Hawke’s Bay

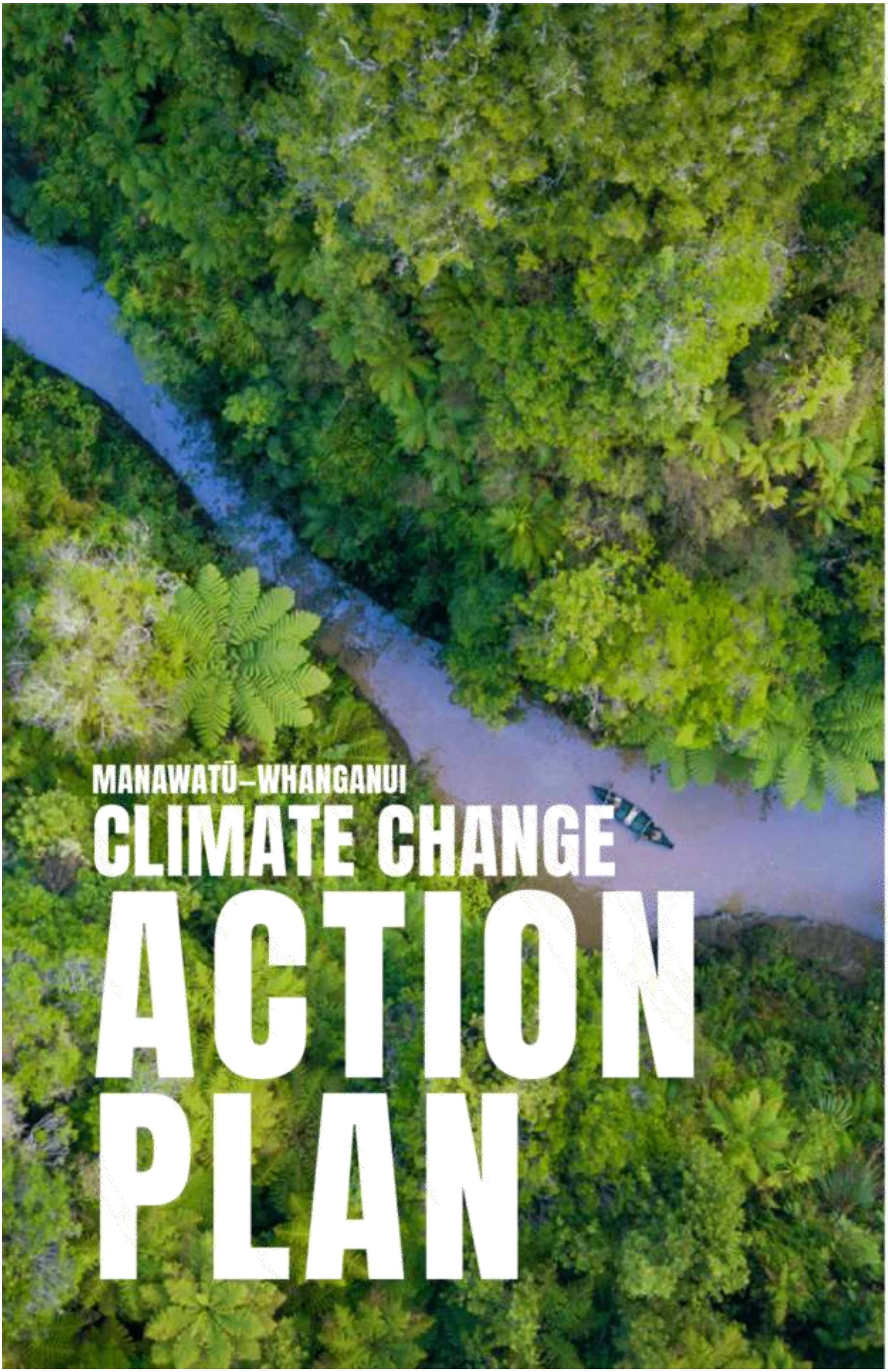
Meeting of the Climate Action Joint Committee

Date: 22 May 2023

Time: 1.30pm

Venue: Council Chamber
Hawke's Bay Regional Council
159 Dalton Street
NAPIER

Attachments excluded from Agenda



2023

Te Ao Māori

Across the Manawatū-Whanganui rohe that encompasses the principle homes of many Iwi and Hapū, acknowledging a vast range of important maunga, awa, moana, ancestral sites / sacred areas and significant environmental entities in each of these different places, we acknowledge that the Māori worldview has foundations, ethics and understandings that differ from those that developed in Europe and its colonies.

These foundations include the notions that:

1. The universe is holistic and dynamic; there is within it an ongoing process of **continuous creation** and recreation.
2. Everything in the universe, inanimate and animate, has its own whakapapa, and all things are **ultimately linked** to the two primal beings of Ranginui and Papatūānuku.
3. There is no distinction or break in this cosmogony, nor in the whakapapa between supernatural and natural. Both are part of **a unified whole**.
4. The bond this creates between human beings and the rest of the physical world is both **indisputable and non-severable**.
5. Uri share this **descent from the elemental atua or vast range of environmental entities**, other supernatural guardians including taniwha and other spiritual beings[1].

This worldview has contributed to the development and practice of a unique environmental ethic, which holds Te Taiao as intensely central to human/environmental wellbeing. This ethic is sacred and remains in special places and spaces across the rohe. Tangata whenua relate to Te Taiao through genealogical connections from time immemorial. This is highlighted in meaningful ways because they live it as tangata whenua on their marae and remain embedded within nature.

Māori have traditionally ensured sustainability through the handing down of a sophisticated system of customary practices, developed over several generations. Connections to the land, sea, air, and water are recalled in layers of oral tradition; they are closely linked to customary rights and authority over an area defined by ahi kā. This is the continuous period of time the fires of an Iwi have burned within their domain, undisturbed by conquest and despite the impacts of colonisation and environmental decline. Such long associations establish an intimate relationship between tangata whenua and the local environment, centred on sustainable use and guardianship of all kin therein. Knowledge is passed on to the next generation through oral traditions and practical observations – practices that remain vital for Māori wellbeing and cultural survival.

Tikanga varies between tribal groups, according to their own traditions and kōrero tuku iho and as an ongoing expressions of self-determination.

Who We Are

In 2021, in recognition of the urgency of responding to climate change, our region's eight councils agreed to form the Manawatū-Whanganui Climate Action Joint Committee. Iwi across this wide region were invited to identify nominees to join the committee. The seven Iwi-nominated members each contribute unique skills and experience; collectively, they ensure that a Māori perspective is reflected in the committee's work.

This action plan draws on both Māori and Western worldviews to work together in response to climate change. It is an action plan that embraces Te Ao Māori and views the complex issues through the lens of our relationship with the environment. Te Taiao must be healthy for communities to thrive, therefore action to restore balance that traverses the environmental, cultural, social and economic realms, is urgent and critical.

The committee acknowledges the authority of individual Iwi and Hapū, and the importance of Treaty principles in relationships between councils and tangata whenua. These include partnership, reciprocity, autonomy, active protection, and equal treatment.

Committee members are:
Chris Shenton, Hannah Rainforth, Huhana Smith, James Kendrick, Jill Sheehy, Jonathan Proctor, Lorraine Stephenson, Andrew Tripe, Andy Watson, Bernie Wanden, Grant Smith, Helen Worboys. Rachel Keedwell, Tracey Collis, Weston Kirton

The committee acknowledges the contribution of Hamish McDouall and Don Cameron, members of the Climate Action Joint Committee until October 2022.

Supported by

Manawatu District Council · Horizons Regional Council · Tararua District Council · Ruapehu District Council · Horowhenua District Council · Rangitīkei District Council · Whanganui District Council · Palmy

1. *Ko Tō Whanganui Titiro/Whanganui Hapū/Iwi World View: Outstanding Natural Landscapes Cultural Assessment Report Prepared by Te Rūnanga o Tamaupoko & Te Rūnanga o Tūpoho to inform the Whanganui District Plan Review – Proposed Plan Change 48.*

CONTENTS

CLIMATE CHANGE

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The climate in our Manawatū–Whanganui region is changing now.

Flooding and damage to homes and transport networks are increasing. Many of the things we value are vulnerable to climate change. Without action, existing social and environmental issues are likely to get worse.

This plan is about understanding how we will respond to climate change in the Manawatū-Whanganui region and working together to reduce potential harm.

The Māori worldview (Te Ao Māori) acknowledges that all living and non-living things are interconnected and the principles of kaitiakitanga (guardianship of the land) should guide us. This means caring for the land given to us by our ancestors, restoring mana to the land, and leaving it in a better state for future generations. It's about putting our local environment at the heart of our multi-faceted responses to climate change.

A healthy environment is critical for the social and economic wellbeing of everyone living in Manawatū-Whanganui. We need to look to the future of low-lying coastal communities, protect against flooding, preserve burial sites and other important cultural places and ensure the future of native species.

We also need a healthy environment to support a vibrant local economy – a changing climate will impact fisheries, farming and forestry, as well as transport networks and supply chains.

We must take action to adapt and reduce carbon emissions. The sooner we act, the more options we will have for building our community's resilience and preserving our environment.

It's about central Government, local authorities, tangata whenua, businesses, communities and individuals working together to get the best results for our region.

Many council and community projects are already underway, including flood protection, improved town water supplies and better public transport, cycleways and walkways.

The *Manawatū-Whanganui Climate Change Action Plan* builds on this work and makes recommendations to councils and communities on ways we can collaborate on issues we can't solve on our own. A well-designed plan means our efforts are aligned – locally and nationally.

This plan looks at changes we can make that will improve our lives, strengthen our economy and help reduce adverse impacts on the environment at the same time.

We have numerous opportunities to take a lead in developing and delivering new technologies that will change how we travel, eat and interact with each other in the future.

As one of our consultation participants noted 'We still have the luxury of choices in our part of the world'. Let's choose the sort of future we want and work together to achieve it – sharing lessons learnt and celebrating success along the way.

Dr Huhana Smith
Dr Rachel Keedwell

Co-Chairs Climate Action Joint Committee

KEY POINTS

Rangitīkei – GNS

1. The changing climate is happening now. Over time, it will affect our whānau, farms, businesses and communities in many different ways.

2. Climate change is one aspect of the relationship between people and the environment. Supporting a healthy environment by actively enhancing Te Taiao is at the heart of our response to climate change.

3. Councils will work with communities, tangata whenua and central Government to adapt to the changing climate, make our region more resilient and reduce emissions.

4. As we adapt to climate change, councils are committed to making changes in a fair and equitable way and upholding the principles of the Treaty of Waitangi.

5. This report makes recommendations to the eight councils in the region and includes proposals to reduce our contribution to climate change and adapt to its effects in Manawatū-Whanganui.

6. Councils also need central Government's support to adapt and transition.

7. There are things we can all do now, to make the things we care about more resilient to the impacts of a changing climate. Each of us doing what we can to reduce our carbon footprint will also reduce the severity of those impacts.

8. Taking action now to adapt and reduce carbon emissions will give us more options to respond as the climate changes.

OUR REGION

The Manawatū-Whanganui region extends from Ruapehu in the north and Horowhenua in the south, to Whanganui in the west and Tararua in the east.

Around
250,000 PEOPLE
call it home

We have
7 DISTRICTS
and approximately
89%
of our ratepayers live in urban centres

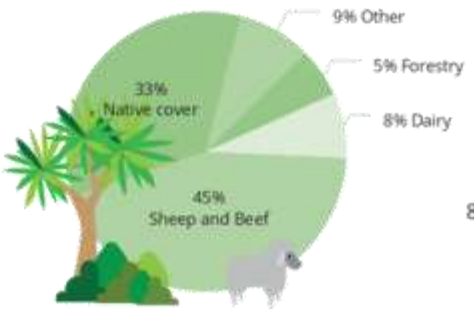
We have one of the largest areas of hill country in New Zealand and
HIGHEST PROPORTION OF HIGHLY ERODIBLE LAND OF ANY REGION

Almost a quarter of our region's people identify as Māori. There are many Iwi and Hapū and more than
60 MARAE

206,000 HECTARES OR 18%
of the nation's versatile soils are in the region

We have
3
major river systems
2 COASTS
and the Central Plateau

LAND USE



The Horizons Region is made up of
2.2 MILLION HECTARES OF LAND
8% of New Zealand's total land area, plus 31,000 hectares of marine area

There are over
35,000KM
of waterways in the Horizons Region

Approximately
109,000
ratepayers contribute to our work programs

We have
230 LAKES
This includes 67 dune, 44 riverine, 24 landslide, 7 volcanic lakes and 88 artificial reservoirs

Mean annual rainfall in the region ranges from
900MM TO OVER 2,000MM

There are
40 ESTUARIES
in our region, including Manawatū Estuary, an internationally recognised RAMSAR site

HOW WE DEVELOPED THE PLAN

Over the course of 2022, the Climate Action Joint Committee developed the *Manawatū-Whanganui Climate Change Action Plan.*

We drew on the *Manawatū-Whanganui Regional Climate Change Risk Assessment* published in September 2021, information about the region's emissions profile and emerging central Government policy. We considered our key regional climate change challenges and how we can work together more effectively.

Tangata whenua told us about how they are responding to climate change through efforts to care for the environment and communities. We spoke with Palmerston North and Whanganui youth councils to better understand the perspectives of younger people.

Those conversations – like this action plan itself – are just the beginning of ongoing dialogue with our wider community about our changing climate.

A reo Māori version of the *Manawatū-Whanganui Climate Change Action Plan* has also been made available.

'Our plan focuses on how we can work together – councils, tangata whenua and communities – to collectively tackle the issues we can't resolve alone.'

Dr Huhana Smith

LOCAL IMPACTS

The impacts of climate change are wide-ranging, rippling out beyond weather patterns to affect people's assets and community infrastructure, biodiversity and human health.

The *Manawatū-Whanganui Regional Climate Change Risk Assessment* highlights specific risks for the districts of our diverse region.

IMPACTS

A **Hill Country:** Transport networks damaged by landslides and soil erosion. Extreme weather events cause crop damage and economic disruption. Increased fire risk.

B **Plains:** Damage to housing, public spaces and infrastructure from flooding. Crop damage caused by drought.

C **Estuaries:** Erosion and coastal inundation in some coastal areas – damage to commercial and residential buildings, and energy infrastructure.

D **Social Impacts:** Risk of inequitable outcomes as costs and impacts fall unevenly across the community.

E **Tourism:** Reduced snow and ice cause economic disruption. Extreme weather events impact tourism.

F **Urban Areas:** Landslides, soil erosion and inland flooding highest risk to urban areas like Palmerston North. Extreme weather events. Water supplies affected by reduced rainfall and drought.

IMPACTS

G **Tohu*** change and are less reliable, affecting planting, resource gathering and hunting.

H Damage to culturally significant **marae and urupā** from flooding and erosion.

I **Loss of taonga species** (in freshwater systems, on land, and along the coast) as the climate warms.

J **Manaakitanga** threatened if manuhiri cannot be offered local delicacies and marae are damaged.

K Loss of **tikanga and mātauranga** around resources, affecting future generations.

CASE STUDIES

1-5 See pages 16-23 for case studies of Climate Change actions already underway.

ADDITIONAL IMPACTS ON MĀORI

Climate change is likely to have a bigger impact on Māori because of their relationship to the environment, the things that are culturally significant to them, and the ongoing effects of our colonial past.

* **Tohu** are indicators (the blossoming of a flower, the departure of a migrating bird, the appearance of a star in the predawn sky) developed and used by Māori to track changes in the natural environment.

https://environment.govt.nz/facts-and-science/climate-change/how-climate-change-affects-maori/

https://www.horizons.govt.nz/HRC/media/Data/20210902_Horizons-CCRA_Report-signed_1.pdf

ALIGNING NATIONAL AND LOCAL ACTION

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IN DEVELOPING OUR ACTION PLAN, WE HAVE DRAWN ON THE EVOLVING NATIONAL AND INTERNATIONAL CONTEXT.

Local leaders recognise the need to work constructively with central government to address climate change. There will be issues to work through as national policy develops, to ensure that it meets local needs.

The National Adaptation Plan (NAP) was released in August 2022. It aims to ensure communities have the information and support they need to prepare for the impacts of climate change.

The first plan focuses on setting out what the government will do to enable better risk-informed decisions, drive climate-resilient development in the right locations, help communities assess adaptation options (including managed retreat) and embed climate resilience into all of the Government's work.

Actions in the NAP focus on reforms already underway, including resource management reform to foster collaboration between local and central government, the local government review, three waters reform.

Central government has committed to explore co-investment with local government in flood protection.

The NAP identifies three main roles for local government:

PROVIDING LOCAL INFRASTRUCTURE, AND ENSURING IT IS RESILIENT TO CLIMATE CHANGE

PLANNING AND REGULATING LOCAL DEVELOPMENT

BEING THE AGENCIES CLOSEST TO EXPOSED COMMUNITIES

'We believe central government and local government need to work together to resolve funding questions and make processes more efficient – improved alignment will support local communities in their response to climate change.'

Dr Rachel Keedwell

Manawatū River

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IN MAY 2022, THE GOVERNMENT RELEASED FINAL EMISSIONS BUDGETS FOR 2022-35 AND AN EMISSIONS REDUCTION PLAN (ERP).

The ERP implies several strengthened or new expectations of councils:

- Funding local infrastructure.
- Delivering Te Ao Māori-centred, nature-based solutions.
- Driving towards a circular economy, and preventing organic waste from entering landfills.
- Reducing vehicle kilometres travelled (including specific targets for Palmerston North).
- Providing walking and cycling infrastructure, including active transport plans around schools.
- Supporting community based transition plans.
- Supporting increased public transport use.
- Reducing high-emissions energy generation and support renewables.
- Supporting sustainable construction and renovation of existing buildings.
- Implementing national direction under the proposed Natural & Built Environments Act and National Planning Framework, including planning for compact, functional urban form.

THE ERP INCLUDES A FOCUS ON EMPOWERING MĀORI.

The Government undertakes to work with Māori to:

- Embed partnership and representation.
- Support Māori-led strategy and alignment, elevating Te Ao Māori within the climate response, in a way that is aligned with Māori customs and protocol (tikanga and kawa).
- Fund kaupapa Māori and tangata Māori actions and solutions.

Strategic planning legislation is also being developed and will potentially be a useful tool in our climate response. Regional spatial strategies will, however, only be as good as the data and discussions that inform them. The work we do now will help to ensure spatial planning is effective.

MANAWATŪ-WHANGANUI PRIORITIES

PUTTING THIS PLAN INTO ACTION WILL REQUIRE INVESTMENT TO IMPROVE TRANSPORT NETWORKS AND STORM-WATER MANAGEMENT, ADDRESS RISKS AND ENCOURAGE CLIMATE-RESILIENT DEVELOPMENT.

SOMETIMES, THIS WILL REQUIRE RETHINKING HOW WE HAVE DONE THINGS IN THE PAST. INVESTMENT WILL BE REQUIRED IN RELATIONSHIPS, TOO, AS LOCAL COUNCILS SUPPORT COMMUNITIES THROUGH THE TRANSITION AHEAD.

Groups across the region are already working to tackle climate change: some of these initiatives are illustrated in the case studies on the following pages. Local councils, iwi and communities are working with Massey University to develop climate response plans at Tangimoana and Pūtiki. A similar project has been completed with the community at Anzac Parade in Whanganui.

This action plan will inform councils' future decisions, in consultation with affected communities, about priorities, approaches, and funding. It provides a foundation for us to work together to respond to climate change and ensure our region remains a great place to live for future generations.

The Climate Action Joint Committee recommends that councils in the region commit to the following actions:

- Prioritise nature-based solutions in response to flooding, coastal issues, storm water, and erosion.
- Incorporate projected changes in rainfall patterns (drought, flood, and erosion risk), and impacts on biodiversity into integrated catchment management (Regional Council).
- Review planning provisions to encourage on-site storm-water management and (on-farm) water storage.
- Limit exposure to hazards by preventing development in areas at heightened risk of flooding or erosion as a result of climate change.
- Reduce the need for short car trips by developing compact, well-designed urban centres and prioritising active transport infrastructure (Territorial Authorities).
- Assess and manage climate related risks to local services and critical infrastructure.
- Redouble efforts to address existing issues that will be exacerbated by climate change such as freshwater health, biodiversity loss, flooding and erosion.

COUNCILS IN OUR REGION RECOGNISE THAT CLIMATE CHANGE REQUIRES URGENT AND COLLECTIVE ACTION. OUR ACTIONS FOCUS ON FOUR KEY AREAS:

Empowering communities

Working with nature

Addressing known issues

Supporting good decisions

Manawatū River, Palmerston North

- Work with at-risk communities to develop local adaptation plans (including community-led initiatives).
- Measure and reduce emissions from council activities.
- Incorporate carbon emissions and a preference for nature-based solutions into council procurement policies.
- Work with Joint Committee members to engage with youth, community, and tangata whenua groups in support of local climate action.
- Allocate resource to drive action forward, build relationships with tangata whenua, and engage with communities.
- Respond proactively to Government direction that enables further local action on climate change.
- Embed this joint response into each council's own plans at a local level.

The Climate Action Joint Committee proposes to lead several joint initiatives:

- Support sharing of mātauranga-based responses to climate change.
- Make widely available information that supports individual and community action.
- Identify and prioritise information we need to guide future decisions (such as adaptation planning, development strategies, and investment decisions).
- Incorporate projected changes in rainfall intensity into storm-water, drainage and flood risk modelling for population centres and areas where growth is planned.
- Identify communities with the greatest need for support in responding to a changing climate.
- Work to better understand impacts on tangata whenua and how local government can best help.
- Produce and implement a region-wide waste strategy.
- Engage central government support for our region's transition, and align the region's response to government direction.
- Monitor the effectiveness of this joint action plan and update it as new information comes to hand.
- Investigate:
  - Ecological impacts of a changing climate in our region and how we can support healthy, connected ecosystems and indigenous biodiversity.
  - Ways to ensure food supply (including mahinga kai) is resilient to a changing climate.
  - Options to improve the energy efficiency and climate resilience of buildings.
  - Best use of forestry, including native reforestation, as part of the region's climate response (incorporating biodiversity, pest control, carbon sequestration, erosion, fire risk, and other outcomes).

