HUTT CITY
TE AWA KAIRANGI

Greenhouse Gas Inventory Report

2021/2022

Owner	Jonathan Linders
Approved by	Jörn Scherzer

This report has been produced in accordance with ISO 14064-1:2018.

Emissions are discussed in Scopes, for consistency with other reports.

Version	Author	Date	Description
V 1.0	Jonathan Linders	31/10/2022	Reviewed by George Gray, Lumen
V 2.0	Jonathan Linders	22/12/2021	Final

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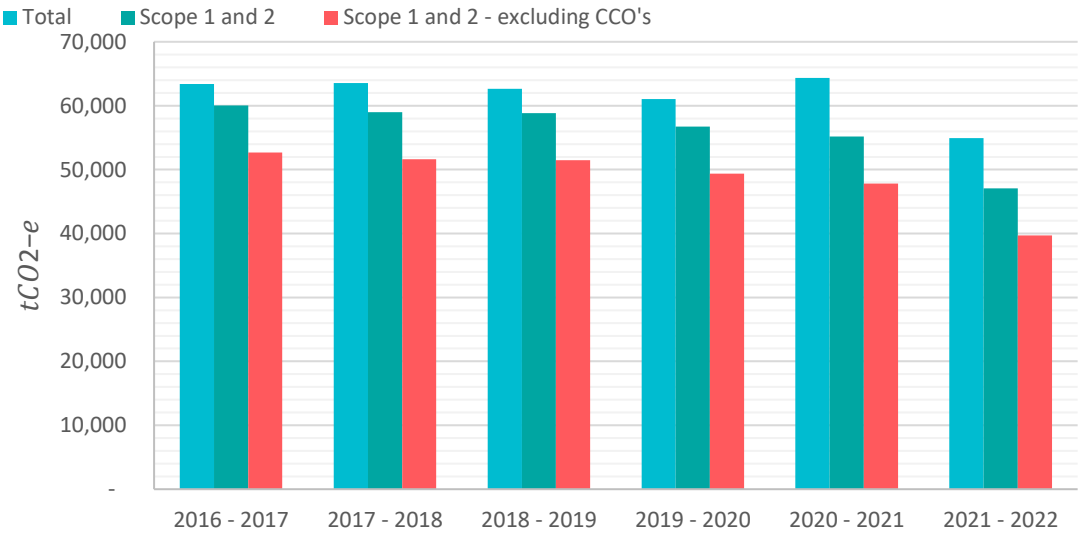
SUMMARY

On the 1st of July 2021 Hutt City Council (HCC) finalised its Interim Carbon Reduction and Climate Resilience Plan for Hutt City Council, the present greenhouse gas inventory assesses HCCs performance against this plan. Hutt City Councils carbon footprint is estimated to be 56,500 tCO_{2-e}.

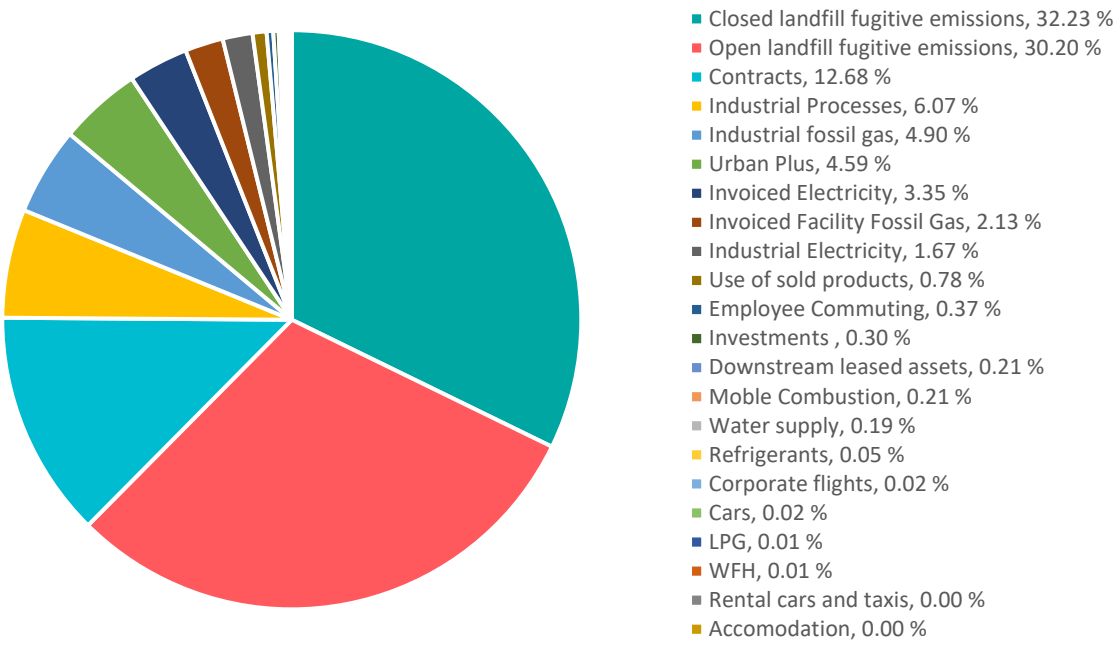
As below[1], the work Hutt City Council is doing in areas where it has operational control is successful. In terms of magnitude, the most significant improvements have been achieved with the landfills (a combined reduction of 7,810 tCO_{2-e} compared to the year prior), but in terms of proportional changes the largest reductions in emissions have occurred in our transport fleet (a 33% reduction for our corporate fleet, and a 65% reduction in our rental/taxi 'fleet').

However, some emission sources have increased, for example emissions associated with corporate flights have risen by 4 tCO_{2-e} (40%) as conferences resume following the COVID-19 pandemic. Note that these emissions are offset via surrendered emission units.



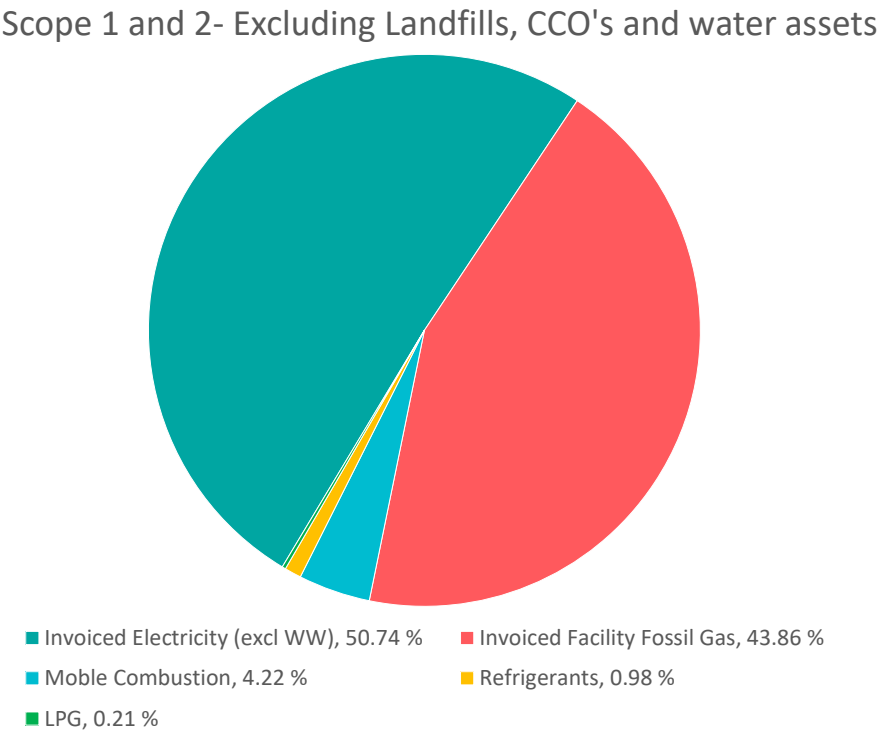
More work is required to gain a better understanding of the broader 'supply-chain' emissions, this is underway. As shown in the pie chart on the following page, some of these downstream emission sources are potentially significant. Many of our downstream emissions are not comparable to previous assessments due to changes in estimation methodology and categorisation/understanding; for example, the reported emissions associated with HCCs contracts are lower than last year, but this is primarily due to collecting more accurate data and not due to improvements in operations.

[1] Since there is potentially high uncertainty in the emissions reported by Microsoft, they are included in the report, but are not included in the summary totals. Moreover, theses emissions are not consequential for HCC as Microsoft will aim to have net negative emissions from 2030.



Note: the figure above excludes emissions associated with cloud computing, land use, and categories that have no emissions associated.

Most of Hutt City Councils direct emissions are associated with the landfills (Silverstream and Wainuiomata). Excluding these, Seaview Wastewater Treatment Plant is the second largest single emissions source; from the first of July 2024 facilities will be HCC's largest emission source (following the landfills). The graph below excludes these 'oversized' assets so that smaller emission sources can be assessed:



1. INTRODUCTION

ORGANISATIONAL BOUNDARIES

For this Greenhouse Gas Inventory an equity share consolidation approach is used, meaning that Council Controlled Organisations (CCOs) are considered an equal component of the footprint to the 'main council' operations. This is due to the report being for councillors to assess the carbon reduction programmes performance. The Hutt City councillors as a governance body do not have the ability to exert operational control, which therefore causes an operational consolidation approach to be redundant. Moreover, Hutt City Council either has complete or significant financial interest in its CCOs which results in significant active influence.

The Hutt City Council organisation contains the following entities:

Governance of Seaview Marina and Urban Plus is carried out by the respective governance boards and ultimately by Hutt City Council. Seaview Marina and Urban Plus limted are 100% owned by HCC; which controls these companies through an annual Statement of Intent and the appointment of each companies board (or part of the board).

Wellington Water as a whole is 20% owned by Hutt City Council. Each shareholding council is represented on the Wellington Water Committee by one representative, Wellington Water additionally has a board of independent directors. Hutt City has varying stakes in paticular assets that are managed by Wellington Water; for example, Hutt City Council has 100% legal ownership of Seaview Wastewater Treatment Plant, with varying degrees of annual funding responsibilty (averaging at 70%) split between Hutt City Council and Upper Hutt City Council.

Hutt City has complete ownership and operational control of the Silverstream landfill and the closed Wainuiomata landfill, which collect waste from the entire Greater Wellington region. This results in Hutt City Council having a disproprtionately large carbon footprint compared to other organisations within the city, as waste itself is estimated at 7% of Lower Hutt City's emissions.

1.1 REPORTING BOUNDARIES

Scope 1, 2, and 3 are included. Specific categories are reported as below:

Scope and categories	Subcategories	Included
Scope 1 - Direct emissions and removals		
Stationary combustion	LPG used Seaview Marina	YES
	Gas used in facilities	YES
	Direct flaring from landfills	YES
	Diesel used in generators	YES
	Biomass fuel	No biomass is used
Mobile combustion	Fuel used in owned vehicles	YES
Direct process emissions and removals from industrial processes.	Seaview Wastewater treatment Plant	YES
Direct fugitive emissions	Refrigerants (HFC)	YES
	Open landfill fugitive emissions	YES
	Closed landfills fugitive emissions	YES
Scope 2 - Indirect emissions from imported energy		
Purchased energy	Electricity	YES
	Steam	No steam is used
	Heating & cooling	No additional purchased heating and cooling
Scope 3 - Indirect emissions		
Upstream scope 3 emissions		
Purchased goods and services	Contracts	YES
	Cars	YES
	Urban Plus	YES
	Water Supply network	YES
	IT networking and data storage	YES
Capital goods	Buildings owned	Excluded as these cannot currently be accurately assessed
	Seaview Marina	
Fuel- and energy-related activities (not included in scope 1 or scope 2)	Boat activities within Marina area	YES
Upstream transportation and distribution	Three-water management and network	YES
Waste generated in operations	Seaview Wastewater Treatment Plant	Captured in scope 1, via Silverstream landfill
	Demolition wastes	Captured in scope 1, via Silverstream landfill
	Corporate wastes	Captured in scope 1, via Silverstream landfill
Business travel	Corporate flights	YES
	Rental cars and Taxis	YES
Employee commuting	Staff travel to work	YES
Working from Home	Working from Home	YES
Upstream leased assets	Building owned and leased	YES
Couriers	Couriers	YES

Downstream scope 3 emissions

Downstream transportation and distribution	Product transportation	No distributed sold products
	Three-water management and network	YES
Processing of sold products	Not relevant	No processed sold products
Use of sold products	Urban Plus houses	YES
End-of-life treatment of sold products	Urban Plus houses	No products have reached end of life. Urban plus is a young company in terms of product lifecycle.
Downstream leased assets	Facilities	YES
Franchises	Not relevant	No franchises
Investments	Public investments	YES

OTHERS

Land Use change	YES

1.2 EXCLUSIONS

Scope 3 emissions are not captured in their entirety. For contracts that Hutt City enters only scope 1 and 2 emissions of contracts valued over $250,000 per year were requested. The remaining contracts had their emissions estimated via a spend based method, the same method used for all contracts in the 2020/2021 greenhouse gas inventory.

Through the spend based method it was determined that Hutt Cities scope 3 emissions were mostly generated by a few large civil contracts. Scope 3 emissions were not requested from smaller contractors.

The emissions associated with capital goods are excluded as they cannot currently be assessed with accuracy. Hutt City Council is required to maintain financial records for the prior seven years, many of HCC's assets are older than seven years.

1.3 BASE YEAR

The base year for assessing Hutt Cities emission reduction performance is 2016-2017, this was the year first assessed by HCC (carried out by AECOM). There are some differences in methodology and exclusions between the initial assessment and the present assessment, so these reports cannot be directly compared; (eg the initial report excluded fugitive emissions from closed landfills). These differences are individually noted in the results section of the report.

The differences in methodology result in a substantial difference in estimated emissions; initially the base year was estimated to have emissions of approximately 20,000 tCO_{2-e} while the updated methodology estimates approximately 60,000 tCO_{2-e} in this same year.

2. METHODOLOGY

Generally, emissions were calculated as per *Ministry for the Environment. 2022. Measuring Emissions: A Guide for Organisations: 2022 Detailed Guide. Wellington: Ministry for the Environment,* (hereafter referred to as 'the MFE guide'). Where the methodology differs, the differences are discussed in this methodology section.

While some emission factors used could be considered out of date, such as those retrieved from Motu publications that are based on spend, an inflationary factor has been applied to update these.

2.1 SCOPE 1 – DIRECT GREENHOUSE GAS EMISSIONS

2.1.1 Stationary Combustion

Direct flaring from landfills

Refer to appendix 1. Hutt City carbon footprint – active and closed landfill assessment for the detailed methodology.

Seaview Marina

Calculated as per the MFE guide, using invoiced consumption. The marina consumes bottled LPG and standard diesel. Previously the mass of LPG consumed was reported, this year this was estimated based on spend.

2.1.2 Industrial Processes

Emissions associated with Seaview Wastewater Treatment plant are calculated by Wellington Water. The greenhouse gas inventory is produced with reference to Water NZ Guidelines 2021 and as per the MFE guide.

2.1.3 Direct Fugitive Emissions

Open landfill fugitive emissions

Refer to appendix 1. Hutt City carbon footprint – active and closed landfill assessment for the detailed methodology.

Closed landfill fugitive emissions

Refer to appendix 1. Hutt City carbon footprint – active and closed landfill assessment for the detailed methodology.

2.2 SCOPE 2 – INDIRECT EMISSIONS FROM IMPORTED ENERGY

Emission factors from the MFE guide are used. Since MFE has only published factors up to 2020, this most recent factor is used for all following months. Renewable Energy Certificates are not used by Hutt City Council.

2.3 SCOPE 3 – UPSTREAM INDIRECT EMISSIONS

2.3.1 Purchased Goods and Services

Contracts

This report is written with the purpose of measuring councils progress towards environmental targets, identifying opportunities for further emission reductions, and with the express purpose of helping Hutt City Councillors make decisions surrounding carbon mitigation.

Scope 3 emissions are therefore detailed where they are relevant to Hutt City Councils operations and where Hutt City Council has the capacity to generate emission reductions through contractual arrangements or other methods.

