestry (Net Emissions)

Native forests (e.g., mānuka and kānuka) and exotic forest (e.g. pine) sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. Harvesting of forests emits emissions via the release of carbon from organic matter and soils following harvesting. When forest sequestration exceeds emissions from harvesting in a particular year, forestry is a net-negative source of emissions which results in the area's total net emissions being lower than their total gross emissions. Conversely, when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then forestry is a net-positive source of emissions which results in the area's total net emissions being higher than their total gross emissions. 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.

In FY23, Forestry in Wellington City was a net negative source of emissions. These results have not been updated since the FY22 inventory as they do not impact Wellington City's gross emissions and are unlikely to have changed significantly since FY22.

Table 4 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO_2e
Harvest Emissions	5,531
Native Forest Sequestration	-62,707
Exotic Forest Sequestration	-22,733
Total	**-79,908**

3.9 Total Gross Emissions by Greenhouse Gas

Each greenhouse gas has a different level of impact on climate change, which is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e). This assessment uses conversion figures (i.e. global warming potentials with climate change feedback) from the IPCC 5th Assessment Report (2014).

Table 5: Wellington City's total gross emissions by greenhouse gas

Greenhouse Gas	Tonnes	Global Warming Potential (GWP)	Tonnes of CO_2e
Carbon Dioxide (CO_2)	715,382	1	715,382
Biogenic Methane (CH_4)	2,084	34	70,842
Non-biogenic Methane (CH_4)	571	34	19,419
Nitrous Oxide (N_2O)	65	298	19,346
Other / Unknown Gas (in CO_2e)	62,167	1	62,167
Total	**780,268**	**-**	**887,155**

3.10 Biogenic Emissions

Biogenic CO_2 emissions result from the combustion of biomass materials that store and sequester CO_2, including materials used to make biofuels (e.g., trees, crops, vegetable oils, or animal fats). Biogenic CO_2 emissions from plants and animals are excluded from gross and net emissions as they are part of the natural carbon cycle.

Table 6: Biogenic Carbon Dioxide in Wellington City in FY23 (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO_2) (Excluded from gross emissions)		
Biofuel	30,456	tCO_2
Landfill Gas (Biogas)	14,516	tCO_2
Total Biogenic CO_2	**44,972**	**tCO_2**

Biogenic CH_4 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 CO_2. Biogenic methane represents 0.3% of the total gross tonnage of GHG emissions in Wellington City but 9% of total gross GHG emissions when expressed in CO_2e. This is caused by the higher global warming impact of methane per tonne compared to carbon dioxide. Table 7 shows biogenic methane in Wellington City in FY23 in tonnes of methane by emission source.

Table 7: Biogenic Methane in Wellington City in FY23 (Included in gross emissions)

Biogenic Methane (CH_4) (Included in gross emissions)		
Landfill Gas	1,550	tCH_4
Enteric Fermentation and Manure Management	342	tCH_4
Wastewater Treatment	136	tCH_4
Biofuel	39	tCH_4
Composting (Green Waste)	17	tCH_4
Total Biogenic CH_4	**2,084**	**tCH_4**

4.0 Variance Analysis FY22 to FY23

Annual total gross emissions decreased by 1.4% from FY22 to FY23 while annual total net emissions in Wellington decreased by 1.6%. The decrease in both gross and net emissions was driven by a reduction in the emissions intensity of national electricity generation which meant that electricity was 44% less carbon intensive per unit consumed than in FY22. The decrease in electricity emissions was somewhat balanced by a rebound in transport fuel use following the impacts of Covid-19 (particularly aviation and on-road fuel).

The previously published FY22 inventory for Wellington City (December 2022) was updated as part of the Greater Wellington Region FY22 Emissions Inventory[4] (June 2023) based on more accurate petrol and diesel fuel sales data, see Section 5.0. The updated FY22 results are presented here.

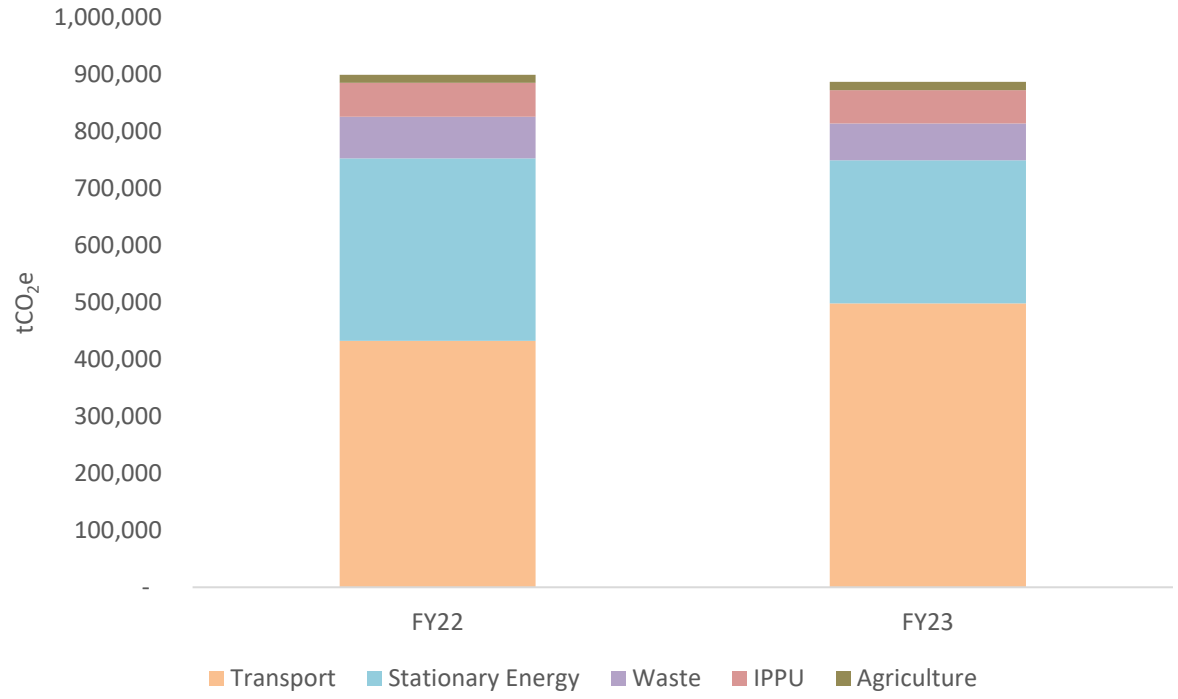

Figure 4 Change in Wellington's total gross GHG emissions from FY22 to FY23

For emission sources representing less than 10% of total gross emissions combined, emissions for FY23 have been estimated based on the results of the FY22 inventory. Where this has occurred, this has been noted in Table 8 and Table 9. This approach was taken to produce a streamlined inventory between full inventory years. This approach is still in alignment with the GPC methodology used for city-wide emissions reporting.

