Whanganui Community Carbon Footprint 2019

August 2020

horizons
REGIONAL COUNCIL

Prepared for:

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Executive Summary

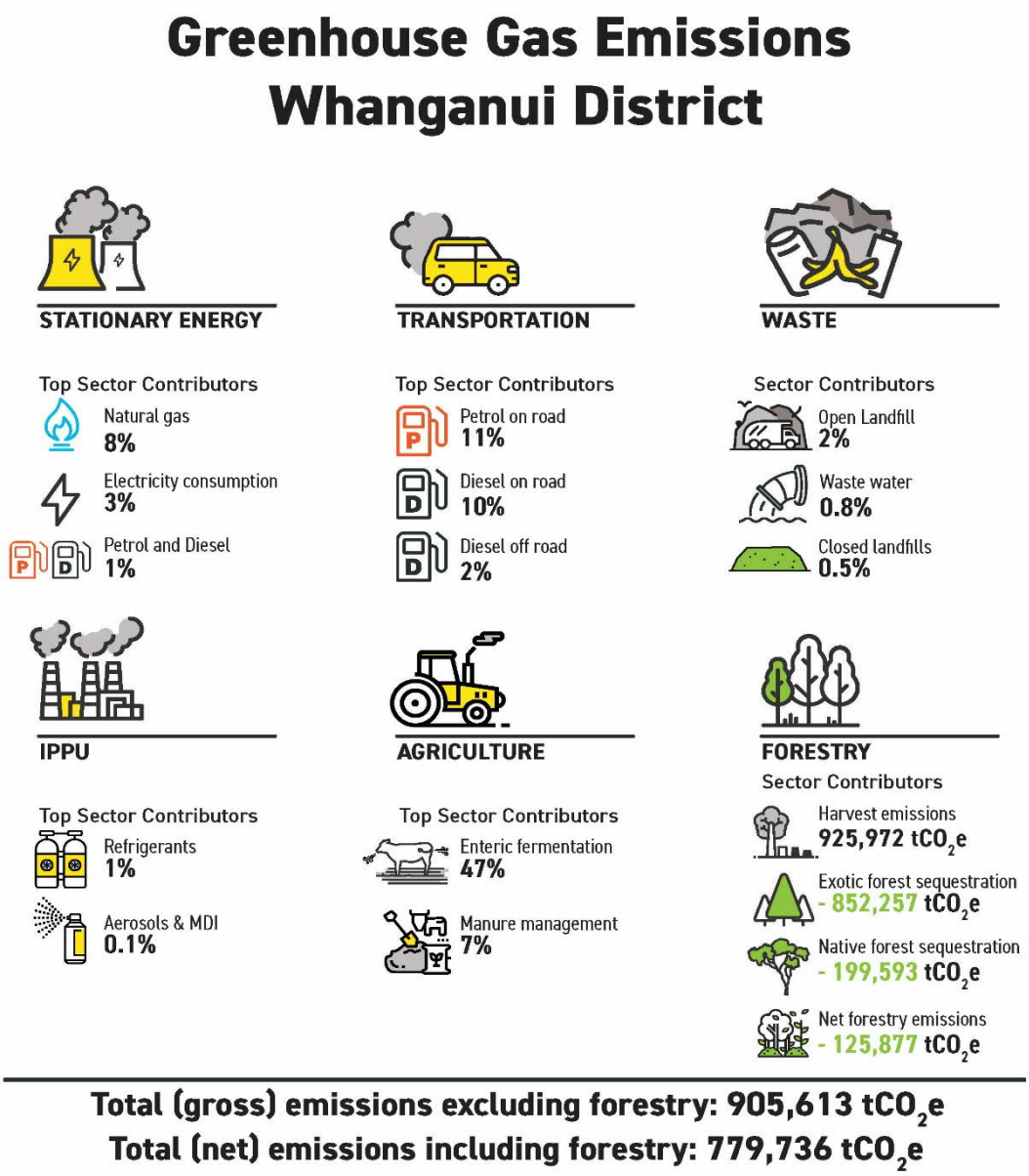
Greenhouse Gas (GHG) emissions for the Whanganui Territorial Authority have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC). The method includes emissions from stationary energy, transportation, waste, industry (IPPU), agriculture and forestry sectors.

This document reports greenhouse gas emissions produced in, or resulting from activity or consumption, within the geographic boundaries of Whanganui Territorial Authority for the 2018/19 financial reporting year, referred to hereafter more commonly as 2019 for ease. Whanganui Territorial Authority is referred to hereafter as Whanganui. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e). The results of the community carbon footprint are summarised in Figure 1.

Major findings from the 2019 Emissions Inventory:

- In the 2019 reporting year, Whanganui emitted **gross 905,613 tCO_2e**.
- Agriculture (e.g. emissions from livestock and crops) is the largest emitting sector in Whanganui, representing 57% of total gross emissions, with sheep and cattle accounting for 98% of agricultural emissions. Transport (e.g. road, rail, and air travel) is the second largest source of emissions, accounting for 24% of total gross emissions, with petrol and diesel (on and off-road) accounting for 99% of transport emissions. Stationary Energy (e.g. consumption of electricity and natural gas) is the third highest emitting sector in Whanganui, producing 15% of total gross emissions.
- After consideration of carbon sequestration (carbon captured and stored in plants or soil by forests) and emissions from the forestry sector, Whanganui emitted **net 779,736 tCO_2e** emissions. Carbon sequestration from forests in Whanganui totalled 1,051,850 tCO_2e in 2019 while emissions produced by harvesting of forestry totalled 925,972 tCO_2e.

Figure 1 Summary of change in emissions in Whanganui 2018/19 including top contributors to total gross emissions from each sector in 2018/19



1.0 Introduction

AECOM New Zealand Limited (AECOM) has been commissioned by Horizons Regional Council (HRC) to assist in the development of a greenhouse gas footprint for the Region and each territorial authority in the Region for the 2018/19 (2019) financial year. The study boundary incorporates the jurisdiction of Whanganui Council.

2.0 Approach to Analysis

The methodological approach used to calculate emissions follows the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) published by the World Resources Institute (WRI) 2015. The GPC includes emissions from stationary energy, transport, waste, industry, agriculture and forestry activities within Whanganui's boundary. The sector calculations for Agriculture, Forestry, Solid Waste and Wastewater 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 guidance published by the WRI for emissions measurement when needed. Data are reported in the GPC sectors, and per activity/emission source, using the format recommended by the GPC.

The same methodology has been used for other community scale greenhouse gas (GHG) inventories around New Zealand, (e.g. Wellington, Auckland, Christchurch, Dunedin, Tauranga and Southland) and internationally. The GPC methodology[1] represents international best practice for city and regional level GHG emissions reporting.

This 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 (Scope 2). All other indirect emissions such as cross-boundary travel (e.g. rail and flights), and energy transportation and distribution losses fit into Scope 3.

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

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedbacks using the 100-year Global Warming Potential (GWP) values[2]. Climate change feedbacks are the climate change impacts from GHGs that are increased or decreased 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 GHG's.
- GPC reporting is 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 comparison between different studies. Production-based approaches generally exclude globally produced emissions relating to consumption (e.g. embodied emissions relating to products produced elsewhere but consumed within the geographic area).
- Total emissions are reported as gross emissions (excluding forestry) and net emissions (including forestry)
- Where location specific data was not accessible, information was calculated via a per capita break-down of national or regional level data.