The Climate Action Joint Committee acknowledges the leadership role of the Regional Transport Committee in reducing the region's transport emissions. Integrated transport planning can support wider climate action by:

- Increasing use of public transport.
- Reducing dependence on private motor vehicles for short trips.
- Helping to make active transport safe and convenient.
- Improving use of rail and port infrastructure.

ACTIONS WE CAN ALL TAKE

There are actions we can take to make our communities and households more resilient, reduce our carbon footprints, and improve our lives at the same time.

Building community and household resilience

Water
Store rainwater for emergencies and to ease shortages in summer.

Plant trees
Many trees provide shade in hot summers.

Building or renovating
Expert advice and financial support is available to help make homes and other buildings warmer, drier and cheaper to run as well as reducing their emissions.

House and contents insurance
Provides peace of mind as we face more storms and flooding.

Well-installed insulation
Keeps your home warm in winter and cooler in summer. Government Warmer Kiwi Homes grants are available for insulation and/or an efficient heater for lower-income households.

Plan emergency housing
How might climate change affect your home? What would you do in an emergency? How would you keep your family safe?

Reducing our carbon footprint

Shopping
Planning meals for the week will help cut down on takeaways and the stress of deciding what to cook. Shopping 'retro' can save you money and help keep clothes and other items in circulation for longer.

Eating
Consider a meatless meal once a week. University of Otago research estimates emissions from the typical Kiwi diet could drop by 7% if we ate vegetables instead of meat for one meal a week.

Travel
Using public transport, walking or biking can reduce carbon footprint – and it might improve your health and wellbeing, too. 19% of New Zealand's emissions are from transport: changing how you get to work just one day a week would make a difference.

Encouraging others
Take the time to talk to friends and family members about our changing climate and actions we can take. If you've saved money by installing insulation or riding your bike to work, tell them about it!

Around home and on the marae
Plant trees, reduce water use, recycle and avoid wasting electricity. Switching your lightbulbs to LEDs will save energy and cut down your power bill.

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'DOING WHAT WE CAN INDIVIDUALLY IS A STEP TOWARD SYSTEMIC CHANGE'

Dr Rachel Keedwell

EECA's Gen Less website has lots of ideas about how to reduce your carbon footprint. There is also advice and tools for businesses: genless.govt.nz

The Ministry for the Environment also has good tips for cutting emissions on the marae and at home: environment.govt.nz/what-you-can-do/

Visit the Horizon's Regional Council website for more ideas about things you can do – or to find out if funding is available for your project: horizons.govt.nz/climate

Clean Car Discount supports change to low or zero emission cars to reduce emissions

Future Fit provides a snapshot of your impact on the planet, and helps you make positive changes in the way you live to help reduce your personal carbon footprint.

Full tide by the Ōhau River where spawning of inanga/whitebait takes place and where enhanced constructed wetlands shall be expanded with extensive native planting.

16 CONSTRUCTING WETLANDS IS A RELATIVELY LOW-COST WAY TO PROTECT AGAINST FLOODING AND MAKE LOWER REACHES OF LAND TOWARDS SEA MORE CLIMATE RESILIENT.

An example of this type of restoration is Tahamata Incorporation's coastal farm, south of Levin, an Iwi/Hapū led enterprise which traverses both banks of the Ōhau River.

The Board decided it needed to act to protect the operation against the risk of flooding and the increase in frequency and intensity.

479-HECTARES

Dairy farm runs 520 cows.

ENVIRONMENTAL ISSUES STARTED IN 1972-1974

when the Ōhau River was diverted or cut for the development of coastal farmland.

Adjacent swamps and wet areas were drained and whilst intensive dairying was profitable, mana whenua became increasingly concerned about pollution in the Ōhau River remnant lagoon and its poor water quality. Kaumātua reported the loss of bountiful supplies of fish, and healers were reluctant to use the water because of pollution.

Iwi/hapū led research assessed a range of adaptation strategies for the farm and three surrounding land holdings in Māori tenure, with the changing climate making these issues increasingly urgent. For the Tahamata case study, researchers recommended re-creating wetland ponding systems, in areas where the pastures were marginal along the Ōhau River.

Kuku Ōhau Estuary with loop area marked in dark green,constructed wetlands marked in white within the wider area marked in light green requiring coastal protection and enhancement from climate change impacts, including protecting significant ancestral landscape features.

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The Board is exploring innovative land uses, such as flax production for fibre, with additional projects that aim to use natural dyes.

Ponding systems
Ponding systems are successfully used in the Waikato and the board wanted to build on this work, while incorporating tried and proven Mātauranga Māori approaches that had been activated since 2002. The Kuku ponding systems were co-designed and co-developed with a freshwater engineer, a climate modeller, a Māori designer and Māori researchers, who were supported by the Māori Farm Board, food gatherers and Māori shareholders.

Wetland construction
Constructing wetland ponds is relatively simple and low-cost. Large, shallow planted ponds filter stormwater runoff, slow flows and help control flooding. These constructed environments provide home and shelter to wildlife, similar to a natural wetland. The wider area is renowned for its peat (due to being deep wetland regions before they were drained); enhanced peat formation in the constructed wetlands acts as a carbon sink.

The Kuku coastal land project aims to trial practical solutions to climate resilience, building upon a body of research about wetland ponding systems and their effectiveness.

Plantings of reeds, grasses and sedges will also support a habitat for whitebait spawning, with whitebait being restored to abundant levels again, reflecting its long–standing status as a taonga species and food source for mana whenua.

Looking forward
To restore the land to some of its former glory, whānau volunteers are also replanting many native species such as harakeke (flax) and manuka along the banks of the Ōhau River, leading to discussion about future use of the land. The board is exploring innovative land uses, such as flax production for fibre, with additional projects that aim to use natural dyes. Dairying will continue on the productive pastures.

Sharing of knowledge
An important aim of the constructed wetlands project is to build upon research knowledge about nature-based solutions to climate change. These solutions will support hapū agricultural landowners with low-lying coastal farms to transition to innovative land uses in the face of a changing climate. Results from the trial will be shared with other iwi and hapū, councils and interested stakeholders.

COMMUNITY-LED COASTLINE PLANNING

Castlecliff – Whanganui District Council

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KEY CHALLENGES INCLUDE

Erosion

Significant natural sand movement

Ecological degradation of the beaches due to human land use

A community led coastal action plan is making the coast from Castlecliff to Kai Iwi more resilient in the face of climate change.

500+ PEOPLE

Recently responded to a Whanganui District Council survey about what they value about their coastline.

Responses came from

EVERY SUBURB

in Whanganui and comments reflected how important the coast is for the health and wellbeing of the entire community.

'Watching the sunsets, gathering resources such as driftwood and harakeke and shellfish, and building sandcastles.'

'The coast makes me feel renewed and alive.'

'For Māori, the connection to the elements is entrenched in whakapapa.'

Kai Iwi – Whanganui District Council

Different parts of the coastline have very specific issues and will need their own management approaches.

Castlecliff
Gradual build-up of windblown sand has created an extensive and unstable dune system. The community has also raised problems with rubbish, vehicles on the beach and dogs.

To develop a management plan, the Whanganui District Council is working alongside Te Mata Puau to make sure hapū are at the centre of all planning, through application of a framework, He Ara Tuku Rau, which ensures compliance with Te Awa Tupua. The plan will go beyond the protection of facilities and aim to improve social, cultural and environmental health.

Kai Iwi
Kai Iwi faces significant challenges from a rapidly retreating coastline and erosion, which is likely to accelerate with a changing climate. People responding to the survey also raised concerns about water quality in the stream. The council is working with the community, the Tamareheroto Hapū and specialists to consider proposals for Kai Iwi, using past reports and submissions by community members.

Proposals include managed advance (in the form of an offshore reef), managed retreat, installation of a breakwall, new and reinforced seawalls, or a combination of options. Survey responses highlight that the community wants an abundant coastline – healthy seafood, sustainable coastal management, healthy dune systems and coastal forest.

Next steps for the coastal plan include meetings between the council and key community groups, community-based resource mapping and engineering and ecological advice and costing for potential management options.

The plan will provide a pathway for the community to work together to increase the wellbeing and resilience of the people and environment 50 to 100 years into the future. It will be a 'living document', regularly reviewed and updated to reflect any changes in scientific data, community aspirations and access to funding. For example, South Beach is now being scoped for inclusion in the plan, following feedback from the community.

PROMOTING TRANSPORT MODE-SHIFT

Tranzit Coachlines, Palmerston North

20 *Transport is responsible for 20% of New Zealand's total greenhouse gas emissions – fossil fuels, such as petrol and diesel, produce harmful emissions that contribute to climate change.*

THE UAS HAS, IN EFFECT, TAKEN 173 CARS OFF THE ROAD AND, DESPITE A FALL IN BUS USE DURING THE COVID PANDEMIC, SAVED AN AVERAGE OF NEARLY 70 TONNES OF CARBON EMISSIONS A YEAR.

Reducing car use

To encourage people to get out of their cars, Horizons Regional Council and Massey University offer free bus trips for students and staff on all services in Palmerston North through an Unlimited Access Scheme (UAS). This is funded by Waka Kotahi, Massey University and Horizons.

At their peak, free UAS trips have exceeded 600,000 annually, making up nearly half of all bus trips in the region.

The UAS started as a small scheme with UCOL in 2004. It was expanded in 2005 to solve parking congestion at Massey University, and to ease peak traffic congestion in the city. Councils and Waka Kotahi also wanted to minimise expansion of roading infrastructure by shifting more people onto public transport.

Initially, the free bus service was funded by Massey University, which introduced car parking charges on its campus to cover costs. The trial was successful and expanded to connect to Massey University from the CBD and suburbs of Palmerston North.

Scheme expansion plans

More recently, the scheme has further expanded to include two other tertiary education providers: English Teaching College and IPU New Zealand.

Horizons Regional Council is encouraging other organisations to offer free travel on council services. Horizons' Regional Public Transport Plan (2022-2032) promotes free transport schemes to support organisations working to encourage the use of more sustainable transport modes.

Horizons' plans target a 30% reduction in regional carbon emissions from land transport by 2030, including a lower-emissions public transport fleet.

Council policies support the Government's Emissions Reduction Plan which highlights the importance of reducing emissions from transport through better public transport, walking and cycling. As well as reducing emissions, 'mode shift' will support access to affordable housing and improve the liveability of our urban centres.

Find out more

Horizons Regional Public Transport Plan
Information on mode shift

FARMING INNOVATION - STEWART DAIRYLANDS

Riparian planting – Stewart Dairylands

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'People come and go, but the land remains forever. We don't own it, we just pay for the privilege to look after it. It is now our turn.'

David A Stewart.

Going beyond compliance

The Stewart family has farmed for over 120 years in the Manawatū. Their mission is to produce high-quality dairy products from healthy, well-bred animals, by caring for their animals and the environment.

For the Stewart Dairylands team, it's about going beyond compliance and becoming a carbon neutral business. An environmental plan covers the entire farm, there are regular open days, and relationships with both environmental and iwi groups.

Reducing carbon emissions

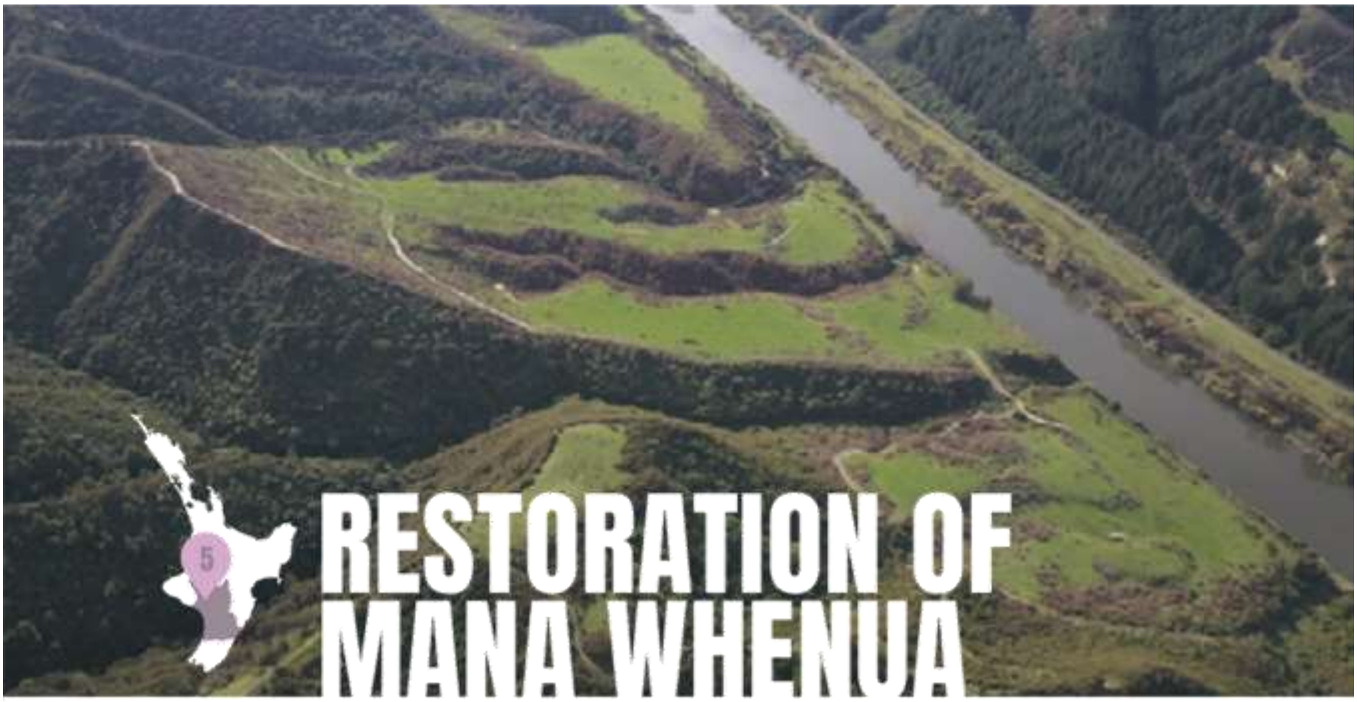
Stewart Dairylands has installed solar panels on the dairy shed roof to replace a gas-fired system that heated hot water in the dairy shed. Installing solar panels has reduced total energy use by 30%. Stewart Dairylands is close to the Bunnythorpe sub-station and there is potential for the property to become a solar farm and run sheep around the solar installations.

Building ecosystems

The team actively looks for opportunities for the least productive land, such as gullies. Over the past decade, 10,000 trees have been planted on the less viable parts of the property. The team is focusing on how to plant trees to reduce the farm's carbon footprint – rather than planting solely for water quality and shelter.

The goal is also to build and protect ecosystems – by planting contoured native woodlots, creating manmade wetlands, sediment traps, nutrient interceptor beds and innovative ecological engineering for water flow harvesting.

Field days are used to show these innovative approaches to neighbours and other farmers, who have now formed the Stoney Creek Catchment Collective, covering 2400 hectares. This dedicated catchment group works proactively on their land to help improve and further enhance the water quality of the Stoney Creek catchment.



Paetawa Station

22 THE GOAL IS TO RESTORE THE LAND TO ESTABLISH A THRIVING MĀORI AGRIBUSINESS WITH A NET ZERO CARBON FOOTPRINT.

Te Urumingi Whanau Trust
Descendants of Te Ratana Te Urumingi and Heeni Piirato have big aspirations for their land.

Their 1214–hectare Paetawa Station is located in rugged Whanganui River hill country, with only about 80 hectares suitable for traditional farming. Te Urumingi Whanau Trust runs the station through its subsidiary company Heeni Investment.

Heeni Investment faced challenges, including previous over-spraying, limited grazing, weeds and poor pasture.

USING EXPERT ADVICE, HEENI INVESTMENT NOW HAS AN INTEGRATED FARM PLAN, BASED ON A MĀORI TAIAO PERSPECTIVE OF THE ENVIRONMENT.

Actions taken
The station team has designed a cost-effective biological approach to the remediation of the soil – by building up its microbial health and feeding the microbes with a mixture of seaweed and fish-based products.

This has led to increased production, and controlled weeds, without using synthetic fertiliser. Stock is in better condition, healthier and getting better prices – and there is less use of drenches.

THE BUSINESS IS RUN ON FOUR PRINCIPLES:

Taiao (Environment)
Improve our natural asset base (soil and water quality; erosion-prone land; waterway margins; biodiversity).

Mātauranga (Education)
Cultural: enhance our mahinga kai; kaitaikitanga, whakairo, maanakitanga, whakawhanaungatanga.

Create an opportunity through a kaupapa Māori nursery for our people to return to the Whanganui River to learn and to work.

Ōhanga (Economics)
Create diverse sustainable economic opportunities through the expansion, permanence, and diversification of forest on our whenua.

Kīnakitanga (Enhancement)
Leadership: establish a thriving Māori agribusiness with a net zero carbon footprint that demonstrates minimal reliance on synthetic fertilisers to reduce on-farm biological emissions and nutrient run-off into waterways.

So far, Heeni Investment has

PLANTED 400 HECTARES IN NATIVES & MANUKA

River flats on the station are now ready to be fenced and planted.

AN ADDITIONAL 420 HECTARES OF NATIVES

such as manuka, karamu, tī kōuka and tōtara are being or are planned to be planted.

INSTALLING SEDIMENT TRAPS

To capture runoff and protect waterways.

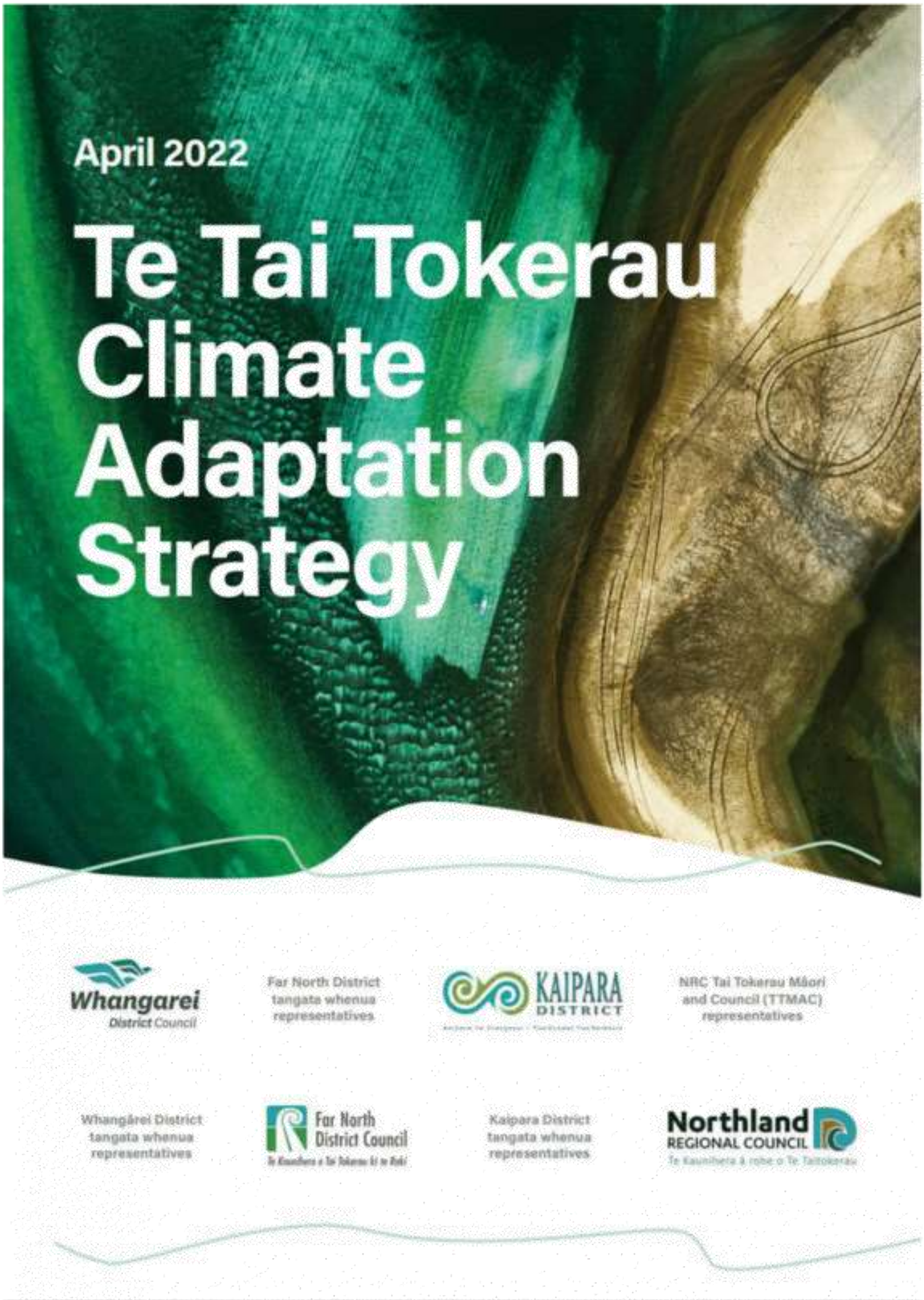
TO HELP REDUCE CARBON EMISSIONS

Heeni Investment is shifting from breeding cows to dry stock and is exploring carbon farming, potato milk and alternative proteins.

'We know what the land looked like 40 years ago and we want to bring it back to its full glory. We still have Kaumatua who know this stuff. We have got to set in place something for future generations and we are now on that journey.'

Ben Potaka, Heeni Investment Co Ltd.