[4] https://www.gw.govt.nz/environment/climate-change/monitoring-emissions/

Due to rounding, there may be some discrepancy between totals and the sum of results in the tables.

Table 8 Wellington City - Change in emissions by sector from FY22 to FY23

Sector / Emissions Source	Emissions (tCO_2e)		Percentage Change FY22 - FY23 (%)
	FY22	FY23	
Transport[1]	432,661	498,182	15.1%
Stationary Energy[1]	320,493	251,441	-21.5%
Waste (incl. wastewater)[1]	73,038	64,451	-11.8%
Industrial Processes and Product Use[1]	59,322	58,631	-1.2%
Agriculture[2]	14,450	14,450	0.0%
Total Gross Emissions	**899,964**	**887,155**	**-1.4%**

Note [1] = Majority of data collected and calculated / [2] = No adjustment of FY22 results

Table 9 Wellington City - Change in emissions by source from FY22 to FY23

Sector / Emissions Source	Emissions (tCO_2e)		Percentage Change FY22 - FY23 (%)
	FY22	FY23	
On-Road Transport[1]	306,868	345,782	12.7%
Natural Gas[1]	129,085	126,801	-1.8%
Electricity Consumption[1]	156,091	87,084	-44.2%
Air Travel[1]	43,472	69,892	60.8%
Solid Waste[1]	61,233	52,705	-13.9%
Refrigerant and Air Conditioning Gasses (IPPU) [1]	55,192	54,837	-0.6%
Marine Transport[1]	47,068	43,571	-7.4%
Off-Road Transport[1]	30,033	34,071	13.4%
Stationary Diesel and Petrol Use[1]	16,093	18,390	14.3%
LPG (Stationary Energy and Transportation)[3]	14,382	14,305	-0.5%
Enteric Fermentation from Livestock[2]	11,484	11,484	0.0%
Wastewater Treatment (incl. household septic tanks) [3]	10,821	10,763	-0.5%
Rail Transport[2]	5,221	4,867	-6.8%
Other Industrial Gasses (IPPU) [1]	4,131	3,794	-8.1%
Other Agriculture Emissions[2]	2,966	2,966	0.0%
Biofuel and Biogas[2]	2,929	2,948	0.6%
Coal[2]	1,914	1,914	0.0%
Composting (Green Waste) [2]	983	983	0.0%
Total Gross Emissions	**899,964**	**887,155**	**-1.4%**

Note [1] = Data collected and calculated / [2] = No adjustment of FY22 results / [3] = Adjustment of FY22 result based on change in population

4.1 Transport

Transport emissions increased 15% between FY22 and FY23, this is mainly due to a rebound in transport fuel use following the impact of Covid-19. This is especially true of on-road petrol and diesel fuel sales which were reduced in FY22 by Covid-19 related restrictions on travel, and also air travel fuel use due to an increase in international (and domestic) air travel passenger numbers following the lifting of restrictions on travel.

On-road fuel emissions increased 13%, back to pre-FY20 levels. Air travel emissions increased 61%, particularly due to an increase in international flights. Air travel international passenger numbers are still 40% lower than FY19, and domestic passenger numbers are still 15% lower than FY19, suggesting that annual air travel emissions may continue to increase in coming years.

4.2 Stationary Energy

Stationary Energy emissions decreased by 22%, this is mainly due to a reduction in the emissions intensity of national electricity generation which meant that electricity was 44% less carbon intensive per unit consumed than in FY22.

Electricity consumption was relatively unchanged (less than 0.4% different) so emissions from electricity consumption were 44% lower than in FY22. The emissions intensity of national electricity generation 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, with FY23 representing a particularly low year for the emissions intensity of New Zealand's national grid.

A 2% reduction in natural gas consumption also contributed to the decrease in Stationary Energy emissions.

4.3 Waste

Waste emissions decreased by 14% between FY22 and FY23 mainly due to a reduction in open landfill emissions due to increased landfill gas capture at Southern and Spicer Landfill sites. Closed landfill emissions also reduced as no new waste enters these sites.

At the open landfill sites that process Wellington City's landfill waste (Southern and Spicer landfills), the total landfill gas (CH_4) produced annually increased by 1% between FY22 and FY23 due to increases in annual waste volumes sent to landfill over the last 20 years. However, improvements to landfill gas capture systems have meant that more landfill gas (CH_4) has been captured and flared or used for energy generation, reducing the emissions impact of open landfill by 31%.

Annual emissions from closed landfill sites reduced by 6% between FY22 and FY23. As no additional waste enters these sites, annual emissions from this source will continue to fall over time.

4.4 Industrial Processes and Product Use (IPPU)

IPPU emissions decreased by 1%, following the national trend for these emissions sources. A decrease in refrigerant and aerosol emissions mainly drives the decrease in IPPU emissions. This may be a decrease in the quantity used or an increase in the use of lower emissions-impacting refrigerants and aerosols. Note that national-level data is used for this sector and is portioned out using a population approach; actual emissions for Wellington City are unknown.

4.5 Agriculture and Forestry

Agriculture and Forestry results for FY23 are unchanged from the FY22 inventory as FY23 data was not collected for this source as part of the streamlined emissions calculation process.

5.0 Update to FY20 to FY22 Inventory Results

The previously published FY22 inventory for Wellington City (December 2022) was updated as part of the Greater Wellington Region FY22 Emissions Inventory (June 2023) based on more accurate petrol and diesel fuel sales data. This update affected the FY20, FY21, and FY22 total emissions for Wellington City.

The impact of this update was a 5%-6% increase in reported annual total gross emissions and total net emissions for the FY20, FY21, and FY22 years in Wellington City, with a 10%-11% increase in annual Transport emissions. As all years were updated equally, the reported trends in Wellington City's emissions during the period from FY20-FY22 were unchanged.

Table 10 presents the Wellington City FY20 to FY23 emissions inventory results for reference, this includes the updated FY20 to FY22 results.