[1] http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities
[2] https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (Table 8.7)

- Emissions for individual main GHG gases are provided in the supplementary spreadsheet information supplied with this report.
- Transport emissions:
  - Transport emissions associated with air, rail and port activity were calculated using the induced activity method. Fuel consumption data was determined from the number of journeys taken, distance travelled and consumption rates for the appropriate transport mode.
- Solid Waste
  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day. Solid waste emissions were calculated for the currently operating landfill sites at Bonny Glen and Levin. In the years prior to each landfill site's operation we have allocated the remaining waste volume to 'Closed landfill sites'.
- Wastewater emissions:
  - Emissions have been calculated based on the data provided following IPCC 2006 guidelines. Where data is missing, IPCC and MfE provided figures have been used. Wastewater emissions from individual septic tanks have been calculated.
  - Wastewater emissions include those released directly from wastewater treatment, flaring of captured gas and from discharge onto land/water.
- Industrial emissions
  - Due to data confidentiality, the inventory reports all the known industrial product use emissions as one single value and does not break-down emissions by product type. The availability of emissions associated with industry is also restricted due to confidentiality issues and constraints in communication from relevant stakeholders.
  - Industry and solvent related emissions are estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2017 report (MfE 2019). Emissions are estimated on a per capita basis applying a national average per person.
- Forestry emissions:
  - This inventory accounts for forest carbon stock changes from afforestation, reforestation, deforestation and forest management (i.e. it applies land-use accounting conventions under the UN 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 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 GHG inventory have been provided to HRC in calculation table spreadsheets. All assumptions made during data collection and analyses have been detailed within **Appendix B – Assumptions**.

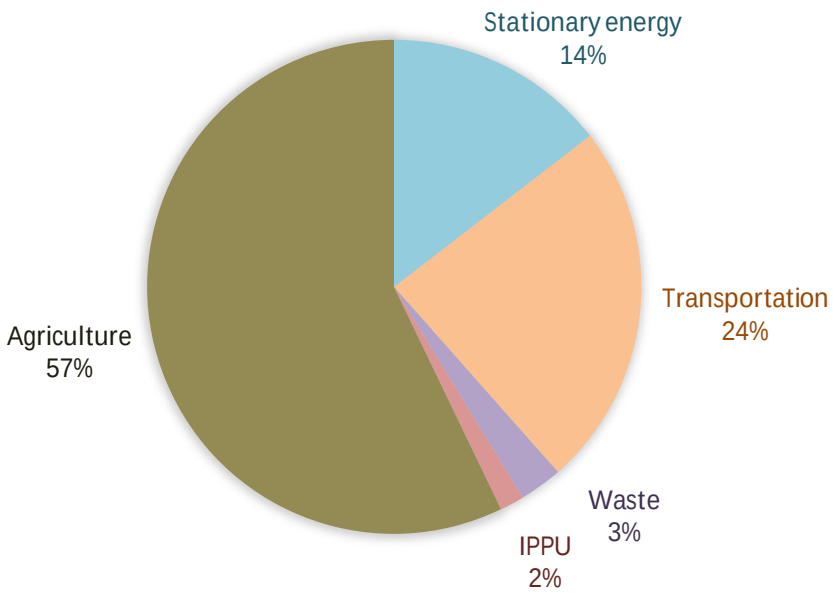
3.0 Overall Results

The paragraphs, figures and tables below explain the overall emissions and emissions from each sector. The focus of the information presented are the gross emissions produced in Whanganui. Reporting of gross emissions informs and enables local action to address emissions.

Discussion of per capita emissions is limited to when it is useful for comparing emission figures across with other geographic areas. Net emissions including results from forestry resources are reported separately.

During 2019, Whanganui emitted **gross 905,613 tCO_2e** and **net 779,736 tCO_2e** emissions. The population in 2019 was approximately **47,000** people, resulting in per capita gross emissions of **19.3 tCO_2e/person.** Agricultural emissions are the largest contributor to the inventory for Whanganui, followed by Transport (refer to Figure 2 and Table 1).

Figure 2 Whanganui's GHG emissions gross emissions split by sector (tCO_2e)



The carbon footprint inventory comprises emissions for six different sectors, summarised below:

Stationary Energy: Producing 131,788 tCO_2e in 2019, stationary energy was Whanganui's third highest emitting sector (14.6% of total gross emissions). Electricity consumption was the cause of 26% of stationary energy emissions (34,258 tCO_2e, or 4% of total gross emissions). Natural gas consumption was the cause of 61% of stationary energy emissions (79,777 tCO_2e, or 9% of total gross emissions). Petrol and diesel consumption used for stationary energy was the cause of 8% of stationary energy emissions (10,904 tCO_2e, or 1% of total gross emissions). Stationary uses of LPG, coal and biofuel produced the remaining 5% of stationary energy emissions (6,849 tCO_2e).

Stationary energy demand is broken down by fuel type, and also by the sector in which it is consumed. Stationary energy demand is reported for the following sectors: industrial (which includes agriculture, forestry and fishing); commercial; and residential. Additional 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.

- Residential stationary energy consumption accounts for 15% of stationary energy emissions (19,576 tCO_2e) and 2% of total gross emissions. Residential stationary energy is energy used in homes (e.g. for heating, lighting and cooking).

- Commercial stationary energy consumption accounts for 17% of stationary energy emissions (21,902 tCO_2e) and 2% of total gross emissions. Commercial stationary energy is energy used in all non-residential and non-industrial settings (e.g.in retail, hospitality, education and healthcare).
- Industrial stationary energy consumption accounts for 60% of stationary energy emissions (79,406 tCO_2e) and 9% of total gross emissions. Industrial stationary energy is energy used within all industrial settings (e.g. mining, food processing, textiles and building and construction activities), and includes agriculture, forestry and fishing activities.
- The remaining 8% of stationary energy emissions (10,904 tCO_2e, 1% of gross emissions) were produced by diesel and petrol, which were not allocated to the above categories. Stationary Energy uses of diesel and petrol include use in stationary generators and motors and for heating.

Transportation: The second highest emitting sector, transport, produced 216,588 tCO_2e in the reporting year (23.9% of Whanganui's gross total emissions). Almost all of these emissions can be attributed to Petrol and Diesel used for transport, which produced a total of 214,475 tCO_2e (99% of the sector's emissions and 24% of total gross emissions). The rest of the transport emissions are produced by air, rail, LPG and port activities totalling 2,113 tCO_2e (1% of the sector's total emissions and 0.2% of total gross emissions).

Waste (solid & wastewater): Waste originating in Whanganui (solid waste and wastewater) produced 25,739 tCO_2e in 2019 which comprises 2.8% of Whanganui's total gross emissions. Solid waste produced 18,558 tCO_2e in 2019, making up 72% of total waste emissions. Wastewater produced the remaining 28% of waste emissions (7,181 tCO_2e).

Solid waste emissions include emissions from open landfills and closed landfills. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill. Open landfills contributed 14,317 tCO_2e (2% of Whanganui's total gross emissions). Closed landfills emitted 4,241 tCO_2e (0.5% of Whanganui's total gross emissions).

Wastewater produced 7,181 tCO_2e making up 28% of total waste emissions (0.8% of Whanganui's total gross emissions). Wastewater tends to be relatively small emission source compared to solid waste as advanced treatment of wastewater produces low emissions. In contrast, solid waste generates methane gas over many years as organic material enters landfill and emissions depend on the efficiency and scale of landfill gas capture.

Industrial Processes and Product Use (IPPU): This sector includes emissions associated with the consumption of GHGs for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and Sulphur Hexafluoride for electrical insulation and equipment production. The IPPU sector also includes emissions associated with industrial activity within Whanganui, which due to confidentiality of data, are reported as a single value. 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 due to the difficulty of allocating emissions to particular geographic locations. Addressing IPPU emissions is typically a national policy issue.