Kahikatea swamps are favoured habitat for native fish, including tuna (elvers) and provide the paru (mud) used to dye harakeke for puipui, kete and whariki.


April 2022

Te Tai Tokerau Climate Adaptation Strategy

Whangarei District Council

Far North District tangata whenua representatives

Kaipara District

NRC Tai Tokerau Māori and Council (TTMAC) representatives

Whangārei District tangata whenua representatives

Far North District Council

Kaipara District tangata whenua representatives

Northland Regional Council
Te Kaunihera ā rohe o Te Taitokerau

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Whangarei District Council	Whangārei District tangata whenua representatives
Far North District Council	Far North District tangata whenua representatives
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Northland Regional Council	NRC Tai Tokerau Māori and Council (TTMAC) representatives

About the authors

In early 2020, chief executives and mayors of the four Northland councils recommended the establishment of the collaborative Joint Climate Change Adaptation Committee. It was agreed that the Joint Committee be comprised of eight members with an equal representation (50:50) of councillors and iwi/hapū representatives from across the region. Each council nominated one elected member (with another as back-up/alternate) and one iwi/hapū representative (with another as backup/alternate).

The Te Tai Tokerau Māori and Council Working Party provided their nominations for membership on behalf of Northland Regional Council at their March 2020 meeting. District council elected member representatives were determined at the respective council meetings. District council tangata whenua representatives were nominated through tangata whenua forums and then endorsed by representative bodies (Far North District Council, Whangarei District Council), or through direct engagement based on partnership agreements (Kaipara District Council).

This strategy was drafted in a collaborative process by Climate Adaptation Te Tai Tokerau, a joint working group made up of staff from all four Northland councils (Kaipara, Whangarei and Far North District councils, and Northland Regional Council), as well as hapū and iwi representatives. A key objective for the group is to align local government climate adaptation policy, information and methodologies, and pursue collaborative opportunities to enable effective regional adaptation planning.

This strategy has been endorsed by Northland's Joint Climate Change Adaptation Committee; a formal standing committee set up under the Local Government Act 2002. Each council has independently contributed to, reviewed and formally adopted this strategy.

Foreword

There is no longer any doubt our climate is changing – we are facing a climate crisis. The question now is what will the impacts be, and how can we best prepare our people, places and industries?

New Zealand's government declared a climate emergency on 2 December 2020 and holds the lead responsibility for Aotearoa's transition to a low-emissions society and economy. Local government has a supporting role in this climate change mitigation mahi, to assist and enable the required transitions in districts and regions.

Climate change adaptation, however, must be led by councils, iwi, hapū, industry stakeholders and the wider community. This strategy represents a first step by Northland councils towards a collaborative, region-wide response to the impacts of climate change. We are already living with the effects of a changing climate, and many communities in Te Tai Tokerau have been using their own resources and networks to develop plans to prepare and adapt. Through this strategy, Northland councils and tangata whenua are building on these plans, seeking integration and alignment across the region, and working to create meaningful partnerships to help us all adapt together.

This strategy is the foundation that sets out our commitment to taking action, to aligning with our communities, to listening, understanding, and working together. We expect the strategy will evolve and actions will change as this adaptation kaupapa progresses and our understanding grows.

Through this strategy, we are asking these important questions of ourselves and of Te Tai Tokerau. What do our communities need to effectively adapt to the impacts of our changing climate? What can councils do to support local initiatives? Where are the areas that are most at risk, who are the most vulnerable? What information should we be guided by and what flow-on effects should we be planning for? How does the climate change kaupapa fit with tangata whenua whakaaro, and how can councils integrate and honour that whakaaro in future planning cycles?

These questions need to be carefully worked through; bringing representatives from Northland councils and tangata whenua to the same table to develop this strategy has been an important first step. The scale and complexity of the climate challenges ahead provide an opportunity for inclusive, progressive and creative solutions. Our actions and decisions from now must be focused on the future we want for our children's children.

Together, we can adapt and thrive.

Amy MacDonald – Chair

"If fear is on one end of the scale, then complacency is on the other."

– Delaraine Armstrong, Te Orewai hapū of Ngāti Hine, Deputy Chair of Climate Adaptation Te Tai Tokerau

As a tangata whenua descendent of 31 generations from Kupe arriving in Aotearoa, through my earliest Ngāpuhi whakapapa to Rahiri, to a further 20 more generations till I feature, I am anchored firmly to Te Ao Māori through my Ngāti Hinetanga, through the hapū of Te Orewai. As such, I am typically representative of iwi Māori.

Before Kupe, we tātai through the cosmic creation of the universe, to the creation of ngā Atua followed by the common physical world where tangata have evolved. Change is dynamic in this holistic world view. The view and responsibility for tangata whenua and climate change is physical, spiritual and social across generational relationships from the long past and into the distant future.

The ethnocentric lens of Te Ao Māori is fundamentally different to the dominant cultural view of the natural world in which tangata whenua live and interact. The differences between the indigenous world view and the prevailing world view creates systemic differences which divide us and, in many instances, create inequities for tangata whenua, including and beyond climate change. The definition of tangata whenua, as people of the whenua, personifies the spiritual relationship between tangata whenua and the natural world. This world view is difficult to capture and genuinely have regard for in the current structural practice and implementation of local government bureaucracy, including climate change adaptation.

We must work hard to rebalance the systemic framework, and co-design new, relevant tools and practices to ensure tangata whenua are resourced to work in genuine partnership to reduce the gaping inequities for Māori communities who are kaitiaki of the previous generations of sovereign rights and responsibilities over wahi tapu, whenua Māori and the broader landscape of Aotearoa. The concept of property rights is in direct conflict with tangata whenua relationships to the whenua, ngā awa, ngā maunga, te ngāhere. This is the challenge confronting the development of climate adaptation and the many other reforms that are interactive in addressing natural resource management in the future.

The rhetoric of tangata whenua involvement must be genuinely enabled and supported. However, this responsibility doesn't sit only with non-Māori. Tangata whenua must step into the space we demand and provide clear advice and structural options for a new framework to work with councils. The beginning of this journey in Tai Tokerau is reflective of the willingness to do that, but far more resource is needed to build capability and capacity with tangata whenua, communities and workforces.

Delaraine Armstrong – Deputy Chair

Executive summary

Our planet is on an undeniable climate change trajectory. We now know more about the causes and implications of climate change than ever before, and our timeframes have shifted from imminent to immediate. Effects are already being felt across Te Tai Tokerau. It is our responsibility to identify ways in which the councils can help communities adapt to the localised impacts of a changing climate.

The main, and most urgent, response to the causes of climate change is mitigation through reducing greenhouse gas emissions. While central government controls the main policy and economic levers to drive emissions reductions nationally, the councils can and should help the transition towards net-zero emissions. However, this will not resolve the need to address the impacts of climate change that are already locked in.

This strategy focuses on adapting to the impacts of climate change in Te Tai Tokerau. It is not a solution to climate change impacts and risks. It indicates the strategic and practical direction our local councils need to take to create equitable, lasting adaptation approaches that have positive outcomes for our communities and natural environment.

The strategy outlines the key ways climate change will affect council functions and services, lists some of the councils' current adaptation actions, and proposes future actions that are likely to be required. Affected council services cover a wide range of activities, and are presented as seven broad themes:

1. governance and management
2. impacts on Māori
3. coastal communities
4. water availability
5. natural hazards
6. ecosystems and biosecurity
7. public infrastructure.

The strategy also outlines a comprehensive programme of actions covering four areas where the councils can improve their response to climate change (see Part 5):

1. building stronger relationships and partnerships
2. improving how the councils understand climate impacts and the risks they pose to communities and the natural environment
3. taking concrete actions to reduce existing and projected risks
4. building capacity to respond.

These actions are divided into short-, medium- and long-term categories. Short-term actions are the immediate priority. Te Tai Tokerau is already experiencing the effects of a changing climate. These impacts will continue to increase in the coming decades. Some changes, such as sea level rise, will take centuries to slow or reverse, and some may be irreversible. Te Tai Tokerau councils need to understand and prepare for climate risks to reduce the impacts of these changes.

Climate impacts compound existing factors that reduce well-being and have a large and potentially disproportionate effect on Te Tai Tokerau's tangata whenua. Climate change affects their relationship with te taiao and ngā whenua (the natural world and the land), cultural and whānau values, and iwi/hapū taonga.

Tangata whenua hold evidence-based knowledge of Te Tai Tokerau's history, natural environment and communities, which is integral to addressing climate impacts. Developing strong and lasting partnerships with tangata whenua is key to a successful long-term response to climate change.

Councils have an important role to play to support the resilience of communities and natural systems as we adapt to climate impacts. They possess tools that can help address climate impacts, such as planning frameworks and the provision of infrastructure. Given the complexity of climate change's challenges, it is essential for the councils to work alongside iwi/hapū, communities and stakeholders to co-develop flexible solutions that address existing limitations on wellbeing, respond as the climate shifts, and recognise opportunities for betterment.

This strategy, including its recommended priority actions, is a living document. Our responses to climate change need to be dynamic, so significant changes in evidence, community context and legislation can inform how our adaptation approaches evolve. Ongoing engagement with tangata whenua and communities is likely to highlight new evidence and perspectives that may result in changes to how the councils approach, resource and implement adaptation.

There are also significant changes in government legislation currently in development, including Resource Management Act reform, a new Climate Change Adaptation Act, Three Waters Reform and the creation of a national adaptation plan. These will lead to a greater focus on climate change, and new tools for local government to carry out adaptation actions.

Case law is also developing apace. Councils are now being challenged in the courts on planning decisions, both for being overly restrictive and for not taking sufficient precautions. In addition, new law in Aotearoa requires the mandatory disclosure of financial risks associated with climate change by financial institutions. This new law is likely to affect local government, as insurance and banking organisations seek to reduce risk exposure.

Given this rapidly evolving physical, social, legislative and legal environment, councils need to be extremely attentive and agile in developing climate change programmes and policy. This strategy has an inbuilt review function that enables it to respond to changes as needed, allowing future adaptation approaches to progressively build on the foundations currently being developed.

The purpose of creating a regional strategy is to ensure the approach to climate change adaptation by Te Tai Tokerau councils is robust, consistent and coordinated. The Joint Climate Change Adaptation Committee and the Climate Adaptation Te Tai Tokerau working group provide a platform to support this coordinated approach and ensure the effective use of resources. While this is a team effort, each council will need to take responsibility for individual actions as part of realising the joint approach.

If councils, iwi/hapū and communities work together flexibly across Te Tai Tokerau, we can be resilient in the face of climate change.

Foundations

WHAKATAUKĪ

Te amorangi ki mua, te hapai o ki muri.

The leader at the front and the workers behind the scenes.

This is about everyone having a role, playing a part. It is a reference to marae protocol where the speakers are at the front of the meeting house and the workers are at the back making sure everything is prepared and that the guests are well looked after. Both jobs are equally important, and without one, everything would fail.

SCOPE AND PURPOSE

Mitigating climate change through emissions reduction and carbon removal is the urgent, primary response we must adopt to address climate change. Central and local governments have roles in mitigation, providing information and support, setting rules and policy, and making operational decisions. All Northland councils are working on reducing greenhouse gas emissions through complementary strategies and plans.

Given a certain amount of warming is locked in, the necessary, secondary council response to climate change is to implement measures that ensure our people and environment can adapt to current and future climate impacts. This can include limiting the exposure to climate hazards and increasing resilience and adaptive capacity.

This strategy is intended to ensure positive long-term outcomes for Northland. We can do this by embracing a robust, collaborative approach to developing local government adaptation responses to the impacts of climate change. Building a foundation for effective local action also involves acknowledging the need to remain agile in a changing legislative environment.

Vision

The people and the environment of Te Tai Tokerau thrive and are resilient in a changing climate.

Mission statement

Across Te Tai Tokerau, we work together with iwi/hapū partners, communities and stakeholders to proactively understand, plan for, and respond to the impacts and opportunities of climate change.

Principles

- **Treaty of Waitangi and Te Tiriti o Waitangi:** work collaboratively with tangata whenua, demonstrating the principles of partnership, participation and protection.[1]

[1] Local government has responsibilities under the LGA and RMA in relation to the Treaty of Waitangi. The Treaty is referenced as 'the Treaty of Waitangi (Te Tiriti o Waitangi)' in the definition of the RMA and has the same definition as in the Treaty of Waitangi Act 1975, being that the '**Treaty** means the Treaty of Waitangi as set out in English and in Māori in Schedule 1 *(of the Act)*'. For hapū in Te Tai Tokerau, He Whakaputanga o nga Rangatira o Nui Tireni and Te Tiriti o Waitangi need to be read together and Te Tiri o Waitangi forms the basis for the relationship between hapū and local government.

- **Whanaungatanga:** work together to build relationships and a sense of connection across the region, enabling sincere partnerships and collaborative working relationships.
- **Western science and mātauranga Māori:** alongside Western science, enable mātauranga Māori (Māori knowledge) to help understand climate change and inform decisions.[2] The right answers for the future are best found by first understanding the mātauranga left to us by our tūpuna.[3]
- **Equitable:** empower communities and ensure 'no one is left behind' through fair and tika processes, resourcing and outcomes.
- **Considered:** use research-led, evidence-based, values-driven policy and decision-making to proactively manage risks and identify opportunities.
- **Ka mua, ka muri:** walking backwards into the future – balance present-day needs and responsibilities with the rights of future generations, learning from the past using guidance from our ancestors.
- **Transformative:** use innovation to take advantage of opportunities to build a better future.
- **Transition:** address and reduce transition risks.
- **Holistic:** strengthen the four wellbeings – enhancing social wellbeing, regenerating mauri and environmental systems, supporting cultural values, and promoting economic resilience.
- **Integrated:** embed a climate change lens across all council activities and align adaptation with emissions reduction.

Objectives

- Improve and broaden our understanding of the risks of climate change in Te Tai Tokerau, especially in relation to local government activities.
- Clarify adaptation needs and responsibilities.
- Identify opportunities to improve local government adaptation responses.
- Recommend priority actions for local government.
- Outline a process by which the strategy will be responsive to feedback and changing circumstances.

The principles and objectives of this strategy align with the vision of all four councils, and iwi and hapū member reference groups.[4] The objectives and priority actions also align with the strategic goals identified by Northland Regional Council's Te Tai Tokerau Māori and Council Working Party that relate to climate change (goals 10, 11 and 12).

What are we doing and why is it important?

Climate change will increasingly affect Northland's wellbeing

A changing climate affects our social and cultural wellbeing, our businesses and economy, our homes, buildings and infrastructure, and the ecosystems and natural world that surround us. We are seeing and experiencing effects on these realms now. From a te ao Māori perspective, the environment can be understood as the

[2] Te Iwi o Ngātiwai, Iwi Environmental Policy Document, 2007.

[3] Ngāti Hine, Ngā Tikanga mo te Taiao o Ngāti Hine: Ngāti Hine Iwi Environmental Management Plan, 2008.

4 Far North District Council's Climate Change Roadmap, Kaipara District Council's Kaipara Ki Tua: Climate Smart Strategic Framework, Whangarei District Council's Sustainability Strategy and Climate Action Plan, and Northland Regional Council's climate change strategy *Ngā Taumata o te Moana*.

embodiment of generations of whakapapa from ngā atua.[5] Hapū and iwi report that the realms of ngā atua and kaitiaki are degraded, mauri has been destroyed and there is potential for detrimental environmental, cultural and social effects.[6] Generations to come will continue to experience the impacts of climate change.

Adaptation is the response to change. Adaptation helps us cope with the effects of climate change and reduces potential negative impacts. When we adapt, we reduce our exposure and vulnerability. We grow capacity in our communities, economies, and natural environment so we can keep adapting to whatever climate impacts are on the horizon.

Most importantly, adaptation offers opportunities for betterment. The legacy of our ancestors and the lives of our future generations are linked to the relationship we have with the natural environment. Adaptation is an opportunity to improve this relationship.

In meetings with elected members, opportunities such as the following were identified:

> "What does going proactive on carbon banking look like?"
>
> "What does it mean for tourism when we really become the winterless north? We keep telling people we are when actually we're not."
>
> "You can sell a product and have a carbon negative label on it."

Responding to climate change impacts will affect how local government operates

Northland councils have an important role to play in adaptation, including providing education and advice, as well as planning and implementing adaptation responses at a local and regional level. Together with hapū and iwi partners, our communities and central government, Northland councils need to plan for and manage impacts on the things we value to help local communities become more resilient.

This is a new, challenging space for Northland councils and for many communities. To best facilitate adaptation and assist communities, Northland councils will continually work to improve our information and approaches.

This strategy sets out a vision for how Northland councils can improve their ability to prepare for and adapt to the impacts of climate change. It sets out clear steps to position Northland councils to respond to climate change, and to support community responses as well as possible. Adaptation will increasingly be part of our core business.

A strategy that evolves

Climate change is dynamic, and our understanding of its causes and consequences continues to evolve. Likewise, this strategy needs to be a living document so it can develop and adapt as Northland does. We will update this strategy as required, to respond to new evidence from mātauranga Māori and Western science, the changing needs of communities and iwi/hapū partners, and changes in the legislative and legal environment.

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[5] Patuharakeke Te Iwi Trust Board, Patuharakeke Hapū Environmental Management Plan, 2014. Pg 12, 13.

[6] Te Iwi o Ngātiwai, Iwi Environmental Policy Document, 2007. Pg 11.
Ngāti Hau, Hapū Environmental Management Plan, 2016.
Ngāti Hine, Ngā Tikanga mo te Taiao o Ngāti Hine: Ngāti Hine Iwi Environmental Management Plan, 2008.
Te Uri o Hau Settlement Trust Environs Holdings, Te Uri o Hau Kaitiakitanga o te Taiao, 2011.

Upcoming legislation, including the Climate Change Adaptation Act, may change the legal landscape and the tools the councils use to implement adaptation. There is some uncertainty around the details, but leading legal research[7] suggests councils should continue to follow best practice to ensure we are acting on our knowledge of climate impacts. The express aim of this strategy is to identify gaps and take advantage of opportunities to improve the councils' current capacity for adaptation decision-making, in preparation for new legislation.

This strategy also needs to respond to the voices of our communities and of tangata whenua. As Northland councils continue on this journey, feedback from iwi and hapū partners, communities, businesses and other stakeholders will continue long after the first version of this strategy is published. In particular, engagement with tangata whenua has so far been limited to feedback from iwi and hapū partner representatives. Actions within this strategy include a process to expand engagement across iwi and hapū to marae and whānau, to better reflect the understanding, experiences and aspirations of tangata whenua.

The strategy has six parts:

Part 1. 'Background and context' explains the rationale and context for the strategy.

Part 2. 'Key adaptation issues, responses and opportunities' provides detail on issues of concern, including governance and management, impacts on Māori, coastal communities, water availability, natural hazards, ecosystems and biosecurity, and public infrastructure.

Part 3. 'Enabling effective adaptation' outlines four areas for action to help improve adaptation responses in Northland: 1) improving knowledge and understanding, 2) growing relationships, 3) reducing risk and vulnerability, and 4) building capacity.

Part 4. 'An evolving strategy' outlines how the strategy will develop over time, in response to feedback and legislative changes.

Part 5. 'Priority actions' contains a list of 46 recommended actions for the councils.

Part 6. 'Climate risk overview' (technical report) provides an overview of different perspectives on climate change impacts and implications in Northland, and approaches to risk management.

[7] Iorns, Catherine and Stoverwatts, J, Adaptation to Sea-Level Rise: Local Government Liability Issues (July 1, 2019). Victoria University of Wellington Legal Research Paper No. 62/2020, Available at SSRN: https://ssrn.com/abstract=3685492 or http://dx.doi.org/10.2139/ssrn.3685492

Enviroschools planting at Lake Waiporohita. See https://enviroschools.org.nz/

Part 1. Background and context

The need for adaptation

Adaptation is about responding to the impacts of climate change. Adaptation does not replace the need for urgent greenhouse gas emissions reductions; it acknowledges that the climate is changing and that, in the words of the United Nations, we need to "develop adaptation solutions and implement actions to respond to the impacts of climate change that are already happening, as well as prepare for future impacts".[8]

Adaptation is a key component of the long-term global response to climate change, to protect people, livelihoods and ecosystems. Regardless of the success or speed of programmes to reduce global emissions, greenhouse gases already in the atmosphere have a 'locked in' warming potential. Additional warming is 'virtually certain'[9] to keep exacerbating climate change and its impacts in coming decades.

The Climate Change Adaptation Technical Working Group, established by central government,[10] described effective adaptation as reducing the risks of climate change on two fronts:

- reducing the exposure and vulnerability of our social and cultural systems, natural and built environment (including physical assets), and economy
- maintaining and improving the capacity of our social, cultural, environmental, physical and economic systems to adapt.

There is an urgent need to understand, prepare for and respond to present-day and projected climate impacts. While local government will play a prominent leading role, we will also learn with and from our communities and mana whenua partners. Local knowledge, support and leadership will be vital for successful adaptation responses.

Understanding and communicating about climate change

The impacts and implications of climate change are complex and can be challenging to understand and communicate. Different knowledge systems, perspectives, objectives, worldviews and values can bring very different approaches for engaging with climate risks and framing the issues. While these different ways of understanding the impacts of climate change can be complementary, they can also be confusing and can get in the way of developing solutions that work for everyone.

This strategy attempts to use a systems approach to draw on both a Western scientific understanding of climate impacts (which tends to compartmentalise issues, then look at relationships between them), as well as Māori perspectives (guided by the core principle of whanaungatanga connecting everything[11]). The Climate Risk Overview in Part 6 of this strategy (which is a technical report) explores this in more detail.