For this footprint only scope 1 and 2 emissions were requested from our contractors. Scope 3 was not requested as this would be very time consuming for our suppliers, and existing contracts do not require this. Future contracts will include full carbon footprints, with requirements surrounding reductions in scope 1 and 2 emissions.

Scope 1 and 2 footprints were requested from all contracts that have an annual expenditure over $250,000. Smaller contracts, and large ones whose data was supplied late, had their emissions estimated based on contract spend and emission factors provided by Motu in "*Consumption-based greenhouse gas emissions input-output model". 2014. Obtained by Motu Economic and Public Policy Research from Statistics New Zealand, MBIE and MFE in 2013. Unrestricted dataset available online from www.motu.org.nz.* While this is not a precise method, it acts as a suitable proxy. These factors have been adjusted based on MBIE inflation figures.

Only the net figure is reported.

Cars

Upstream emissions associated with the purchase of vehicles are estimated based on Motu factors and amortised across the duration of vehicle ownership.

Urban Plus

Urban Plus Limited provided information on expenses associated with construction and demolition, equipment, operational expense, and cleaning. Emissions are estimated by using Motu factors and are included here

Wellington Water

Wellington Water completed an operational footprint and did not include emissions associated with purchased goods and services. Last year Wellington Water provided an inventory of maintenance related expenses, emissions associated with these are included and assumed to be the same as the previous year.

IT networking and data storage

HCC uses Microsoft Azure for our cloud usage. Microsoft Azure reports all scopes of emissions associated with this usage; their reported scope 3 emissions are approximately 20 times greater than the entirety of the rest of HCCs catalogued emissions, rendering all else comparatively irrelevant.

Hutt City Council can exert no direct influence on Microsoft Azures scope 3 emissions for this service. HCC can, however, reduce Microsoft Azures scope 1 and 2 emissions for this service through data sobriety, and these are included in this report. Due to uncertainties surrounding the accuracy of the emission report from Microsoft Azure these emissions are excluded from the summary.

2.3.2 Business travel

Corporate flights

HCC uses Orbit Travel as a travel agent. As part of this service, they produce a quarterly environmental impact report detailing the emissions associated with air travel. This is calculated using the appropriate emission factor from the MFE guide.

2.3.3 Employee commuting

A staff survey was completed, and the associated emissions of each respondent was calculated as per the MFE guide. These emissions were averaged and extrapolated to account for every council staff member.

2.3.4 Employees working from home

A staff survey was completed, and the associated emissions of each respondent was calculated as per the MFE guide. These emissions were averaged and extrapolated to account for every council staff member.

2.3.5 Couriers

Emissions associated with couriers were estimated based on contract spend and emission factors provided by Motu in "*Consumption-based greenhouse gas emissions input-output model". 2014. Obtained by Motu Economic and Public Policy Research from Statistics New Zealand, MBIE and MFE in 2013. Unrestricted dataset available online from www.motu.org.nz.* The specific factor used was "Postal and courier pickup and delivery services". While this is not a precise method, it acts as a suitable proxy. These factors have been adjusted based on MBIE inflation data.

2.4 SCOPE 3 – DOWNSTREAM INDIRECT EMISSIONS

2.4.1 Downstream transportation and distribution

The only significant upstream transportation and distribution that Hutt City Council carries out is associated with the Three Waters. These emissions are therefore captured elsewhere (scope 2, scope 3 – purchased goods and service, and scope 3 – capital goods).

Houses sold by Urban Plus are not transported.

2.4.2 Use of sold products

Emissions associated with houses sold by Urban Plus have been estimated based on the cumulative number of houses sold by UPL and StatsNZ data on regional household emissions.

2.4.3 Downstream leased assets

The majority of HCCs leased assets are captured within scope 1 and 2. As HCC is invoiced for energy consumption at these sites, and then pass this on to the lessee.

For the remaining sites, the tenanted houses, the emissions are estimated based on the average Wellington household emissions from StatsNZ, as well as StatsNZ data on the average number of occupants in a household, *Greenhouse gas emissions by region (industry and household): Year ended 2019, 2021* and *New data shows 1 in 9 children under the age of five lives in a multi-family household, 2020*.

2.4.4 Public investments

The emissions associated with our public investments are calculated by using the Motu derived emission factor for the *Banking and financing; financial asset investing* industry.

2.5 LAND USE, LAND USE CHANGE, FORESTRY

Only carbon sequestration certified by Carbon Forestry Services LTD through the New Zealand Emission Trading Scheme is considered. This necessarily undercounts the volume of sequestration that is occurring within HCC operations as there are many hectares of forestry not yet registered. As well as a programme to improve the quality of existing HCC forestry. Street and recreational park trees are also not considered.

3. RESULTS

3.1 2021/2022 EMISSIONS

Scope and categories	Subcategories	Included
Scope 1 - Direct GHG emissions and removals		
Stationary combustion	LPG used Seaview Marina	6
	Fossil gas (facilities and industrial)	4,099
	Direct flaring from landfills	Included with fugitive emissions (so as not to double count)
	Diesel used in generators	-
	Biomass fuel	-
Mobile combustion	Fuel used in owned vehicles	120
Direct process emissions and removals from industrial processes.	Seaview Wastewater treatment Plant	3,534
Direct fugitive emissions	Refrigerants (HFC)	26
	Open landfill fugitive emissions	17,586
	Closed landfills fugitive emissions	18,763
Scope 2 - Indirect emissions from imported energy		
Purchased energy	Electricity (facilities and industrial)	2,921
	Steam	-
	Heating & cooling	-
Scope 3 - Indirect emissions		
Upstream scope 3 emissions		
Purchased goods and services	Contracts	7,383
	Cars from HCC	13
	Urban Plus	2,674
	Water Supply network	109
	IT networking and data storage	30,964
Capital goods	Buildings owned	Excluded as these cannot be accurately assessed
	Seaview Marina	
Fuel- and energy-related activities (not included in scope 1 or scope 2)	Boat activities within Marina area	Included in use of sold products
Upstream transportation and distribution	Three-water management and network	Captured in other categories
Waste generated in operations	Seaview Wastewater Treatment Plant	Noted, however captured in scope 1, via Silverstream landfill
	Demolition wastes	Captured in scope 1, via Silverstream landfill
	Corporate wastes	Noted, however captured in scope 1, via Silverstream landfill
Business travel	Corporate flights	14
	Rental cars and Taxis	3
Employee commuting	Staff travel to work	215
Working from Home		6
Upstream leased assets	Building owned and leased	-
Couriers	Couriers	17

Downstream scope 3 emissions

Downstream transportation and distribution	Product transportation	No distributed sold products
	Three-water management and network	Captured elsewhere
Processing of sold products	Not relevant	-
Use of sold products	Urban Plus houses	453
End-of-life treatment of sold products	Urban Plus houses	-
Downstream leased assets	Facilities	124
Franchises	Not relevant	-
Investments	Public investments	174

OTHERS

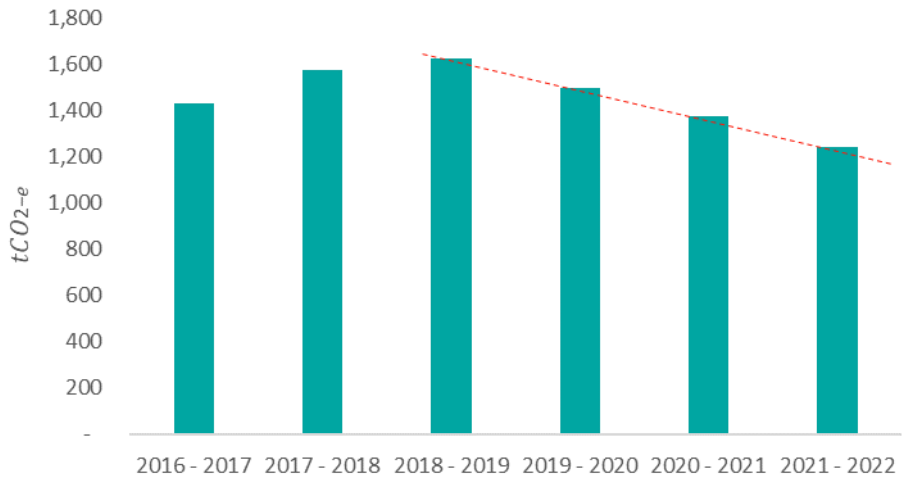
Land Use change	Land use change	-	3,286

3.2 SCOPE 1 – DIRECT GREENHOUSE GAS EMISSIONS

3.2.1 Stationary Combustion

Fossil gas used in facilities

Emissions from fossil gas consumption have been steadily reducing since the 2019 calendar year, initially due to the closure of Naenae pool, and then due to the decarbonisation programme. Hutt City Council is committed to removing fossil gas from all facilities by 2030, which consequentially means that Hutt City will not directly consume any fossil fuels from the next decade outside of emergency situations (during a civil defence emergency Hutt City Council will operate diesel generators to support the emergency response centres).



Direct flaring from landfills

Direct flared emissions are those associated with the engines which destroys/combusts methane, producing carbon dioxide and electricity. These are noted separately as some landfill emissions are fugitive, whilst these are 'purposeful'.

In all totals and time series these emissions are included with 'open landfill emissions', due to this breakdown only being available for one year. Refer to Appendix 1. Hutt City carbon footprint – active and closed landfill assessment for more detail on landfill emissions.

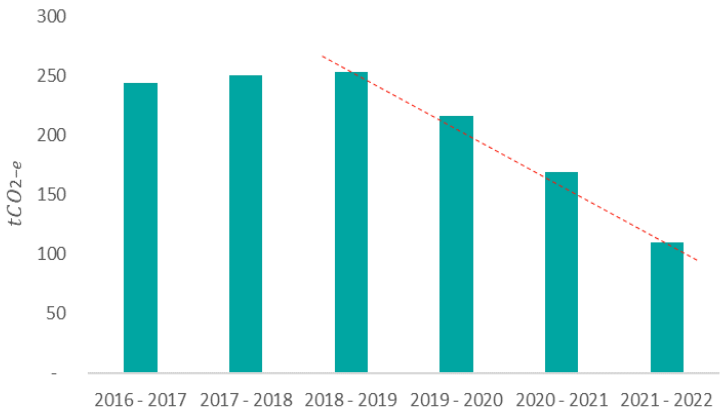
	Silverstream fugitive emissions separated by pathway (tCO_{2-e})			
	Stage 1 & 1a		Stage 2	
Financial year	Through cap	From engines	Through cap	From engines
2021/22	1,472	1,856	7,833	9,923

Seaview Marina

Seaview Marina uses LPG to heat its showers. Emissions associated with this have reduced since the previous inventory, albeit this is likely due to the noted change in methodology.

3.2.2 Mobile Combustion

As per action 9 of the Interim Carbon Reduction and Climate Resilience Plan for Hutt City Council, emissions from transport fuels are rapidly decreasing. By the end of the 2021-2022 financial year 42% of the corporate fleet were electric vehicles. By the end of the 2023 calendar year 50% of the fleet will be electric, and by 2030 100%.



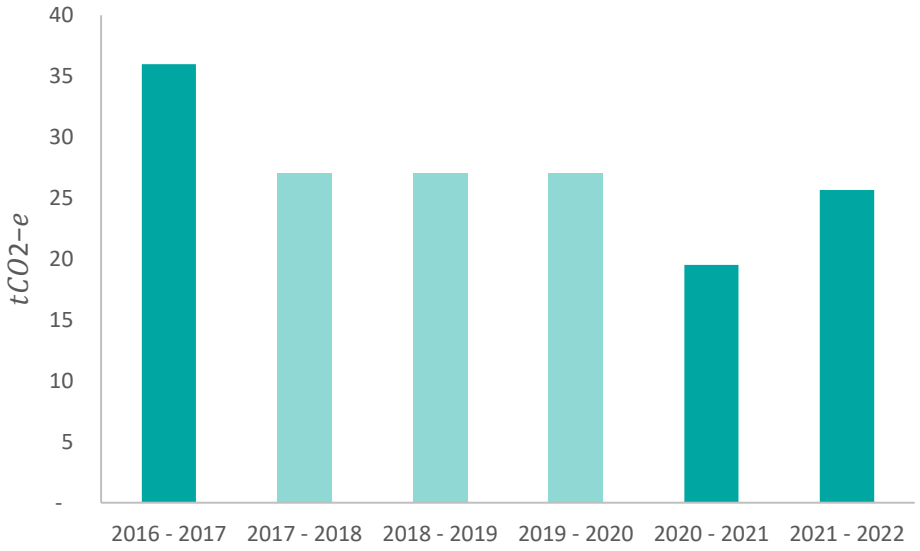
3.2.3 Industrial Processes

Scope 1 emissions associated with Seaview Wastewater Treatment plant, other than stationary combustion, are included here and estimated to be 3,535 tCO_{2-e}.

3.2.4 Direct Fugitive Emissions

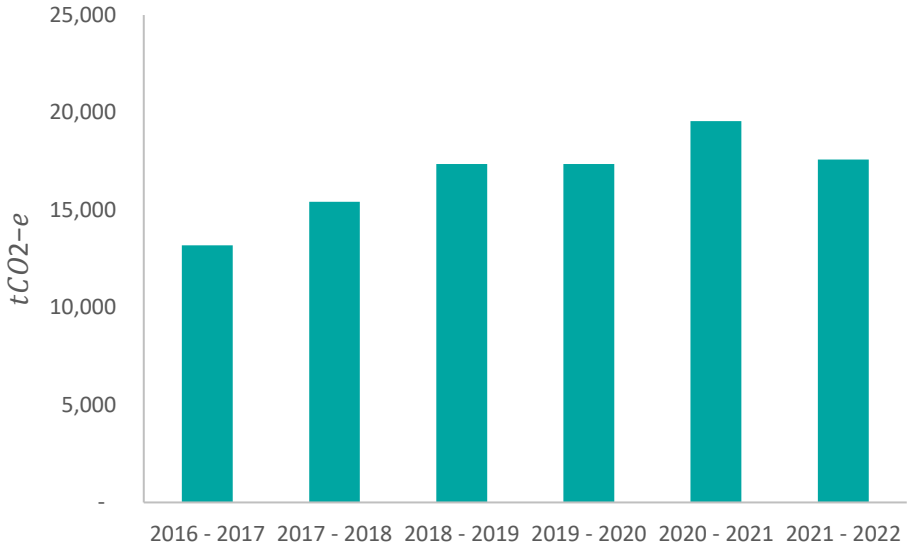
Refrigerants

Emissions associated with refrigerant use is estimated to have increased compared to the previous year, as two pieces of equipment failed and leaked. Note that 2017/18 – 2019/20 are averages of the three years for which we have data.



Open landfill emissions

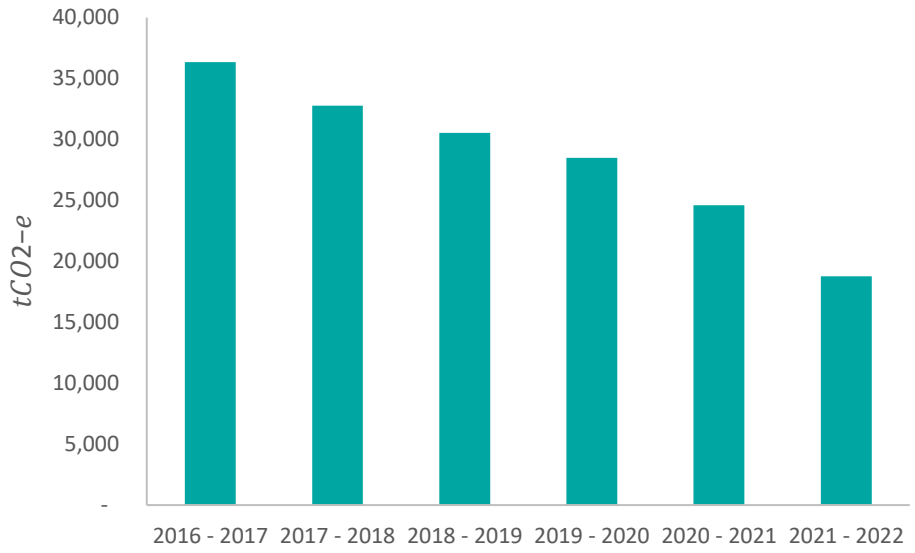
The emissions associated with Silverstream Stage 2 have decreased compared to the prior year due to improvements in methane destruction. As shown in the table below, the amount of methane destroyed has increased significantly, and the long-term trend of emissions growth has been reversed. Refer to Appendix 1. Hutt City carbon footprint – active and closed landfill assessment for more detail on landfill emissions.