IPPU in Whanganui produced 14,177 tCO_2e in 2019, contributing 1.6% to the area's total gross emissions. 92% of IPPU emissions (13,103 tCO_2e) are the result of the use of refrigerants.

Agriculture: The highest emitting sector, agriculture, emitted 517,321 tCO_2e in 2019, 57.1% of Whanganui's total gross emissions. Agricultural emissions are the result of both crop and livestock farming. Livestock farming emitted 99% of agricultural emissions. Sheep are farmed in the largest numbers across the area, accounting for 86% of farmed livestock (569,923 animals) and 54% of agricultural emissions. Cattle make up 13% of farmed livestock (83,063 animals) and 44% of agricultural emissions.

Enteric fermentation produced 82% of Whanganui's agricultural emissions (423,295 tCO_2e), with dairy cattle, non-dairy cattle and sheep emitting the vast majority of these emissions (16%, 28%

and 55% respectively). The second highest source of agricultural emissions were produced from N_2O released by manure from grazing animals on pasture (63,253 tCO_2e or 12% of the sector), with dairy cattle, non-dairy cattle and sheep emitting the vast majority of these emissions (17%, 25% and 58% respectively). A breakdown of agricultural emissions by source is shown in Table 6 in Appendix A.

Forestry: Whanganui has a regenerative native forested area which includes Gorse, Broom, Manuka, Kanuka, Mixed Exotic Shrubland and Broadleaved Hardwoods. Regenerating natives occupy 30,535 ha with exotics occupying a further 22,453 ha of land. In total, 1,051,850 tCO_2e were sequestered by forests in Whanganui in 2019.

Of the total sequestered CO_2, native forests sequestered 199,593 tCO_2e while exotic forests sequestered 852,257 tCO_2e in 2019. Forest harvesting releases carbon stored in forests in the form of carbon dioxide. Harvesting of forestry in Whanganui in 2019 produced 925,972 tCO_2e.

Table 1 Summary of gross emissions split by Sector and associated sub-categories

Sector	tCO_2e	% Gross	% Sector
Stationary Energy			
Electricity Consumption	31,658	3.5%	24.0%
Electricity T&D Loss	2,600	0.3%	2.0%
Natural Gas	68,798	7.6%	52.2%
Natural Gas T&D Loss	10,980	1.2%	8.3%
LPG	3,489	0.4%	2.6%
Stationary Petrol & Diesel Use	10,904	1.2%	8.3%
Coal	2,597	0.3%	2.0%
Biofuel / Wood	763	0.1%	0.6%
Total:	131,788	14.6%	100%
Transportation			
Petrol	105,045	11.6%	48.5%
Diesel	109,430	12.1%	50.5%
Rail Emissions	730	0.1%	0.3%
Jet Kerosene	1,176	0.1%	0.5%
Aviation Gas	120	<0.1%	0.1%
Marine Diesel	3	<0.1%	<0.1%
LPG	84	<0.1%	<0.1%
Total:	216,588	23.9%	100%
Waste			
Open landfill	14,317	1.6%	55.6%
Closed landfill	4,241	0.5%	16.5%
Wastewater	7,181	0.8%	27.9%
Total	25,739	2.8%	100%
IPPU			
Industrial Emissions	14,177	1.6%	100%
Total	14,177	1.6%	100%
Agriculture			
Enteric Fermentation	423,295	46.7%	81.8%
Manure from Grazing Animals	63,253	7.0%	12.2%
Other Agriculture	30,772	3.4%	5.9%
Total	517,321	57.1%	100%
Forestry			
Exotic Forest Sequestration	- 852,257	N/A	N/A
Native Forest Sequestration	- 199,593	N/A	N/A
Harvest Emissions	925,972	N/A	N/A
Total	- 125,877	N/A	100%
Total (net) incl. forestry	**779,736**		
Total (gross) excl. forestry	**905,613**		

3.1 Biogenic emissions

Biogenic CO_2 and methane emissions are stated in Table 2 and Table 3, respectively.

Biogenic CO_2 emissions from plants and animals are excluded from gross and net emissions as they are part of the natural carbon cycle. For example, as wood biofuels originate from forestry the Biogenic CO_2 from biofuels is excluded from gross emissions.

Biogenic CH_4 emissions are included in gross emissions due to their relatively large impact on warming relative to Biogenic CO_2. For example, farmed cattle produce Biogenic CH_4 emissions, via enteric fermentation, that are included in gross emissions.

The importance of Biogenic CH_4 is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes targets to reduce Biogenic CH_4 by between 24 percent and 47 percent below 2017 levels by 2050, and a 10 percent reduction 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 2 Biogenic CO_2 (Excluded from gross emissions)

Biogenic CO_2 (Excluded from gross emissions)		
Biofuel	8,032	t CO_2
Biodiesel	-	t CO_2
Landfill Gas	4,580	t CO_2
Total biogenic CO_2	**12,612**	**t CO_2**

Table 3 Biogenic Methane (Included in gross emissions)

Biogenic Methane (Included in gross emissions)		
Biofuel	20	t CH_4
Biodiesel	-	t CH_4
Landfill Gas	420	t CH_4
Wastewater Treatment	194	t CH_4
Enteric Fermentation	12,450	t CH_4
Manure Management	327	t CH_4
Total biogenic CH_4	**13,411**	t CH_4

3.2 Net emissions

Net emissions differ from gross emissions because they include emissions related to forestry activity within an area. Emissions from forestry include two main types of activity. Harvesting of forest increases emissions via the use of fuel by equipment and releasing carbon from plants and soils. Planting of native forest e.g. Manuka, Kanuka, and exotic forest e.g. pine, sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. When sequestration by forests exceeds emissions from harvesting the extra quantity of carbon sequestered by forest reduces total gross emissions.

Overall, forestry is a net negative source of emissions of 125,877 tCO_2e due the sequestration of carbon mostly by exotic forest (see Figure 3). The net-negative emissions from forestry reduce gross emissions by 14% to a total of 779,736 tCO_2e (total net emissions). Figure 4 shows gross emissions versus net emissions in 2019 and the impact of sequestration by Forestry.

Figure 3 Horizons Region's forestry harvest emissions, forestry sequestration and net forestry emissions (tCO_2e)