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8 https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean

9 IPCC AR6 Climate change 2021 - the physical science basis. https://www.ipcc.ch/report/ar6/wg1/#SPM

10 https://environment.govt.nz/publications/adapting-to-climate-change-in-new-zealand-stocktake-report-from-the-climate-change-adaptation-technical-working-group/

11 Te Uri o Hau Settlement Trust Environs Holdings, Te Uri o Hau Kaitiakitanga o te Taiao, 2011.

In thinking about risks from climate change, the National Climate Change Risk Assessment for New Zealand[12] report adopted a Western scientific approach. It grouped societal values into five broad value domains (natural environment, built environment, human, economy and governance domains). Value domains of this nature can be a practical way to create high-level summaries of climate change impacts from multiple hazards, but can also compartmentalise and separate social values.

This framing of climate risks into separate domains can create practical problems when trying to develop adaptive solutions for interacting or compounding climate hazards that cut across different value domains. The systems approach for mapping climate risks, which is explored in the Climate Risk Overview (in Part 6), attempts to overcome this issue by using a causal diagram to show interactions between hazards and affected areas of society and the environment. Nonetheless, neither approach reflects or incorporates Māori values, and ongoing work is needed to build a shared understanding of climate risks.

From a te ao Māori perspective, the environment can be understood as the embodiment of generations of whakapapa from ngā atua.[13] Whanaungatanga describes genealogical relationships between people, between people and natural resources, even between related bodies of knowledge. Relationships of importance in mātauranga Māori are explained through kinship. Māori relationships with the cultural landscape are explained through whakapapa. The first step in understanding the Māori relationship with the landscape is to understand that descent from it is an essential Māori belief.[14]

What is whanaungatanga and why is it important?

Whanaungatanga: the principle of kinship. As explained in Ko Aotearoa Tenei, "In te ao Māori, all of the myriad elements of creation – the living and the dead, the animate and inanimate – are seen as alive and inter-related. All are infused with mauri (that is, a living essence or spirit) and all are related through whakapapa. Thus, the sea is not an impersonal thing but the ancestor-god Tangaroa, and from him all fish and reptiles are descended. The plants of Aotearoa are descendants of Tāne-mahuta, who also formed and breathed life into the first woman, and his brother Haumia-Tiketike. The people of a place are related to its mountains, rivers and species of plant and animal, and regard them in personal terms. Every species, every place, every type of rock and stone, every person (living or dead), every god, and every other element of creation is united through this web of common descent, which has its origins in the primordial parents Ranginui (the sky) and Papa-tu-ā-nuku (the earth). This system of thought provides intricate descriptions of the many parts of the environment and how they relate to each other. It asserts hierarchies of right and obligation among them."

Pūrākau (stories, legends) and mātauranga passed down through generations describe the relationships with and between ngā atua, which help tangata whenua understand what practices need to be followed to tiaki (protect) the environment, to understand why certain effects and changes occur, and to identify the responses needed to address or adapt to the effects. Pūrākau also remind us that tūpuna (ancestors) Māori faced similar situations.

12 https://environment.govt.nz/publications/national-climate-change-risk-assessment-for-new-zealand-main-report/

13 Ngati Hau, Hapū Environmental Management Plan, 2016

14 Waitangi Tribunal Report, *Ko Aotearoa Tenei: A Report into Claims Concerning New Zealand Law and Policy Affecting Māori Culture and Identity*, 2011.

Discussing climate risks from these starting points could be more relevant for Māori communities, and the solutions that are identified may offer options for application in other locations.

Central and local government adaptation: roles and responsibilities

Central and local government have different roles in adapting to climate change. Central government responsibilities are primarily delivered through functions set out in the Climate Change Response Act; and the key tools for adaptation are National Climate Change Risk Assessments and National Adaptation Plans. Once developed, these will set out government priorities and strategies for adaptation. The first national climate change risk assessment is complete, and the first National Adaptation Plan will be delivered before the end of 2022. Both are likely to have implications for local government, and influence adaptation at a regional and district level. We will need to review this strategy once the National Adaptation Plan is available.

Central government has also signalled its intention to reform the resource management system. This includes repealing New Zealand's core planning law, the Resource Management Act 1991 (RMA), and replacing it with three new statutes. Among the reform's key objectives are to better prepare for adapting to climate change and risks from natural hazards, and to better mitigate emissions contributing to climate change. The government has indicated that climate change adaptation and mitigation will be central themes in all three new statutes developed through the reforms.

The reforms will affect local government and could change the functions and roles of the councils in climate change adaptation. It is very likely, though, that there will remain a strong role for local government in planning for and implementing adaptation at community and regional levels. This will include undertaking risk assessments for council-owned and maintained community assets.

The Waitangi Tribunal report following Wai 262, the most comprehensive of all government claims, included recommended changes to the Crown's laws, policies and practices – including but not limited to intellectual property, indigenous flora and fauna, resource management, conservation, science, education and health. The objective of many of the proposed reforms was to establish genuine partnerships.[15] In response, central government is aiming to develop a whole-of-government approach to consider the issues raised by claimants and the Waitangi Tribunal in the Wai 262 enquiry. Direct and indirect changes for local

New climate change legislation

The Ministry for the Environment is currently drafting new legislation and guidance as part of the RMA reform, which includes a Climate Change Response Act. These will change how local government is able to respond to climate change impacts.

Items specifically related to climate change include:

- Climate Change Adaptation Act: to address the legal and technical issues associated with managed retreat and adaptation.
- Adaptation funding mechanism: creating a national funding mechanism for proactive adaptation and risk mitigation.
- National Adaptation Plan: to determine the approach for climate change, including the measures and indicators required.

In response, we will need to review this strategy. A review process is laid out in Part 4 – 'An evolving strategy'.

15 Te Pae Tawhiti: Wai 262 (tpk.govt.nz)

government are likely to result from this approach. These will need to be embedded in local government responsibilities, including climate change adaptation responses.

At a local government level, regional and district councils have different roles in adaptation which reflect their different functions. The Local Government Act 2002 states that the purpose of local government is (a) to enable democratic local decision-making and action by, and on behalf of, communities, and (b) to promote the social, economic, environmental and cultural wellbeing of communities in the present and for the future.

Regional councils are primarily concerned with environmental and coastal resource management and planning, flood management, water quality and quantity, pest control, and public transport. District councils (also known as territorial authorities) are responsible for a wide range of local services, including district planning, roads, stormwater, water reticulation, sewerage and refuse collection, libraries, parks, recreation services, cemeteries, local regulations, and community and economic development.

Councils need to plan for adaptation to manage the risks posed by climate change. Much of this responsibility relates to managing risks from natural hazards (such as coastal erosion or flooding) under the Resource Management Act 1991. Responsibility also extends to providing and managing infrastructure, obtaining technical information, managing natural resources and facilitating community adaptation processes. Adaptation, especially as it relates to increasing risks posed by natural hazards and climate change, is necessarily 'local' – hazards and values vary widely, as do response options.

Climate change mitigation (managing greenhouse gas pollution by reducing emissions and carrying out activities that capture and store carbon) is also a responsibility of local government. In New Zealand, the main mechanisms to enable broad emissions reductions lie with central government through the Climate Change Response Act 2002 and the Emissions Trading Scheme. However, the councils should work to reduce their own organisational emissions, and help enable the reduction of district and regional emissions through activities such as urban planning and public transport. Beginning in 2022, regional consents must also consider greenhouse gas emissions under the RMA.

As decision-making authorities delegated by the Crown, local government has a responsibility to uphold Treaty guarantees. Local government has legislated Treaty of Waitangi/Te Tiriti o Waitangi[16] (Treaty) responsibilities that are applicable in all our activities, including responding to climate change and local government's adaptation responsibilities. A Waitangi Tribunal precedent signals local government requirements and the enforcement of Treaty duties. While there are no Waitangi Tribunal claims specifically related to climate change adaptation, there are claims such as Wai 262 and enough relevant cases to demonstrate that Treaty principles of "active protection and partnership, especially the facilitation of consultation, will apply no matter what the process is".[17]

16 Local government has responsibilities under the LGA and RMA in relation to the Treaty of Waitangi. The Treaty is referenced as 'the Treaty of Waitangi (Te Tiriti o Waitangi)' in the definition of the RMA and is stated to have the same definition as in the Treaty of Waitangi Act 1975, being that the 'Treaty *means the Treaty of Waitangi as set out in English and in Maori in Schedule 1 (of the Act)'*.
The LGA does not provide an interpretation or definition of the Treaty, but it does reference responsibilities to meet commitments from other enactments, which of course includes the RMA. The absence of the LGA specifically referring to one text or the other does not give us the option of choosing which text we think it is referring to – but in any case, the contra proferentem principle applies and the indigenous language text takes preference.

17 Iorns Magallanes, 2019, p.62. Deep South Challenge, *Treaty of Waitangi duties relevant to adaptation to coastal hazards from sea-level rise* research is the most comprehensive and up-to date work covering coastal hazards adaptation and Treaty duties.

What can the councils do?

While the legislated functions of local government for managing the risks of natural hazards and providing infrastructure are well established, Northland councils are at an early stage in developing focused climate change adaptation responses. To date, these responses have broadly focused on capacity and relationship building, information gathering and analysis, and preparation and planning.

Councils have an important function in developing knowledge by investigating and collating locally relevant information on current and future climate change risks, and by undertaking ongoing monitoring and evaluation. They provide adaptation support to communities through leadership and guidance; and they can help enable co-designed solutions through community engagement and adaptation planning. Councils also manage climate risks, such as through land-use planning rules, providing public infrastructure, supporting emergency responses, and enhancing the resilience of natural systems.

While councils face many challenges as they begin climate adaptation journeys, there are many areas of strength and opportunity. Northland councils have developed strong inter-council working relationships and have background knowledge and information to support an ambitious works programme. All four councils and our hapū and iwi partners have collaborated to establish a joint governance committee on climate change adaptation. This group's existence is a milestone, and demonstrates the energy, commitment, knowledge, trust and networks characterising the partnership.

A growing awareness of climate change's significance and increasing support from council leadership enables the councils to take a stronger stand on adaptation planning. Widespread community buy-in and a desire for action to address climate change impacts also contribute to this approach. Public feedback through Long-Term Plan consultation processes has supported all four councils to significantly increase climate change adaptation funding in their 2021–2031 Long-Term Plans.

Tangata whenua have a strong interest in climate change adaptation. There is a significant opportunity for the councils and tangata whenua to build on the existing relationships formed at governance and staff levels, to partner in this mahi and achieve outcomes that everyone desires. Within hapū and iwi planning documents, reports to the councils and other government reporting, hapū and iwi within Tai Tokerau have articulated the challenges that local government processes and decision-making have created within the taiao (natural world) and their relationship with the taiao.[18] Engagement with tangata whenua has highlighted the need to consider legacy relationship challenges between local government and tangata whenua, as well as issues and other socio-economic drivers when understanding and planning for climate risks with Māori communities. Te Tai Tokerau councils have committed to working- and governance-level relationships with hapū and iwi in this mahi. This is positive, and reflects a shift in council thinking to heal relationships and work towards genuine partnership.

Te Tai Tokerau councils can also support other highly affected communities, such as our farming communities, to build resilience and plan for adaptation. We can build on existing local government and community initiatives and carry out targeted engagement to identify needs and opportunities unique to agriculture and horticulture. These opportunities extend beyond responsibilities specific to local government but are important for the wider

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18 Patuharakeke Te Iwi Trust Board, Patuharakeke Hapū Environmental Management Plan, 2014.
Waitangi Tribunal Report, *Ko Aotearoa Tenei: A Report into Claims Concerning New Zealand Law and Policy Affecting Māori Culture and Identity*, 2011.
Chetham, J, Cooper J, Tautari R, *Tane Whakapiripiri: Lifting Nga Hapū o Whangārei Capacity to Engage with Local Government in Regard to Environmental Protection and Management*, 2019.

economic and social wellbeing of Northland's places and people and add momentum to the positive work already underway.

Part 2 of this strategy explores the key local government activities that are affected by climate change, what the current local government adaptation responses are, and highlights where opportunities have been identified as future actions by the four Northland councils. While the focus is on local government, we acknowledge a whole-of-community response to climate change will include activities and initiatives that are the responsibility of other agencies and parties. This could mean some local adaptation responses are led by non-council parties, such as iwi/hāpu or community groups.

Part 2. Key adaptation issues, responses and opportunities

A wide range of issues regarding local government's response to climate change risks have been raised by iwi and hapū, elected members, council staff, and community members. These issues involve seven themes:

1. Governance and management
2. Impacts on Māori
3. Coastal communities
4. Water availability
5. Natural hazards
6. Ecosystems and biosecurity
7. Public infrastructure

The seven themes are discussed in detail here, with insight into relevant issues, current responses, and future opportunities specific to local government. The insights in this section also inform Part 3 – 'Enabling effective adaptation' which outlines future directions and areas for action. Reference is made within this section to related actions in Part 5 – Priority actions'.

While the grouping of the issues makes sense in a local government context, it may not align with the integrated and interconnected approach of Māori. There are other more relevant groupings to Māori such as the four pou: wai (from which everything emerges[19]), kai, whenua and whare (as used by Te Hau Ora o Ngāpuhi and others in the health sector). It is likely that the four pou will be a more effective approach to engage with Māori communities.

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1. Governance and management

WHAT ARE THE KEY ISSUES?

Councils across Northland have started to acknowledge their role in developing climate change adaptation responses in recent years. There are still opportunities to improve. There are external and internal risks for the councils relating to governance and management of climate change adaptation. External risks include those arising from the uncertainty of climate projections and the lack of clear guidance from central government. Internal risks include those arising from inadequate internal council policies, processes and capabilities.

Despite these risks, not doing anything to adapt to climate change is considered to be the biggest risk of all.

[19] Ngāti Hine, Ngā Tikanga mo te Taiao o Ngāti Hine: Ngāti Hine Iwi Environmental Management Plan, 2008.

External issues

Effective adaptation by local government is inhibited by external barriers. For example, the complexity of climate impacts, and the uncertainty in projections of those impacts, can lead to hesitancy to take action. National policy and guidance can be poorly defined or non-existent, which makes it challenging to align local government responses. Existing legislation does not enable pre-emptive actions to reduce climate risks. It provides only partial guidance for local government on how to integrate complex adaptation plans into local regulations. At the time of writing, central government is working on new legislation that may help to address these issues.

Internal issues

Local government approaches to adaptation can be fragmented. There is often a lack of clarity about roles, responsibilities, and legal obligations. Internal policies and strategies can be poorly aligned. There is a risk that council responses to climate change will remain ad hoc, inconsistent, siloed, and potentially deferred. This could result in inadequate and inconsistent policy and strategic direction, leading to inappropriate infrastructure planning and poor community outcomes. For example, government approaches to environmental management are based on Euro-centric perspectives, which exclude Māori values. There is a risk that maintaining environmental management based on these perspectives may result in continued worsening environmental outcomes. This is expanded on in the next focus area, Part 2 – Impacts on Māori.

The relationships between the councils and communities is complex. In some places the two are disconnected or strained by historic issues. This is particularly evident in council relationships with Māori communities. The need for sincere engagement is acknowledged as a high priority. There are many opportunities for the councils to nurture ongoing relationships and incorporate a wider range of community views in decision-making processes. To be effective, adaptation planning will require building trust with communities. This will involve purposeful and resource-intensive engagement with communities across a range of areas.

Capacity to undertake effective adaptation actions will be an ongoing issue for the councils. There will be pressure on staff resourcing because there is a limited pool of adaptation expertise in the country and hiring and developing staff skills can be challenging. Furthermore, operational costs are high for risk assessments and adaptation planning, and funding of adaptation implementation actions is not secured.

Climate change adaptation requires shared understanding of climate risks across the organisation(s). At present there is no consistent approach to the integration of adaptation objectives into the councils' planning processes. For example, climate risk assessments in infrastructure asset management plans are not standardised. This is due to the emerging nature of the issue and the fact there is no policy to require consistent consideration of climate change in planning and decision-making. Climate change risks may not be sufficiently acknowledged, monitored, or disclosed. The ownership of mitigation actions is not clearly reflected in organisational KPIs across departments or articulated in job descriptions.

Implementation of adaptation actions can be expensive and contentious. The Hawke's Bay councils' experience with adaptation implementation illustrates the costs and complexities involved in proactively managing risks.[20] There is currently no central government or EQC funding for pre-emptive climate change risk reduction, and communities may not be willing or able to fund the costs of adaptation. Roles and responsibilities for

[20] https://environment.govt.nz/publications/challenges-with-implementing-the-clifton-to-tangoio-coastal-hazards-strategy-2120-case-study/

management and funding of adaptation responses between district and regional councils are also unclear, which impedes implementation.

WHAT ARE THE CURRENT RESPONSES?

Councils are building the foundations for the necessary leadership, relationships, internal processes, knowledge base, capability and capacity, and required funding to plan and implement effective adaptation actions.

The Joint Climate Change Adaptation Committee is a governance group comprising elected members from each council and equal tangata whenua representation from each council boundary (as distinct from hapū and iwi boundaries). This Committee has been established to provide governance oversight and consistency between Northland councils. It is supported by the joint staff group Climate Adaptation Te Tai Tokerau, which has been collaborating since 2018 to develop shared approaches and resources to enable a consistent adaptation response. All Northland councils have recently committed funds to support adaptation planning activities, by creating new staff positions and/or allocating operational funding in their Long-Term Plans.

Priority action 2 is to embed Māori values in council processes. This involves co-design with iwi and hapū representatives of a decision-making framework for Northland councils based on Te Ao Māori concepts and values. It is hoped this framework will assist council staff to understand and consider mātauranga Māori when making decisions on projects, policies or plans that may impact on the cultural values of iwi and hapū. It is also proposed that the decision-making framework will support Māori and technical specialists to better understand council systems and processes in the context of decision-making. The framework must recognise that there are regional and local differences within Te Tai Tokerau that affect how local authorities operate.

The process of developing the framework is an opportunity to build better relationships between the councils and hau kainga, marae, hapū, iwi and Māori practitioners. The framework will be developed by engaging with those on the ground within Māori communities. Relationships built through this work could form the foundations for the community adaptation planning that the councils intend to start over the next 12 months, within priority action 1.

The councils have yet to review their policies to understand the gaps and conflicts between internal documents and adaptation needs. These reviews are in the planning stage at each council. A proposal for a regionally consistent climate change policy is in development.

Current council adaptation funding allows for a small number of community adaptation planning pilot projects to be delivered across the region in the next three years. Existing funds will also support a small number of iwi/hapū-led adaptation planning projects. Investigation into some priority issues, such as the impacts of climate change on biosecurity and biodiversity, are not yet funded.

There is poor understanding of, or planning for, the capital infrastructure funding required to reduce climate risks such as coastal hazards and flooding. There are already places where the current flood management infrastructure does not provide adequate protection for the required planning horizon. For example, some property owners in Ruawai are unable to obtain resource or building consents because they are located within a mapped hazard zone. This is causing widespread community concern. Central government is working on funding mechanisms for climate change adaptation, but the details and timeframes remain unclear. Many infrastructure costs will continue to be the responsibility of local government and communities for the foreseeable future.

WHAT ARE SOME FUTURE ADAPTATION OPPORTUNITIES?

Our adaptation approach must be comprehensive and consistent. This requires coordination between the councils, and across council departments (e.g. civil defence, strategy, infrastructure, community engagement, RMA planning and consents teams). Such coordination requires leadership, dedicated staff, appropriate management structures and internal capacity-building. This should be supported by consistent internal strategies and policies. Many of the priority actions recommended in this strategy are designed to improve region-wide consistency.

Better processes to disclose climate risk, including the setting of KPIs and targets, will assist the councils to establish clear priorities for actions and risk reduction (priority action 40). A 'climate change maturity assessment' of policies will inform an improvement programme to support alignment and consistency within the councils. The development of an overarching regional policy framework will embed consideration of climate change impacts in council processes. Regular review and alignment with changes to central government legislation and guidance will be necessary. These issues are addressed in priority actions 38 and 39.

Priority actions #38 and #39

38 Joint climate change policy framework

Aim:	Ensure consistent consideration of climate change issues across individual councils.
Description:	Develop consistency between climate change policies that embed consideration of climate change impacts and adaptation responses in all council decision-making (which may also include council emissions reduction). This framework should define approaches and principles on data/information, definitions, reporting, standards and criteria.

39 Policy review and improvement plan

Aim:	Embed climate change objectives across individual council policies, strategies, plans and processes.
Description:	1) Identify improvement opportunities by undertaking a maturity assessment for each council of all relevant policies, strategies, plans and processes (may also include council emissions reduction), and 2) develop and deliver a climate change policy improvement plan that outlines a programme of policy updates to embed climate change objectives within a defined timeframe.

We will increase interaction with central government initiatives, such as input into the National Adaptation Plan or nationwide forums such as the Iwi Chairs Forum climate workstream. This will help us share resources and knowledge and improve alignment between national and regional/local scales. Ongoing advocacy and engagement to ensure Northland's voice is heard in the development of new government legislation or funding streams is essential. Where there are multiple agencies and organisations addressing adaptation issues (e.g.

drought response), better coordination between funding avenues and supporting agencies will make the process simpler and more efficient, with improved outcomes. This is addressed in priority actions 4–6 and 36.

Priority actions #4, #5, #6 & #36

4 Advocacy

Aim:	Promote Northland's voice in central government policy and legislation development.
Description:	Targeted advocacy with central government, regarding the development of new funding mechanisms and legislation.

5 Central government engagement

Aim:	Ensure Northland has input into central government adaptation policy and legislation development.
Description:	Prioritise engagement and advocacy with MfE on development of new legislation including RMA reform, the National Adaptation Plan and the Climate Change Adaptation Act.

6 National partnerships

Aim:	Develop partnerships and knowledge sharing with regional and sector groups.
Description:	Contribute to collaborative projects and partnerships, and leverage existing knowledge from other regions and internationally.

36 Water resilience funding coordination

Aim:	Improve coordination between agencies/organisations to improve water resilience outcomes.
Description:	Improve coordination between agencies to build collaborative, aligned water resilience responses including: tangata whenua, CDEM, district councils (Four Waters Advisory Group), and agencies (FENZ, MPI, TPK, DIA).