Table 10 Wellington City - Change in emissions by sector from FY20 to FY23

Sector / Emissions Source	Emissions (tCO_2e)				Percentage Change in Emissions FY20 - FY23 (%)
	FY20	FY21	FY22	FY23	
Transport	489,505	456,590	432,661	498,182	2%
Stationary Energy	339,893	410,467	320,493	251,441	-26%
Waste (incl. wastewater)	78,980	76,393	73,038	64,451	-18%
Industrial Processes and Product Use	60,481	59,983	59,322	58,631	-3%
Agriculture	15,177	14,450	14,450	14,450	-5%
Total Gross Emissions	**984,035**	**1,017,883**	**899,964**	**887,155**	**-10%**
Net Forestry	-64,024	-79,908	-79,908	-79,908	
Total Net Emissions	**920,011**	**937,974**	**820,055**	**807,247**	**-12%**

6.0 Closing Statement

Wellington City's GHG emissions inventory provides information for decision-making and action by the council, Wellington City stakeholders, and the wider community. We encourage the council to use the results of this study to update current climate action plans, set emission reduction targets, and track changes in emissions over time.

The emissions footprint developed for Wellington City covers emissions produced in the stationary energy, transport, waste, IPPU, agriculture, and forestry sectors using the GPC reporting framework. Sector-level data allows Wellington City to target and work with the sectors that contribute the most emissions to the footprint.

Understanding of climate change's extensive and long-lasting effects is always improving. It is recommended that this emissions footprint be updated regularly to inform ongoing positive decision-making to address climate change issues.

The availability, quality, and applicability of data limit the accuracy of any emissions footprint. These results may need updating in the future with changes in data and methodology to enable comparable figures to assess trends over time.

7.0 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 **September** and **October 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

Appendix A Assumptions and Data Sources

The calculation method for the FY23 GHG emission inventory for Wellington City differs from previous GHG emission inventories completed for Wellington City by AECOM. Data for this GHG emissions inventory has been collected for a list of emission sources which cover approximately 90% of Wellington City's emissions. These emission sources were calculated as per previous inventories, and remaining sources have been based on the FY22 GHG emissions inventory, with some of these sources adjusted based on population change where this was deemed relevant.

The following table details assumptions, exclusions and whether data has been collected, adjusted or not adjusted based on the FY22 emissions inventory.

Sector / Category	Assumptions and Exclusions
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied.
Population	Population figures are provided by StatsNZ. The 2022 calendar year population was used as the closest estimate to 2023 financial year population.
Global Warming Potential Used	Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) using the 100-year Global Warming Potential (GWP) values including climate feedbacks, from the IPCC 5th Assessment Report (AR5).
Full Inventory	Emissions for all sources broken down by individual main greenhouse gases are provided in the supplementary spreadsheet information supplied with this report.
GPC Production Approach	GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption. 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.). Cross-boundary movements such as air travel and marine freight journeys departing or arriving in Wellington City have been included with emissions related to the journeys split equally between the origin and destination, despite the emissions being produced outside the Wellington City geographical boundary, as per the GPS requirements.
Emission Factors	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.
Transport Emissions	
Petrol and Diesel:	Total petrol and diesel consumption in Wellington City was calculated from aggregated petrol and diesel sales data for the Wellington Region which was 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). 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). 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. 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. - 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. This method produces results for off-road and stationary uses of petrol and diesel that are heavily impacted by changes in on-road transport uses of petrol and diesel as this represents the largest proportion of petrol and diesel sales. Better data and understanding of off-road and stationary uses of petrol and diesel are required to improve the applicability of these results. *Data collected for FY23.*
Rail Diesel	Consumption was calculated by Kiwi Rail using the induced activity method for system boundaries. The following assumptions were made: - 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. 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. Data was not available for FY22 therefore the FY21 value has been used for FY22. *No adjustment of FY22 results.*
Jet Kerosene	Calculated using the induced activity method as per rail diesel. An estimate of fuel use was calculated for flights arriving and departing from Wellington Airport: - 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 City Airport. The remaining 50% of each leg was allocated to the originating or destination airport. An estimation of fuel use from military, freight, private, and other flights for FY22 has been estimated based on data provided in 2023. 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. *Data collected for FY23.*
Aviation Gas	Aviation gas is mostly used by small aircraft for relatively short flights. 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 FY20 inventory. 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. *Adjustment of FY22 results based on population change.*
Marine Diesel – Freight	Calculated using the induced activity method as per rail diesel and jet kerosene. An estimate of fuel use was calculated for vessels arriving and departing from CentrePort (Wellington Port): - 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. 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). *Data collected for FY23.*
Marine Diesel (Local)	Port operational vessels: - Fuel use has been provided directly from Wellington Port (CPL) for FY21 - The FY21 figure has also been used for years since. - All emissions from this source have been allocated to Wellington City Local ferries: - Diesel fuel use has been provided directly by the ferry operator. - Electricity usage has been provided directly by the ferry operator (beginning in FY22) - All emissions from this source have been allocated to Wellington City Private use, other commercial operators, and commercial fishing:

	- 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. *No adjustment of FY22 results.*
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. *No adjustment of FY22 results.*
Cruise Ships	No reliable data was available to determine the emissions from cruise ships. As data and understanding of cruise ship fuel usage improve, it is recommended that emissions from this source are included in future city-wide emissions inventories. *No adjustment of FY22 results.*
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. *Adjustment of FY22 results based on population change.*
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 Wellington City. 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). *Data collected for FY23.*
Public Transport Electricity	Electricity used in the public transport system is included in the Transport sector (where known). *Data collected for FY23.*
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 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. *No adjustment of FY22 results.*
Biofuel and Wood Consumption	For FY23, national biofuel consumption data has been provided by the Ministry for the Environment (MfE, 2023) for the 2021 year. This is the most recent year available. Biofuel consumption has been divided between territorial authorities on a per capita basis. Biofuel emissions are considered to be biogenic. Biofuel CO_2 emissions are not included in total gross emissions but are reported separately. FY20, FY21, and FY22 use the FY19 figure, adjusted for population change. *No adjustment of FY22 results.*
LPG Consumption	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. 'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG. Sales have been divided between territorial authorities on a per capita basis. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data. *Adjustment of FY22 results based on population change.*
Petrol and Diesel (stationary energy end use)	Total petrol and diesel consumption in Wellington City was calculated from aggregated petrol and diesel sales data for the Wellington Region which was 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). As most petrol and diesel is used for transport uses, this provides the most accurate way of calculating this data. 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. - 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. This method produces results for stationary uses of petrol and diesel that are heavily impacted by changes in transport uses of petrol and diesel. Better data and understanding of stationary uses of petrol and diesel are required to improve the applicability of these results.