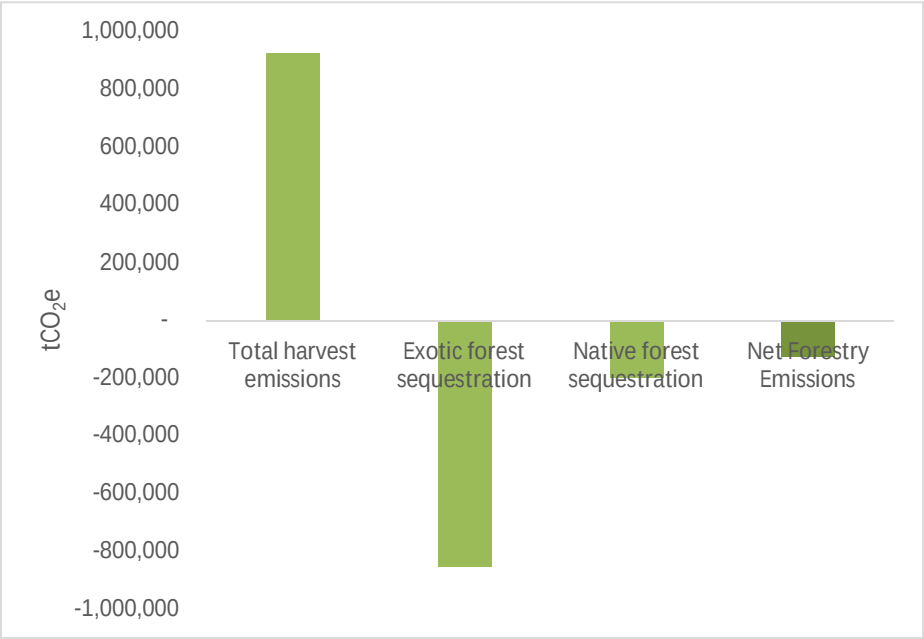
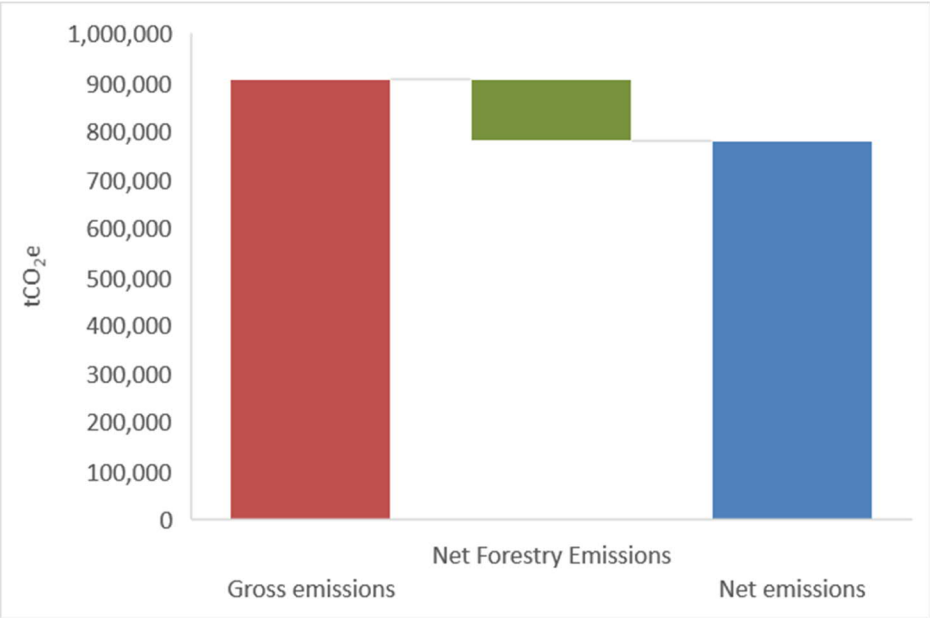


Figure 4 Horizons Region's Gross and Net emissions including net forestry emissions (tCO_2e)



Carbon sequestered by forestry can be viewed as a liability/risk needing careful consideration. For example, what happens if there is large downturn in exports of exotic pine? If plantations are not replanted or other land use change occurs to exotic forested areas, then emissions will quickly rise. Equally, if native forest is not protected from removal, and removal does happen, then emissions will rise. In summary, when a large of amount of carbon is captured by forests, long-term planning is needed on how best to manage this carbon sink.

3.3 Comparison with other territorial authorities in the region

Table 4 shows gross emission results across the Horizons Region. Whanganui contributed to 11% of the Horizons Region's total gross emissions for the 2019 reporting year.

Whanganui had the third highest population, and the joint second lowest emissions in the region. The relatively low total emissions were due to much smaller agricultural emissions and relatively low transport emissions. Whanganui had the lowest per capita transport emissions and second lowest agricultural emissions in the Region resulting in the second lowest per capita emissions.

Table 4: Gross emissions in the Horizons Region, by territorial authority

	Horowhenua	Manawatū	Palmerston North	Rangitīkei	Ruapehu	Tararua	Whanganui
Total Gross Emissions (tCO_2e)	819,053	1,419,704	905,802	1,519,421	1,203,611	1,752,405	905,613
% of Region Gross Emissions	10%	17%	11%	18%	14%	21%	11%
Total Gross Emissions Per Capita (tCO2e)	23.6	45.2	10.3	97.2	94.8	94.3	19.3

Figure 5 Breakdown of gross emissions between the cities and districts in the Horizons Region (tCO_2e)

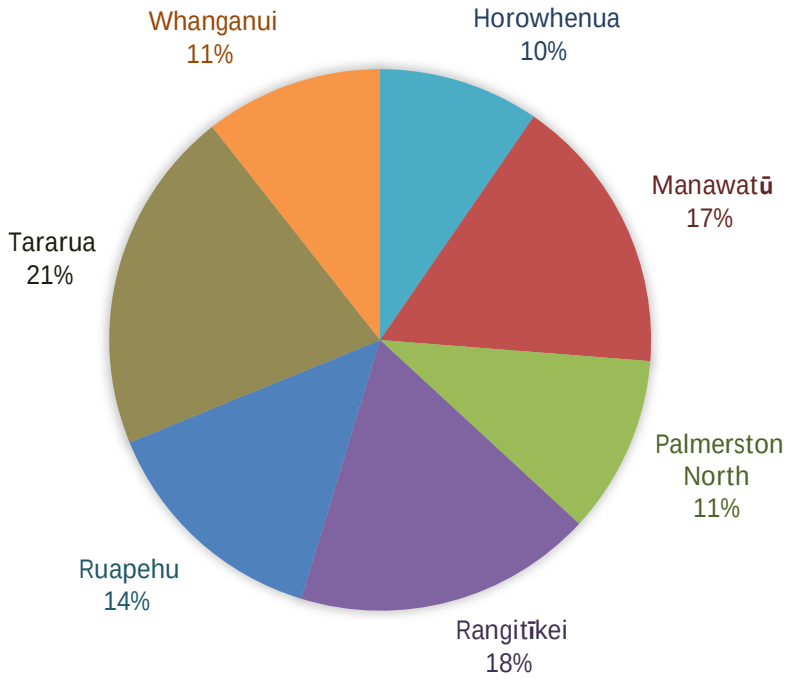


Figure 6 Total gross emissions in the Horizons Region, by sector (tCO_2e)

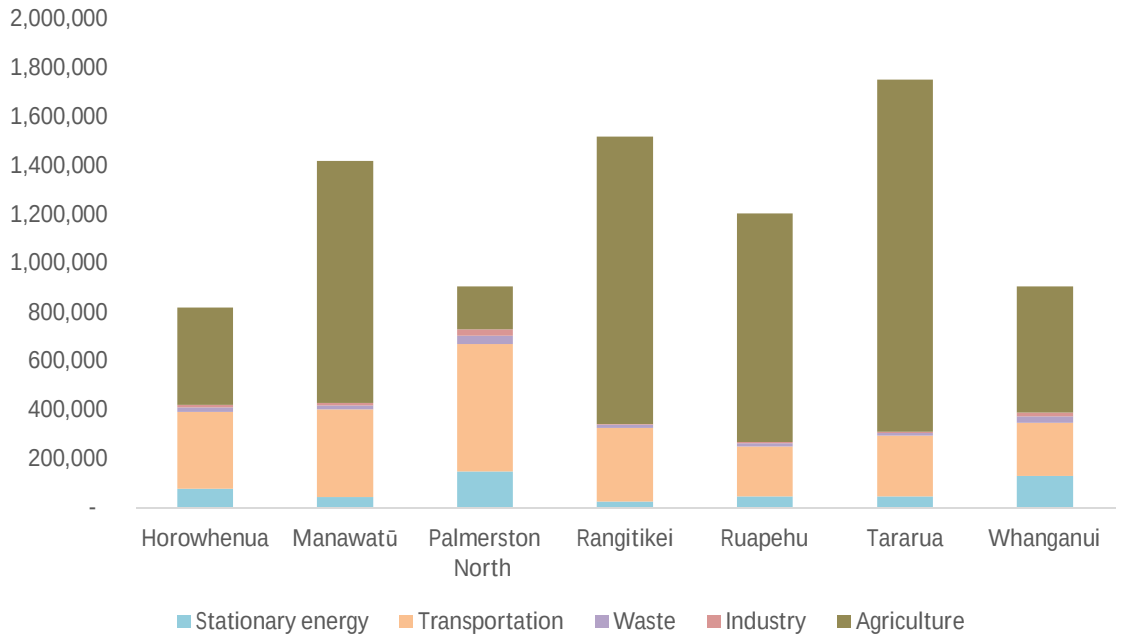


Table 5 shows net emissions including sequestration from forestry and emissions from the forestry sector. Net emissions can produce a widely different pattern of results across the region than gross emissions. For example, net emissions for Ruapehu, which has the one of the highest gross emissions, are lower than all other territorial authorities due to high levels of sequestration from forests in the area.