Financial year	Fugitive emissions estimate in t CO_2e (emissions destroyed by combustion in brackets)		
	Silverstream		Wainuiomata
	Stage 1 & 1a	Stage 2	
2016/17	6,814 (24,713)	13,182 (42,583)	29,545 (0)
2017/18	6,375 (23,137)	15,416 (53,106)	26,412 (0)
2018/19	6,375 (23,137)	17,362 (58,805)	24,173 (0)
2019/20	6,995 (25,390)	17,356 (67,228)	21,487 (0)
2020/21	5,350 (19,416)	19,559 (58,766)	19,249 (0)
2021/22	3328 (20,231)	17,757 (87,024)	16,563 (0)

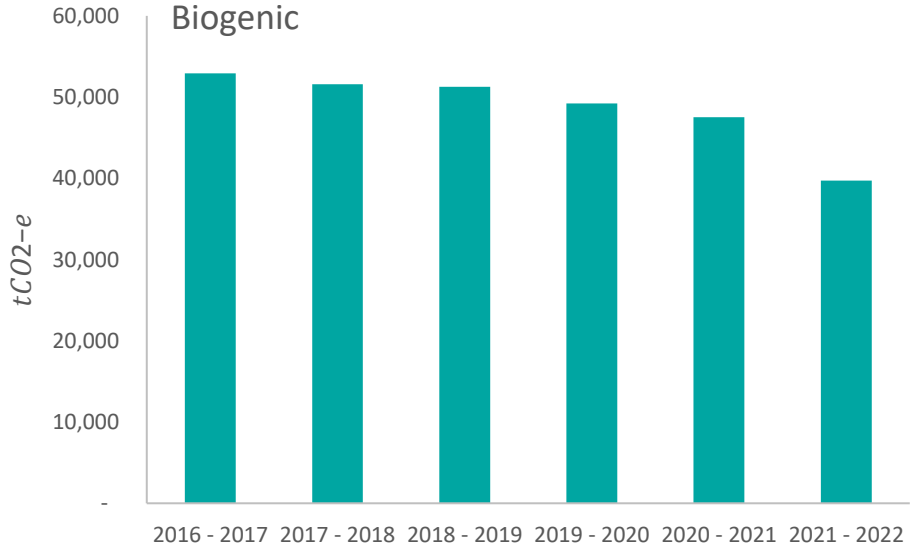
Closed landfill fugitive emissions

As expected, these emissions have declined. Closed landfill emissions decline with age. A flare is currently being tested at Wainuiomata closed landfill, in order to accelerate the elimination of this emission source. Refer to Appendix 1. Hutt City carbon footprint – active and closed landfill assessment for more detail on landfill emissions.



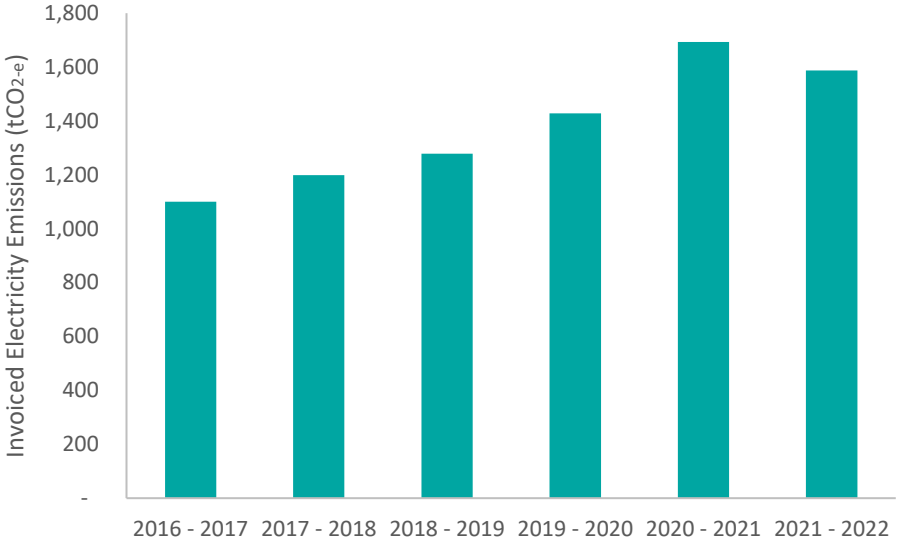
3.2.5 Biogenic emissions

As below, biogenic methane emissions are declining, largely due to improvements in methane capture and destruction at Silverstream landfill. Note that biogenic emissions are not additional to those noted elsewhere. Refer to Appendix 1. Hutt City carbon footprint – active and closed landfill assessment for more detail on biogenic emissions.

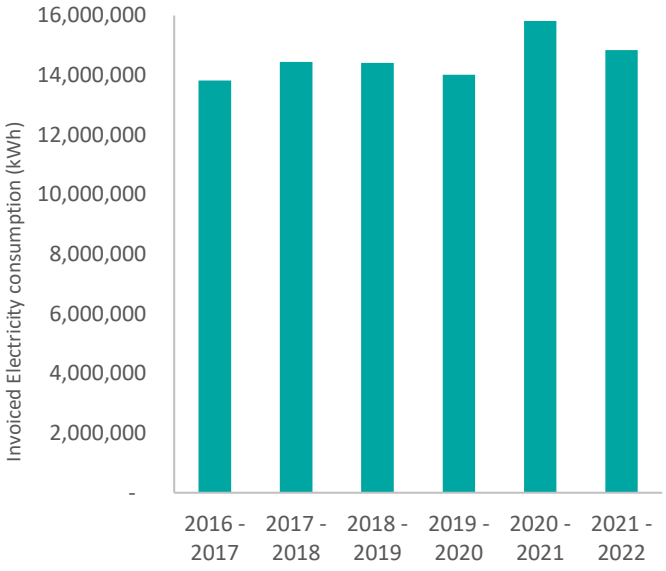


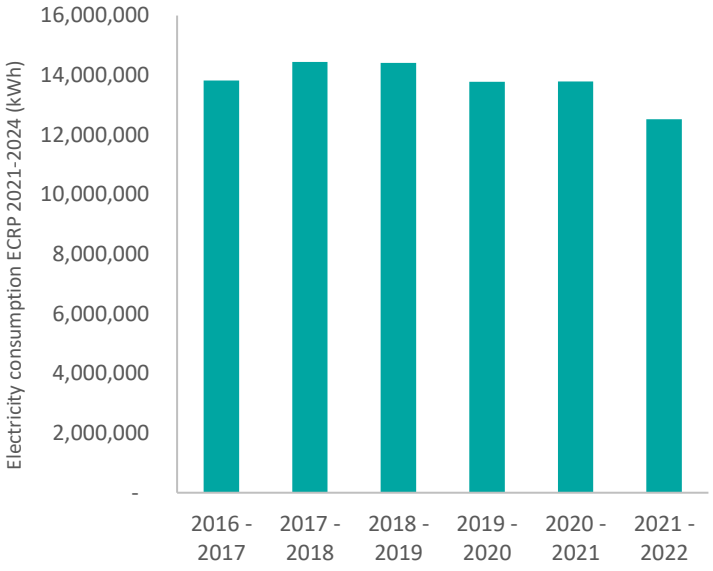
3.3 SCOPE 2 – INDIRECT EMISSIONS FROM IMPORTED ENERGY

Below are the direct invoiced emissions associated with electricity consumption, this is the value that is included in the gross and net organisational totals. Invoiced energy consumption is used due to Hutt City Council maintaining absolute emission reduction targets, albeit this target will need to be reassessed if the three waters reform progresses.

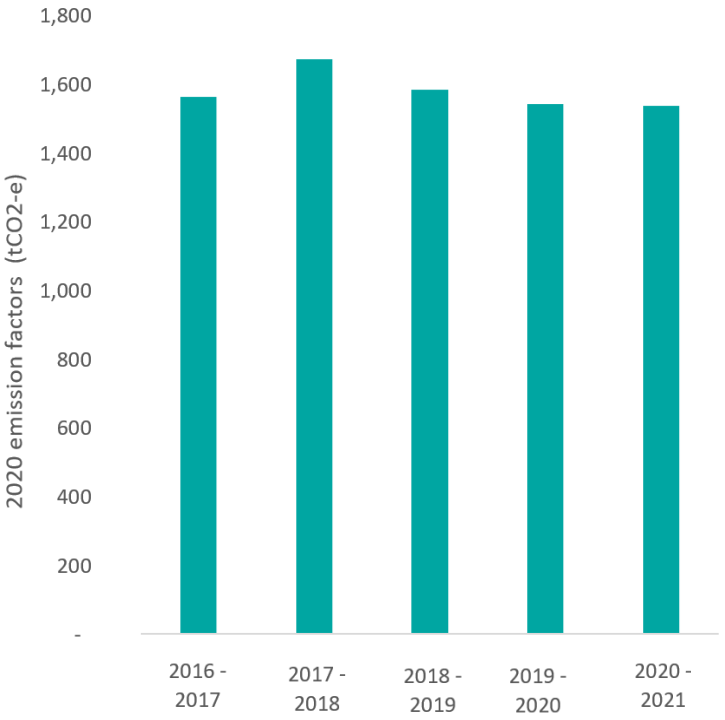


When assessed in terms of the Hutt City Council Energy and Carbon reduction plan 2021-2024, the programme is more productive:



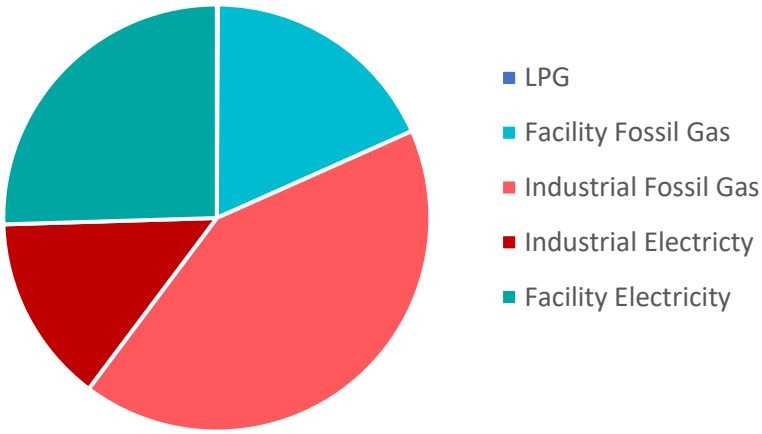


The emissions associated with electricity consumption differ in this report from last year's carbon footprint, due to the Ministry for the Environment (MFE) reassessment of past electricity emission factors. Revised electricity emission factors have been released by MFE in December 2020, and in April, May, and August of 2022. This relatively significant difference in emissions is due to the emission factor estimations changing from a consumption to production-based estimation:



Electricity consumption associated with Seaview Wastewater Treatment Plant cannot be compared to prior years and are estimated to be 973 tCO_{2-e} for the 2021/2022 year.

Hutt City Councils stationary energy mix is therefore primarily (over 50%) associated with the Seaview Wastewater Treatment Plant, termed ‘industrial’:

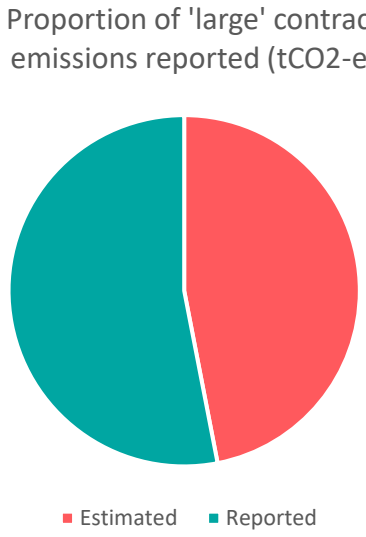


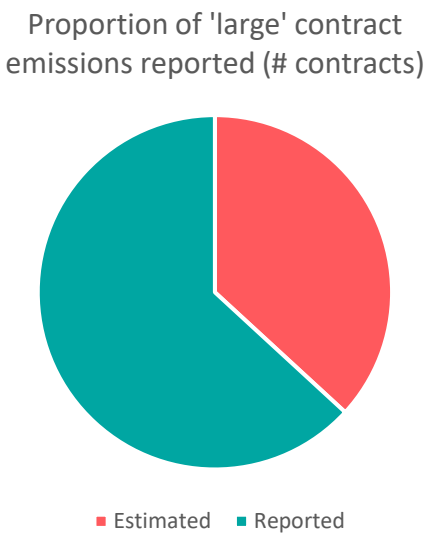
3.4 SCOPE 3 – UPSTREAM INDIRECT EMISSIONS

3.4.1 Purchased Goods and Services

Contracts

As described in the methodology section, all contracts that cost under $250,000 per year had their emissions estimated based on spend and Motu factors. Contracts worth over $250,000, large contracts had emission reports requested. As below, in terms of the number of contracts, the majority of contractors reported their emissions by the requested date; however, most emissions, in terms of tCO_{2-e} were estimated. This possibly indicates that using the emission factors for procured goods and services overestimates emissions.

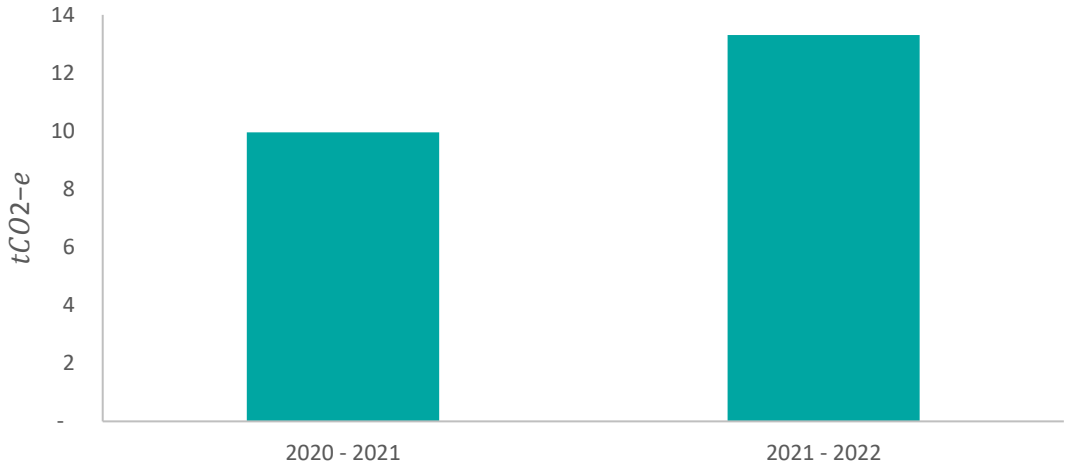




This year the emissions from major contracts were estimated to be 5,170 tCO_{2-e} and the emissions from minor contracts was estimated to be 3,240 tCO_{2-e}.

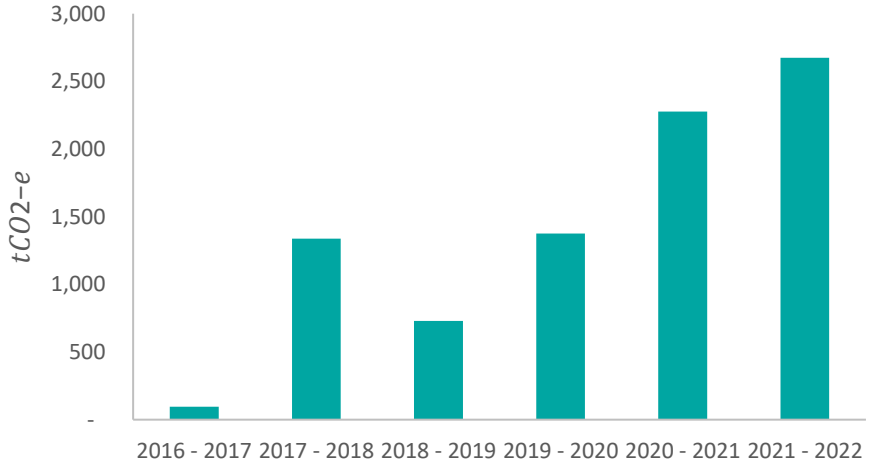
Cars

The amortised lifecycle emissions of purchased cars is estimated to have grown slightly, due to an increase in the reported size of the fleet.