	Data collected for FY23.
Natural Gas Consumption	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. For Wellington City, this is Tawa A and Tawa B connection points. *Data collected for FY23.*
Biogenic Emissions	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_2e.
Agricultural Emissions	
Agriculture	Agriculture emissions relates to emissions produced by livestock, crops and fertiliser in the geographic area. Agriculture emissions do not relate to imported foods or goods (reported in a consumption-based footprint), or agricultural activities such as farm transport or food processing within the geographic area (these are reported in this inventory under transport or stationary energy respectively). Territorial authority livestock numbers and fertiliser data taken from the 2017 Agricultural Census (StatsNZ). Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use in wellington City since 2017. *No adjustment of FY22 results.*
Solid Waste Emissions	
Landfill Emissions	Landfill waste volume and landfill gas capture system information has been provided by the respective council departments. 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). This approach differs from that used by WCC for their organisational footprint which includes WCC-owned landfill sites[1]. The WCC organisational footprint method calculates the likely future emissions from the waste entering landfill that year, and attributes those emissions to that year (and doesn't include emissions from waste already in the landfill, or emissions from closed landfill sites). Waste volume: - Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis (MfE, 2023). - Contaminated soil has been excluded from the calculation to be consistent with previous years as it is considered to be inert for the purposes of this assessment (this differs from the Council's organisational emissions inventory) Landfill gas capture system efficiency: - Southern Landfill – Efficiency of the system used in the emissions calculations has been taken from data provided by WCC. - Spicer Landfill – Efficiency of the system used in the emissions calculations has been taken from data provided by Porirua City Council.

	Landfill gas flaring / burning for energy generation: - Southern Landfill – 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 FY20 and FY22. - Emissions relating to burning of landfill gas for energy generation have been included in the Stationary Energy sector. 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: - All emissions from waste in Southern landfill has been allocated to Wellington City (despite knowledge that some waste in Southern landfill will be coming from outside Wellington City) - 21.5% of emissions from waste in Spicer landfill have been allocated to Wellington City, this is based on WCC owning 21.5% of Spicer landfill (this number has been used in lieu of real-world data on origin of waste) *Data collected for FY23.*
Wastewater Emissions	
Wastewater Treatment	Wastewater Treatment Plants: - Emissions have been calculated by an external party for FY21 following the WaterNZ (2021) guidance and verified by AECOM. - 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 has been included in the Solid Waste emissions source. - Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority. Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority: - All emissions from wastewater in the Moa Point, and Western wastewater treatment plants have been allocated to Wellington City - 27.6% of emissions from the Porirua wastewater treatment plant have been allocated to Wellington City based on Wellington City Council's ownership share of the treatment plant (this number has been used in lieu of real-world data on origin of wastewater) Individual Septic Tanks: - Populations not connected to known wastewater treatment plants are assumed to be using septic tanks. - The population not connected to centralised wastewater treatment has been estimated based on the number of rateable properties not connected to sewerage. *Adjustment of FY22 results based on population change.*
Industrial Processes and Product Use 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).

	Data collected for FY23.
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 1990-2021 report (MfE 2023). Emissions are estimated on a per capita basis applying a national average per person. *Data collected for FY23.*
Forestry Emissions	
Exotic Forestry Harvested and Exotic Forest coverage	Harvested forestry, and forest cover information for each territorial authority has been derived from MPI, StatsNZ, and Landcare Research data. This emissions footprint 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 footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state. *No adjustment of FY22 results.*
Native Forest	Native forest land area for each territorial authority has been provided by Landcare Research. *No adjustment of FY22 results.*

[1] https://Wellington.govt.nz/climate-change-sustainability-environment/climate-change/what-were-doing-about-climate-change/our-climate-action-areas/action-area-Wellington-city-council

Appendix B

Wellington City Emissions Inventory FY23 – Full Inventory Tables

Appendix B Wellington City Emissions Inventory FY23 - Full Inventory Tables

Transport Emissions

Table 11 Wellington City FY22 and FY23 Transport emissions by emission source

Emissions Source	FY22 Emissions (tCO_2e)	FY23 Emissions (tCO_2e)	Percentage of Total Gross Emissions in FY23 (%)
Petrol[1]	196,817	219,730	24.8%
Diesel[1]	138,031	158,083	17.8%
Jet Kerosene (Air Travel)[1]	43,244	69,665	7.9%
Marine Freight[1]	25,693	22,200	2.5%
Marine (Inter-Island Ferries)[2]	19,414	19,414	2.2%
Rail (Diesel)[2]	4,416	4,416	0.5%
Marine Diesel (Local)[2]	1,953	1,953	0.2%
LPG[3]	1,814	1,805	0.2%
Rail (Electric)[2]	805	450	0.1%
Bus (Electric)[2]	238	235	<0.1%
Aviation Gas (Air Travel)[1]	228	227	<0.1%
Marine (Electric)[2]	7	5	<0.1%
Total	**432,661**	**498,182**	**56.2%**

Note [1] = Data collected and calculated / [2] = No adjustment of FY22 results / [3] = Adjustment of FY22 result based on change in population

Stationary Energy Emissions

Table 12 Wellington City FY22 and FY23 Stationary Energy emissions by emission source

Emissions Source	FY22 Emissions (tCO2e)	FY23 Emissions (tCO2e)	Percentage of Total Gross Emissions in FY23 (%)
Natural Gas[1]	119,431	117,318	13.2%
Electricity Consumption[1]	141,123	78,864	8.9%
Stationary Petrol & Diesel Use[1]	16,093	18,390	2.1%
LPG[3]	14,382	14,305	1.6%
Electricity Transmission and Distribution Losses[1]	14,968	8,221	0.9%
Natural Gas Transmission and Distribution Losses[1]	9,654	9,483	1.1%
Biofuel[2]	2,874	2,874	0.3%
Coal[2]	1,914	1,914	0.2%
Landfill Biogas (used for energy generation)[1]	55	74	<0.1%
Total	**320,493**	**251,441**	**28.3%**

Note [1] = Data collected and calculated / [2] = No adjustment of FY22 results / [3] = Adjustment of FY22 result based on change in population