Reducing greenhouse gas emissions is not the focus of this strategy. However, the transition to a zero-carbon society is important to Northland communities. The risks associated with this transition may need to be considered at the same time as adaptation planning. This is an opportunity for the councils to develop models that integrate transition risks (associated with emissions reductions and the move to a zero-carbon economy) with climate risk assessments and planning, including at the community scale. This consideration is likely to influence a number of priority actions (e.g. 9, 10, 16, 23, 24 and 39). Further participation in national research initiatives will enhance the councils' abilities to address transition risks (priority action 24). Northland Regional Council is planning a regional multi-sector approach to support the transition to a zero-carbon economy in Northland.

Effective adaptation requires ongoing investment in staff resources, training, operational funding and implementation. We could establish and resource a climate change management structure, with identified teams and roles, to develop organisational resilience and capacity. We could also work with hapū or iwi to develop partnership structures to support the emerging requirements of climate change adaptation. Priority actions 43, 44 and 46 address these matters.

Priority actions #43, #44 & #46

43 Climate change teams

Aim: Establish appropriate portfolio, programme and project governance and management structures to build organisational capacities.

Description: Establish appropriate teams to deliver organisation-wide climate change implementation at each council, reporting to an appropriate level of management and given sufficient support.

44 Staff resources

Aim: Ensure sufficient staff resourcing and capacity.

Description: Ensure sufficient staff resources are allocated to enable ongoing organisation-wide climate change response, including climate change focused roles and professional development and training.

46 Inter-council collaboration

Aim: Continue to develop collaborative inter-council programmes and shared services.

Description: Continue to support and invest in the regional collaborative adaptation work programme, including establishing a process for sharing of resources between councils on specific projects, acknowledging the significant benefits and efficiencies of collaboration. Expand group to include Northland Transport Alliance.

Councils need to identify funding opportunities for the implementation of adaptation plans. These plans will be varied and may involve activities such as large infrastructure projects, nature-based solutions, changes to planning rules, property purchases, and increases in monitoring requirements. Potential funding options could include targeted rates, lease-back arrangements, low-interest loans, private-public partnerships, or alternative revenue streams. As the experience from Hawke's Bay shows, it is essential to define the adaptation management and funding responsibilities between the councils prior to implementation. Councils will need to identify existing funding streams and advocate for new, external sources, such as government grants and philanthropic trusts. Developing 'shovel-ready' infrastructure projects ahead of time allows the councils to take advantage of intermittent funding opportunities. Priority actions 4, 42 and 45 are relevant responses.

Priority actions #4, #42 & #45

4 Advocacy

Aim: Promote Northland's voice in central government policy and legislation development.

Description: Targeted advocacy with central government, regarding the development of new funding mechanisms and legislation.

42 Alignment of adaptation plans

Aim: Ensure community adaptation planning processes are aligned with council funding processes.

Description: Develop processes to ensure alignment of community adaptation plans with council plans and policies, including long-term plans, infrastructure strategies and financial plans.

45 Adaptation funding

Aim: Identify and pursue adaptation funding avenues.

Description: Investigate and prioritise potential funding opportunities to enable the implementation of adaptation responses.

2. Impacts on Māori

Conversations about climate change between the councils and Māori are beginning to yield shared understanding and agreements. However, as the councils listen more closely to the voices of iwi and hapū, knowledge and insights about the real impacts of climate change from a Māori perspective will emerge. It is vital for the success of adaptation in Northland that the strategy evolves in an ongoing manner in response to insights from Māori.

WHAT ARE THE KEY ISSUES?

Hapū report that the realms of ngā Atua are degraded, the mauri has been destroyed and there is potential for detrimental environmental, cultural and social effects.[21] Some contend that local government decision-making (based on Euro-centric perspectives) has contributed to this environmental degradation.[22] Environmental management practices have not required the restoration of mauri, which is necessary for survival and a key part of future adaptation responses.

21 Iwi and Hapū Environmental Management Plans: Patuharakeke, Ngāti Wai, Ngāti Hine, Ngāti Hau, Ngāti Kurī (2018), Ngāti Rēhia (3rd ed, 2018) Whatitiri Resource Management Plan, Te Uriroroi Hapū Environmental Management Plan & Whatitiri Hapū Environmental Plan, 2016. Te Uri o Hau Settlement Trust Environs Holdings, Te Uri o Hau Kaitiakitanga o te Taiao, 2011.

22 Patuharakeke Te Iwi Trust Board, Patuharakeke Hapū Environmental Management Plan, 2014. pg 21. Royal, Te Ahukaramu Charles (Ed), *The Woven Universe: Selected Writings of Rev. Maori Marsden*, 2003. Ngāti Hine, Ngā Tikanga mo te Taiao o Ngāti Hine: Ngāti Hine Iwi Environmental Management Plan, 2008. Chetham, J, Cooper J, Tautari R, *Tane Whakapiripiri: Lifting Nga Hapu o Whangarei Capacity to Engage with Local Government in Regard to Environmental Protection and Management*, 2019.

Iwi and hapū representatives say their ability to successfully adapt is intimately connected with how local government decision-making over current and future environmental management takes place, and whether Māori are partners in that decision making.[23] Currently, local government decision-making does not give sufficient voice to the specific needs of tangata whenua.[24] There is inequity in the information local government relies on, from whom the information is sought, the resourcing of data collection, and how the information is valued. If we do not address how local government makes decisions, council responses to climate change may limit the ability of tangata whenua to adapt to climate change. If the ability of tangata whenua to participate in decision making is limited there is increased risk of maladaptation; and a perpetuation of existing inequalities and breaches of Treaty obligations.

For some time, iwi and hapū representatives and kaimahi have highlighted the pressure on their capacity to participate within local government processes and operations,[25] although the aspiration and necessity remains. The need to be involved in climate change responses by local government adds further pressure. There is an opportunity to build relationships between the councils and Māori and to enable tangata whenua to take the lead on adaptation planning for Māori communities. The complex and sometimes strained relationship between Māori and the councils creates a playing field that is not equal between Māori and Pākehā. This work presents a real opportunity for Māori to participate in council decision-making processes.

For many Māori, climate change is not an isolated risk but one that is intrinsically connected to other issues such as social development needs, housing, environmental degradation, and poverty. We have heard from hapū that climate change poses an existential risk and may result in an inability to enjoy the customary use of their whenua. Climate impacts on ecosystems have implications for spiritual connection to taonga and to whakapapa, as well as for practical issues such as food security.

Some hapū say climate change could exacerbate inequalities already faced by Māori and is likely to have disproportionately large impacts on Māori cultural values and community wellbeing.[26] This is because many Māori communities are exposed to physical climate effects, both geographically and economically. As expressed by Ngāti Rēhia, "the economic future of Ngāti Rēhia is linked inextricably to our natural and heritage resources."[27]

Exposure

There are many factors which indicate high levels of exposure for Māori communities. Due to land confiscation, land remaining in Māori ownership often has some form of natural hazard limiting development potential and increasing risk. Many hapū have strong cultural and historic affiliations with coastal areas projected to be impacted by climate change. This means that flooding, coastal erosion, storm surge and regular tidal inundation may disproportionately affect Māori communities. There are likely to be impacts on cultural infrastructure such as marae and urupā, places for food gathering such as mahinga mataitai, and places of cultural significance such

23 Climate Adaptation Te Tai Tokerau Risk Assessment Workshops with Māori, Feb 2020.

24 Chetham, J, Cooper J, Tautari R, *Tane Whakapiripiri: Lifting Ngā Hapū o Whangarei Capacity to Engage with Local Government in Regard to Environmental Protection and Management*, 2019.
Whatitiri Resource Management Plan, Te Uriroroi Hapū Environmental Management Plan & Whatitiri Hapū Environmental Plan, 2016.

25 Key issue raised in the Te Karearea Standing Committee of Whangarei District Council
Chetham, J, Cooper J, Tautari R, *Tane Whakapiripiri: Lifting Ngā Hapū o Whangārei Capacity to Engage with Local Government in Regard to Environmental Protection and Management*, 2019.
Thomas Hohaia and Delaraine Armstrong, Climate Adaptation Te Tai Tokerau meeting, 4 November 2021.

26 Patuharakeke Te Iwi Trust Board, Patuharakeke Hapū Environmental Management Plan, 2014. pg 37

27 Ngāti Rēhia, 3rd ed, 2018

as wāhi tapu and archaeological sites.

Climate change will impact people's homes and incomes. Housing unaffordability and global pandemics contribute to greater numbers of whānau returning to their tūrangawaewae from other regions and nations, increasing the number of people exposed. Adaptive responses may be limited under current regulatory provisions because of natural hazard notations or high amenity notations, such as Significant Natural Areas, over land most suitable within their rohe for retreat.

Rural Māori are often not connected to reticulated secure and safe drinking water supplies and can be more susceptible to the effects of drought. Other less-visible effects may involve health impacts in rural areas; for example, an increase in mosquito-borne pathogens due to higher temperatures.

Indirect economic impacts may affect hapū and iwi. There may be changes to agricultural productivity. There is likely to be a loss of transport connectivity for settlements serviced by roads at risk of regular inundation due to sea level rise. In Whangaruru, for example, some school children are frequently unable to attend school because of flooding. The impacts this has on their education has been raised with elected members by local schools and by the children themselves.

Sensitivity and vulnerability

Iwi and hapū in Te Tai Tokerau are vulnerable to climate change from a socio-economic and infrastructure services perspective. Across Tai Tokerau, Māori experience significant disparities in incomes and public services received. This disparity increases for Māori communities/whānau living in more geographically isolated places. Income disparity can reduce Māori communities' capacity to afford the costs of protecting against, avoiding, and recovering from droughts and extreme weather events. In terms of infrastructure vulnerability, services in outlying areas are more often affected by drought or weather events. For example, transport infrastructure in outlying areas tends to be more prone to flooding and slips.

Māori in Te Tai Tokerau are also largely employed in primary industries, a sector which is affected by weather extremes. Projected climate impacts such as extended droughts, fluvial flooding, salinisation of water tables, and tidal inundation of coastal land are likely to have direct impacts on the incomes of many whānau.

Risks related to the transition to a low-carbon economy are not often discussed alongside adaptation. However, emissions reduction policies have the potential to disproportionately affect Māori in Northland. Councils need to keep this in mind when working with Māori communities on adaptation planning, and should aim for the integration of adaptation, emissions reduction and carbon removal goals together.

Finally, climate change impacts are likely to threaten the taonga and natural systems that iwi and hapū whakapapa to. The inseparable links between Māori and the environment will mean that projected climate change impacts on natural systems, including on individual species, biodiversity, invasive pests and pathogens, ecosystem function, waterways, and coastal systems, will have cultural and personal impacts on Māori.

WHAT ARE THE CURRENT RESPONSES?

For Māori, mātauranga was developed from the need to live sustainably and in harmony with the environment and seasons to avoid 'severe and drastic consequences'.[28] Successful management was reliant on the strength of whānau and hapū to work together for the collective good. It was reliant on the relationships forged by whanaungatanga and kotahitanga. These are relevant starting points for discussions with Māori communities so they can draw on their kōrero tuku iho, or traditions, to guide their pathways planning.

Hapū and iwi aspire to reaffirm their mātauranga, tikanga and pūrākau – their own frameworks of reference – as they consider and plan for climate change.[29]

Hapū and iwi are well-known for intergenerational thinking when planning – looking to the guidance of their ancestors to plan for the wellbeing of their mokopuna and generations not yet born. This is reflected in how indigenous knowledge systems adapt to the changing world. Further to that, hapū and iwi environmental planning documents articulate the expectations that hapū and iwi have of local government responses to climate change.[30] These include:

- not increasing vulnerability and risk through council operations
- planning for and providing adequate infrastructure to cope with climate change (community-based, minimal-impact design solutions being preferred)
- ensuring communities are prepared for the negative impacts of climate change and doing effective adaptation planning, while being placed to take advantage of the opportunities
- recognising the impacts of climate change that will affect hapū and iwi, and incorporating that into strategic planning
- moving toward an integrated catchment-based management approach
- providing resourcing to enable hapū planning and responses
- incorporating mātauranga into local government strategies and plans.

Hapū and iwi are also taking action themselves. They use mechanisms such as iwi and hapū management plans to present policy positions and work with regional councils, crown research institutes, government departments, universities and other organisations to contribute to regional, national and international climate change policies and processes.

Northland councils want to listen to, and learn from, iwi and hapū to reach agreement on respectful and appropriate ways to be guided by Māori perspectives in adaptation responses, both at a strategic governance level and operationally. Hapū and iwi have indicated support for the collaborative adaptation approaches being developed. At the time of writing, a hapū-based kairangahau (researcher) is reviewing examples of successful adaptation engagement processes with Māori across the country. This work will add to the repository of information and tools that support hapū and iwi adaptation responses and assist the councils to engage with Māori communities in meaningful ways when planning.

28 Ngāti Rēhia, 3rd ed, 2018

29 Patuharakeke Te Iwi Trust Board, Patuharakeke Hapū Environmental Management Plan, 2014. pg 37.

30 Patuharakeke Te Iwi Trust Board, Patuharakeke Hapū Environmental Management Plan, 2014. pg 39; Ngāti Hine Environmental Management Plan, 2008. Page 82; Ngāti Rēhia, 3rd ed, 2018; Te Aupōuri (DRAFT)(2018).

In section 2.1 – 'Governance and management' we refer to the development of a decision-making framework for local government that is based on Te Ao Māori, which addresses priority action 2. The intention is to build an understanding of cultural differences into council climate change adaptation processes. The framework will be accompanied by a suite of tools to support its implementation.

Relationships between the councils and iwi and hapū are at different stages of maturity. Influences include the quality of legacy relationships, multiple overlapping hapū and iwi interests where Treaty Settlement processes add complexity, and the quality of current relationships with staff and leadership.

Priority actions #1 & #2

1 Tangata whenua involvement

Aim:	Ensure tangata whenua are appropriately involved in adaptation decision-making.
Description:	Ensure inclusive processes for tangata whenua representation at all stages of adaptation decision-making, including providing appropriate resourcing, supporting training and developing targeted programmes.

2 Embed Māori values in council processes

Aim:	Ensure Māori values and worldviews are included in council processes and decision-making relating to climate change.
Description:	Co-design with iwi and hapū representatives of a decision-making framework based on Te Ao Māori concepts and values. The framework will include implementation tools and will recognise that there are regional and local differences within Te Tai Tokerau that inform how local authorities operate.

The establishment of the Joint Climate Change Adaptation Committee is a significant step forward in collaborative co-governance, with equal numbers of elected and tangata whenua representatives from each council. Te Ao Māori decision-making frameworks draw on kōrero tuku iho and pūrākau to guide engagement with Māori communities. This work responds to priority actions 1 and 2 and should enable stronger foundations to undertake other priority actions, including 7–10 and 32–36.

Through whakapapa and whanaungatanga, the close social ties and cultural networks of Māori communities enable whole-of-community responses to build resilience, such as those shown during the Covid-19 response. In terms of kaitiakitanga, kotahitanga and whanaungatanga, some hapū see opportunities for collaboration within and between hapū for the collective good.[31] These values, and priority actions 9 and 10, will support Māori-led adaptation responses.

[31] Ngāti Rēhia, 3rd ed, 2018

WHAT ARE SOME FUTURE ADAPTATION OPPORTUNITIES?

For Te Tai Tokerau councils to address the consequences of climate change, we must acknowledge issues specific to Māori. The stresses and hazards climate change bring are part of a changing array of challenges threatening Māori cultural integrity and continuity. Councils need to work alongside Māori to develop a response to climate change that respects the diverse needs and aspirations of Māori. This might be through establishing inclusive structures and processes to enable co-design of adaptation planning programmes, as well as supporting Māori communities to develop their own responses. We understand that for some Māori communities, there is anticipation and openness toward the opportunities that climate change might present, as their histories tell examples of their tupuna successfully adapting to and using change for their betterment.[32]

Priority actions #9 & #10

9 Māori adaptation impact assessment

Aim:	Improve bi-cultural understanding of climate risks and consequences.
Description:	Work with tangata whenua to undertake iwi- and hapū-focused risk assessments, including communicating risks from Te Ao Māori perspectives, identifying risks associated with climate hazards, impacts of adaptation responses and limits to Māori adaptive capacity. This may include direct impacts on cultural values such as wāhi tapu; as well as compounding risks, such as interactions between councils and government legislation resulting in unintended consequences, or barriers for Māori adaptation responses.

10 Iwi/hapū-focused adaptation

Aim:	Enable iwi/hapū-led adaptation planning at appropriate scales.
Description:	Work with tangata whenua to develop a programme to facilitate hapū or iwi-led holistic climate change adaptation plans to integrate multiple climate risks as well as other community objectives. Draw on approaches to adaptation engagement with Māori that have been successful in the past. This may include provisions to support iwi/hapū with risk assessments and technical analysis as well as enabling data sovereignty.

Locally appropriate risk assessments underpinned by tikanga Māori will enable Māori perspectives on change, risks, vulnerabilities and consequences to be incorporated into adaptation decisions. Councils also need to acknowledge the role of planning rules and connecting infrastructure (e.g. roads and water networks) to enable successful adaptation for Māori communities. These are outside the control of iwi and hapū. Better involvement of Māori in infrastructure planning would help to bridge this gap.

At different stages of developing this strategy, hapū and iwi reiterated the need for tools to consider climate risks and impacts on resources, papakāinga, and marae under threat. They want to be able to develop appropriate responses that navigate a changing legislative environment. As part of the wider programme of adaptation, we

32 Ngāti Hine Environmental Management Plan, 2008. Page 81. Patuharakeke Hapū Environmental Management Plan, 2014. Page 37.

should develop a toolkit and resources to enable hapū-led adaptation at the local scale. This will help communicate climate risk in meaningful ways to Māori communities. Councils can work with local knowledge-holders to combine Western science and risk analysis with indigenous knowledge, and apply this in appropriate planning contexts. There is opportunity to support iwi and hapū to develop their own adaptation plans with tools, hazards advice and other support, while ensuring data sovereignty. Councils could support the development of these tools and their application in priority actions 9 and 10.

The inability to fund implementation of adaptation plans or other adaptation responses is an ongoing issue. The impact of this is exacerbated in small rural Māori communities, which may be unable or unwilling to pay for the costs of the long-term measures required to protect community values exposed to climate hazards. Advocacy and engagement with central government is essential to secure funding for equitable and proactive adaptation measures. Addressing the inability of smaller Māori communities to finance adaptation measures is essential, and alternative approaches such as philanthropic or international funding may be an option.

3. Coastal communities

WHAT ARE THE KEY ISSUES?

Northland has a coastline of over 3,200km. Many towns, settlements and cultural sites are located on the coastal fringe.

Sea level rise is projected to result in ongoing permanent loss of land, through coastal erosion and tidal inundation. It will also increase the frequency and severity of periodic storm surge events.

An initial coastal hazard risk screening study identified about 70 towns and localities where properties and assets are projected to be significantly affected by coastal flooding, erosion, and permanent inundation due to sea level rise. Both Māori and non-Māori coastal communities will be highly impacted. Many Māori communities, particularly in the Far North, occupy land nearby or on coastal floodplains, with several Marae projected to be directly impacted by coastal hazards. Farming communities will be highly impacted as a significant amount of agricultural and horticultural land is in low-lying, coastal flood areas. There are also rural areas under pressure from development within coastal hazard zones.

Council infrastructure such as roads, water supply, stormwater and wastewater networks, and coastal stopbanks, will be impacted by sea level rise. In many places the road network is located on estuarine fringes, such as in the Hokianga. Road connectivity will be increasingly impacted by inundation at high tide. The location of large council infrastructure, such as wastewater treatment plants, within the coastal environment will be increasingly impacted by rising groundwater levels. This will impact on the effectiveness of land disposal systems.

Coastal protection infrastructure operated by the councils, such as sea walls, will become increasingly difficult and expensive to maintain. In some places, sea walls and stopbank systems have been funded privately or directly by communities, and the increasing cost to maintain and/or upgrade them is becoming unaffordable. Higher tidal boundaries mean that the impact of river flooding is exacerbated, resulting in more days where roads are impassable. This impact is already being experienced in places like Punuruku and Panguru.

Most coastal communities do not have town water supplies, with households relying on tanks and shallow bores. Both of these sources of water will come under pressure with climate change due to increased drought and sea level rise. These communities are also often reliant on septic systems. Rising groundwater levels could impact on the effectiveness of waste disposal systems. Sea level rise will impact coastal agricultural areas as groundwater salinity impacts the ability to draw water for stock or irrigation, and low-lying land is affected by salinity.

Tasman Heights, Ahipara

WHAT ARE THE CURRENT RESPONSES?

There is a comprehensive programme of mapping coastal inundation and completing erosion hazard assessments across the region. These are being used to develop climate risk assessments and plan adaptation programmes. Councils are working together to develop an aligned region-wide programme, working with communities to develop local adaptation plans in at-risk areas (see 'Coastal adaptation programme' in the box below).

Coastal adaptation programme (see priority actions 29 and 30)
Northland councils are developing a work programme to address climate change risks to coastal communities. The programme will set out guidance on ways councils, communities, tangata whenua and key stakeholders can co-develop community adaptation plans.