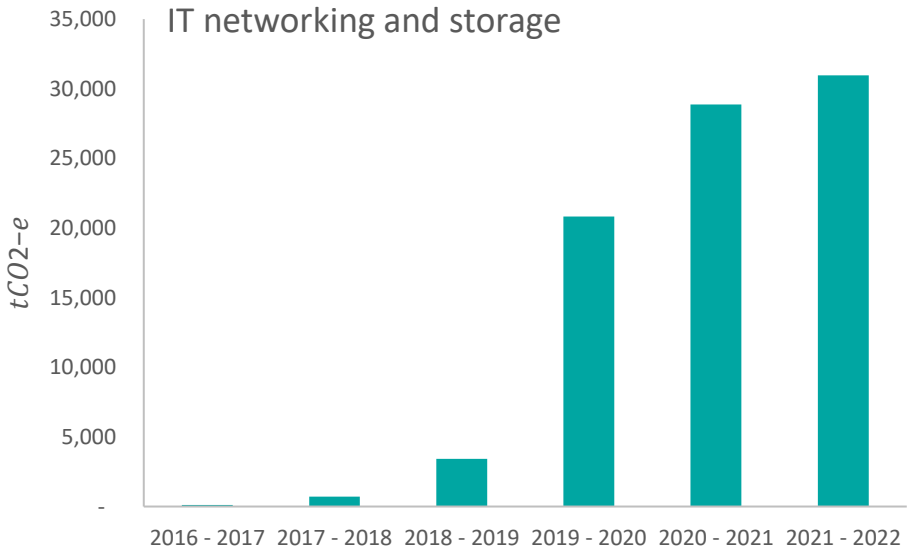
Urban Plus

These emissions are primarily derived from the construction and demolition activity that Urban Plus limited undertakes. Due to only having financial figures that combines the demolition and construction costs, this is likely an overestimation of emissions. Urban Plus also accounts for the costs of a project upon completion, which accounts for some of the annual variation in these emissions. Work is being undertaken to reduce the operational emissions of the properties (via Homestar), but it is not apparent if the embodied emissions will be reduced.



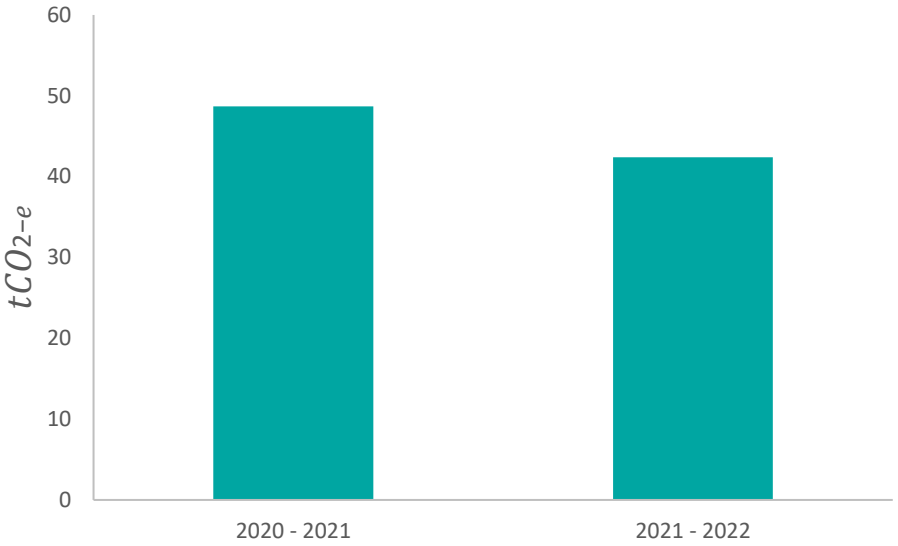
IT networking and data storage

According to information reported by Microsoft this is a significant emission source. However, we have low confidence that this information is accurate, therefore these emissions are accounted for here, but excluded from the 'headline' total emissions.



3.4.2 Waste from facilities

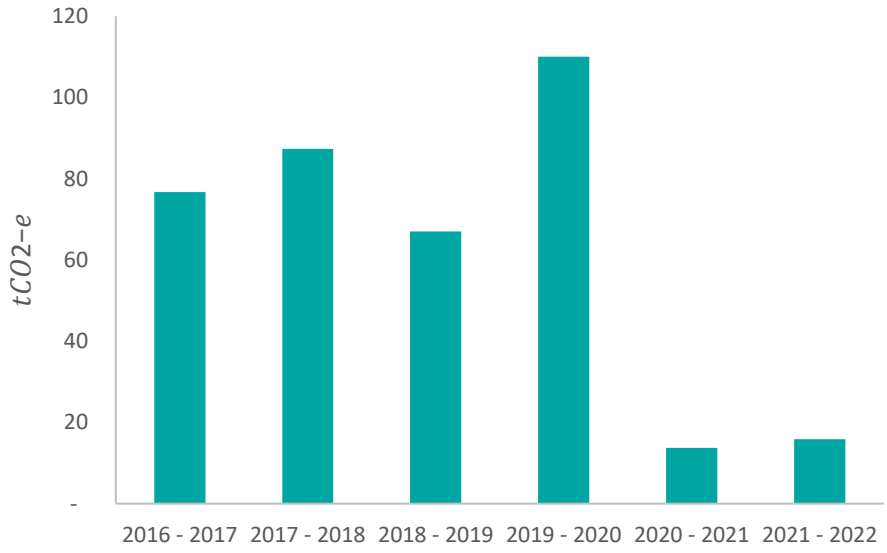
Emissions associated with our facility waste has reduced moderately. HCC have produced a slight reduction in the mas of waste to landfill, and an increase in recyclable waste. These are not included in our total emissions due to Silverstream landfill being an HCC asset.



3.4.3 Business travel

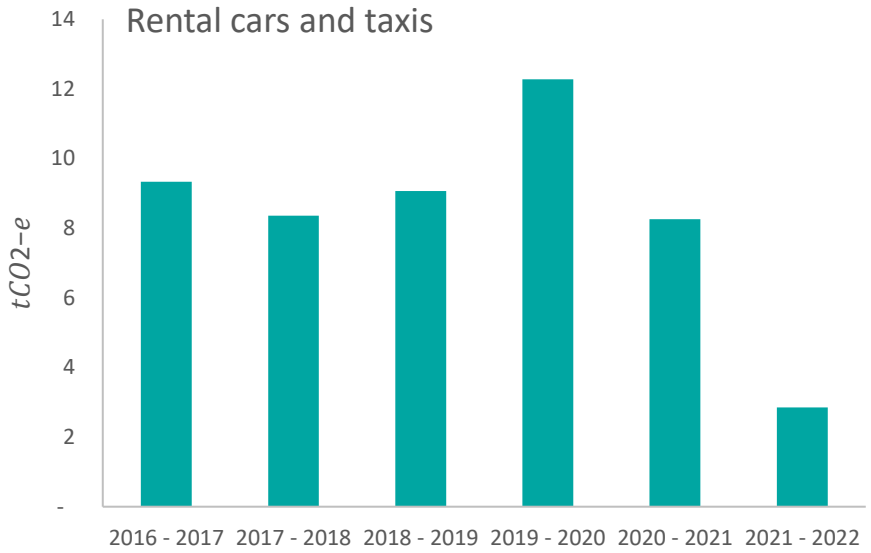
Corporate flights

Emissions from corporate flights remain suppressed due to the COVID-19 pandemic. This is as expected as for much of the past financial year New Zealand has been at either the 'Red' or 'Orange' level of the COVID-19 Protection Framework. Anecdotally remote meetings have become the preferred communication mode, with webinars and teleconferencing remaining popular following the easing of COVID-19 related restrictions. We can expect that emissions from corporate flights will increase somewhat in the 2022-2023 financial year as COVID-19 protections are further reduced.



Rental cars and taxis

In line with corporate flights, these emissions are likely to have also reduced as a result of COVID-19.



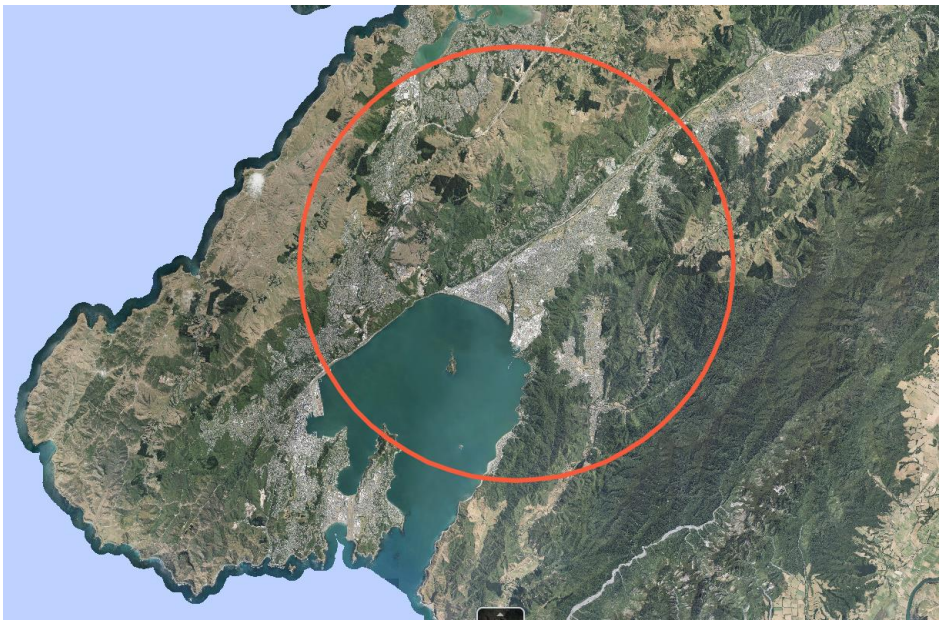
3.4.4 Employee commuting

The emissions associated with our employees commuting are estimated to be 215 tCO_{2-e}, for this inventory a staff survey was produced specifically for commute emissions calculations. This figure can therefore not be compared to last year's report.

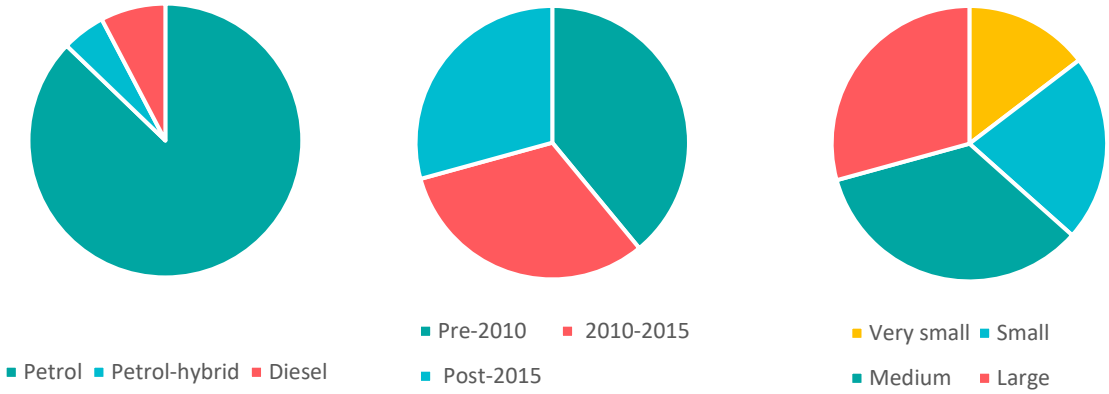
Notable insights include:

- 25% of respondents use public transport at least once per week.
- 23% of reported commutes are on public transport.
- 9% of reported commutes are through active transport.
- 41% of respondents have a multimodal commute
- 4% of respondents carpool

Most of our staff seem to commute from within the Hutt Valley, with a mean commute distance of 10.771 km:



Hutt City Councils commuter fleet is primarily petrol, of mixed age and mixed size:



3.4.5 Employees working from home

Emissions associated with staff working from home have been estimated at 5.91 tCO_{2-e}, which is significantly less than the emissions associated with commuting (215 tCO_{2-e}). This is partially due to the relatively low use of public transport within HCCs staff.

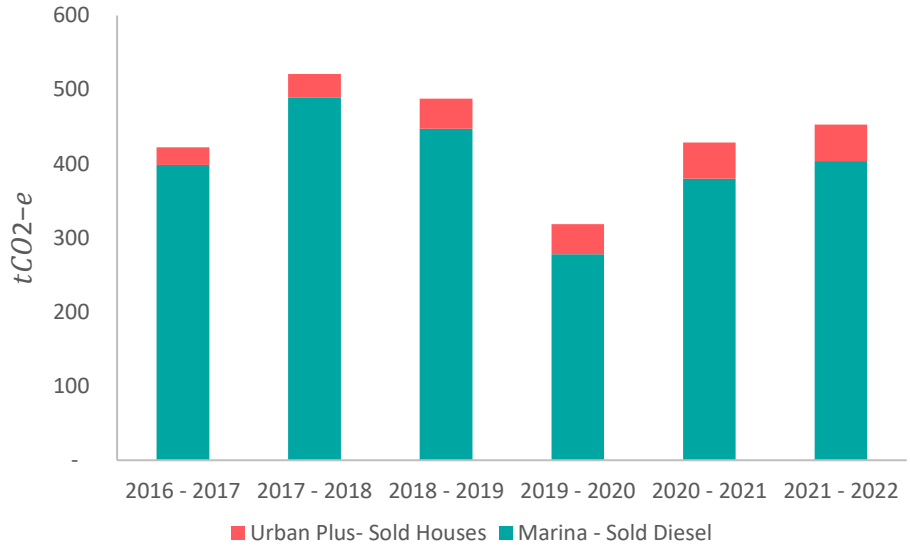
HCC should, through the wellbeing function, continue to support staff to embrace hybrid/flexi-working so that transport emissions can be downshifted through reduced commuting. These emissions are estimated to primarily originate from space heating, therefore HCCs staff should be supported to choose efficient heating solutions through council's eco-design advisor.

3.5 SCOPE 3 – DOWNSTREAM INDIRECT EMISSIONS

3.5.1 Use of sold products

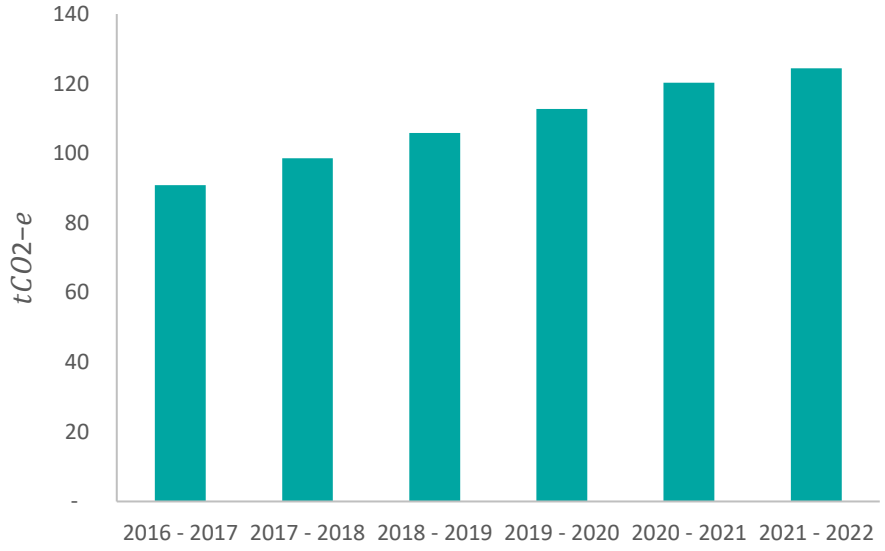
Hutt City Council only has two sold products, both from CCO's. Primarily diesel from the Marina to local boaters, and secondarily (in terms of climate impact) houses, which are small emission source through the occupant's usage.