Waste Emissions

Table 13 Wellington City FY22 and FY23 Waste emissions by emission source

Emissions Source	FY22 Emissions (tCO2e)	FY23 Emissions (tCO2e)	Percentage of Total Gross Emissions in FY23 (%)
Closed Landfill sites[1]	41,615	39,238	4.4%
Open Landfill Sites[1]	19,619	13,467	1.5%
Wastewater Treatment Plants[3]	7,776	7,735	0.9%
Individual Septic Tanks[3]	3,045	3,028	0.3%
Composting (Diverted from Landfill)[2]	983	983	0.1%
Total	**73,038**	**64,451**	**7.3%**

Note [1] = Data collected and calculated / [2] = No adjustment of FY22 results / [3] = Adjustment of FY22 result based on change in population

IPPU Emissions

Table 14 Wellington City FY22 and FY23 IPPU emissions by emission source

Emissions Source	FY22 Emissions (tCO2e)	FY23 Emissions (tCO2e)	Percentage of Total Gross Emissions in FY23 (%)
Refrigerants and air conditioning[1]	55,192	54,837	6.2%
Aerosols[1]	3,075	2,781	0.3%
SF6 - Electrical Equipment[1]	601	557	0.1%
Foam Blowing[1]	241	244	<0.1%
SF6 - Other[1]	118	117	<0.1%
Fire extinguishers[1]	95	95	<0.1%
Total	**59,332**	**58,631**	**6.6%**

Note [1] = Data collected and calculated / [2] = No adjustment of FY22 results / [3] = Adjustment of FY22 result based on change in population

Agriculture Emissions

Table 15 Wellington City FY22 and FY23 Agriculture emissions by emission source

Emissions Source	FY22 Emissions (tCO2e)	FY23 Emissions (tCO2e)	Percentage of Total Gross Emissions in FY23 (%)
Enteric Fermentation[2]	11,484	11,484	1.3%
Manure from Grazing Animals[2]	1,679	1,679	0.2%
Other Agriculture Emissions[2]	648	648	0.1%
Atmospheric Deposition[2]	456	456	<0.1%
Manure Management[2]	151	151	<0.1%
Agricultural Soils[2]	32	32	<0.1%
Total	**14,450**	**14,450**	**1.6%**

Note [1] = Data collected and calculated / [2] = No adjustment of FY22 results / [3] = Adjustment of FY22 result based on change in population

Forestry Emissions

Table 16 Wellington City FY22 and FY23 Forestry emissions

Sector / Emissions Source	FY22 Emissions (tCO2e)	FY23 Emissions (tCO2e)
Harvest Emissions[2]	5,531	5,531
Native Forest Sequestration[2]	-62,707	-62,707
Exotic Forest Sequestration[2]	-22,733	-22,733
Total (Net)	**-79,908**	**-79,908**

Note [1] = Data collected and calculated / [2] = No adjustment of FY22 results / [3] = Adjustment of FY22 result based on change in population

Appendix C

Additional On-Road Transport Emissions Breakdown

Prepared for
Wellington City Council
ABN: N/A

Wellington City On-Road Transport Emissions

FY19 to FY23

08-Dec-2023
Doc No. Document No

Wellington City On-Road Transport Emissions

FY19 to FY23

Client: Wellington City Council

ABN: N/A

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Rev	Revision Date	Details	Approved	
			Name/Position	Signature
01	08-Dec-2023	Final	Anthony Hume Associate Director - Practice Leader Sustainability & Resilience	

Table of Contents

1.0 Executive Summary

This section details the additional analysis undertaken to further break down Wellington City's on-road transport Greenhouse Gas (GHG) emissions as reported in the Wellington City Emissions Inventory 2023. On-road transport represented 39% of Wellington City's total gross emissions in the FY23 governmental financial year (1st July 2022 to 30th June 2023). The study boundary incorporates the jurisdiction of the Wellington City Council.

This document addresses emissions produced from on-road transport in FY23 and examines trends in on-road transport emissions from FY19 to FY23. Within on-road transport emissions, this assessment looks at the relative contribution of each vehicle type (cars, commercial vehicles, buses, etc.) to Wellington City's transport emissions.

Greenhouse gas emissions are generally reported in this document in Carbon Dioxide Equivalent (CO_2e) units and are referred to as 'emissions'.

Key findings of this analysis include:

FY23 On-Road Transport Emissions by vehicle type:

- Cars represented 64% of Wellington City on-road transport emissions, and 24% of Wellington City's total gross emissions (220,847 tCO_2e). Cars represented 71% of on-road Vehicle Kilometres Travelled (VKT) in Wellington City.
    - Electric cars represented 0.15% of Wellington City's on-road transport emissions (504 tCO_2e), and 2% of on-road Vehicle Kilometres Travelled (VKT) in FY23.
- Commercial vehicles represented 35% of Wellington City's on-road transport emissions and 13% of Wellington City's total gross emissions (120,531 tCO_2e).
    - Light commercial vehicles (e.g. 'utes' and vans) represented 17% of Wellington City's on-road transport emissions while heavy commercial vehicles represented 18% of Wellington City's on-road transport emissions.
    - 25-50+ tonne heavy vehicles represented 14% of all on-road emissions and 7% of all VKT.
- Busses represented 1.4% of all on-road transport emissions (this includes public transport, electric busses, school busses, and coaches).
    - Electric busses represented 6% of bus emissions in Wellington City, with diesel busses accounting for 94% of bus emissions in Wellington City

Changes in On-road Transport Emissions from FY19 to FY23:

- On-road transport emissions decreased 1% (1,966 tCO_2e).
- COVID-19 restrictions contributed to decreased on-road transport emissions in FY20 and FY22, by 7% and 9% respectively compared to the year before. Emissions from on-road transport rebounded by 4% and 13% in FY21 and FY23 respectively following these COVID-19 affected years.
- Car emissions decreased by 5%, driven by a decrease in petrol and diesel car emissions.
    - During this period, use of hybrid and electric cars increased, potentially contributing to the reduction in total car emissions. Electric car emissions increased by 437%, driven by a 382% increase in fleet size.
- Commercial vehicle emissions increased 8%, driven by a 41% increase in heavy commercial vehicle emissions.
    - Light commercial vehicle emissions decreased by 13% during the same period.
- Bus emissions decreased by 16%, from 1.7% to 1.4% of all on-road transport emissions. This is likely due to a transition to electric busses, whose emissions have increased 444% during this period from a very low starting point in FY19.