The preferred, best-practice engagement and decision-making approach to be used in the coastal adaptation programme is adaptive pathways planning, which is described in the 2017 Ministry for the Environment document 'Coastal hazards and climate change guidance for local government'. This process enables communities to be intimately involved in developing adaptation plans for their own communities through a structured process. It uses community panels to collaboratively determine adaptive pathways using risk assessments, engineering designs, options assessments, and prioritisation processes.
The result will be a flexible, long-term adaptation plan for each community, signed off by a governance body and the relevant councils. While this approach will be appropriate for larger communities, we will also work with smaller communities to develop and implement community-led adaptation plans at the local or hapū scale. Funding for pilot community engagement projects has been allocated in the 2021–31 Long-Term Plans for all Northland councils.
Following the endorsement of community adaptive pathways plans, councils will be responsible for monitoring environmental indicators and delivering actions when specific trigger points are reached, such as changing land-use zoning or delivering new infrastructure. To ensure the plans are consistent with other organisational activities, councils will also need to embed community adaptive pathways

Current responses to coastal erosion and inundation by councils are guided by the New Zealand Coastal Policy Statement 2010, which states a preference for nature-based solutions. Private landowners are responsible for building and maintaining coastal protection for their individual properties, which can give rise to a patchwork of consented and unconsented coastal management approaches. Sea walls are generally only constructed by councils where infrastructure is at risk from coastal erosion, although there are situations where councils have constructed coastal protection on behalf of private landowners. Beach nourishment has been undertaken at a small number of sites, including recent work at Matapouri. Nature-based solutions, such as the Northland Regional Council's CoastCare coastal restoration programme, can help reduce the immediate risk of coastal erosion while providing additional biodiversity benefits.

WHAT ARE SOME FUTURE ADAPTATION OPPORTUNITIES?

There is an opportunity to develop an integrated approach to coastal management to ensure the long-term success of coastal adaptation responses. If we improve knowledge of coastal hazards and processes, particularly in complex systems like estuaries and agricultural drainage areas, we will improve our ability to understand and plan for future coastal impacts.

Working with coastal communities to plan how to reduce the risks posed by climate change is an emerging role for local government. The ways the councils work with communities, tangata whenua and key stakeholders to develop community adaptation plans will evolve. Community coastal adaptation plans are flexible plans that outline short-, medium-, and long-term actions and transitional pathways for the coastal community area. An adaptive pathways approach, similar to the 'dynamic adaptive policy pathways' (DAPP) process suggested in government guidance[33], is our preferred engagement, decision-making and planning approach. The programme of region-wide coastal adaptation planning is included in priority actions 29 and 30.

Priority actions #29 & #30

29 Coastal adaptation programme

Aim:	Develop a programme of coastal adaptation planning projects aligned with community needs.
Description:	Develop a region-wide coastal adaptation programme, identifying key locations, timeframes and engagement methodologies, using recommended considerations in *Coastal Community Profiles* and *Adaptation Engagement Framework* reports.

30 Coastal adaptation planning projects

Aim:	Enable flexible, planned adaptation responses to coastal hazards by co-developing adaptation plans with communities.
Description:	Deliver projects in the coastal adaptation programme. Undertake community pre-engagement to confirm site selection and appropriate engagement methodology. Work alongside communities to understand, plan and implement adaptation responses by co-developing community adaptation plans in at-risk areas, following the recommendations in *Coastal Community Profiles* and *Adaptation Engagement Framework* reports.

The resulting community adaptation plans will need to integrate with council processes and the regulatory environment. Implementation of these plans may challenge existing council processes. Councils will need to assess integration issues when the adaptation actions are identified, and the preferred pathways are decided. For example, some adaptation actions may require rules and policies to enable land-use planning changes or to provide for or change infrastructure. Where climate change risks require changes to operational council activities (such as infrastructure plans or environmental management programmes) the implementation of adaptation

33 Ministry for the Environment (2017) https://environment.govt.nz/publications/coastal-hazards-and-climate-change-guidance-for-local-government/

plans will need to be embedded in each council's Long-Term Plan funding models, financial and infrastructure strategies, and work programmes.

4. Water availability

WHAT ARE THE KEY ISSUES?

Climate projections indicate that periods of low rainfall combined with high temperatures and evapotranspiration rates[34] are likely to result in droughts of increasing regularity and severity in Northland. Reductions in spring and winter rain are also likely to impact communities and the primary sector.

Fifty per cent of Northlanders are not connected to a municipal water supply (in the Kaipara this is closer to 70%, and in the Far North this is around 65%). Many homes and marae also have outdated or poorly functioning water collection, storage, and treatment facilities. Some council water supply networks are vulnerable to extended dry periods, especially those that rely on run-of-river sources or shallow bores. Climate change-related reductions in the reliability of summer rainfall will impact the already limited water resilience of affected properties. Increased volumes of rain falling during high-intensity weather events will also make it more difficult to catch and store water offline, as a larger holding capacity will be required. Heavy rainfall can create sedimentation and erosion issues, impacting on the quality for both rural and town water supplies.

Surface water and groundwater extraction is already highly- or over-allocated in several catchments, with little head room for increased water takes by the primary sector or by industry. Competing interests for water, such as new horticulture, alongside new minimum environmental flow requirements and allocation limits, mean that opportunities to extract freshwater from natural systems for use by the primary sector and by industry will become increasingly limited. Some groundwater supplies, such as the Aupōuri aquifer, are now supplying large quantities of bore water for horticulture crops – the science to support allocation of water from such sources can be very complex and this is compounded by the uncertainty around future effects of climate change.

In many coastal communities water is supplied via rainwater tanks with back-up bores which are reliant on shallow aquifers over summer. The impact of over-extraction during dry periods already creates significant salinity issues in shallow bores. With drier conditions and increased demand, water availability limits are likely to be reached more often. This effect also applies in places where irrigation is affected by groundwater salinity.

WHAT ARE THE CURRENT RESPONSES?

Water flow monitoring is conducted across the region as part of resource consent and state of the environment monitoring. Drought forecasting models have been developed to help predict drought in the near-term. As an emergency response, civil defence teams may provide backup water supplies in the event of droughts. Iwi and hapū networks have provided essential services by supplying emergency water to outlying communities.

District councils are responsible for the provision of drinking water to communities. Town water supplies have varying levels of reliability under drought conditions. Some supplies, such as Whangārei, have large storage facilities, dedicated catchments and plans in place for alternative supply options. However, other town supplies which rely on river takes or bores experience water shortages more regularly under drought conditions. While

[34] Evapotranspiration is the process where water held in the soil is gradually released to the atmosphere through a combination of direct evaporation and transpiration from plants (NIWA, https://niwa.co.nz/climate/information-and-resources/drought/charts).

the Three Waters Reform process will significantly change the management arrangements for water supply (and wastewater), the risk of prolonged drought conditions under climate change scenarios is unresolved.

Building long-term water resilience for communities outside areas with council water supplies has been largely uncoordinated. Numerous government agencies provide funding assistance, including the Ministry of Business Innovation and Employment (MBIE), the Ministry for Primary Industries (MPI) and the Department of Internal Affairs (DIA), as well as philanthropic trusts. Many of these agencies assist with funding for improved water collection, storage and treatment facilities at the household or marae scale. Northland Regional Council has allocated funding to help improve water resilience at the household level by funding improvements to private water collection, storage and treatment. More must be done. A government-funded programme is also operating that will see the construction of at least two large reservoirs to enable irrigation for horticultural use.

WHAT ARE SOME FUTURE ADAPTATION OPPORTUNITIES?

There is an opportunity to support early drought responses and long-term water resilience by providing better information, and through the use of models such as drought forecasting. We could include research on the interaction between population growth, water extraction demand, groundwater recharge, and sea level rise to improve understanding of water availability in coastal townships and agricultural regions. Ongoing investments in infrastructure to improve the reliability of town water supplies will be necessary to mitigate drought risk. In addition, demand reduction measures, including community education, are likely to be required.

Drought, Takou Bay area

It is a priority to assist rural communities and marae to establish water resilient infrastructure. Existing efforts to enable appropriate and equitable water supply solutions will be more effective with better coordination of multiple funding sources. These actions relate to priority actions 23, 35 and 36.

Priority actions #23, #35 & #36

23 Community drought adaptation opportunities

Aim:	1) Improve understanding of the impacts of drought on rural and community water supplies, and 2) identify opportunities to support community adaptation to drought.
Description:	Collate data on drought vulnerability, and develop community vulnerability assessments. (N.B. The responsibility for this item may be impacted by the Three Waters Reform process.) Investigate priority hapū and community needs and existing adaptation/water resilience programmes/actions; and clarify opportunities for the Councils to add value in facilitating adaptation planning.

35 Water tank assistance

Aim:	Improve community water resilience through water tank programmes.
Description:	Provide assistance to communities to install water collection, storage and treatment with a focus on community resilience, e.g. NRC's water tank programme.

36 Water resilience funding coordination

Aim:	Improve coordination between agencies/organisations to improve water resilience outcomes.
Description:	Improve coordination between agencies to build collaborative, aligned water resilience responses including: tangata whenua, CDEM, District Councils (Four Waters Advisory Group), and agencies (FENZ, MPI, TPK, DIA).

Councils may be able to assist primary producers through water supply. Potentially, they can support research and provide advice on alternative, drought-resilient crops and livestock, and on incorporating alternative irrigation designs and additional supportive land-use practices. This support could involve targeted engagement and seeking external funding with farming communities and primary industries stakeholders to identify opportunities. Kaipara District Council's Kaipara Kai and Kaipara Water projects (resourced by MBIE's Provincial Growth Fund) are examples of these opportunities in action.

If rural fires become more commonplace, it is likely that increased volumes of dedicated firefighting water storage will be needed on rural properties.

5. Natural hazards

WHAT ARE THE KEY ISSUES?

Flooding due to heavy rain is one of the region's most commonly experienced natural disasters. Climate change projections indicate that heavy rain events are likely to become more frequent and intense, potentially resulting in increased damage to homes, properties and livelihoods. Flood management infrastructure is largely managed by the councils, including urban stormwater systems, river flood protection works such as stopbanks and spillways, and agricultural flood management schemes. All of these services will be impacted by increases in heavy rainfall events, effectively reducing the levels of service provided, and requiring further investment in risk management responses.

Sea level rise will also exacerbate river flooding in coastal communities, and future coastal protection works may create drainage problems behind coastal structures. Other hazards that may be influenced by climate change, that we have very little information for, include extreme windstorms and tornados, geotechnical stability and slips, and wildfire.

Landslides and slips regularly have major impacts on regional transport routes, with a number of key state highways cut due to slips in recent years (e.g. Mangamuka Gorge and Kawakawa). Projected higher intensity rainfall is likely to result in higher likelihoods of geotechnical failures, as were seen following the July 2020 floods across Northland.

While few serious wildfires have impacted Northland in recent years, future climate projections show an increased likelihood of fire weather due to the combination of prolonged drought, extended high temperatures and heatwaves, high pressure systems and strong winds. Northland's exposure to risk from wildfires may be increasing due to the expansion in fire-prone land-uses such as exotic forestry, alongside urban expansion into at-risk areas.

WHAT ARE THE CURRENT RESPONSES?

Flood risk has been modelled and mapped across the entire region using new LiDAR data. This can be used to understand risk, help prioritise work programmes, and inform land-use planning rules. Local flood models are being developed to inform stormwater planning and long-term adaptation infrastructure, such as the Whangārei Blue/Green Network Strategy. Flood warnings are informed by river monitoring data and flood models, with emergency responses coordinated by civil defence teams.

The district councils manage urban and road flooding through the provision of stormwater infrastructure. When planning and designing new or replacement infrastructure, design specifications need to factor in the climate change projections for rainfall and sea level rise. However, additional solutions to address shortfalls in existing infrastructure will be required if climate projections are realised.

A large flood management programme will increase flood protection for priority at-risk townships including Kaitāia, Ōtiria/Moerewa, Kawakawa, Kāeo and Whangārei. The programme involves community consultation, and the planning, designing, and construction of river management structures such as stopbanks, flood walls and spillways.

Priority actions #18 & #19

18 River flood risk assessment

Aim: Improve understanding of river flood risk under climate change and plan future river flood management programmes.

Description: Undertake risk assessments for communities exposed to flooding using region-wide flood model projections, and use this information to prioritise future flood management programmes. Ensure all river flood models include consistent climate change factors, including rainfall intensity and sea level rise.

19 Coastal hazards

Aim: Improve understanding of coastal hazards under climate change scenarios.

Description: Continue to improve coastal hazards assessments, including methods for understanding impacts, considering the combination of river and coastal flooding, sea level rise and ex-tropical cyclones, and coastal erosion.

The Northland Transport Alliance is working on a transport resilience project to identify key sections of the roading network at risk from slips and landslides. This will inform forward work programmes to reduce risk at sites across the region.

WHAT ARE SOME FUTURE ADAPTATION OPPORTUNITIES?

Using risk assessments to better understand flood risk to communities across the region will help the councils to plan future work programmes for river flood management. We also need to better understand the interaction of river and coastal flooding in estuaries to anticipate the potential impacts of ex-tropical cyclones (priority actions 18 and 19).

There are opportunities to reduce exposure to flood risk by adopting different approaches, such as 'making room for the river' and ensuring floodplains are free from inappropriate urban development. In some areas, investment in river management infrastructure will be required to reduce flood risk to existing communities (priority action 33). For large urban areas such as Whangārei, a multi-hazard, strategic approach will be required to address coastal inundation and river flooding concurrently. This might be achieved by working together to implement the Blue-Green Network Strategy (see priority action 34).

Priority actions #33 & #34

33 River flood management

Aim: Reduce flooding risk to communities through river management.

Description: Continue to deliver prioritised river flood management projects, and plan and secure funding for future flood management implementation across the region.

34 Coordinated flood risk management

Aim: Improve coordination between the District and Regional Councils in pluvial and fluvial flood management.

Description: Work together to promote projects with multiple partners and co-benefits (e.g. the Blue-Green Network involving WDC and NRC).

We can improve our ability to reduce risks and improve community resilience by building a more comprehensive database of hazards (e.g. landslides and wildfires) under climate change scenarios (priority actions 20 and 21). We can use downscaled national models (such as the Crown Research Institute Scion's assessment of wildfire risk under climate change scenarios) to enable more detailed assessment of potential exposure and key sites of concern. This can support setting of informed policy (e.g. vegetation setbacks, fire-fighting access, and water storage on properties) alongside emergency preparedness and planning with Fire and Emergency New Zealand. Close work with civil defence teams can also help bridge the gap between forward adaptation planning and hazard event responses (priority action 31).

We will work with Fire and Emergency New Zealand to manage increased wildfire risk.

Priority actions #20, #21 & #31

20 Land hazard data

Aim: Improve understanding of land hazards under climate change scenarios.

Description: Collate existing information on geotechnical instability and slips in a common spatial database; and look for research partnerships (e.g. GNS, Waka Kotahi, NTA) to further develop information and data.

21 Wildfire hazard data

Aim: Improve understanding of wildfire risk under climate change scenarios.

Description: Collate information on projected fire hazards and at-risk landscape information into a common spatial database; and look for research partnerships (e.g. FENZ, Scion) to further develop information and data.

31 Civil defence

Aim: Integrate civil defence and community adaptation planning objectives.

Description: Ensure alignment of civil defence response plans, climate risk assessments and adaptation planning.

6. Ecosystems and biosecurity

WHAT ARE THE KEY ISSUES?

It is expected that a shift towards a more extreme, hotter climate will bring profound and lasting changes to the ecological composition and character of Northland's natural environment. Northland's indigenous ecosystems have not evolved to cope with projected environmental changes such as extreme heat, drought, and wildfire. The resulting impacts on endemic temperature-sensitive species, such as altitude-limited plants and animals, may result in localised extinctions in the absence of human intervention. The rate of change also means species have limited ability to adapt, migrate or evolve response mechanisms.

Past environmental degradation worsens the impacts of these changes. The resilience and mauri of the indigenous ecosystems has deteriorated for generations due to wetland and swamp drainage, deforestation and vegetation clearance, intensifying coastal development and invasive species damage.

In 2020, the Department of Conservation released a five-year Climate Change Adaptation Action Plan[35], alongside a supporting science plan[36]. The science plan notes the paucity of data to assist understanding and

[35] https://www.doc.govt.nz/our-work/climate-change-and-conservation/adapting-to-climate-change/

[36] https://www.doc.govt.nz/globalassets/documents/our-work/climate-change/climate-change-adaptation-science-plan.pdf

planning for climate impacts on natural heritage: "There are significant gaps in knowledge that limit our ability to both adapt our management and understand how climate change will affect the resources we manage. This is both in terms of current state, but also future risk. Amongst other effects, this includes how climate change will alter native species distributions, timing of phenology, prevalence and distribution of animal and plant pests...".

Specific impacts of climate change on ecosystems in Northland are not well documented in the scientific literature. The resulting scientific uncertainty makes it difficult to prioritise adaptation responses such as monitoring, pest control and conservation interventions, given the burden of existing biosecurity and conservation threats and the limited resources available. While there is an urgent need to protect and restore remaining habitat, there is a corresponding need to be aware of future threats. We must prioritise our efforts to ensure future risks are managed alongside current issues.

Other relevant policies and plans addressing the impacts of climate change on ecosystems and biodiversity include the upcoming National Policy Statement on Indigenous Biodiversity, and the New Zealand Biodiversity Strategy Te Mana o te Taiao (2020)[37]. The latter includes actions to ensure that potential impacts from climate change have been integrated into ecosystem and species management plans and strategies. It also calls for improved understanding of the potential for carbon storage from the restoration of indigenous ecosystems. While the Department of Conservation (DoC) has a central role to play, regional councils will have an important function to implement and monitor actions, particularly for ecosystems that fall outside the national conservation estate. Northland councils will also need to improve understanding and set strategic direction around support for ecosystem restoration under their respective emissions mitigation and carbon sequestration targets and work programmes.

Biosecurity

Being at the northern tip of an island nation means many species of indigenous flora and fauna are likely to migrate southwards to cooler climates, leaving voids that may be filled by exotic invasive species. These pests are likely to expand via new overseas introductions and the expansion of existing ranges. Impacts may include terrestrial (e.g. heat- and drought-tolerant invasive plants, insects and other animals, and pathogens), aquatic (e.g. aquatic weeds, parasites of native fish) and coastal/marine ecosystems (e.g. invasive crustacea and smothering algae). Climate-induced reduction in species resilience may also see a rise in the impacts of plant and animal pathogens, parasites, and insect infestations.

Coastal

Northland's coastal ecosystems are unique in the country. They are sensitive to climate impacts such as atmospheric and marine heatwaves, disturbance events from coastal storms and rising sea levels. Intertidal species have been shown to suffer high mortality in heatwaves, such as the massive shellfish die-offs seen in recent summers. These events are projected to increase in frequency. Marine heatwaves are likely to have significant impacts on near-shore habitats such as coral reefs and macroalgal communities.

Open coast areas are likely to suffer increased storm damage. This is already an issue for vulnerable ground-nesting birds such as fairy terns. Northland also hosts important migratory bird nesting sites including the sandy Eastern beaches and numerous estuarine and harbour environments, including the Kaipara and Rangaunu harbours. These coastal floodplains are likely to see a gradual change in vegetation and ecology due to sea level

[37] doc.govt.nz/nature/biodiversity/aotearoa-new-zealand-biodiversity-strategy/

rise, affecting available habitat for birds such as the Australasian bittern. Higher rates of sedimentation due to higher intensity rain events will impact estuarine and near-coast habitats, as well as freshwater systems.

Coastal squeeze is a real issue for Northland's coastal habitats. In many cases the need for ecological communities to migrate landward due to sea level rise may be restricted by existing land uses and coastal stopbanks. It is likely that the construction of new coastal protection structures and floodgates will further prevent re-establishment of coastal ecosystems such as mangroves, saltmarsh and tidal habitats, including inanga spawning sites on private land. Many of these ecosystems play critical roles as habitats and are important carbon sinks.

Freshwater

Northland freshwater ecosystems are extremely sensitive to climate change, given the current state of water quality and ecological health. Freshwater and riparian habitats are already extensively degraded, with water extraction during dry periods, eutrophication, high summer temperatures and high sediment loads currently affecting ecological communities. These impacts are expected to worsen given projected increases in mean temperatures, the frequency of heatwaves, and extended dry periods. Stratification[38] of water bodies can lead to extreme oxygen cycles, which can lead to ecological shifts from macrophyte to cyanobacterial/algal dominated communities. This is made worse by eutrophication caused by runoff from surrounding land use, impacting a wider range of ecological communities. More high intensity rainfall events could also worsen the impacts of sedimentation, which is already one of the region's most serious water quality issues.

Wetland habitats in Northland are adapted to periodic dry conditions. However, the increasing frequency and severity of drought is likely to place additional pressures on species which require permanent moisture. Wetland habitats are currently restricted by existing pressures from grazing and land conversion. This reduces resilience to weather events. Northland's diverse dune lakes are also threatened, and many of these host rare species which are especially vulnerable to changes in temperature and rainfall patterns.

Forests

New climatic conditions are likely to have significant impacts on forest ecosystems, including taonga species like kauri. The impacts of drought have been documented to affect kiwi food foraging and kauri snail mortality. However, measures to improve the resilience of native forests through control of browsing pests are reported to reduce the impact of drought on vegetation. This results in better food access for kiwi than in forests with higher pest loads.

The southwards migration of many indigenous forest species due to gradual mean temperature rise is likely to occur. This will lead to changes in ecosystem dynamics and open the way for a shift in ecological composition, favouring exotic and invasive species. Vegetation communities limited to higher altitudes may face localised extinction due to the limited availability of cool mountain climates to migrate toward.

[38] When water bodies, such as lakes, 'divide' into different layers of density due to differing temperatures.

Disturbance events through wildfire and severe windstorms may accelerate the shift in forest community composition, with fast-growing warm-adapted exotic species potentially dominating. An increase in extended dry periods and wildfires is also likely to impact the distribution of species and may ultimately affect the composition of vegetation communities.

Creating resilient Kiwi habitat through pest control
A Whangārei Heads biosecurity programme helped create a positive outcome for its resident kiwis. During the 2020 drought, when many kiwi populations elsewhere in Northland were suffering due to poor foraging conditions, kiwi in a Whangārei Heads reserve showed improved foraging and access to water. This shows that improving the resilience of our forests through pest control will provide direct, positive benefits for native fauna.

WHAT ARE THE CURRENT RESPONSES?

Councils already face huge challenges managing and monitoring existing pressures on ecosystems. There is a need to provide better resourcing to investigate, plan for, and deliver programmes to address climate impacts on the environment.