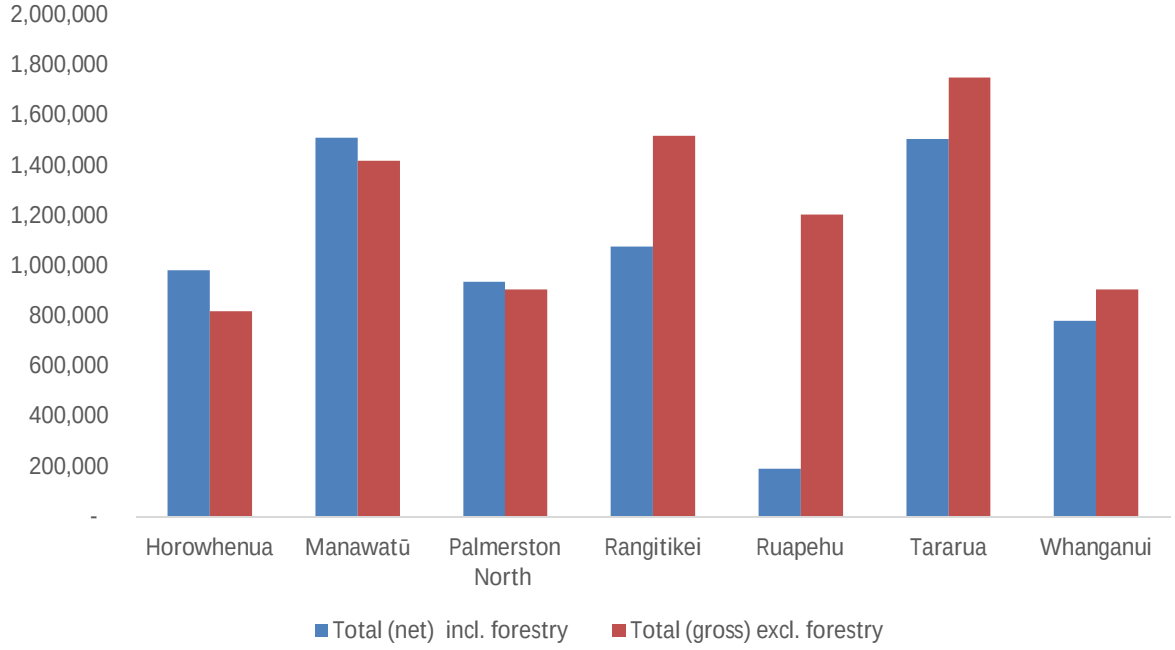
Table 5 Net emissions (incl. forestry) in the Horizons Region, by territorial authority

	Horowhenua	Manawatū	Palmerston North	Rangitīkei	Ruapehu	Tararua	Whanganui
Total Net Emissions (tCO_2e)	983,864	1,512,606	936,737	1,077,814	192,008	1,505,774	780,544
% of Region Net Emissions	14%	22%	13%	15%	3%	22%	11%

The influence of forest sequestration of carbon, and forestry emissions, on gross emissions across the Horizons Region, can be seen clearly in Figure 7.

In Rangitīkei, Ruapehu, Tararua and Whanganui, forest sequestration of carbon was greater than the carbon released through forest harvesting in 2019, this meant that total net emissions were lower than total gross emissions. In Horowhenua, Manawatū and Palmerston North, carbon emissions from forest harvesting were greater than the carbon sequestered from forests in 2019, therefore total net emissions were higher than total gross emissions.

Figure 7 Gross emissions and net emissions (incl. forestry) in the Horizons Region (tCO_2e)

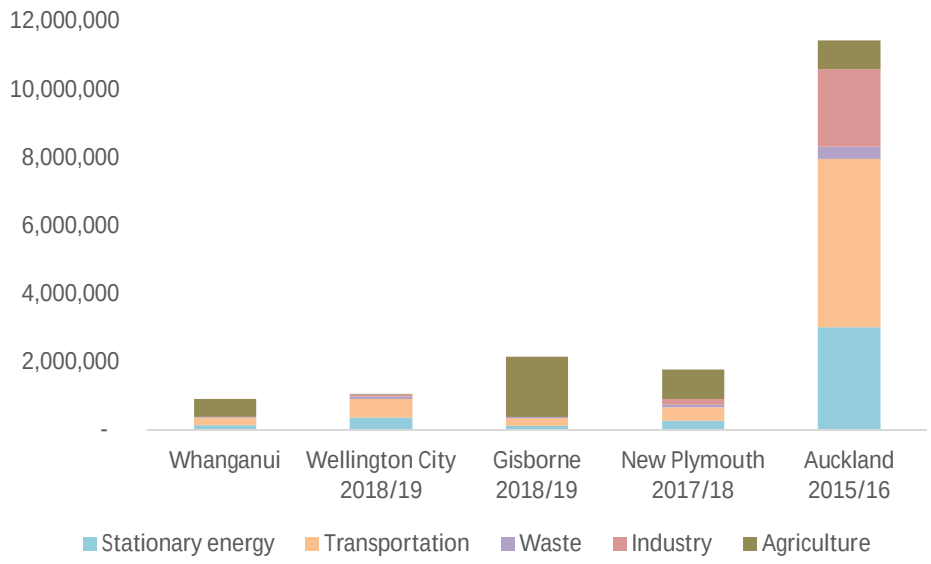


4.0 Comparison with other areas in New Zealand

Figure 8 shows a comparison of gross emissions (excluding forestry) for Whanganui with other local authorities in New Zealand split by sector. These studies have been chosen to represent different areas of New Zealand and are all reported using the GPC approach. Note however, that these studies were conducted at differing geographic levels, in differing timeframes, with vastly different population numbers and with slight differences in methodology.

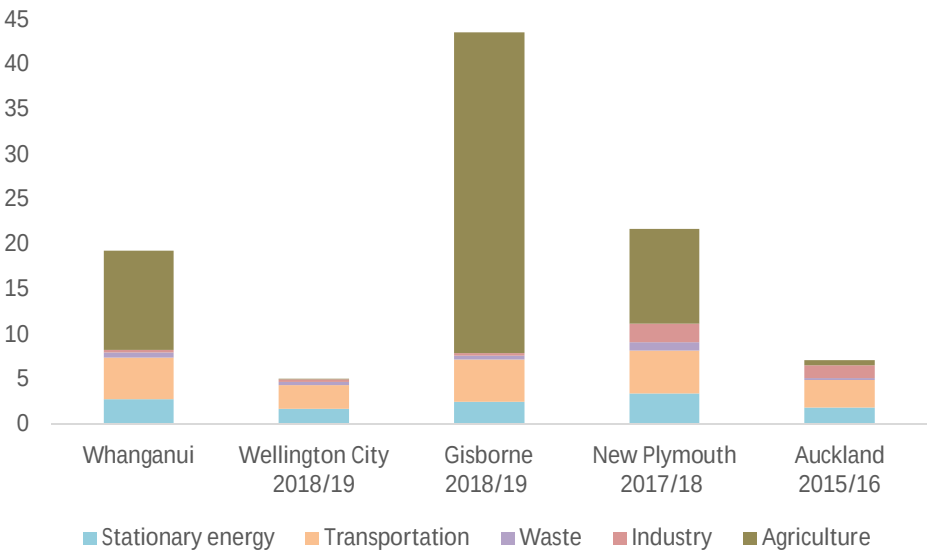
When compared, Whanganui had lower gross emissions than each of the compared areas.