Emissions associated with sold houses will reduce through the Homestar initiative. Emissions associated with sold diesel may reduce through the adoption of electric or sail-only boats, which HCC may choose to incentivise/promote.



3.5.2 Downstream leased assets

These emissions are related to occupants living in houses owned by Urban Plus, these are estimated to have increased due to the increasing number of rentals owned by UPL.

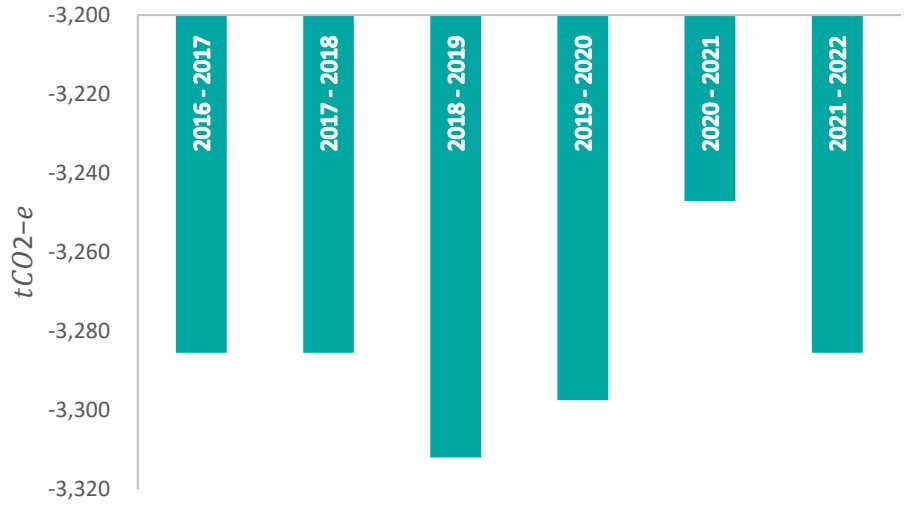


3.5.3 Public investments

Hutt City Council does not currently have a green investment policy, in contrast Auckland, Dunedin, Palmerston North, Waikato Regional, and Christchurch City Councils have already adopted binding policies to divest from fossil fuels.

3.6 LAND USE, LAND USE CHANGE, FORESTRY

As shown below annual carbon sequestration in HCC forestry is estimated to be largely constant. Due to using New Zealand Emission Trading Scheme registered credits as a proxy for LULUCF many aspects are not accounted for, such as, growth of street trees, removal of trees for developments undertaken by Urban Plus, and growth of unregistered forestry.

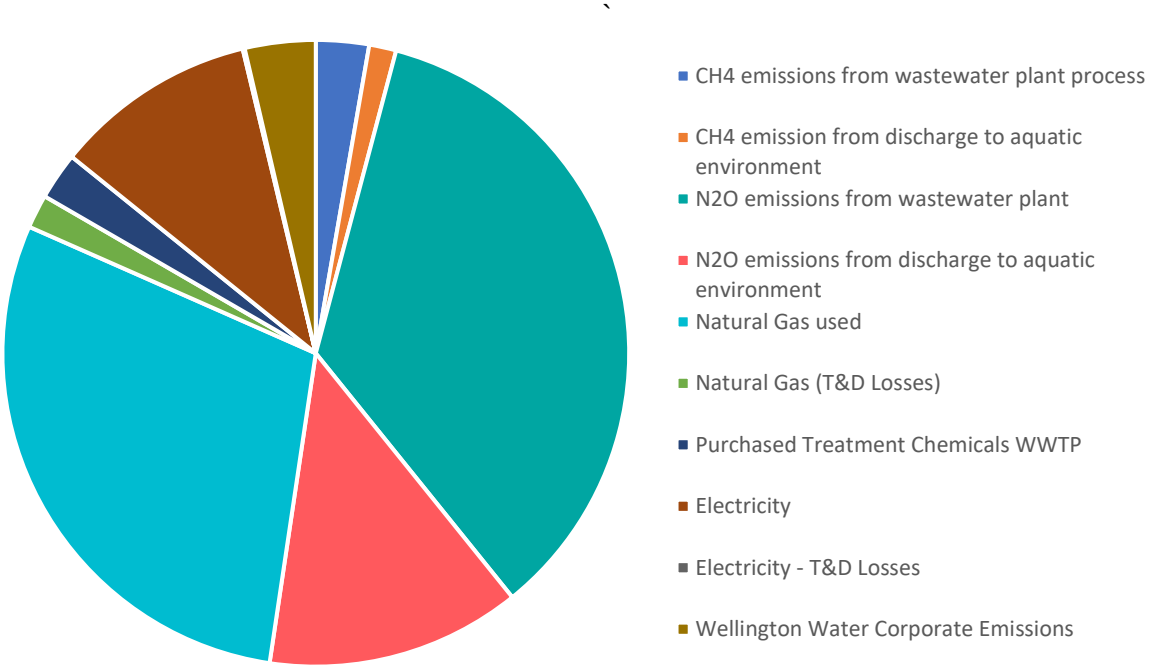


3.7 COUNCIL CONTROLLED ORGANISATION EMISSIONS

Note that these emissions are represented within their appropriate category above.

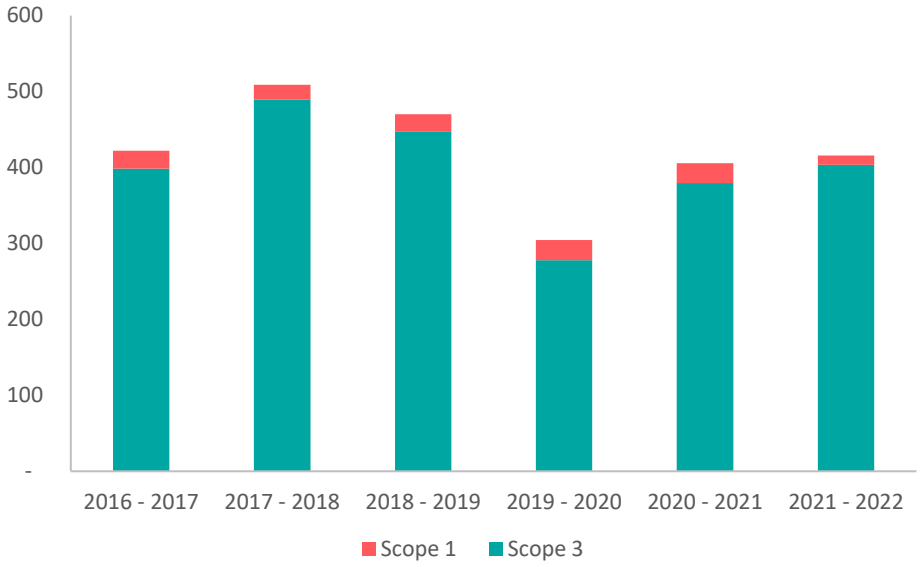
3.7.1 Wellington Water

The emissions as categorised by Wellington Water are shown below:



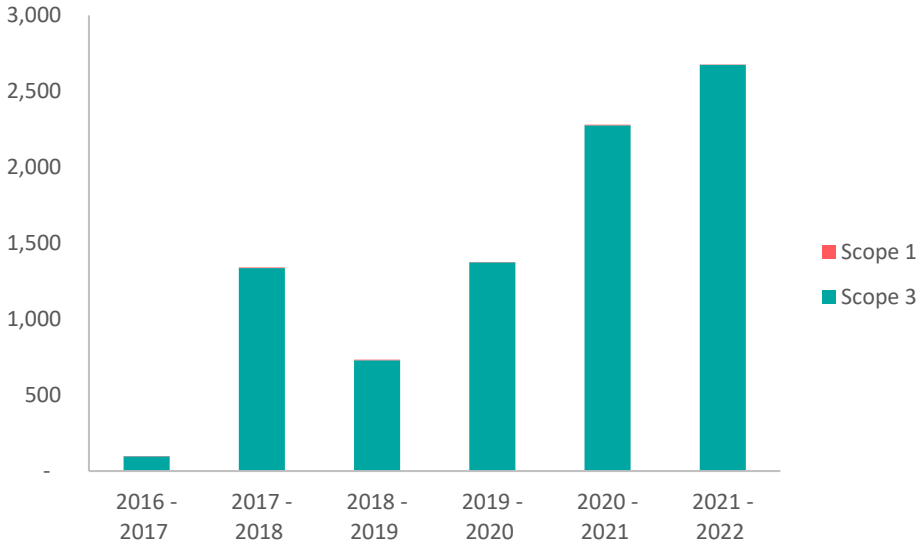
3.7.2 Seaview Marina

As below, the majority of Seaview Marina's carbon footprint is associated with Diesel sold to marina customers (scope 3). Scope 1 for the marina includes diesel used for the Ute and travel lift, and LPG bottles for the showers. Electricity is invoiced directly to Hutt City Council and is therefore not included here.



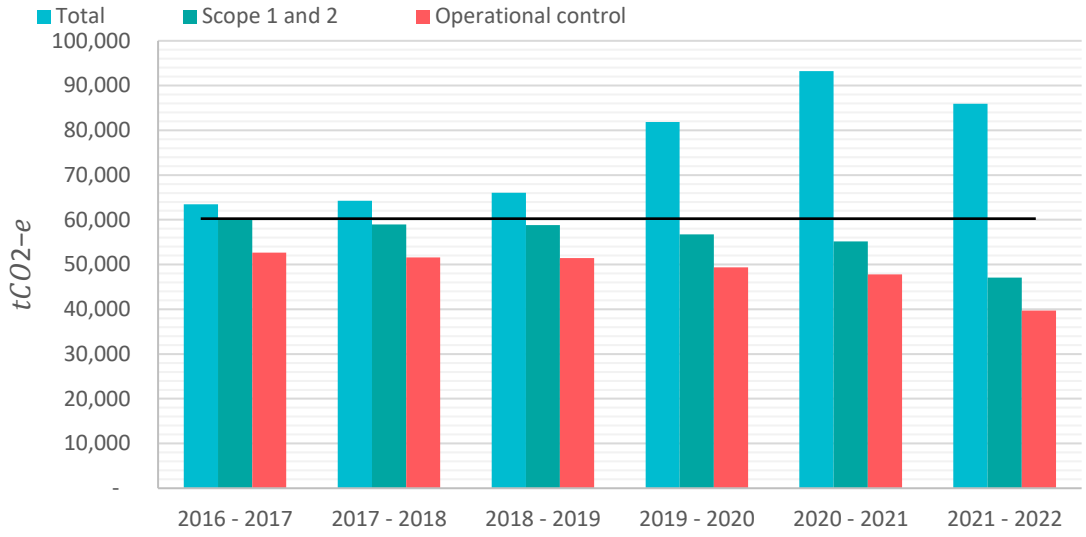
3.7.3 Urban Plus Limited

As below, almost the entirety of Urban Plus's emission profile is estimated to originate from its downstream emissions. Urban Plus's scope 2 emissions are also invoiced directly to Hutt City Council and are therefore not shown below.



4. PERFORMANCE ASSESMENT

4.1 PERFORMANCE COMPARED TO THE BASE YEAR



As above, Hutt City Councils internal carbon reduction work is progressing well. The assessment indicates that the emissions associated with the corporate supply chain (scope 3) are increasing, this is due to these emissions being better understood, rather than an increase in activity.

In contrast to the executive summary, Microsoft's reported cloud computing emissions are included in the plot above.

4.2 PERFORMANCE COMPARED TO PRIOR REPORTS

The amount of sequestered carbon dioxide reported here for previous years differs to that of previous reports. This is a consequence of using emission trading scheme registered credits as a proxy for the actual value. For several geographic areas, the updated data only contains forestry growth for the 2021 calendar year, for others growth is provided for the 2018 – 2021 years; note that this updated data is in addition to forestry reported in previous years and that reservoirs are not considered in this annual report.

A number of reported emission categories cannot be directly compared to prior years, due to improvements in the estimation methodology; those being:

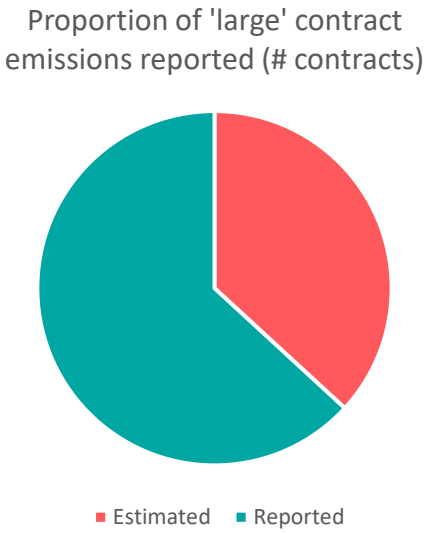
- Emissions associated with Wellington Water, excluding pumping stations.
- Contracts
- IT networking and data storage
- Employee commuting
- Employees working from home

4.3 PERFORMANCE COMPARED TO THE COUNCIL ACTIONS FROM THE *INTERIM CARBON REDUCTION AND CLIMATE RESILIENCE PLAN 2021-2031* (ICRCRP)

The ICRCRP is being implemented successfully, albeit it has only been in place for one year so it is likely too early to make a robust assessment; moreover, many actions are not planned to be taken yet. Below is a summary on progress towards all HCC internal climate change mitigation actions:

4.3.1 Measuring procurement-related carbon reductions

The timeline set out in the ICRCRP targeted measuring HCCs procurement/contracted related emissions by 2025. While there is some way to go towards understanding the emissions associated with 'small' contracts and more 'detached' downstream emissions (eg our contractor's scope 3 emissions), emissions associated with 'large' contracts are well understood:



4.3.2 Embedding carbon reductions through procurement

This workstream has had some modest success but is in the early stages. For example the new waste collection contract is using an electrifying fleet (and will be entirely electric from 2025), and the landfill management contract has minimum emission reduction requirements.

4.3.3 Incorporating sustainability into the rebuild of Naenae Pool

Naenae pool is designed to achieve a Greenstar design and build rating of five, and the energy demand is entirely electricity based.

4.3.4 Incorporating sustainability into the Riverlink project

Riverlink is still in the design phase of the project, and is working towards:

- An Infrastructure Sustainability rating of gold
- Draft key result areas for the programme have been completed, with reference to the step-change initiatives towards sustainable outcomes as required as part of the New Zealand Upgrade Programme.
- A first draft of a project carbon budget has been completed and are in the process of formally creating a baseline.

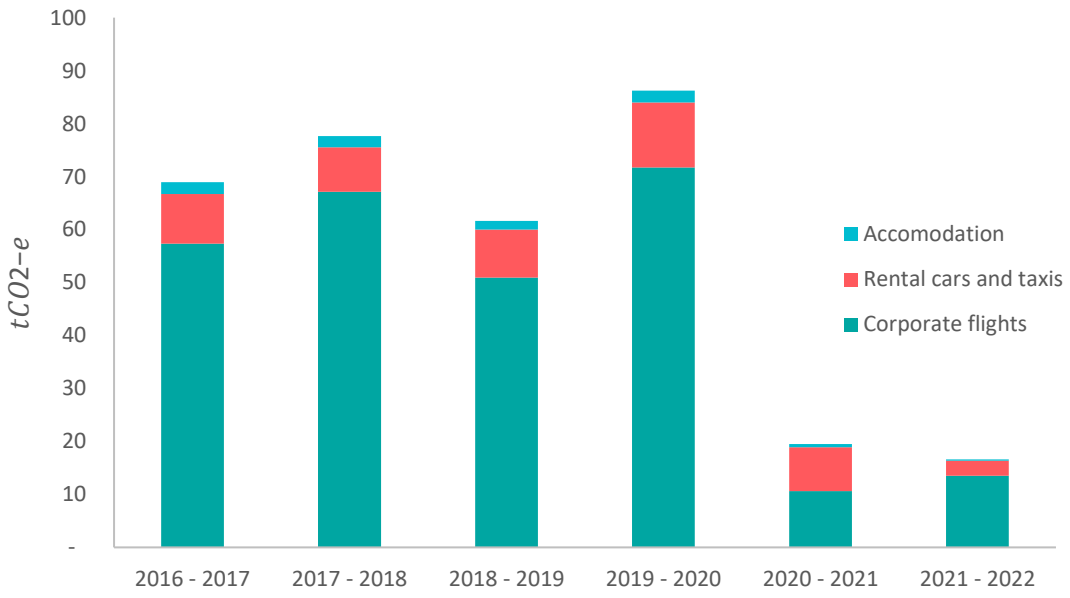
4.3.5 Optimising refrigerant use

Council committed to prioritising global-warming-potential when selecting refrigerants. No formal policy in place, albeit the only breakdown this financial year resulted in a refrigerant replacement from R410a (GWP = 2,088) to R407C (GWP = 1,774).