While climate change risks to the natural environment are acknowledged as being regionally significant, little is known of the detailed impacts on specific habitats and ecosystems. This knowledge gap means we do not have pre-emptive monitoring programmes in place to assess ongoing changes due to climate impacts. Nonetheless, existing environmental monitoring programmes such as state of the environment reporting, targeted monitoring of water quality, flow regimes in rivers and aquifers, and assessments of wetlands and coastal habitats all provide important data to assess long-term trends.

Northland has a well-established biosecurity programme that monitors and responds to ongoing threats. However, little is known of potential biosecurity risks under future climate change scenarios for terrestrial, freshwater or marine environments. In some open ecosystems such as marine environments, border controls are difficult or impossible to impose, making monitoring and control challenging.

Existing regional and district planning aims to reduce further environmental degradation and ensure the gradual restoration of natural values. However, the current planning structure does not effectively address the threats to natural values due to climate change.

WHAT ARE SOME FUTURE ADAPTATION OPPORTUNITIES?

Investigations and research will improve the baseline understanding of climate change risks to the natural environment and ecosystems. This will reduce uncertainty and assist the councils in prioritising at-risk species and developing intervention plans. Possible investigations include the identification of potential biosecurity threats, hotspots and key indicator species. This would enable the development of targeted monitoring and early interventions (priority action 16). Investigations are required to identify at-risk species and ecosystems to help develop monitoring and response plans across a wide range of ecosystems (priority action 17). Modelling of potential impacts on the ecological parameters of at-risk species is needed to understand which species are likely to face increasing threats due to climate change. This would enable the councils to build ecological resilience and protect and establish refuge locations which will be critical to threatened species. In extreme cases in the future, it may be necessary to translocate species and establish genetically viable populations in southern locations.

Priority actions #16 & #17

16 Biosecurity risk assessment

Aim:	Improve understanding of climate change-driven biosecurity threats and develop monitoring and response programmes.
Description:	Undertake preliminary high-level investigations into future biosecurity threats (both sleeper and offshore), aligned with national research programmes and information from agencies (e.g. MPI and MoH). The scope may include: human pathogens, primary industry pests and pathogens (agriculture, horticulture and aquaculture) and environmental pests (freshwater, terrestrial and marine). Develop prioritised monitoring and response programmes for relevant target species.

17 Ecosystem and biodiversity risk assessment

Aim:	Improve understanding of climate change impacts on biodiversity and ecosystem function and develop monitoring and response programmes.
Description:	Undertake preliminary high-level investigations identifying major at-risk species and ecosystems, followed by targeted research into key ecosystems. Develop monitoring and response plans for key species, habitats and ecosystems, including wetland/peat, terrestrial, marine, freshwater, lakes, coastal dunes, and foreshore and estuarine ecosystems.

Increased use of nature-based solutions to address coastal erosion is an example in which ecological and aesthetic co-benefits can occur while achieving short and medium-term hazard mitigation. The existing Northland Regional Council CoastCare programme supports communities to undertake dune restoration in places subject to coastal erosion, while protecting the nesting habitat of migratory birds. Alignment of these projects with adaptation plans using recent coastal erosion data would help improve adaptation outcomes (priority action 32).

Better understanding of potential species migration requirements would assist planning of landscape-scale management such as establishing habitat corridors. Improved use of spatial planning tools may assist with the development of planning rules to build the resilience of natural systems; for example, land-use rules to maintain viable populations of saltmarsh habitat where this is threatened by coastal squeeze (see priority action 26).

Priority actions #26 & #32

26 Spatial planning

Aim: Embed climate change risks and adaptation planning into strategic spatial plans.

Description: Undertake region-wide spatial planning to highlight risks and opportunities for strategic land-use planning that enables adaptation responses and enhances wellbeing. (N.B. RMA reforms will impact this item and review may be required.)

32 Nature-based solutions

Aim: Promote nature-based solutions as interim hazard-reduction options for coastal impacts.

Description: Continue to support community dune restoration and enhancement projects such as the Coast Care programme in line with regional adaptation planning, and as alternative interim measures in place of hard protection structures.

The carbon-storage function of coastal blue carbon ecosystems (mangroves, saltmarsh and seagrass) also needs to be considered, with the potential for habitat expansion and restoration to be funded through carbon credits (Northland Regional Council has an action to investigate this in its climate change strategy).

Northland councils can develop clear policy on how to account for the carbon-storage and offset potential of ecosystem restoration activities to guide decision-making and encourage nature-based solutions. Where coastal stopbanks impede the landward migration of coastal habitat, infrastructure adaptation planning should consider habitat and carbon storage values in options assessments.

7. Public infrastructure

WHAT ARE THE KEY ISSUES?

Public infrastructure managed by the councils provides many of the basic functions that enable our communities to function. It includes a wide range of built assets such as: stormwater, wastewater and water supply (e.g. reticulation, storage, pump stations, treatment plants, devices and ponds); roads, culverts and bridges; flood management schemes and assets; agricultural drainage schemes; and coastal management structures. Other associated 'natural assets' include open drains, waterways, buffering, receiving environments and protective reserves. Non-council-owned infrastructure such as electricity distribution and supply networks form an essential part of the supply chain for some council assets such as pump stations and wastewater treatment plants.

Significant climate change hazards and stressors which are likely to impact infrastructure include: increased rainfall intensity, higher temperatures/heatwaves, permanent tidal inundation and groundwater salinity due to sea level rise, coastal erosion, coastal flooding, severe windstorms, and increased drought frequency and severity. Impacts can also compound across hazards and infrastructure types, creating further unexpected issues. An example of this is the impact of high sedimentation on water treatment plants due to high intensity rainfall after drought.

The level of the councils' understanding of climate change impacts on infrastructure varies between infrastructure types and hazards. There are many opportunities for improvement. In some cases there is good information on climate hazards, but the consequences are poorly understood (e.g. the impact of higher tides with sea level rise on stormwater drainage). Where there is uncertainty in the hazard data (e.g. the relationship between increased rainfall intensity and the geotechnical stability of roads) understanding is further limited.

Requirements for infrastructure upgrades to address climate change projections can be difficult to calculate given the high levels of uncertainty. This makes it difficult to develop cost projections. Balancing future planning requirements against the need to maintain current levels of service and replace aging infrastructure can be challenging in the absence of adequate climate risk information and planning tools.

Key risks for some major infrastructure groups are described below.

Water supply

Northland traditionally has a high mean annual rainfall spread over the entire year with a peak in winter, which allows urban water supplies to rely on consistent rainfall to maintain dam storage and extraction from river flows. Under climate projections, seasonal variations and increases in the frequency and severity of drought conditions are expected to create issues for water supply infrastructure.

A demonstration of Northland's sensitivity to prolonged periods without significant rainfall occurred in the 2020 drought, during which all three Northland districts imposed restrictions, and emergency water provisions were required in the Far North, including in the towns of Kaitāia and Kaikohe. Following the flooding events that broke the drought, large amounts of sediment entered water treatment plants, resulting in cuts to water supplies in some areas. Drought can also affect non-council supplies, with many households running out of tank or spring water during the 2020 drought, resulting in prolonged waiting times for rural tanker supplies. Marae and rural communities were particularly affected, and a coordinated effort was required to provide emergency water supplies to communities.

Coastal communities relying on shallow groundwater to supplement tank supply (e.g. Matapouri and Russell) have experienced saline intrusion due to high levels of extraction during low rainfall periods, and limited groundwater recharge. Sea level rise is likely to exacerbate this occurrence and could potentially render the groundwater permanently undrinkable in some areas. Continued impacts on communities without council water supplies may result in increased requirements to provide a reticulated supply, or to improve emergency supply facilities.

Wastewater, stormwater and flood management

As rainfall intensity increases with climate change, what are currently infrequent minor flooding events are projected to become more regular events. This will affect councils' ability to provide expected levels of service for stormwater and wastewater. Other impacts related to rainfall intensity include the increase in sediment entering stormwater networks, causing pipe blockages, and an increase in the frequency of stormwater ingress into wastewater pipes systems, causing overloading of networks and exceeding the capacity of treatment systems.

While climate change projections are built into specifications for new assets, the existing stock of aging infrastructure is unlikely to be able to cope with the combined pressures of climate change, population growth and urban redevelopment. Retrospective upgrades of urban wastewater and stormwater networks to meet future needs are often prohibitively expensive.

Turntable Hill flooding

Stormwater services are also impacted by sea level rise. In some Northland townships (e.g. Whangārei and Dargaville), stormwater networks are located on low-lying coastal plains, with tidal tailwater conditions restricting drainage even at current day high tides. This can result in surface flooding at high tide, causing significant damage to property, which will be worsened with sea level rise. In townships where coastal flood protection is required, investment in stormwater pumping infrastructure may be necessary to remove ponded stormwater behind stopbanks. Ongoing investment in short to medium-term adaptation solutions such as sea walls can create the risk of incentivising development in areas that face future exposure to sea level rise. This may result in higher long-term risk for communities.

Raupo land drainage scheme

Since 1905 the Raupo land drainage scheme and stopbank system in Kaipara District has managed river and coastal flooding and catchment drainage for 8,200ha of highly productive land, including the township of Ruawai and settlements of Raupo and Naumai. Once Kahikatea and Kauri forests and swampland, the majority of this land is well below sea level. The drainage scheme consists of 130 kilometres of drains, 70 kilometres of stopbanks, 52 saltwater floodgates, three flood detention dams, and one pumping station (as the system relies mostly on gravity). Management of the scheme is predominantly funded by a targeted rate for farmers and residents residing in the drainage district.

Even with the flood management and drainage system in place, coastal hazards mapping shows extreme exposure for Ruawai, Raupo and Naumai residents and for public infrastructure. A high proportion of the roading network, wastewater systems, and water reticulation systems is exposed to 50 year and 100 year coastal flooding and permanent tidal inundation. Kaipara District Council and the Ruawai community are limited in their ability to fund future costs to upgrade the stopbanks and drainage systems to continue to manage coastal flooding, river flooding and permanent tidal inundation.

Most Northland councils operate flood management and/or agricultural drainage schemes that may be affected by increased rainfall intensity and sea level rise. For example, Kaipara District Council operates and maintains 30 drainage districts. Major schemes in Northland include the Raupo land drainage scheme (Kaipara District Council), the Hikurangi flood management scheme (Whangarei District Council), and the Awanui flood protection scheme and coastal stopbanks (Northland Regional Council). The ability of these schemes to continue functioning efficiently in future climate scenarios is poorly understood. Climate change impacts will likely make overtopping events more regular, which reduces the economic value of the schemes and requires investment. Urban flood protection schemes (e.g. Whangārei, Kaitāia and Kāeo) will also be impacted, with further infrastructure likely to be required to maintain current levels of service.

Roading

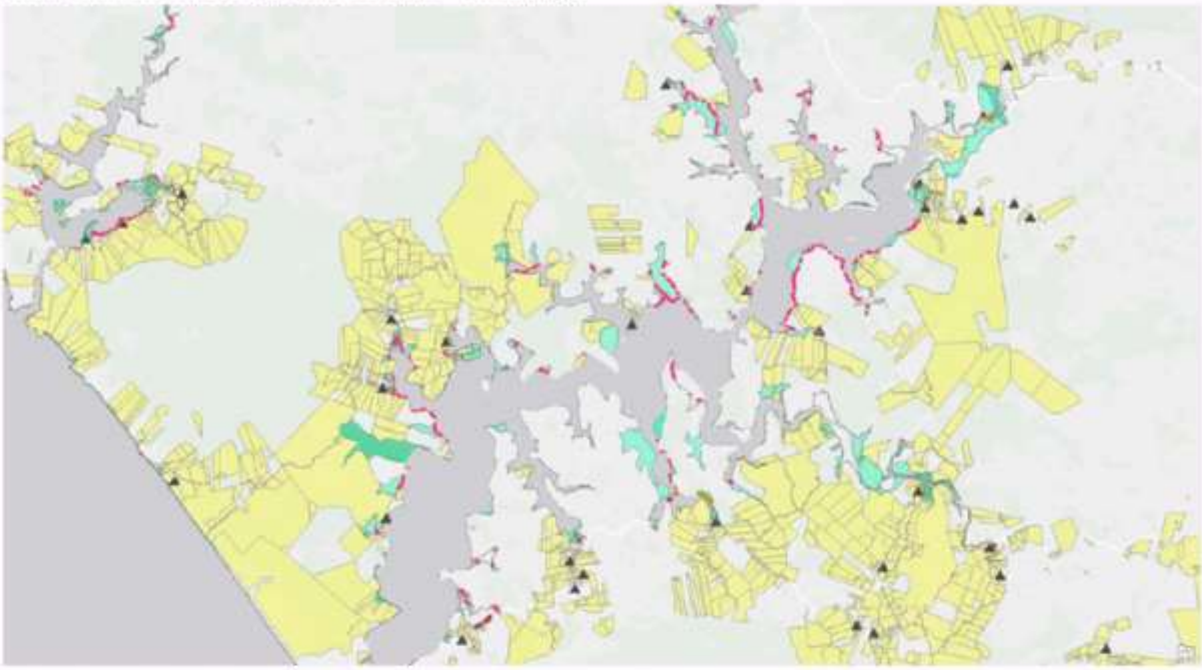
Northland's roads are already affected by hazards such as river flooding (e.g. SH1 Whakapara), slips and geotechnical instability (e.g. SH1 Mangamuka gorge), coastal erosion (e.g. SH12 Ōpononi) and frequent coastal flooding (e.g. West Coast Rd, Panguru). In some areas local roads are also affected by tidal inundation, which impedes drainage from rain events (e.g. Pururuku).

Climate projections indicate that these impacts will all increase in frequency and severity over time. A 2019 study by NIWA showed that Northland has around 10% of the total length of roads across New Zealand which are projected to be exposed to coastal flooding under sea level rise scenarios[39]. Analysis of existing roads in the northern Kaipara using recent modelling shows that up to 80km of roads could be inundated by regular high tides due to sea level rise by 2130. In a 100-year coastal flooding event, nearly 100km of roads are projected to be flooded to a depth of more than one metre. This indicates that interruptions to road connectivity, especially in outlying areas, are likely to become more regular and prolonged.

Mapping of permanent tidal inundation with sea level rise shows that many sections of Northland's roads will require raising or relocation. In some areas such as the Hokianga, roads are already affected by spring tides, so the projected impacts of sea level rise will affect the connectivity of communities over time. The costs of implementing effective adaptation solutions may be unaffordable for the councils, and poses a risk that these communities, which have high Māori populations, are likely to be disproportionately affected.

Waste disposal

Road inundation due to sea level rise – Hokianga



The map above shows Māori freehold land (yellow) and marae (black triangles), overlaid by projected extents of high-tide inundation by 2130 – land (green) and roads (pink/orange). Connecting infrastructure (such as roading) is likely to play a major part in climate adaptation responses for remote communities in this and similar areas.

39 https://deepsouthchallenge.co.nz/wp-content/uploads/2021/01/Exposure-to-Coastal-Flooding-Final-Report.pdf

There are several landfill sites in Northland that may be subject to coastal or river flooding and erosion. These include both formal landfills (often operated and maintained by the councils) and informal sites (e.g. illegal or ad-hoc dumps), as well as unidentified sites. While some obvious coastal sites such as Pohe Island (Whangārei Harbour) are assessed to have a low risk, a number of historic landfills have been mapped as higher risk due to their proximity to areas prone to coastal hazards.

WHAT ARE THE CURRENT RESPONSES?

Information and planning

Detailed region-wide and catchment-specific models and information on river flooding and coastal hazards have been developed and are continually refined by Northland Regional Council. This information helps inform the specifications for new infrastructure, such as road levels and drainage requirements for subdivisions. The district councils are investing in models to help understand climate risks. For example, Whangarei District Council is developing a stormwater network model that will enable the development of engineering adaptation options. This information will aid community adaptation planning for the delivery of the Blue-Green Network Strategy, which aims to reduce river and coastal flood risk and provide transport connectivity and waterway restoration outcomes.

Councils are now using hazard information to undertake high-level climate risk assessments on infrastructure assets. The coastal adaptation programme (which is currently being developed) uses recent coastal hazard assessments to document at-risk three waters and roading infrastructure in coastal communities. The Northland Lifelines group is conducting a lifelines infrastructure risk assessment, and the Northland Transport Alliance is developing resilience assessments for roads. Nonetheless, infrastructure risk assessments in Northland largely remain at a relatively low ('risk screening') level of resolution. Mostly they do not consider multiple hazards, impacts on network connectivity, differential consequences across infrastructure types, or estimated costs of mitigation or risk management.

Risk management actions

Engineering designs for new council infrastructure generally incorporate design guidance requiring allowance for climate change, for instance stormwater drainage capacity (extreme rainfall), or tailwater levels and road surface height (sea level rise). Adaptation responses for existing infrastructure are generally limited to improvements during asset replacements and upgrades, such as bridge soffit levels.

Water supply infrastructure is in different stages of adaptation maturity. In Whangārei district, an adaptive planning approach has been taken to anticipate future drivers of demand for the city's water supplies. While this has largely been to address anticipated population growth, demand level indicators have been used to trigger different programme requirements. These include increasing efficiency of the current system, demand management, planning for future needs through engineering assessments, and obtaining resource consents for water takes and land purchases for water storage. In other areas, the focus has been on addressing immediate needs and reducing the risk of water shortages. The Three Waters Reform process should address some of the existing shortfalls in water supply infrastructure.

The region has a 30-year programme of river flood management work, focusing on priority at-risk locations (e.g. Awanui catchment/Kaitāia, Moerewa, Kāeo and Whangārei). The programme will reduce risk for communities through the design and construction of stopbanks, spillways, benching and stream maintenance. Continuing this programme into the future is vital to reduce risks to communities at risk from flooding under climate change scenarios (priority action 33).

Priority action #33

33 River flood management

Aim:	Reduce flooding risk to communities through river management.
Description:	Continue to deliver prioritised river flood management projects, and plan and secure funding for future flood management implementation across the region.

Risk mitigation of coastal flooding and erosion includes the use of sea walls, rock revetments and stopbanks. In general, the councils do not build coastal protection unless council-owned assets are at risk, and the adoption of nature-based solutions, like those promoted by Northland Regional Council's CoastCare programme, are often favoured due to the many co-benefits provided. In some areas such as Ruawai and Awanui, flood management schemes originally designed for agricultural purposes protect small rural townships from regular coastal inundation, although coastal hazard assessments indicate that the level of protection will not continue with future sea level rise.

Tangowahine flooding

WHAT ARE SOME FUTURE ADAPTATION OPPORTUNITIES?

Information and planning

Infrastructure planning is a significant council responsibility that has a major role in enabling communities to adapt. It is essential that infrastructure climate response plans are developed in alignment with community needs and adaptation aspirations (priority actions 15 and 28).

Priority actions #15 & #28

15 Infrastructure planning

Aim:	Ensure consideration of climate change impacts in infrastructure planning.
Description:	Develop and implement processes/policy to ensure consideration of climate change impacts in infrastructure planning, activity management plans and infrastructure strategies, including a monitoring and evaluation plan. This should include consistent application of climate risk assessments and adaptive management approaches. (N.B. This should also include emissions reductions considerations – see priority actions 11 and 12.)

28 Embed community adaptation plans

Aim:	Ensure community adaptation plans are embedded in regulatory instruments.
Description:	Investigate and develop methodologies to embed adaptive pathways plans into planning regimes, including using environmental cues to trigger changes to planning rules. (N.B. RMA reforms will impact this item and review may be required.)

There is an opportunity for the councils to invest in regionally consistent infrastructure climate risk assessments using improved information on climate hazards and infrastructure assets. High resolution data, such as stormwater pipe invert levels, can enable the development of accurate models that inform engineering options assessments and forward planning. Good understanding of the impacts of climate change hazards and stressors on assets will help asset planners develop potential infrastructure solutions under climate change scenarios, which are aligned with community needs and other socio-economic factors (e.g. population growth).

A good first step will be to develop aligned climate risk assessments across all infrastructure departments that demonstrate expected costs and damage loss assessments (priority actions 11–14). Further investigations into the interactions of multiple hazards and stressors on infrastructure is also required.

Priority actions #11, #12, #13 & #14

11 Consistent infrastructure risk assessment criteria

Aim:	Improve consistency and quality of climate risk assessments for council assets and infrastructure.
Description:	Develop consistent standards and processes for undertaking risk assessments for council assets and infrastructure (e.g. agreed criteria, hazard scenarios and damage functions).

12 Infrastructure risk assessments

Aim:	Improve knowledge of climate risk for council assets and infrastructure.
Description:	Undertake infrastructure climate risk assessments for each council and include documented climate risks in infrastructure and financial strategies.

13 Roading risk assessments

Aim:	Improve understanding of long-term climate risks to roading infrastructure.
Description:	Develop a regional roading network resilience plan, assessing critical roads at risk from landslides and slips, with the potential for future assessment of flooding and coastal hazards under climate change scenarios.

14 Lifelines risk assessments

Aim:	Improve understanding of long-term climate risks to lifelines infrastructure.
Description:	Develop a lifelines utilities infrastructure risk assessment, working with Northland Lifelines Group members' spatial data.

Planning appropriate infrastructure to cope with climate impacts will require a focus on risk management approaches for existing infrastructure. This requires scenario planning to anticipate future needs and avoid over-investment in short-term solutions. For example, this could involve moving from a risk elimination strategy (e.g. coastal stopbanks with stormwater pumping) towards a risk acceptance and avoidance strategy (e.g. long-term changes to land use, reduced levels of service and/or managed infrastructure withdrawal). Infrastructure planning approaches should limit reactive or business-as-usual investments that ignore long-term trends due to climate change. This is particularly relevant when climate hazards are experienced as rare events, such as coastal flooding due to cyclones.