2.0 Methodology

The basis for this assessment is the results presented in the Wellington City Emissions Inventory for the FY23 (1st July 2022 to 30th June 2023). The emissions inventory results are based on fuel sales data provided by Wellington City Council. The emissions for on-road transport have then been broken down by sector and vehicle type using Vehicles Kilometres Travelled (VKT) and emissions data from Waka Kotahi, and Fleet Statistics from the Ministry of Transport. The reported emissions align with the results of the FY23 Wellington GHG Emissions Inventory.

Emissions data provided directly by Waka Kotahi covering emissions (by gas) for Wellington City by vehicle class in FY19 has been used to assess the relative contribution of vehicle class types to on-road transport emissions in Wellington City in FY19. Waka Kotahi Vehicles Kilometres Travelled[1] (VKT) and other national and vehicle fleet data from Ministry of Transport[2] covering the years from FY19 to FY23 has been used to estimate changes in on-road emissions during this period, aligning with the results of the Wellington City Greenhouse Gas (GHG) Emissions Inventory for FY23.

Emissions related to energy use from electric vehicles (EVs) is included in the stationary energy sector in Wellingtons City's Emissions Inventory for FY23 (and not included in transport emissions) due to a lack of available data at the time of calculation. However, the total emissions presented here include the EV emissions contribution. Due to this, emissions calculated in this study may differ from the total regional results from Wellingtons City's emissions inventory. These emissions have been calculated using an average electricity consumption per km travelled and are based on the carbon intensity of the national electricity grid in FY23.

All calculated GHG emissions have been converted to tonnes of CO_2 equivalent (tCO_2e) to allow direct comparison with the results of the Wellington City GHG Emissions Inventory for FY23. For this assessment, the word 'emissions' represents GHG emissions only.

Definition of on-road vehicle categories[3]:

- Light duty vehicles:
    - Cars: passenger cars and sports utility vehicles (SUVs). This includes passenger cars and SUVs used for commercial purposes (e.g., taxis).
    - Light commercial vehicles: Utes and vans with gross vehicle mass up to 3.5 tonnes
- Heavy duty vehicles:
    - Heavy commercial vehicles: commercial vehicles with gross vehicle mass higher than 3.5 tonnes
    - Buses with gross vehicle mass higher than 3.5 tonnes

Key Limitations

- The results presented take data provided by Waka Kotahi which have been adjusted to align with Wellington City's GHG Emissions Inventory for FY23.
- The on-road transport total displayed in this analysis includes electric vehicles which are not included in the on-road transport figure in the Wellington City Emissions Inventory as electricity use is included in the Stationary Energy sector.
- The electricity contribution to plug-in hybrid vehicle emissions has not been calculated for this assessment, however it is assumed to have a minimal impact on results.
- Data used for this assessment is based on modelling results provided by Waka Kotahi, there are inherent assumptions within all modelling.

[1] https://www.nzta.govt.nz/planning-and-investment/learning-and-resources/transport-data/data-and-tools/
[2] https://www.transport.govt.nz/statistics-and-insights/fleet-statistics/
[3] https://www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Air-quality/Planning-and-assessment/Vehicle-emissions-prediction-model/VEPM-6.3-technical-report-2022.pdf

3.0 On-Road Transport Emissions in FY23

On-road transport emissions are those relating to cars, commercial vehicles (including utes, trucks, and large commercial vehicles), and buses on-roads. On-road transport is the largest contributor to transport emissions in Wellington City, representing 69% of Transport emissions and 39% of Wellington City's total gross emissions. This is followed by air, marine, and off-road transport.

Table 1 and Figure 1 detail on-road transport emissions per vehicle category and fuel type. Cars in Wellington City tend to be fuelled by petrol while commercial vehicles and buses tend to use diesel (excluding some electric buses in Wellington City). Electric vehicles (EV) represent 0.2% of total on-road emissions in Wellington City but represent approximately 2% of kilometres travelled by vehicles in Wellington City (this includes electric busses).

Of note:

- Cars represent 64% of on-road emissions in Wellington City, and 24% of the City's total gross emissions.
- Commercial vehicles represent 35% of on-road emissions in Wellington City, and 13% of the City's total gross emissions.
- Buses represent 1% of on-road emissions in Wellington City. The bus category includes public transport, school buses, and private commercial buses (including tourist coaches).

Table 1 On-road transport emissions by vehicle type and fuel type in FY23 (tCO_2e)

Vehicle Type	Petrol	Diesel	Electric	Total[4]	% of Total
Cars	204,080	16,263	504	**220,847**	**64%**
Commercial Vehicles	13,634	106,894	3	**120,531**	**35%**
Buses	-	4,677	310	**4,987**	**1%**
Total	**217,713**	**127,834**	**504**	**346,365**	
% of Total	**63%**	**37%**	**0.2%**		

[4] The on-road transport total displayed here and in the following tables includes electric vehicles which are not included in the on-road transport figure in the Wellington City Emissions Inventory as electricity use is included in the Stationary Energy sector.