Figure 8 A comparison of GHG emissions with other areas of New Zealand by gross emissions (tCO2e)



When comparing different regional carbon footprints, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. Whanganui has higher per capita gross emissions than the Wellington City, Tauranga and the Auckland Region, predominantly due to large agricultural emissions within Whanganui. Whanganui has lower total per capita gross emissions than the Gisborne Territorial Authority.

Figure 9 A comparison of GHG emissions with other areas of New Zealand on a per capita basis (tCO_2e)



5.0 Closing statement

Whanganui District Council's GHG inventory provides information for decision-making and action by the council, their stakeholders and the wider community.

The inventory of greenhouse gas emissions the council has developed covers emissions produced in the stationary energy, transport, waste, industry, agriculture and forestry sectors using the GPC reporting framework. Sector-level data allows the council to target and work with those sectors which contribute the most emissions to the footprint.

The agriculture and transport sectors represent the highest emitting sectors in the area, 57% and 24% respectively. Within these sectors, enteric fermentation from farmed livestock and on-road transport (petrol and diesel use) are the largest emissions sources, 47% and 22% respectively. Results clearly highlight the need to reduce the impact of greenhouse gas emissions from on-road travel and the agriculture sector to limit the area's contribution to global climate change.

Data quality and availability varies widely between the sectors. Higher quality data for aviation, solid waste and on-road transport would be beneficial in improving accuracy of the results of future inventories.

Understanding of the extensive and long-lasting effects of climate change is improving all the time. It is recommended that this emissions inventory is updated regularly to inform ongoing positive decision making to address climate change issues locally and globally.

6.0 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 2020 and July 2020** 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

Emissions Breakdown

Appendix A Emissions Breakdown

The pie charts below show a breakdown of the proportion of gross emissions from each sector and source.

Note: Emission sources lower than 1% of total emissions are not shown but can displayed, if needed.

Figure 10 Total gross emissions breakdown, by sector (tCO_2e)

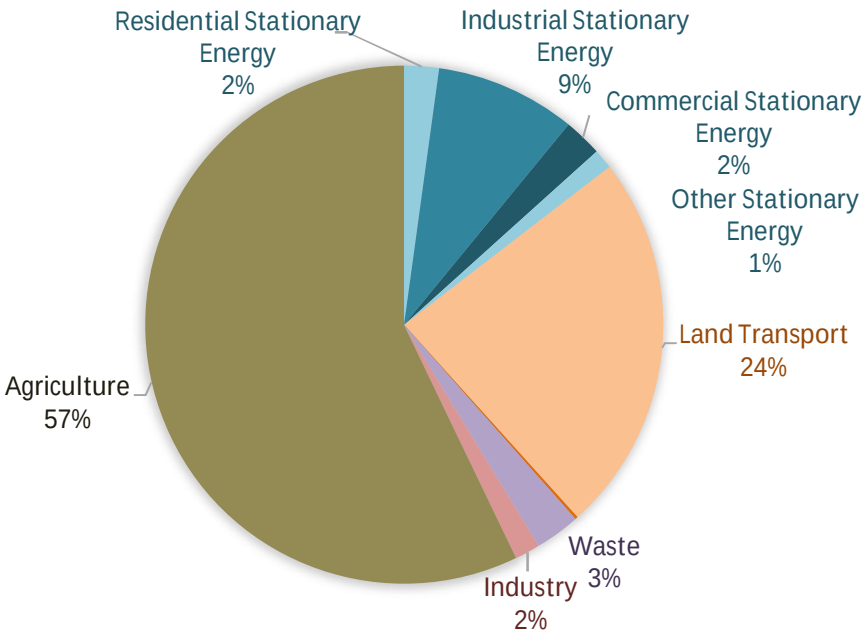

Figure 11 Total gross emissions breakdown, by source (tCO_2e)

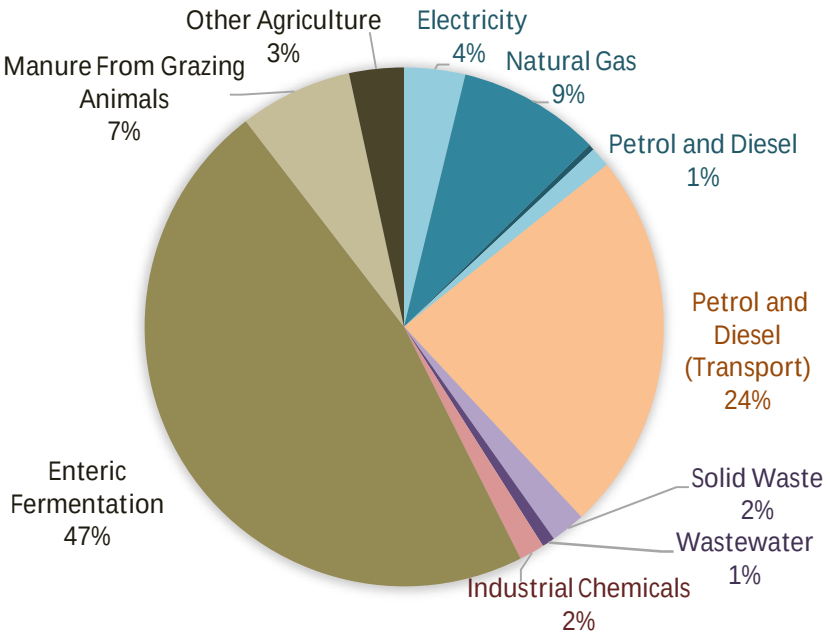

Figure 12 Total gross emissions breakdown, by fuel type source, highlighting stationary energy emissions (tCO_2e)

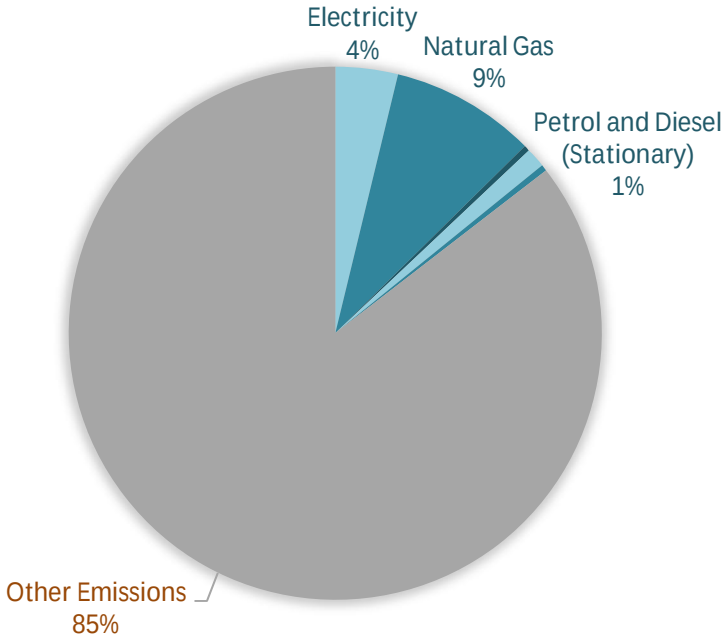

Figure 13 Total gross emissions breakdown, highlighting stationary energy emissions, showing source of stationary energy emissions (tCO_2e)