4.3.6 Optimising office space and Educating staff on climate change

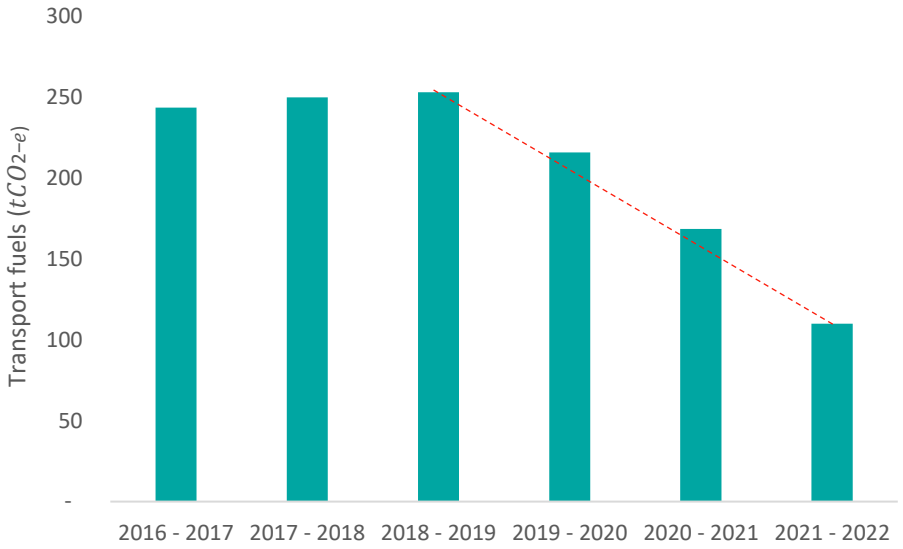
Estimating the success of educating our staff on climate change can best be assessed through the emissions that originate from their behaviour and choices; Air travel, Accommodation, Rental car use, commuting, and working from home (WFH). As can be seen the vast majority of these emission originate from our staff's commute.

Emissions associated with staff working from home and commuting cannot be compared to past assessments. However, for the emission sources that can be compared, we are making promising progress, albeit COVID-19 is the probable cause:

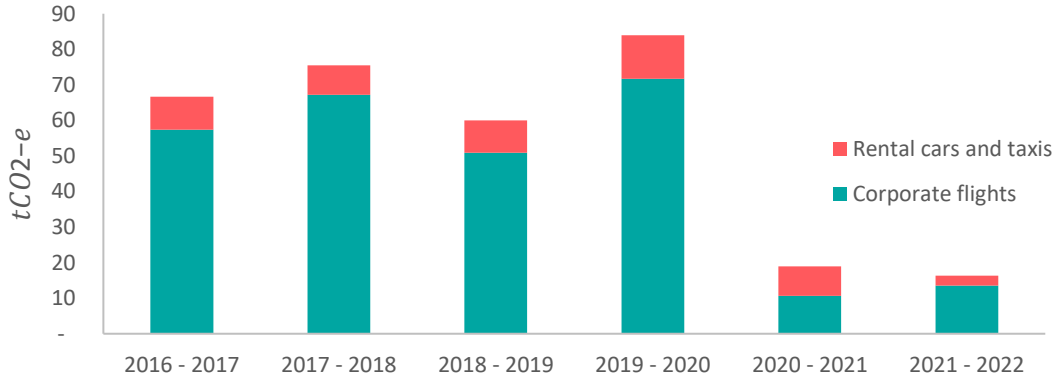


4.3.7 Changing to 100 percent electric vehicles and Decarbonising other travel options

Hutt City Councils formal target is to have a fossil-free fleet by 2030, and HCC is exceeding this target:

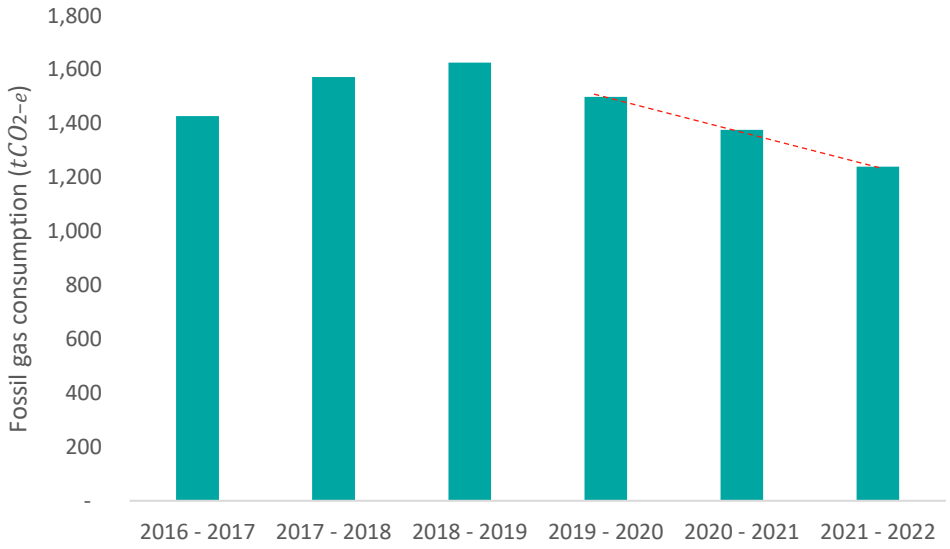


Other travel options are also being decarbonised, with reductions in non-fleet travel emissions. The emission reductions have primarily been achieved through COVID-19, however the associated changes in behaviour have also reduced emissions; for example, through the adoption of Microsoft Teams.



4.3.8 Phasing out natural gas at council facilities

As previously discussed, Hutt City Council's consumption of fossil gas is declining at the appropriate rate:



4.3.9 Upgrading to 100 percent LED streetlighting

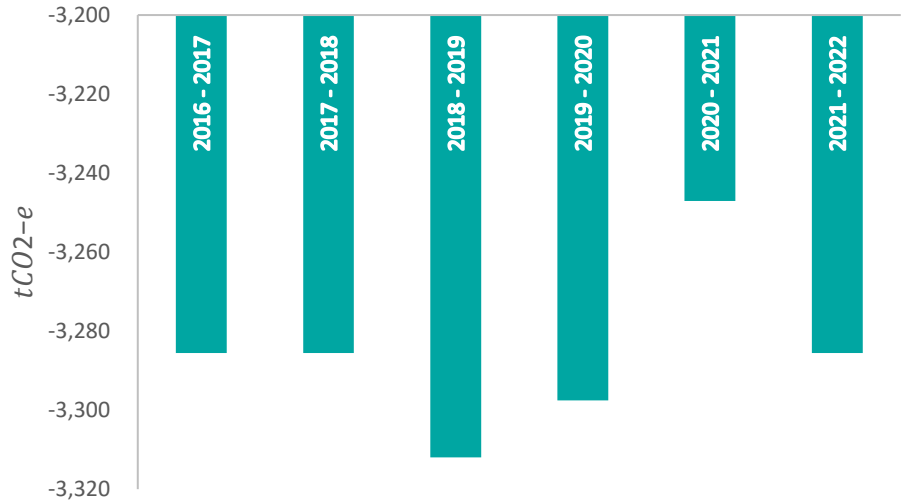
Initially this was scheduled to be complete by June 2021, this project has currently stalled as it was delayed by supply constraints, eg, delays from the manufacturers and through port of Auckland, there were also resourcing conflicts with Transmission Gully. New funding is required to complete this project and it currently sits at 63% complete.

4.3.10 Investigating methane destruction via flare burn-off for the closed landfill in Wainuiomata

As of the 26th of October 2022, test bores have been installed. Dependant on the results from these tests, a flare may be in place by the end of 2023.

4.3.11 Accelerating reforestation of Belmont Regional Park

This is currently on schedule and is expected to be in place by 2025, carbon sequestration for Hutt City Council remains constant through the assessed period, recall that sequestration for the complete financial year is only available 2018-2019 – 2020-2021:



4.3.12 Improving the quality of forests on other reserve land

This is currently on schedule and new activity will potentially be in place in 2023.

5. APPENDIX 1. HUTT CITY CARBON FOOTPRINT – ACTIVE AND CLOSED LANDFILL ASSESSMENT

Tonkin+Taylor

Job No: 82948.017
2 November 2022

Hutt City Council
By email: jorn.scherzer@huttcity.govt.nz

Attention: Jörn Scherzer

Dear Jörn

Hutt City carbon footprint - active and closed landfill assessment

Tonkin &Taylor Ltd (T+T) are pleased to provide an estimate of the carbon emissions from selected waste disposal sites within the Hutt City area. This work was requested by Hutt City Council (HCC) for inclusion in HCC's 2022 carbon footprint inventory.

1 Estimated carbon emissions

Carbon emissions have been estimated for Silverstream (Stages 1, 1a and 2), along with Wainuiomata closed landfill. The emissions are summarised in Table 1 below.

Table 1: Estimated emissions

Financial year	Fugitive emissions estimate in t CO_2e (emissions destroyed by combustion in brackets)		
	Silverstream		Wainuiomata
	Stage 1 & 1a	Stage 2	
2016/17	6,814 (24,713)	13,182 (42,583)	29,545 (0)
2017/18	6,375 (23,137)	15,416 (53,106)	26,412 (0)
2018/19	6,375 (23,137)	17,362 (58,805)	24,173 (0)
2019/20	6,995 (25,390)	17,356 (67,228)	21,487 (0)
2020/21	5,350 (19,416)	19,559 (58,766)	19,249 (0)
2021/22	3328 (20,231)	17,757 (87,024)	16,563 (0)

Note – The Silverstream emissions are after extraction and destruction is taken into account. No rounding undertaken to above figures at request of HCC, so that rounding can be applied elsewhere in inventory.

Exceptional thinking together www.tonkintaylor.co.nz

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The fugitive emissions through the landfill cap and from the gas engines are separated in Table 2 below.

Table 2: Proportion of fugitive emissions through cap and from engines

Financial year	Silverstream fugitive emissions separated by pathway (t CO_2e)			
	Stage 1 & 1a		Stage 2	
	Through cap	From engines	Through cap	From engines
2021/22	1472	1856	7833	9923

2 Non-compliances from 2021 report

Our report for the 2020/21 financial year generated a number of non-compliance comments from the Carbon Inventory peer reviewer, Aecom. We discussed with the peer reviewer how these non-compliances could be resolved on 21 February 2022 (Chris Hillman/Adrien Bouzanville). The table below lists the non-compliances and how they have been addressed within this report.

Table 3: Non-compliance issues

Non-Compliance	How addressed
NC 1 - UEF calculation detail is not provided for Silverstream Stage 2. Include UEF calculation in the report to clarify the various assumptions made.	The Silverstream Stage 2 UEF calculations for 2021 and the first half of 2022 are enclosed in Appendix A
mNC1 - No detail is provided on the diffuse emissions from Silverstream, Stage 1 and 1a to confirm that this has been accounted for in the estimation. Hutt City emissions report to clarify whether diffuse emissions are included in the figures or not.	The emissions observed through the cap are discussed in Section 3 of this report. Diffuse emissions are accounted for in Table 1 above and are estimated to be equal to all estimated methane generation minus the methane destroyed.
mNC 2 - No detail is provided on the diffuse emissions from Silverstream, Stage 2 to confirm how this has been accounted for in the estimation. Hutt City emissions report to clarify whether diffuse emissions are included in the figures or not.	
mNC3 - Part of LFG emissions from Silverstream, Stage 1 and 1a is flared. No detail is provided on the LFG composition over time and the flare efficiency. Details of flaring efficiency or LFG composition to be included in the Hutt City emissions report, if available. Or it should be mentioned that current data was not readily available and average or national figure have been used	Flare efficiency is discussed in Section 5 of this report, as is differentiation between the flared and generator destruction. LFG composition is discussed in Section 6 of this report.

Non-Compliance	How addressed
mNC 4 - Part of LFG emission from Silverstream, Stage 2 is flared. No detail is provided on the LFG composition over time and the flare efficiency. Details of flaring efficiency or LFG composition to be included in the Hutt City emissions report, if available. Or it should be mentioned that current data was not readily available and average or national figure have been used.	Spot checks of landfill gas composition are provided in Section 6. Flare efficiency is discussed in Section 5.
mNC 5 - Account and report any flare down time (linked to direct CH4 emission) from the system. In the future flare down time needs to be calculated in the inventory	Flare downtime is tabulated in Section 4.
mNC 6 - Uncertainty for LFG emission is set at 10% (i.e. Very high confidence) for both open and closed landfills. However, considering the quality of the data currently used (LFG models) and the accounting methodology, the level of confidence could be lowered to Medium confidence - 50%. Provide justification of the uncertainty or update the calculations with a higher uncertainty	Addressed in Section 7 of this report.

3 Location of diffuse emissions

Since 2010, surface monitoring of methane emissions has been undertaken regularly across Silverstream Stages 1/1a and 2. The frequency of monitoring has varied between weekly and monthly over the years and is currently undertaken fortnightly. This monitoring only allows concentrations of methane emitted to be measured, not volumes.

From the body of information gathered, the emissions pathways for landfill gas to escape to atmosphere are typically through:

- Cracks between extraction wells and the clay cap: As the landfill moves, so cracks regularly develop, generally hairline in size, through which gas can escape.
- Exposed leachate gravels in Stage 2: these gravels line the base and sides of the landfill, ensuring downward migration of leachate. They also collect landfill gas. A temporary inhibitor is installed where the gravels daylight, which comprises a polyethylene membrane and compacted clay. On occasions this inhibitor is damaged or disturbed, causing emissions.

An ongoing regime of maintenance is in place to remediate the above pathways.

4 Flare down time

The Carbon Inventory peer reviewer has requested that flare down time be reported for the period. The down time is automatically accounted for in the emissions estimate as the emissions are calculated on the flow of gas through the flare and gas engines. Flare down time, as reported by the operator, LMS, is detailed in Table 4 below.

Table 4: Flare downtime (July 2021 to June 2022)

Month	Report Month Hours (see note)	Flare operating (hrs)	Flare downtime (hrs)	Flare downtime (% of month hrs)
July	811	211	600	74%
August	687	452	235	34%
September	663	519	144	22%
October	744	652	92	12%
November	720	228	492	68%
December	744	361	383	51%
January	744	392	352	47%
February	672	620	52	8%
March	586	569	17	3%
April	720	626	94	13%
May	744	519	225	30%
June	720	710	10	1%

Notes

1) The above readings are made by the operator as close to the month end as possible, which is why the monthly hours do not always equate to 30/31 days.
2) The flare is only operated when required to take excess not consumed by the power plant (the gas is preferentially directed to the power plant to convert into electricity).

5 Flare vs gas engines destruction

The Carbon Inventory peer reviewer indicated that it would be useful to differentiate between the volumes of gas destroyed by the flare vs the gas engines. The volumes of gas flowing through each are detailed on Table 5 below (obtained from LMS records). The destruction efficiency of the engines is taken to be 90% and we understand that the destruction efficiency of the flare is much higher (although for the purposes of the calculated emissions in Table 1, has been assumed to be 90%). Destruction efficiency of the engines and the flare is due to be measured by LMS in the coming weeks.

Table 5: Volumes of gas through the flare vs gas engines (July 2021 to June 2022)

Month	Volume (m^3) of gas through		% of gas volume through the flare
	Gas engines	Flare	
July	806,998	36,550	4%
August	821,421	87,020	10%
September	790,504	69,184	8%
October	773,644	106,649	12%
November	711,623	85,377	11%
December	745,428	72,713	9%
January	691,738	102,882	13%
February	666,781	133,983	17%
March	734,956	127,155	15%
April	632,913	198,206	24%
May	635,061	188,354	23%
June	461,593	421,207	48%

Note: % gas volume through flare = volume of gas through flare divided by sum of gas volume through flare and gas engines.