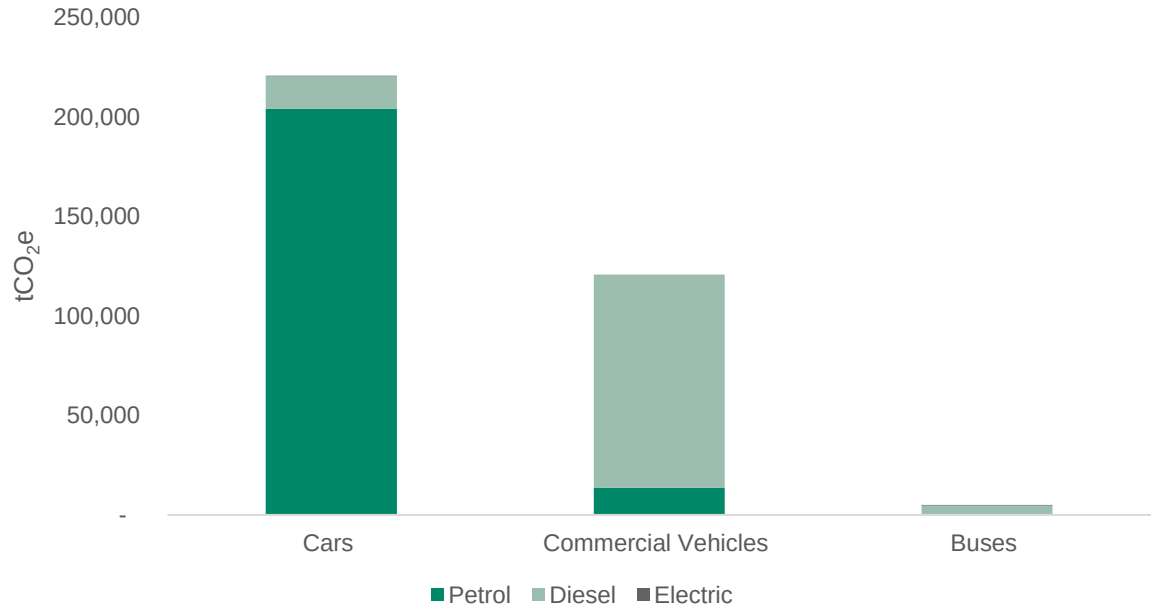

Figure 1 On-road transport emissions by vehicle type and fuel type in FY23

This highlights the impact of both private cars and commercial vehicles on Wellington City's on-road transport emissions. Efforts to reduce emissions from on-road transport need to consider options to address private car emissions such as mode shifts to active travel and public transport, and also options to reduce commercial vehicle emissions such as incentivising lower emission commercial vehicles or shifting freight to alternative modes. Traditionally the focus has often been on private car journeys and hasn't adequately considered the impact of commercial vehicles.

Emissions from these vehicle types can be broken down further by vehicle class. Table 2 details on-road transport emissions per vehicle class.

Of note:

- Commercial vehicles lighter than 3.5 tonnes represent 17% of on-road emissions in Wellington City. Many of these will be commercial 'utes' and small vans.
- Commercial vehicles heavier than 25 tonnes represent 14% of on-road emissions in Wellington City. This generally represents vehicles used for freight movement.

Table 2 On-road transport emissions by vehicle class in FY23 (tCO_2e)

Vehicle Class	GHG Emissions (tCO_2e)	% of Total
Cars	220,847	64%
Light Commercial Vehicles <3.5 Tonne	57,757	17%
Heavy Vehicles 3.5-25 Tonne	12,705	4%
Heavy Vehicles 25-50+ Tonne	50,069	14%
Bus Urban 15-18 Tonne	4,553	1%
Bus Coach >18 Tonne	434	<0.1%
Total	**346,365**	**100%**

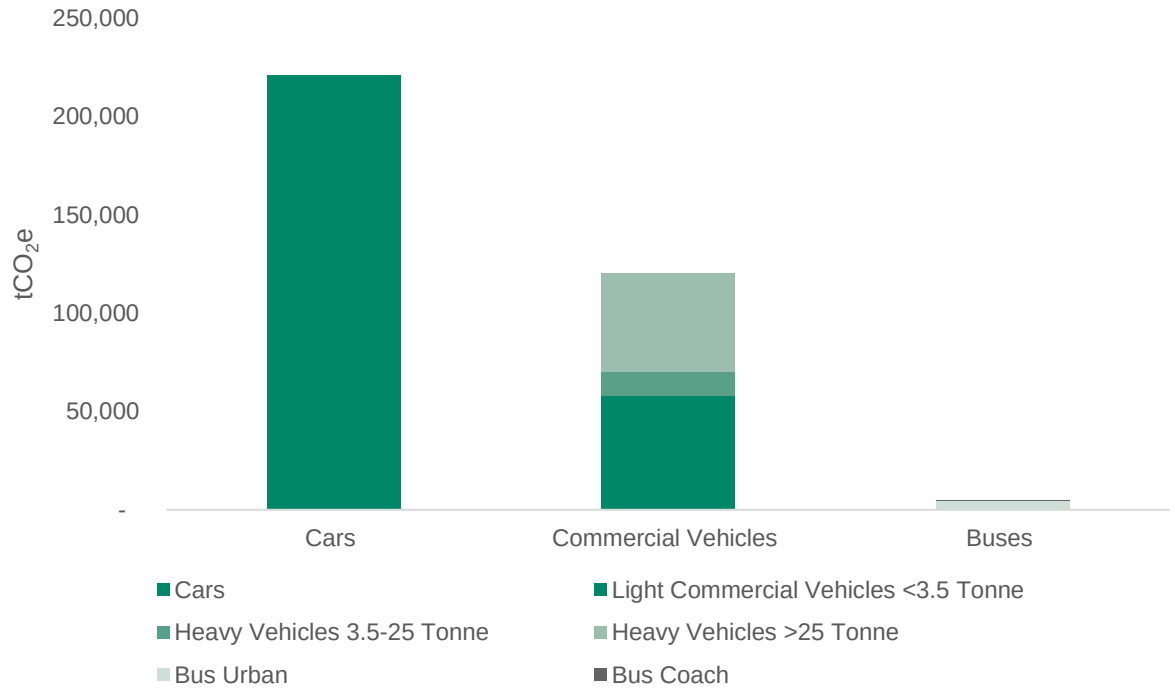

Figure 2 On-road transport emissions by vehicle class in FY23

Alongside total emissions, emissions have also been compared to distance travelled by different vehicle types. Table 3 shows the emissions per vehicle class as above but also includes the VKT by each vehicle class in Wellington City and shows the average emissions per VKT for each vehicle class.

Of note:

- Cars represent 71% of all VKT in Wellington City but represent 64% of all on-road emissions in Wellington City. This is due to the relatively low average tCO_2e per VKT of cars compared to heavier vehicles (which is also partly due to the use of petrol rather than diesel for cars).
- 25-50+ tonne commercial vehicles represent 7% of all VKT in Wellington City but represent 14% of all on-road emissions in Wellington City. This is due to the higher average tCO_2e per VKT of heavy vehicles compared to lighter vehicles.

These figures do not consider the weight of freight, or the number of people being moved per vehicle, where larger vehicles may be more efficient per tonne of freight moved than smaller vehicles, or where busses may be more efficient per person than cars.

Efforts to reduce the kilometres travelled by all vehicles should be considered to reduce emissions from on-road transport. This could include enabling and encouraging increased public transport use or diverting freight from roads onto rail and marine transport options. Efforts to improve the fuel efficiency of all vehicles should also be considered.