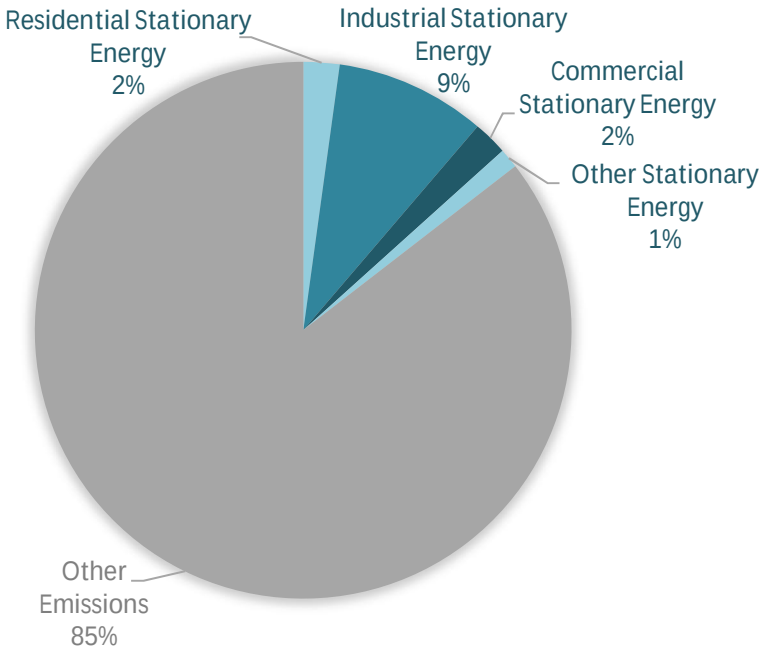

Figure 14 Total gross emissions breakdown, by source, highlighting transport emissions (tCO_2e)

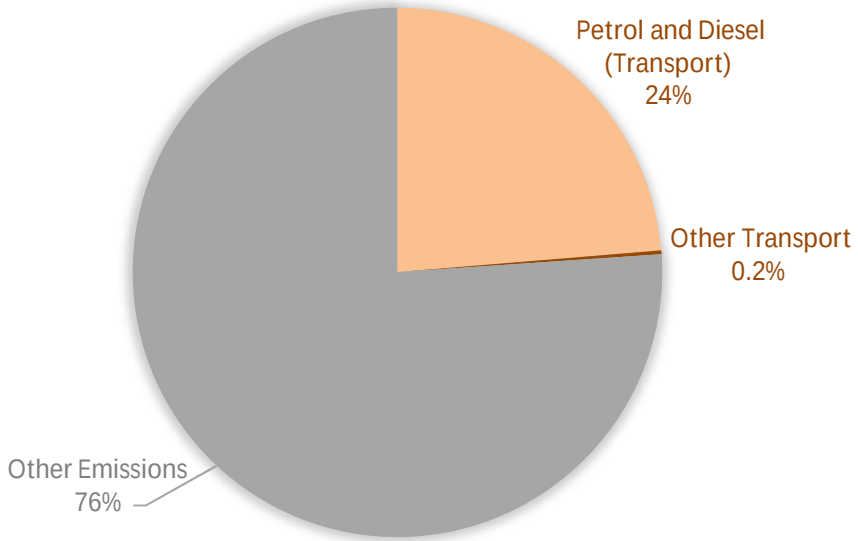

Figure 15 Total gross emissions breakdown, by source, highlighting agriculture emissions (tCO_2e)

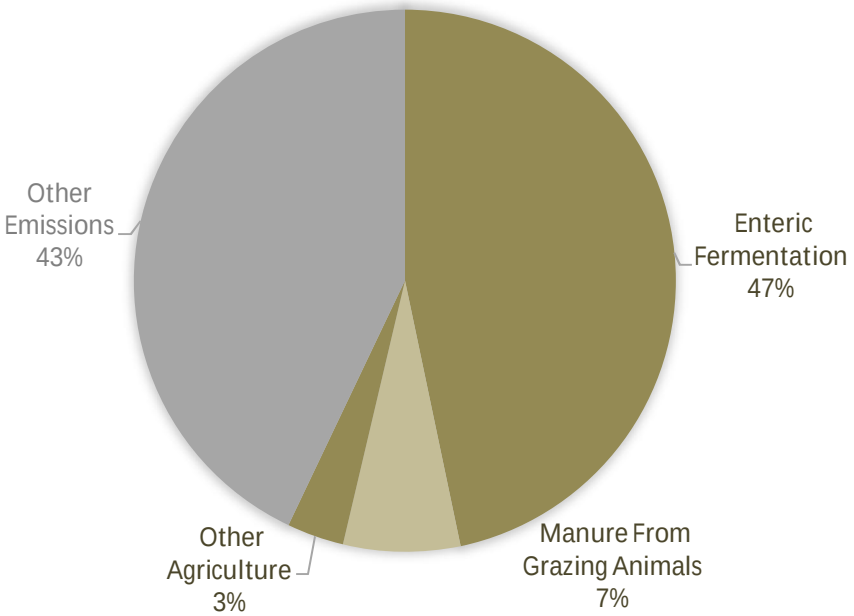

Table 6 Agricultural emissions, by source (tCO_2e)

Emission Source	tCO2e	% Sector
Dairy Cattle	88,651	17%
Non-Dairy Cattle	136,771	26%
Sheep	278,122	54%
Other Livestock	6,343	1%
Crops	7,311	1%
Other Agricultural Emissions	124	0%

Figure 16 Agricultural emissions, by source (tCO_2e)

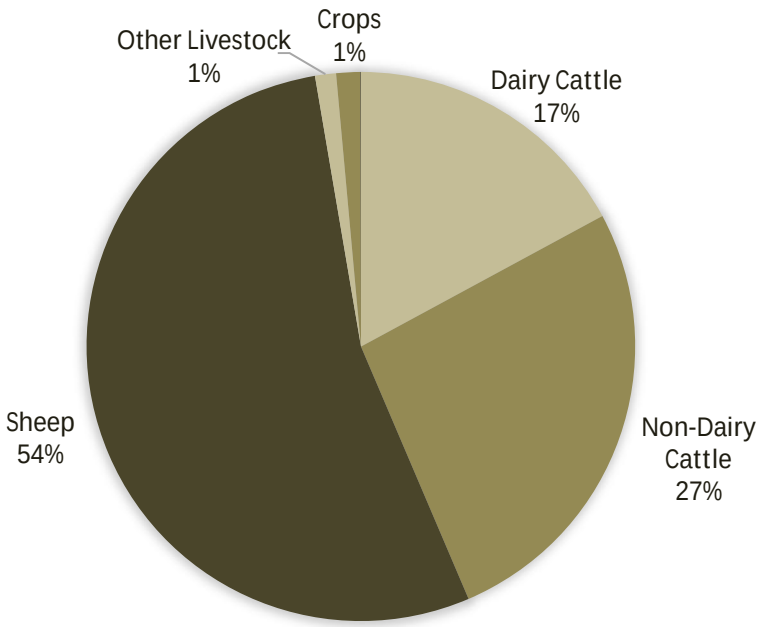

Table 7 Gross emissions, net emissions, per capita emissions and emissions per hectare for all districts within the Horizons Region (tCO_2e)

	Horowhenua	Manawatū	Palmerston North	Rangitīkei	Ruapehu	Tararua	Whanganui
Total Gross Emissions	819,053	1,419,704	905,802	1,519,421	1,203,611	1,752,405	905,613
Total Net Emissions	983,392	1,512,053	935,600	1,077,394	191,684	1,505,497	779,736
Total Gross Emissions per Capita	23.6	45.2	10.3	97.2	94.8	94.3	19.3
Total Gross Emissions per hectare	7.7	5.5	22.9	3.4	1.8	4.0	3.8

Basic and Basic+ emissions reporting (Global Covenant of Mayors)

BASIC and BASIC+ emissions reporting are standardised reporting methods used by the Global Covenant of Mayors for Climate and Energy for comparison of emissions with other cities around the world and to demonstrate the importance of regional-level climate action at a local and global scale. BASIC and BASIC+ emissions are reported as outlined in the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC).