6 Landfill gas composition

The Carbon Inventory peer reviewer requested that composition data for the landfill gas be included in this report. Spot checks throughout the year have been made for Silverstream Stages 1/1a and 2. No monitoring wells are installed at Wainuiomata Closed Landfill.

Gas composition data from Silverstream Stage 1/1a and 2 are enclosed as Appendix B. There are a number of lines of evidence indicating that both the fixed and portable meters are providing inaccurate data for 2022, not least that the gas engines will not operate with a methane concentration of less than 45% (and many of the results for 2022 are below 45%). Both the fixed and portable meters are within calibration. A second portable gas meter was hired and used for spot checks in conjunction with the original portable meter. In addition, a second fixed meter has been installed. Since introducing the second portable and fixed meters, the methane concentration has increased on the original meters. Investigation is ongoing.

7 Uncertainty

The Carbon Inventory peer reviewer has requested that a qualitative assessment of uncertainty be made for the landfill gas emissions estimated for the landfill. To make this assessment, we have compared waste stream content assessment data against the MfE default[1].

Qualitative waste stream content assessments have been undertaken at Silverstream on six occasions since 1994. The 1994 to 2003 assessments would have been on Silverstream Stage 1/1a and the 2014/2022 assessments on Stage 2. The results of these assessments, along with a comparison with the MfE default are summarised in Table 6 below.

[1] Climate Change (Unique Emissions Factors) Regulations 2009 (SR 2009/286) (as at 01 January 2016) Schedule 3 First-order decay model parameters – New Zealand Legislation

Table 6: Waste stream data comparison for Silverstream (% composition)

Waste Stream Component	MfE default	Stage 1				Stage 2		Mean results (See Note)	
								Stage 1	Stage 2
		Dec-94	Jun-98	Jan-03	Apr-03	2014	2022	94 to 03	14 to 22
Food	16.8	-	-	-	-	13.9	10.2	-	72%
Garden	8.3	8	7.9	3.9	7.7	11.5	9.6	83%	127%
Paper	10.7	19	16.1	9.9	10.9	10.7	7.3	131%	84%
Wood	11.9	15	18.5	12.5	14.3	10.8	15.1	127%	109%
Textile	5.6	3	3.8	2.4	3.1	4.6	5.1	55%	87%
Nappies	3	-	-	1.6	1.5	4.8	3.9	52%	145%
Sewage Sludge	3.9	-	-	-	-	3.9	10.3	-	182%
Other	39.8	-	-	-	-	39.8	38.5	-	98%

Note: Mean waste stream results are shown as a percentage of MfE default

Using the mean results from Table 6 above, the methane generation potential and decay rate constant have been calculated for Silverstream (Table 7 below). For Stage 1, the generation potential for the Stage 1 waste is 9% higher than the MfE default. The generation potential for Stage 2, and the decay rate values for both landfills, are similar to the MfE default. This indicates that for Stage 1 gas generation in Table 1 would be underestimated by using MfE default data, rather than the waste stream assessment data.

Table 7: Gas generation parameters estimated using data from Table 6.

Parameter	MfE default	Stage 1	Stage 2
Methane Generation Potential, Lo (m^3 methane/t waste)	79.18	86.38	78.25
Decay rate constant, k (per year)	0.0629	0.065	0.0625

Note: MfE default percentages have been used where there is not data.

Taking the above into account, including the methane monitoring issues discussed in Section 6, we make the following qualitative assessment of the uncertainty for the landfill gas emission estimates:

- Silverstream Stage 2 – Medium confidence (50%).
- Silverstream Stage 1/1a – Medium confidence (40%).
- Wainuiomata – Low confidence (20% as no gas monitoring data – however a flare trial is planned for late 2022).

8 Comments on descrepancies with previous assessments

8.1 Silverstream – Asbestos waste

As discussed in Section 6, there is evidence that methane has been underreported at Silverstream Stage 2 since the start of 2022. A conservative correction has been made to allow for this, but the underreporting is still likely to have overestimated carbon emitted compared to previous years.

Additionally, the 2021/22 estimate for Silverstream does not include asbestos waste as this waste was placed in a separate facility between Stages 1/1a and 2 (ie not placed within the landfills). This waste would not produce landfill gas.

The gas emission estimates for prior years have not been adjusted for the asbestos waste placed outside Stages 1a/1 and 2 (ie asbestos waste was included in the waste tonnages used to calculate gas generation).

8.2 Silverstream – estimate for 2016/17

In August 2018, Aecom provided HCC with a Corporate Carbon Footprint inventory[2], which included assessment of emissions from Silverstream Landfill (Stages 1/1a and 2). The assessment estimated that 12,581 tCO_2e was emitted from Silverstream landfill during the 2016/17 financial year, which differs from the 20,000 tCO_2e in Table 1 above for the combined emissions from Silverstream Stages 1, 1a and 2. The overall method used was the same to arrive at both figures, but the input parameters differed. The main difference is that the efficiency of the gas extraction was assumed to be 90% by Aecom, however in 2016 the efficiency dipped to an estimated value of 84.2%[3]. If the Aecom report had assumed an efficiency of 84.2%, the emissions estimate in the Aecom report would have been approximately 20,000 tCO_2e.

8.3 Wainuiomata – Hutt City Carbon Reduction Plan

For Wainuiomata Closed Landfill, the Hutt City Carbon Reduction Plan estimated lower volumes of carbon than those detailed in Table 1 above. The reason for this is that a methane Global Warming Potential (GWP) factor of 25 was used for the Reduction Plan estimate (the Ministry for the Environment standard) and a GWP of 34 was used for Table 1 above. The request to use a GWP of 34 came from the Carbon Inventory peer reviewer, for the following reasons:

- *The GWP for Methane (34) was chosen as based on IPCC 5th report's figure with climate change feedback because it is appropriate for the type of assessment done e.g. it produces a conservative first order assessment of emissions.*
- *The use of the GWP 34 for methane is based on the recommendation of NZ's IPCC representatives. The use of climate change feedbacks is likely to be included in the IPCC 6th Assessment to be published in early 2022.*

9 Data sources

- Wainuiomata
  - Landfill gas generated (at 50% methane) has been estimated from Figure 3.1 of a Landfill Emissions Report[4], using the T+T Model (Red) line.
  - Wainuiomata has no gas extraction system, however, a 10% oxidation of methane when passing though the cap has been assumed.
- Silverstream, Stage 1 and 1a
  - Gas generation has been estimated assuming the same extraction and destruction efficiency as Stage 2.
  - Silverstream Stage 1/1a landfill gas is extracted to create electricity that is fed into the national grid. A flow logger was installed on 18th October 2019 and has provided data only during the following periods:
    - 18 October 2019 to 19 November 2019 – average flow 267 m3/hr
    - 4 January 2020 to 10 June 2020 – average flow 290 m3/hr

[2] Aecom (Aug 2018) Hutt City Council Corporate Carbon Footprint, 2016-17, prepared on behalf of Hutt City Council.
[3] Efficiency for financial year 2016/17 calculated by taking an average of the efficiency in calendar years 2016 (78.5%) and 2017 (90%)
[4] T+T (March 2021) Wainuiomata closed landfill emissions investigation: Task 2 – Gas generation modelling, draft letter report, prepared on behalf of Hutt City Council.

- 2 January 2020 to Present (11 October 2020) – average flow 210 m3/hr
- Using this data, the following average flows have been assumed:
  - July 2016 to June 2019 - average of the entire dataset, which is 229 m3/hr
  - July 2019 to June 2020 – average of the data available during this time, which is 293 m3/hr
  - July 2020 to June 2022 – average of the data available during this time, which is 210 m3/hr

- Silverstream Stage 2
  - Carbon emissions have been estimated using the data from the UEF assessments for calendar years 2016 to 2021. For 2022, an interim UEF assessment has been used to estimate the gas generation and flow. Where meters show methane to be less than 45%, a value of 45% has been used (see Section 6)

10 Applicability

This report has been prepared for the exclusive use of our client, Hutt City Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
.....	.....
Chris Hillman Senior Environmental Engineer	Ed Breese Project Director

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Appendix A: UEF calculations

Project: Silverstream Landfill | Job No: 82948.028 | 31/01/2022
Description: 2021 UEF Calculation | Page 1 of 4
Computed: ME KL | Checked: HEC

01 SCHOLL CANYON MODEL SINGLE WASTE PROFILE - UEF CALCULATION

The generation of landfill gas is estimated by the Scholl Canyon model, which is a first order decay model. The calculation procedures permits the modelling of:

- single waste/time input profiles
- single gas production per unit weight (L_o)
- changes in the decay parameters to account for the effects of capping a landfill
- capping is presumed to occur at a set period following the placement of any particular unit of waste - this is appropriate for relatively large landfills, where the construction of an effective capping system is likely to occur at intermediate stages throughout a long operational period on large landfills, particularly in climates with high rainfall.

Cap placement definition - after a set period following waste placement

The Scholl Canyon Model is implemented in the USEPA model LandGem. In LandGem the data for incoming waste is provided in discrete annual tonnages. By default this is split into 10 equally spaced placements through the year. In this implementation the unit of time is flexible and the number of increments within this unit of time is also flexible.

LandGem and time units

Reference

DEPARTMENT OF THE ARMY U.S. Army Corps of Engineers CEMP-RT Washington, DC 20314-1000 ETL 1110-1-160 Technical Letter No. 1110-1-160 17 April 1995 "Engineering and Design LANDFILL OFF-GAS COLLECTION AND TREATMENT SYSTEMS"

Units

$Mg := 1000kg$ $tonne = 1 \times 10^3 kg$

Waste parameters

Potential CH_4 generation capacity of the waste (NEW2015 Default) $L_o := 79.18m^3 \cdot tonne^{-1}$

CH_4 generation decay rate constant (Default) $k := 0.063 \cdot yr^{-1}$

Time to reach anaerobic conditions, yrs. (LandGem assumes a lg of 1 year) $Anaerobic_{lag} := 0.5yr$

Engine parameters

LFG destruction (corrected to 50% methane) $Q := 971.620m^3 hr^{-1}$

Destruction efficiency $D := 90\%$

Oxidation factor $Ox := 10\%$

Landfill waste input profile

$Date := \left(Waste^{\langle 0 \rangle}\right) \cdot yr$

$Anwaste := Waste^{\langle 1 \rangle} \cdot tonne$

Waste := (Date: Tonnes/yr)

	0	1
0	2010	11000
1	2011	77335
2	2012	83543
3	2013	110925
4	2014	125280
5	2015	112570
6	2016	121265

Single waste profile lge LF Jan-Dec 2021 CH4 spot - 2020 tonnage corrected.xmcd

Project: Silverstream Landfill
Description: 2021 UEF Calculation
Computed: MEKL

Job No: 82948.028
Checked: HEC

31/01/2022
Page 2 of 4

7	2017	118209
8	2018	122807
9	2019	137393
10	2020	146810
11	2021	148088
12	2022	...

Start date for analysis — $Start := Date_0$ — $Start = 2010 \cdot yr$

Counter for the number of years over which waste is received at the landfill — $Incom := length(Waste^{\langle 0 \rangle})$ — $Incom = 28$ years

Final date for analysis — $Final := Start + Incom \cdot yr - 1yr$ — $Final = 2037 \cdot yr$

Waste placement distribution

The number of increments in a year. 20 provides a reasonable continuum for the generation rate.

LandGem uses 10 increments — $inc := 10$

Function to distribute the waste placement across the years of incoming waste

Placed waste is apportioned over the relevant year in accordance with the number of increments in the year. The waste is placed at the end of each time increment.

$$WastePlaced := \left| \begin{array}{l} \text{for } i \in 0..Incom-1 \\ \quad \text{for } j \in 1..inc \\ \quad\quad wastePlaced_{i\,inc+j} \leftarrow \frac{Anwaste_i}{inc} \\ wastePlaced \end{array} \right.$$

Date of waste placement

Function to determine the date on which the waste is placed

$$DatePlaced := \left| \begin{array}{l} \text{for } i \in 0..Incom-1 \\ \quad \text{for } j \in 0..inc \\ \quad\quad datePlaced_{i\,inc+j} \leftarrow Date_i + \frac{j}{inc} \cdot yr \\ datePlaced \end{array} \right.$$

Landfill gas generation

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Estimated total landfill gas flow rate

If the date of placement exceeds the time of interest, terminate the calculation and return the gas production rate.

ti = Time from waste placement

Value of k is dependent upon capping from time of placement

This assumes that the landfill 50% of the landfill gas is methane.

Total landfill gas production, of which a percentage is methane.

$$
\begin{aligned}
&Gen(time) := \\
&\quad q \leftarrow 0 \cdot m^3 \cdot hr^{-1} \\
&\quad \text{for } i \in 0..last(DatePlaced) \\
&\quad\quad \text{return } q \text{ if } DatePlaced_i > time \\
&\quad\quad \text{otherwise} \\
&\quad\quad\quad ti \leftarrow time - DatePlaced_i \\
&\quad\quad\quad Exp \leftarrow e^{-k\cdot(ti - Anaerobic_{lag})} \\
&\quad\quad\quad \Delta q \leftarrow 2 \cdot k \cdot L_o \cdot WastePlaced_i \cdot Exp \\
&\quad\quad\quad q \leftarrow q + \Delta q \\
&\quad q
\end{aligned}
$$

Single waste profile lge LF Jan-Dec 2021 CH4 spot - 2020 tonnage corrected.xmcd

Project: Silverstream Landfill | Job No: 82948.028 | 31/01/2022
Description: 2021 UEF Calculation | Page 4 of 4
Computed: MEKL | Checked: HEC

Results

Landfill generation rate 2021 (at 50% methane)

$$Gen(2021yr) = 1046 \cdot m^3 hr^{-1}$$

LFG destruction (at 50% methane)

$$Q = 972 \cdot m^3 hr^{-1}$$

Estimated collection efficiency

$$C(time) := \begin{cases} 0.9 & \text{if } Q > Gen(time) \cdot (1 - Ox) \\ \left[D \cdot \frac{Q}{Gen(time) \cdot (1 - Ox)} \right] & \text{otherwise} \end{cases}$$

$$C(2021yr) = 0.9$$

Unique emission factor

$$UEF(time) := 1.19 \cdot (1 - C(time))$$

$$UEF(2021yr) = 0.119$$

Single waste profile lge LF Jan-Dec 2021 CH4 spot - 2020 tonnage corrected.xmcd

Project: Silverstream Landfill | Job No: 82948.028 | 20/10/2022
Description: 2021 UEF Calculation | Page 1 of 4
Computed: MEKL | Checked: HEC

01 SCHOLL CANYON MODEL SINGLE WASTE PROFILE - UEF CALCULATION

The generation of landfill gas is estimated by the Scholl Canyon model, which is a first order decay model. The calculation procedures permits the modelling of:

- single waste/time input profiles
- single gas production per unit weight (L_o)
- changes in the decay parameters to account for the effects of capping a landfill
- capping is presumed to occur at a set period following the placement of any particular unit of waste - this is appropriate for relatively large landfills, where the construction of an effective capping system is likely to occur at intermediate stages throughout a long operational period on large landfills, particularly in climates with high rainfall.

Cap placement definition - after a set period following waste placement

The Scholl Canyon Model is implemented in the USEPA model LandGem. In LandGem the data for incoming waste is provided in discrete annual tonnages. By default this is split into 10 equally spaced placements through the year. In this implementation the unit of time is flexible and the number of increments within this unit of time is also flexible.