Table 3 On-road transport vehicle class VKT, emissions, and calculated average emissions per VKT

Vehicle Type	Vehicle Kilometres Travelled (VKT)	GHG Emissions (tCO_2e)	Average tCO_2e per VKT
Cars	863,849,702	220,730	0.0003
Light Commercial Vehicles <3.5 Tonne	223,252,975	57,757	0.0003
Heavy Vehicles 3.5-25 Tonne	42,544,630	12,705	0.0003
Heavy Vehicles 25-50+ Tonne	79,215,122	50,069	0.0006
Bus Urban 15-18 Tonne	6,182,348	4,553	0.0007
Bus Coach >18 Tonne	938,343	434	0.0005
Total	**1,215,983,120**	**346,248**	**0.0003**

4.0 On-Road Transport Emissions Change from FY19 to FY23

This section displays the change in on-road transport emissions from FY19 to FY23. During this period on-road transport emissions decreased by 1% (1,966 tCO_2e).

COVID-19 restrictions impacted the FY20 and FY22 years, decreasing annual emissions from on-road transport by 7% and 9% respectively compared to the year before. Emissions from on-road transport rebounded by 4% and 13% respectively following these COVID-19 affected years to pre-COVID-19 levels.

Table 4 Change in on-road transport emissions by vehicle type (tCO_2e)[5]

Vehicle Type	FY19	FY20	FY21	FY22	FY23	% Change (FY19 to FY23)
Cars	231,271	211,311	219,984	198,596	220,847	**-5%**
Commercial Vehicles	111,109	107,206	111,455	103,685	120,531	**8%**
Buses	5,951	5,305	5,182	4,837	4,987	**-16%**
Total	**348,331**	**323,821**	**336,621**	**307,119**	**346,365**	**-1%**

[5] The on-road transport total displayed here and in the following tables includes electric vehicles which are not included in the on-road transport figure in the Wellington City Emissions Inventory as electricity use is included in the Stationary Energy sector.

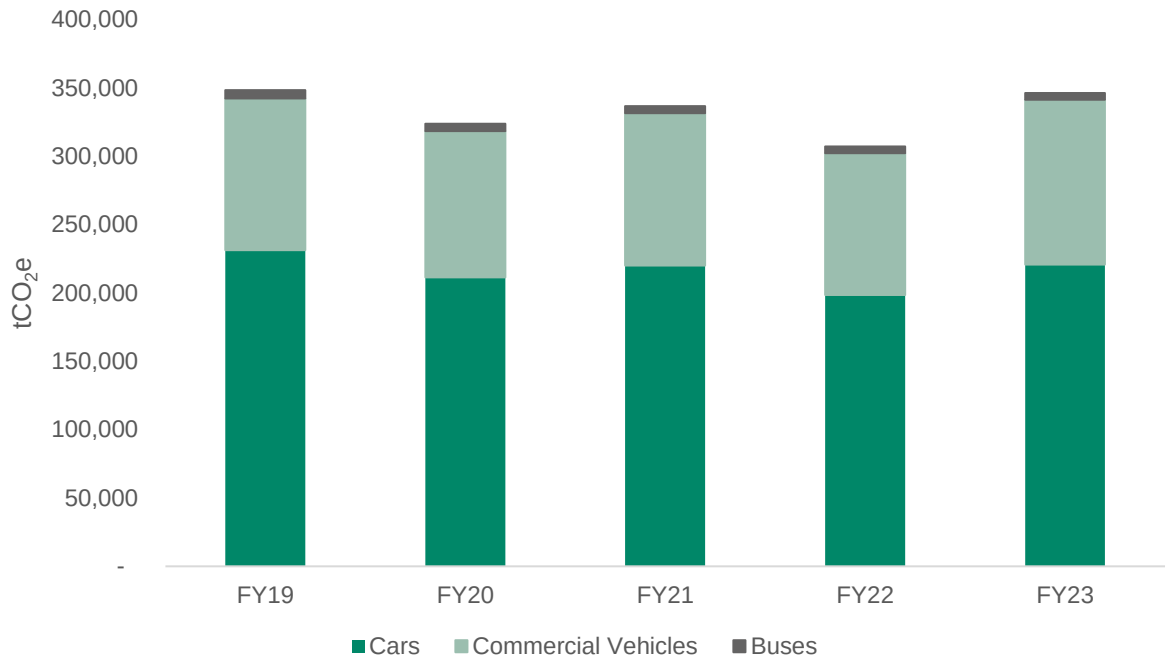

Figure 3 On-road transport emissions by vehicle type FY19-FY23

The results show that the main cause of decreased on-road transport emissions between FY19 and FY23 is a 5% reduction in car emissions (10,424 tCO_2e). We can see the impact of COVID-19 travel restrictions in Wellington City in FY20 and FY22, particularly affecting car emissions. During these years there were periods of restricted travel. Commercial vehicle emissions appear to have been slightly less affected by the COVID-19 restrictions.

Notable changes when examining on-road emissions changes in more detail (Table 5):

- The on-road transport emissions reduction was driven by a 5% (9,020 tCO_2e) reduction in petrol car emissions. This is followed by light commercial vehicles where emissions decreased by 13% (8,888 tCO_2e). Car diesel emissions also decreased, by 22% (4,633 tCO_2e).
- The most significant emissions increase was a 41% (18,310 tCO_2e) increase in heavy vehicle emissions.
- There was also a proportionally large increase in electric and hybrid vehicles of 437% and 166% respectively. There has been a large growth in the number of these vehicles in Wellington City and emissions have grown in line with this increase. However, these vehicles still represent a very small proportion of on-road emissions and are vastly lower emitting than the equivalent internal combustion engine vehicles. This may have contributed to the reduced car emissions in Wellington City, alongside other changes such as improvements in fuel efficiency, and transport mode shift.
- There was a 16% decrease in emissions from buses likely due to a transition from diesel buses to electric buses in Wellington City.

Table 5 Change in on-road transport emissions by vehicle class (tCO_2e)

Vehicle Type	FY19	FY20	FY21	FY22	FY23	% Change (FY19 to FY23)
Car Petrol	208,588	191,291	200,423	179,861	199,568	**-4%**
Car Diesel	20,896	17,991	16,886	15,317	16,263	**-22%**
Car Hybrid	1,693	1,892	2,499	3,168	4,511	**166%**
Car Electric	94	137	176	251	504	**437%**
Light Commercial Vehicles	66,645	59,164	57,673	52,247	57,757	**-13%**
Heavy Commercial Vehicles	44,464	48,042	53,782	51,438	62,774	**41%**
Buses	5,951	5,305	5,182	4,837	4,987	**-16%**
Total	**348,331**	**323,821**	**336,621**	**307,119**	**346,365**	**-1%**

5.0 Limitations

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