BASIC emissions reporting excludes emissions from Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use and greenhouse gas emissions occurring outside the district boundary as a result of activities taking place within the regional boundary. BASIC+ emissions reporting includes those emissions excluded from BASIC emissions reporting (which is equal to the total gross emissions reported in this study).

Table 8 BASIC and BASIC+ emissions

	Emissions tCO_2e
BASIC	360,536
BASIC per capita	7.7
BASIC+	905,613
BASIC+ per capita	19.3

Appendix B

Assumptions

Nova Sector / Category	Assumption and Exclusions
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied
Transport Emissions	
Petrol and Diesel:	Petrol and diesel consumption have been 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. Data provided directly for Whanganui Territorial Authority.
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 carries 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 amount of 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. All rail emissions have been classified as Scope 3.
Jet Kerosene	Calculated using the Induced Activity method as per rail diesel. Palmerston North Airport has been treated as a regional airport serving a wider area than just Palmerston North City. Emissions from aircraft fuel connected to Palmerston North airport have been distributed between all territorial authorities in the region on a per capita basis.

	An estimate of fuel use was calculated for flights departing and arriving from Palmerston North Airport: - Previously obtained fuel use data for FY1617 has been updated and used for this study due to difficulty in obtaining more recent data. An additional scheduled route has been added to Napier since 2017 so this additional fuel use has been calculated and added to the 2016/17 figure. - Departures and arrivals information, and aircraft models, were used to calculate flight numbers, flight distances and fuel use. - All flight-path distances between Palmerston North and the destination / origin airport were calculated. - A density for kerosene of 0.81g/cm³ was applied to all trips. - Fuel Burn (kgCO_2e/km) for each model of aircraft was sourced where accessible. Where not available, the national inventory average figures were applied. - As per the induced activity method, only 50% of emissions calculated per one-way arrival and departure were allocated to Palmerston North Airport. The remaining 50% of each leg was allocated to the originating or destination airport. An estimate of fuel use for Whanganui Airport has also been calculated using the above methodology. Whanganui Airport is a small, local airport and so emissions have been allocated to the Whanganui Territorial Authority only. All aircraft fuel emissions have been classified as Scope 3. Scope 2 electricity use by airport / planes are incorporated within the general electricity consumption data for the territorial authority.
Aviation Gas	Aviation gas is mostly used by small aircraft for relatively short flights. Aviation Gas consumption of 250,000 liters per airport was estimated based on community carbon footprints developed for other regions in New Zealand, using advice from industry experts. Included in this fuel use is fuel consumed by the flight school located at Palmerston North Airport. All aircraft fuel emissions have been classified as Scope 3.
Marine Diesel	Freight and commercial: - This has not been calculated due to difficulty of obtaining reliable data Private use: - This is assumed to be an insignificant contributor to emissions. - Most small private boats use fuel purchased at vehicle gas stations so this consumption will be included in transport petrol and diesel emissions. Port Operations: - All port operations fuel use is allocated to Whanganui District as these vessels do not cross territorial authority boundaries.
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.
Bitumen	Not calculated
Lubricants	Not calculated
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. Additional 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 consumption for the territorial authority has been calculated using grid demand trends from the EMI website (www.emi.ea.govt.nz) to obtain raw grid exit point data. The breakdown into sectors is based on NZ average consumption per sector (residential, commercial and industrial).
Electricity Generation	There is electricity generation in the Horizons Region, however, emissions produced in electricity generation are not required to be reported for the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) standard.
Public Transport Electricity	Any electricity used in the public transport system is included in stationary energy electricity consumption figures.
Coal production	Not Calculated: There are no active coal mines within the region. (NZP&M 2019)
Coal Consumption	Coal consumption calculated using national per capita coal consumption. The breakdown into sectors is based on NZ average consumption per sector (residential, commercial and industrial).
Biofuel and Wood Consumption	Consumption has been calculated based on national per capita Commercial and Residential emissions for biofuel use (provided New Zealand Greenhouse Gas Emissions 1990 -2017 (MfE 2019).
LPG Consumption	LPG consumption has been calculated using total North Island per capita LPG consumption data. 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.
Petrol and Diesel (stationary energy end-use)	Total Petrol and diesel fuel use was 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. Stationary energy petrol and diesel use is defined as fuel not used for transport either on or off roads. Petrol and diesel used for transport has been reported in the Transport sector (see above).
Coal Fugitive Emissions	Not Calculated: There are no active coal mines within the region. (NZP&M 2019)
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
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	
General	No assumptions were made during the collection of agricultural data as it was sourced from territorial authority-specific data provided by Statistics NZ and the Ministry for the Environment National Inventory.
Solid Waste Emissions	
Landfills	Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day. Solid waste emissions

	were calculated for the currently operating landfill sites at Bonny Glen, Levin and Ruapehu. Bonny Glen and Levin do process waste from outside the Region but the data we have only concerns waste produced in the Region. Waste from Ruapehu is treated exclusively at Ruapehu landfill and the site does not accept waste from outside Ruapehu. Where waste volume data was not available, we have used the national per capita waste volume to estimate waste volume for each territorial area and distributed between the landfill sites based on their proportion of the Region's waste volume. In the years prior to each landfill site's operation we have allocated the remaining national average waste volume per person to 'Closed landfill sites'. Unless new data is provided, we assume that there is no landfill gas recovery on closed landfill sites.
Landfill Gas Recovery	LFG efficiency has been estimated based on LFG generation from waste deposited and reported LFG extraction volumes.
Wastewater Emissions	
Wastewater Volume	Wastewater treatment plant data provided at territorial authority level. Emissions have been calculated based on the data provided following IPCC 2006 guidelines. Where data is missing, IPCC and MfE provided figures have been used, e.g. for biochemical oxygen demand (BOD). Calculation of emissions includes emissions released directly from wastewater treatment, flaring of captured gas and from discharge onto land/water. Calculations for wastewater emissions from individual septic tanks are also included. Populations not connected to known wastewater treatment plants are assumed to be using septic tanks. We have not calculated emissions from combustion within sludge digestion. We have also not accounted for overflows, fugitive emissions or sludge removal.
Biochemical Oxygen Demand (BOD)	The biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in water. It is used as a surrogate to measure the degree of organic pollution in water. BOD has been assumed using influent composite samples and inlet flow meters.
Population Connected to WWTP or Septic Tanks	Population connected to wastewater treatment plants have been provided at the territorial authority level.
Industrial Emissions	
Industry & Solvent Emissions	Calculated from MfE National Inventory data, as this the latest, most recently available data on the required solvents. Emissions are estimated on a per capita basis.
Industrial Activity	No information could be obtained from Industry representatives within the territorial authority. National level data has been used and split on a per capita basis to determine the territorial authority's consumption.
Forestry Emissions	
Exotic Wood Harvested	Territorial authority figures were calculated using the assumed percentage share of territorial authority forest area of harvest age (>26 years old) in the region, in the reporting year.
Roundwood Removal	It has been assumed that only 70% of the tree is removed as roundwood and that the above ground tree makes up approximately 74% of the total carbon stored.
Emission Factors	

General	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.

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