LandGem and time units

Reference

DEPARTMENT OF THE ARMY U.S. Army Corps of Engineers CEMP-RT Washington, DC 20314-1000 ETL 1110-1-160 Technical Letter No. 1110-1-160 17 April 1995 "Engineering and Design LANDFILL OFF-GAS COLLECTION AND TREATMENT SYSTEMS"

Units

$Mg := 1000kg$ $tonne = 1 \times 10^3 kg$

Waste parameters

Potential CH_4 generation capacity of the waste (NEW2015 Default) $L_o := 79.18m^3 \cdot tonne^{-1}$

CH_4 generation decay rate constant (Default) $k := 0.063 \cdot yr^{-1}$

Time to reach anaerobic conditions, yrs. (LandGem assumes a lg of 1 year) $Anaerobic_{lag} := 0.5yr$

Engine parameters

LFG destruction (corrected to 50% methane) $Q := 1023.665m^3 hr^{-1}$

Destruction efficiency $D := 90\%$

Oxidation factor $Ox := 10\%$

Landfill waste input profile

$Date := \left(Waste^{\langle 0 \rangle}\right) \cdot yr$

$Anwaste := Waste^{\langle 1 \rangle} \cdot tonne$

Waste := Date Tonnes/yr

	0	1
0	2010	10479
1	2011	76678
2	2012	83025
3	2013	110565
4	2014	118481
5	2015	111319
6	2016	117370
7	2017	117484

Single waste profile lge LF Jan-Sept 2022.xmcd

Project: Silverstream Landfill
Description: 2021 UEF Calculation
Computed: MEKL

Job No: 82948.028
Checked: HEC

20/10/2022
Page 2 of 4

7	2017	117481
8	2018	122419
9	2019	135604
10	2020	140066
11	2021	142393
12	2022	70593
13	2023	...

Start date for analysis — $Start := Date_0$ — $Start = 2010\cdot yr$

Counter for the number of years over which waste is received at the landfill — $Incom := length\left(Waste^{\langle 0 \rangle}\right)$ — $Incom = 28$ years

Final date for analysis — $Final := Start + Incom\,yr - 1yr$ — $Final = 2037\cdot yr$

Waste placement distribution

The number of increments in a year. 20 provides a reasonable continuum for the generation rate.

LandGem uses 10 increments — $inc := 10$

Function to distribute the waste placement across the years of incoming waste

Placed waste is apportioned over the relevant year in accordance with the number of increments in the year. The waste is placed at the end of each time increment.

$$WastePlaced := \left| \begin{array}{l} \text{for } i \in 0..Incom-1 \\ \quad \text{for } j \in 1..inc \\ \quad\quad wastePlaced_{i\,inc+j} \leftarrow \dfrac{Anwaste_i}{inc} \\ wastePlaced \end{array} \right.$$

Date of waste placement

Function to determine the date on which the waste is placed

$$DatePlaced := \left| \begin{array}{l} \text{for } i \in 0..Incom-1 \\ \quad \text{for } j \in 0..inc \\ \quad\quad datePlaced_{i\,inc+j} \leftarrow Date_i + \dfrac{j}{inc}\cdot yr \\ datePlaced \end{array} \right.$$

Project: Silverstream Landfill | Job No: 82948.028 | 20/10/2022
Description: 2021 UEF Calculation | Page 3 of 4
Computed: MEKL | Checked: HEC

Landfill gas generation

Estimated total landfill gas flow rate

If the date of placement exceeds the time of interest, terminate the calculation and return the gas production rate.

ti = Time from waste placement

Value of k is dependent upon capping from time of placement

This assumes that the landfill 50% of the landfill gas is methane.

Total landfill gas production, of which a percentage is methane.

$$\begin{aligned}
&\text{Gen}(\text{time}) := \\
&\quad q \leftarrow 0 \cdot m^3 \cdot hr^{-1} \\
&\quad \text{for } i \in 0..\text{last}(\text{DatePlaced}) \\
&\quad\quad \text{return } q \text{ if } \text{DatePlaced}_i > \text{time} \\
&\quad\quad \text{otherwise} \\
&\quad\quad\quad ti \leftarrow \text{time} - \text{DatePlaced}_i \\
&\quad\quad\quad \text{Exp} \leftarrow e^{-k\cdot\left(ti - \text{Anaerobic}_{lag}\right)} \\
&\quad\quad\quad \Delta q \leftarrow 2 \cdot k \cdot L_o \cdot \text{WastePlaced}_i \cdot \text{Exp} \\
&\quad\quad\quad q \leftarrow q + \Delta q \\
&\quad q
\end{aligned}$$

Project: Silverstream Landfill | Job No: 82948.028 | 20/10/2022
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Computed: MEKL | Checked: HEC

Results

Landfill generation rate 2022 (at 50% methane)

$$Gen(2022yr) = 1124 \cdot m^3 hr^{-1}$$

LFG destruction (at 50% methane)

$$Q = 1 \times 10^3 \cdot m^3 hr^{-1}$$

Estimated collection efficiency

$$C(time) := \begin{cases} 0.9 & \text{if } Q > Gen(time) \cdot (1 - Ox) \\ \left[D \cdot \frac{Q}{Gen(time) \cdot (1 - Ox)} \right] & \text{otherwise} \end{cases}$$

$$C(2022yr) = 0.9$$

Unique emission factor

$$UEF(time) := 1.19 \cdot (1 - C(time))$$

$$UEF(2022yr) = 0.119$$

Single waste profile lge LF Jan-Sept 2022.xmcd

Appendix B: Gas composition data

Stage 1/1A Data

	Portable Meter						Hire GA5000						Fixed Meter	
Date	Stage 1 CH4 (%)	CO2 (%)	O2 (%)	CO (PPM)	H2S (PPM)	Bal (%)	CH4 (Hire)	CO2	O2	CO	H2S	Bal	Total Flow Stage 1	FLOW Stage 1 (NM3/H)
2/07/2021	47.5													212.9
7/07/2021	50.6													203.7
23/07/2021	49.1													212.4
29/07/2021	58.5													252.5
6/08/2021	53.4													190.9
11/08/2021	48.7													231.7
8/09/2021	50.3													42.39
15/09/2021	50.4													198.9
7/10/2021	29.9													182.6
2/11/2021	46.3													208.8
13/12/2022	43.3													211.6
22/12/2021	40													246.2
11/01/2022	38.8													236.4
25/01/2022	30.3													196.1
4/02/2022	39.3													197.5
9/02/2022	44.2													203
17/02/2022	37.3													189.2
12/02/2022	42													207.1
8/03/2022	41.2													200.7
17/03/2022	42.3													212.8
7/04/2022	41.6													296.7
14/04/2022	43.7												4284256	167.3
20/04/2022	43.9												4311977	168.7
5/05/2022	48	28.9	2.1	3	149	21.1							4377651	166.8
12/05/2022	39.2	29.3	1.5	0	FILT	29.9							4413557	176.3
18/05/2022	39.1	29.3	1.7	0	FILT	30							4440739	192.3
23/05/2022	33.3	39.4	1.2	10	FILT	26	55	29.5	1.6	0	FILT	13.9	4460540	222.8
3/06/2022	39.2	26.5	5.3	1	FILT	29	51.5	29.6	2	0	129	16.8	4509358	175
10/06/2022	37.7	26.5	3.2	1	FILT	32.7	49.2	29.1	1.9	0	FILTERED	19.9	4542058	200.9
17/06/2022	31.2	25.9	3.4	3	FILT	39.5	44.1	26.3	13.1	0	FILTERED	29.6	4572640	179.9
27/06/2022	44	32.1	0.7	1	FILT	23.2	59.5	31.1	0.5	1	FILTERED	8.9	4611234	166.4

Stage 2 Data

	Portable Meter (T+T)									Hired Portable Meter (GA 5000)						Fixed Meter		
Date	Stage 2 CH4 (%)	CO2 (%)	O2 (%)	CO (PPM)	H2S (PPM)	Bal (%)	Gas Meter	Time	USER	CH4	CO2	O2	CO	H2S	Bal	Total Flow Stage 2	FLOW Stage 2 (NM3/H)	CH4 old (%)
2/07/2021	47	28	1.6	2	122	23.3	GA5000	12:53	SELO							12230870	866.9	
7/07/2021	50.6	39.1	1.3	9	471	8.9	ga5000	10:38	HAMU							12326640	1023	
23/07/2021	36.3	29.8	8.7	4	330	252	ga5000	11:41	hamu							12710397	1169	
29/07/2021	60.5	36.1	1.4	<<<	>>>	2	ga5000 (hire from geotechnics)	4:25	HAMU							12888722	1139	40.1
6/08/2021	49.8	41.2	0.7	10	484	8.5	ga5000	14:05	hamu							13077892	1091	44.1
11/08/2021	47	39	1.9	9	445	12.2	ga5000	14:52	hamu							13212673	1175	
8/09/2021	48.8	38.4	1.1	9	507	11.7	ga5000	12:56	hamu							13919682	636.1	44.9
15/09/2021	47.2	36.7	1.4	9	470	14.8	ga5000	14:22	hamu							14096318	989.8	44.2
7/10/2021	30.5	25.6	7.7	4	278	36.2	hire ga 5000 from geotechnics	11:10	hamu							14670694	1033	60.6
2/11/2021	45.4	40.5	0.6	5	420	13.5	GA5000	12:44	SELO							15357208	950.9	40.9
13/12/2022	48.3	40.8	0.2	20	590	10.7	GA5000	13:53	HAMU							16372331	9800	43.6
22/12/2021	47.6	41.5	0.8	6	429	10	ga5000 (geotechnics)	11:41	HAMU							16601404	1105	40.1
11/01/2022	46.2	40.1	0.7	11	376	13.1	GA5000	10:02	HAMU							17104596	1122	41
25/01/2022	47.2	37.2	2.2	8	484	13.1	GA5000	15:59	HAMU							17440562	1155	40.3
4/02/2022	44.5	37.1	1.7	8	404	16.6	GA5000	12:35	SSIM							17702854	1117	40.9
9/02/2022	48.3	37.3	1.9	7	428	12.6	GA5000	9:46	HAMU							17839587	1152	42.2
17/02/2022	39.4	36.5	1.3	9	333	22.8	GA5000	13:28	HAMU							18068261	743.9	42.2
12/02/2022	41	38.5	1.5	3	FILTERED	19	GA5000	11:15	HAMU							18286044	1203	43.9
8/03/2022	41.7	36.1	1.4	2	FILTERED	20.8	GA5000	10:19	HAMU							18594032	1199	42
17/03/2022	41	37.5	1.1	3	FILTERED	20.5	GA5000	11:12	HAMU							18849463	1224	42.9
7/04/2022	41	37.4	1.2	3	FILTERED	20.4	GA5000	16:48	hamu							19466882	1213	44.8
14/04/2022	40.3	37.7	1.5	4	FILTERED	20.6	GA5000	14:27	SELO							19665020	1142	42.8
20/04/2022	40.7	38.1	1.5	3	FILTERED	19.8	GA5000	12:15	HAMU							19831529	1123	42.7
5/05/2022	42.7	37.2	1.5	6	327	18.7	GA5000	12:15	HAMU							20191209	1265	42.6
12/05/2022	35.6	38.7	0.8	5	4	24.9	GA5000	16:25	HAMU							20369935	838.2	41.8
18/05/2022	36.1	40.1	1.1	4	4	22.8	GA5000	14:50	HAMU							20516650	1184	42.6
23/05/2022	32.8	36.1	2.2	9	FILTERED	28.9	T+T GA	13:00	HAMU	43.2	38.9	1.1	16	FILTERED	16.8	20369309	744.5	44.3
3/06/2022	34.6	34.4	2.2	5	FILTERED	28.8	T+T GA	13:58	SSIM	43.7	37.5	2.1	5	330	16.6	20974243	1231	44.2
10/06/2022	36	36.8	2.2	6	FILTERED	24.9	T+T GA	13:01	HAMU	47.9	35.1	2	5	FILTERED	14.9	2118646	1113	44.8
17/06/2022	37	38.8	1.6	6	FILTERED	22.5	T+T GA	14:25	hamu	47.8	39.7	1	5	FILTERED	11.5	21373854	1205	48.5
27/06/2022	36.6	40.1	1.3	6	FILTERED	22	T+T GA	14:59	SELO	48.3	40.3	0.8	7	FILTERED	10.6	21659543	1189	47.4

6. APPENDIX 2. HUTT CITY COUNCIL – ORGANISATIONAL CARBON FOOTPRINT: AUDIT SUMMARY

LUMEN

Engineering for a better future

23 December 2022

Jonathan Linders
Advisor Energy & Carbon
Hutt City Council
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Dear Jonathan,

Hutt City Council – Organisational Carbon Footprint: Audit Summary

I have completed my peer review of the council's Organisational Carbon Footprint report, for the council's financial year which runs July 2021 to June 2022.

I have reviewed the overall methodology, calculations, emissions factors, and source data.

Below are my findings.

Overall, the footprint is largely complete with all material emissions sources considered. Most of the changes I have suggested are relatively minor, such as suggested emissions factor changes and changes to nomenclature.

1. Review of calculations and source data

1.1 Flights calculations - it appears the emissions calculations from Orbit/OPUS reports were undercounting emissions from domestic flights. Using the activity data (pkms) from those reports * national average domestic factor with radiative forcing (2020) leads to 14tCO2-e vs the 12tCO2-e that has been reported.

- This has been sufficiently addressed. 23/12/22

1.2 Couriers – The Motu 2014 emissions factor to be adjusted for inflation. Is this not included in totals because it is de minimis (<1%)? or is it included somewhere that I'm missing?

- This has been sufficiently addressed. 23/12/22

1.3 Investments - The Motu 2014 emissions factor to be adjusted for inflation.

- This has been sufficiently addressed. 23/12/22

1.4 IT – as recognised, the data from Microsoft seems to be out by at least a factor of 1000 and no assurance can be provided on these numbers.

- No action required

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Phone: +64 3 377 1546 – **Email**: energy@lumen.net – **Web**: www.lumen.net

1.5 Landfill data – we have reviewed Tonkin and Taylor's reported landfill emissions and did not find any noticeable discrepancies.

- No action required

1.6 Uncertainty – seeing as it is partially calculated, could an estimated range be provided for the final figures in the report. For example, the total emissions in this report are +/- 15-20%.

- This has been sufficiently addressed. 23/12/22

2. Review of report

2.1 Summary, page 3 - comment on the footnote: The council will still need to account for the gross emissions from the IT services it receives from Microsoft, even if Microsoft decides to buy offsets for their own operational emissions.

- No action required

2.2 Reporting Boundaries, page 6 - rental cars are usually under Scope 1. However, if this has been reported as Scope 3 in the past, then stick with that.

- This has been sufficiently addressed. 23/12/22

2.3 Work from home (WFH) emissions (referred to as telecommuting in ISO14064-1) should be included within employee commuting.

- This has been sufficiently addressed. 23/12/22

2.4 Methodology, page 8 – text should be updated to reflect that an inflationary factor HAS now been used.

- This has been sufficiently addressed. 23/12/22

2.5 Scope 3, page 9 –you may wish to include a Scope 2 section, explaining that you have used the location-based method to calculate electricity emissions. This is important as you may choose to move to the market-based method in future, for example if you choose to purchase Renewable Energy Certificates (RECs).

- This has been sufficiently addressed. 23/12/22

2.6 Contracts, page 9 - include information on the inflation adjustment calculation.

- This has been sufficiently addressed. 23/12/22

2.7 LULUCF, page 11 – you may want to separate this from Scope 3. Maybe change to 2.4.

- This has been sufficiently addressed. 23/12/22

2.8 Working from home, page 23 - maybe include some context of WFH vs the average commute emissions? For example. For the average employee of HCC, it is 20% lower emissions to work from home rather than commute to the office - or whatever the conclusion ends up being.

- This has been sufficiently addressed. 23/12/22

2.9 Biogenic Emissions - shouldn't this section be in 3.2 for scope 1? Also "Biogenic methane emissions are declining" biogenic CO2 from flaring and electricity generation is increasing and although it won't be included in the totals the biogenic CO2 should be included somewhere as a footnote or appendix.

- This has been sufficiently addressed. 23/12/22

Now that the findings of this audit have been sufficiently addressed, we can give reasonable assurance, as per ISAE (NZ) 3410 *Assurance Engagements on Greenhouse Gas Statements*, that Hutt City Council have accurately represented their organisation carbon footprint for the financial year July 2021 to June 2022.

Yours sincerely,

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Note:
The assessor has applied Professional and Ethical Standard 3 (ISAE (NZ) 3722) to ensure independence for this assurance.