Risk management actions

Once a reasonable understanding of risks is achieved, pre-feasibility investigations for cultural, engineering, and consenting limitations, alongside cost analyses, can help inform options analyses. These can be used in community engagement for decision-making, either through a community adaptation planning process or on a project basis.

Improved funding models will help embed adaptation in infrastructure planning. These models should include the benefits of proactive risk management in business cases and allow for flexibility in timing of implementation. Improved processes for cost forecasting and inclusion in financial and infrastructure strategies will also be required. Better understanding of the risks to infrastructure will improve the councils' ability to disclose their financial risks and better consider climate change when developing funding applications and business cases (priority actions 40 and 41).

Priority actions #40 & #41

40 Climate risk disclosure

Aim:	Ensure transparent monitoring and reporting of climate risks and responses.
Description:	Clear disclosure and reporting of climate risks, policy maturity, and progress on response actions in alignment with the recommendations of the Taskforce on Climate-related Financial Disclosure. This may include actions such as ensuring climate change is included in council risk frameworks, financial reports and infrastructure strategies; regularly reporting to auditors; and establishing KPIs for senior managers and CEOs.

41 Climate change in business cases

Aim:	Embed climate change considerations in business cases and procurement policies.
Description:	Ensure disclosure of climate change risks in business cases, proposals and procurement documents, including long-term risks such as sea level rise.

Examples of future infrastructure adaptation planning projects may include the following.

Roading

- Develop options to resolve long-term permanent tidal inundation issues, including a prioritisation plan/methodology and costings for road relocation or raising.
- Complete a comprehensive coastal erosion assessment detailing required protection for hotspots, and likely impacts on cultural, community and environmental values.
- Determine requirements for bridge and culvert upgrades, considering the impact of sea-level rise on coastal floodplains.

Wastewater

- Research the impact of higher temperatures on wastewater treatment, especially open ponds (including methane emissions).
- Investigate the impacts of increases of higher intensity rainfall on network and treatment plant capacity.

Stormwater and flooding

- Develop models to show the impact of tidal inundation on drainage in urban areas.
- Improve the integration of compound coastal and river flooding data, including a worst-case cyclone flooding model.
- Undertake better modelling of increased rainfall intensity on urban stormwater networks.

Coastal slip at Kerikeri Basin, below pā site

Part 3. Enabling effective adaptation

Future directions

Responding to the impacts of climate change will affect many activities the councils carry out, so it is vital to have widespread commitment and alignment across (and between) organisations. Climate change acts as a 'risk multiplier' and will likely create the need for different types of adaptation responses, depending on a wide range of activities. Some responses, such as regulatory policy development and environmental management programmes, may require major changes or entirely new activities. Others, such as infrastructure planning, will need to adjust risk management settings.

We have assessed adaptation needs across council activities with the aim of prioritising adaptation actions based on a) the level of understanding of climate risk and impacts, and b) the level of responsibility for the councils to manage the risk. The assessment highlighted areas that urgently required further investigation (such as impacts on biosecurity and biodiversity, and infrastructure assessments); areas where the councils need to do planning and engagement, such as coastal adaptation planning and impacts on Māori; and areas where continued action is required, such as river flood management works.

One recurring theme in adaptation is the need to bring communities along on the journey. This is consistent with the purpose of local government. Developing good relationships and trust with communities is a necessary condition for doing adaptation planning work, particularly where the impacts on communities may be big, or perceived negatively – for example, where adaptation involves progressively restrictive planning rules, or large costs to pay for infrastructure. Using appropriate community engagement processes, as well as decision-support tools that enable community ownership of the process, can help resolve complex and controversial issues.

Working collaboratively with Māori as tangata whenua – and demonstrating the principles of partnership, participation and protection – at all stages of adaptation is vital for the councils. Co-developing holistic adaptation responses to climate change presents an opportunity for the councils to work with Māori on a broad range of environmental, social and cultural issues, across many council functions.

Four areas of action

We have identified priority actions to enable local government to carry out effective adaptation in Northland. These are grouped into four areas:

1. Grow relationships (priority actions 1–8)
2. Improve knowledge and understanding (priority actions 9–24)
3. Reduce risk and vulnerability (priority actions 25–36)
4. Build capacity (priority actions 37–46).

Recommended actions are summarised below, and are described in detail in Part 5 – 'Priority actions', with additional information on lead organisations, delivery timeframes and funding status.

1. Grow relationships

- Partner with tangata whenua at all stages of adaptation planning, ensuring Māori voices are included in decision-making, including supporting hapū and iwi to lead local adaptation planning.
- Facilitate collaborative planning with local communities, by developing trust and long-term relationships and by helping residents and businesses pursue opportunities for resilience.
- Communicate with communities about adaptation information and processes, and listen to their feedback, particularly from farming and coastal communities.
- Work across departments in each council to integrate climate change priorities and ensure alignment between activity areas.
- Continue to coordinate adaptation programmes between the councils and share resources.
- Work together across different levels of government, and sectors including Māori, communities, businesses and research institutes.
- Advocate and engage with central government agencies on adaptation funding, legislation, policy and support.

2. Improve knowledge and understanding

- Identify key knowledge gaps and develop targeted investigations and research.
- Expand the existing knowledge base through research, assessments and investigations.
- Work with iwi and hapū to enable Māori traditional knowledge to guide the councils' climate change approaches.
- Work with communities to understand risks and the range of potential solutions, and to pursue current and future opportunities.
- Monitor, evaluate and report on climate risks, community vulnerability and environmental indicators.
- Develop research partnerships with institutes and collaborate on externally funded research.

3. Reduce risk and vulnerability

- Pre-emptively plan adaptation responses at the local scale, working with communities, tangata whenua, infrastructure providers, government agencies and stakeholders, using appropriate engagement processes and decision-support tools.
- Use adaptation planning engagement and education processes to empower communities to proactively pursue new opportunities, increase resilience and build adaptive capacity.
- Develop rules and policies that reduce risk and enable appropriate and flexible adaptation responses.
- Plan for, and invest in, long-term risk management infrastructure and solutions for a wide range of climate risks.
- Adopt appropriate nature-based responses and interim measures.

4. Build capacity

- Demonstrate leadership through effective and collaborative governance.
- Build internal staff capacity and resources, through specialist teams and across/between organisations.
- Develop consistent climate change policy between the councils, and integrate climate change objectives across council policies, strategies and processes.
- Provide sufficient funding for adaptation activities, including investigations, planning, engagement, and implementation where appropriate.
- Identify collaborative and external funding opportunities.

Riparian planting by a dune lake

Part 4. An evolving strategy

The need to respond to change

This strategy needs to be a living document to remain flexible and responsive to new information, feedback, and changes in the legislative and legal environments, or other major events.

We acknowledge that engagement with tangata whenua and our communities will take time. As we have wider and deeper conversations with those affected by climate change, our understanding of the consequences of climate change and the challenges of adaptation will improve. Updates to the strategy and projects in Part 5 – 'Priority actions' will need to be made as required.

The strategy will also need to be reviewed after the release of new government legislation or guidance, such as the upcoming National Adaptation Plan and RMA reform, including the Climate Change Adaptation Act, or other major changes such as local government reform. New scientific evidence or case law may also prompt the need for a review, as might regular updates aligned with the councils' long-term planning processes. Changes could range from minor alterations to major overhauls, and these will require different approaches.

Review process

Below we outline an ongoing process for the strategy and priority actions to be updated in response to changing needs. Reviews are grouped into three categories.

1. **Technical:** new technical reports or updates to existing reports.
2. **Minor:** operational and minor updates to the strategy and/or priority actions.
3. **Major:** substantive review and major changes to the strategy and/or priority actions.

Reviews can be triggered by different events or requests, with varying levels of permitted changes, and corresponding engagement and approval processes as needed. At a minimum, the strategy will be reviewed at three-yearly intervals prior to Long-Term Plan consultation. Other reviews will occur in response to feedback, legislative change and other events. Updates to the priority actions will be made as required. Where possible, reviews will be combined for efficiency.

Below is an anticipated timeframe for required reviews.

YEAR	TRIGGER	REVIEW TYPE
As required	New technical reports or changes to existing ones	Technical reports
As required	Updates and additions to priority actions	Minor
As required	Tangata whenua and community feedback	Minor
		Major
2022	National Adaptation Plan	Minor
2023–24 (estimated)	Climate Adaptation Act Built and Natural Environments Act Spatial Planning Act	Major
2024	Long-Term Plan review	Major
2024 (estimated)	Three Waters Reform	Major
2026	Second National Climate Change Risk Assessment	Major
(Uncertain)	Local government reform/amalgamation	Major
2027	Long-Term Plan review	Major
2028	Second National Adaptation Plan	Minor

Details of the three review types are listed in the table below.

	1. Technical reports
Intent:	Provide new technical reports or updates to existing technical reports
Triggers:	Iwi/hapū or community feedback
	Joint committee requests
	Staff recommendation (e.g. new information)
Changes permitted:	Updates as and where required
	New technical reports and data
Out of scope:	Changes impacting scope, intent or direction of strategy and priority actions
Engagement required:	Relevant tangata whenua representatives
	Must be evidence based
Approval:	Approval by relevant sponsoring GMs
	Presentation to Joint Committee
	2. Minor updates
Intent:	Operational and minor updates to strategy and/or priority actions
Triggers:	Iwi/hapū or community feedback
	Joint committee requests
	Staff recommendation
	New or updated information (strategy)
	Changes in project scope, details or timeframes, additional funding for new projects (priority actions)
Changes permitted:	Minor editorial changes
	Addition of paragraphs, sentences or other minor elements (strategy)
	Alterations to details in descriptions or timeframes (priority actions)
	Addition of new projects (priority actions)
Out of scope:	Removal of actions
	Alterations to structure or foundational elements
Engagement required:	Relevant tangata whenua representatives
Approval:	Approval by relevant sponsoring GMs
	Presentation to Joint Committee (approval by individual councils not required if changes are operational)
	3. Major review
Intent:	Allow for substantive review and major changes to strategy and/or priority actions
Triggers:	Long-Term Plan process
	New government legislation or guidance
	New case law
	Additional scientific or other evidence
	Local government reform
	Three Waters reform
	Iwi/hapū or community feedback
	Joint committee request
	Staff recommendation
Changes permitted:	Major editorial changes
	Alteration to structure or foundational elements

3. Major review (cont.)	
Changes permitted contd:	Addition of new sections and headings Addition of new text, diagrams, photos Removal or alteration of existing text
Out of scope:	N/A
Engagement required:	Wide engagement with tangata whenua (initially via representative groups, but in some cases wider engagement may be required) LTP review to be completed in year prior to LTP adoption, in conjunction with community consultation Elected members of all councils Relevant council staff and management
Approval:	Approval of review process by joint committee required Approval by sponsoring GMs of all councils Endorsement by joint committee Adoption by all Northland councils All exceptions to be noted in strategy and priority actions

Reporting

Governance

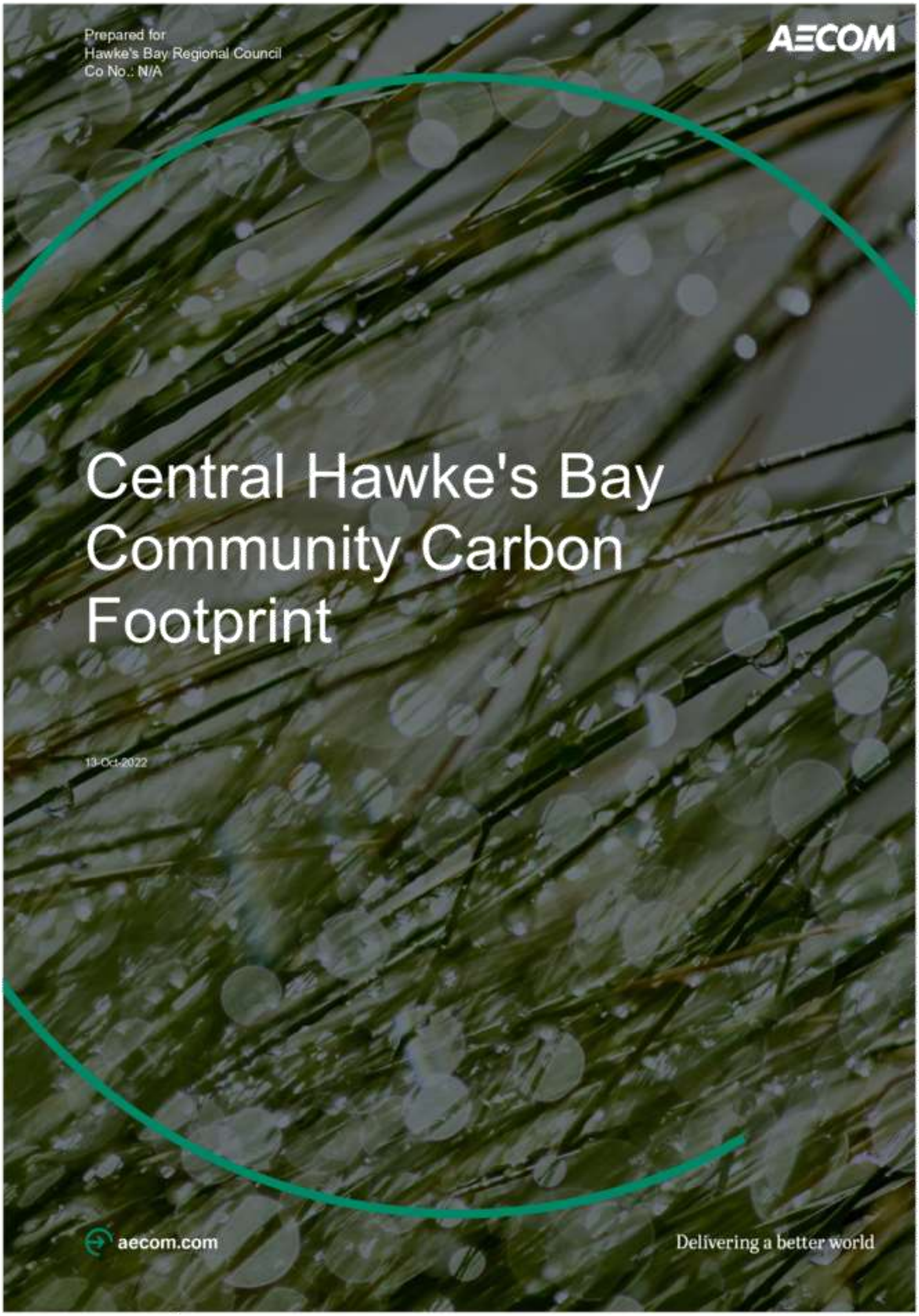
Progress on priority actions will be reported at each Joint Climate Change Adaptation Committee meeting. Progress will also be reported to individual councils and committees where relevant.

Iwi and hapū

Reporting to iwi and hapū will be via existing council representative groups, unless otherwise requested. A process for iwi and hapū engagement will be developed as part of priority actions 1, 2 and 10.

Public communications

A joint regional communications group has been formed to help support the ongoing, public-facing nature of the strategy and the collaborative adaptation work programme. A communications plan for the strategy, as well as for ongoing region-wide adaptation, is being developed as part of priority actions 7 and 8.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Central Hawke's Bay Community Carbon Footprint
13-Oct-2022
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Central Hawke's Bay Community Carbon Footprint

Client: Hawke's Bay Regional Council

Co No.: N/A

Prepared by

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Quality Information

Document Central Hawke's Bay Community Carbon Footprint

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Prepared by Adam Swithinbank and Tanya Milnes

Reviewed by Anthony Hume

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
1	27-Sept-2022	Final	Anthony Hume Team Leader - Sustainability	[signature]
2	13-Oct-2022	Final - includes updated infographics	Anthony Hume Team Leader - Sustainability	[signature]
3	29-Nov-2022	Final - includes updated infographic (Figure 1)	Anthony Hume Team Leader - Sustainability	[signature]

Table of Contents

Executive Summary

Greenhouse Gas (GHG) emissions for the Central Hawke's Bay District Territorial Area (that is covered by the Central Hawke's Bay District Council) have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture and Forestry sectors. This document reports greenhouse gas emissions produced in or resulting from activity or consumption within the geographic boundaries of the Central Hawke's Bay District Territorial Area for the 2020/21 financial reporting year and examines greenhouse gas emissions produced from 2018/19 to 2020/21.

The Central Hawke's Bay District Territorial Area is referred to hereafter as Central Hawke's Bay for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

Major findings of the project include:

2020/21 Emissions Footprint

- In the 2020/21 reporting year (1st July 2020 to 30th June 2021), **total gross emissions** in Central Hawke's Bay were 1,309,347 tCO_2e.
- **Agriculture** (e.g. emissions from livestock and crops) is the largest source of emissions, accounting for 87% of Central Hawke's Bay's total gross emissions, with enteric fermentation from livestock accounting for 68% of gross emissions.
- **Transport** (e.g. emissions from road and air travel) is the second largest emitting sector in Central Hawke's Bay, representing 8% of total gross emissions, with petrol and diesel consumption accounting for 7.9% of gross emissions.
- **Stationary Energy** (e.g. consumption of electricity and natural gas), Waste, and IPPU (e.g. refrigerant use) produced the remaining 4% of total gross emissions.
- Net Forestry emissions were -91,886 in 2020/21 as carbon sequestration (carbon captured and stored in plants or soil by forests) was higher than emissions from forest harvesting (e.g., the release of carbon from roots and organic matter following harvesting). Net **Forestry** emissions are not included in total gross emissions.
- The **total net emissions** in Central Hawke's Bay were 1,217,462 tCO_2e. The total net emissions include emissions and sequestration from forestry.

Changes in Emissions, 2018/19 to 2020/21

- Between 2018/19 and 2020/21, **total gross emissions** in Central Hawke's Bay decreased from 1,395,790 tCO_2e to 1,309,347 tCO_2e, a decrease of 6% (86,443 tCO_2e).
- Over this time the population of the district increased by 5%, resulting in **per capita gross emissions** in Central Hawke's Bay decreasing by 10% between 2018/19 and 2020/21, from 94.5 to 84.6 tCO_2e per person per year.
- Emissions from **Agriculture** decreased by 8%, between 2018/19 and 2020/21 (98,440 tCO_2e), due to a reduction in livestock numbers, particularly of sheep and non-dairy cattle.
- Emissions from **Stationary Energy** increased by 25% between 2018/19 and 2020/21 (6,647 tCO_2e), driven by a 43% increase in electricity consumption emissions (5,428 tCO_2e). This increase in electricity consumption emissions was due to a 1% increase in energy consumption (kWh) and a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).
- **Transport** emissions increased by 4% between 2018/19 and 2020/21 (4,522 tCO_2e), driven by a 5% increase in on-road fuel emissions (4,536 tCO_2e). Marine freight and air travel emissions reduced during this period, likely reflecting the impact of the COVID-19 pandemic.
- **Forestry** was a net-negative source of emissions due to sequestration being higher than emission from harvesting during this period. Emissions from harvesting decreased by 4% (-22,573 tCO_2e)

resulting in the net impact of Forestry changing from -64,703 tCO_2e (2018/19) to -91,866 tCO_2e (2020/21).

Figure 1: Central Hawke's Bay 2020/21 Emissions Footprint

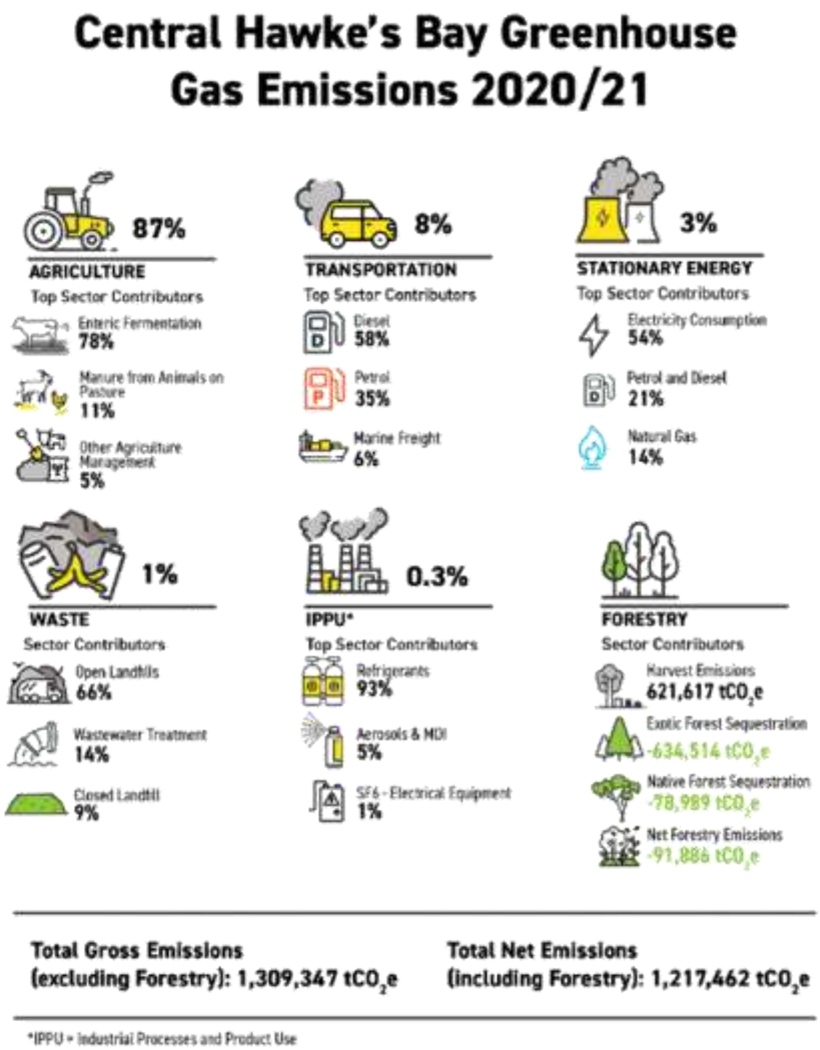
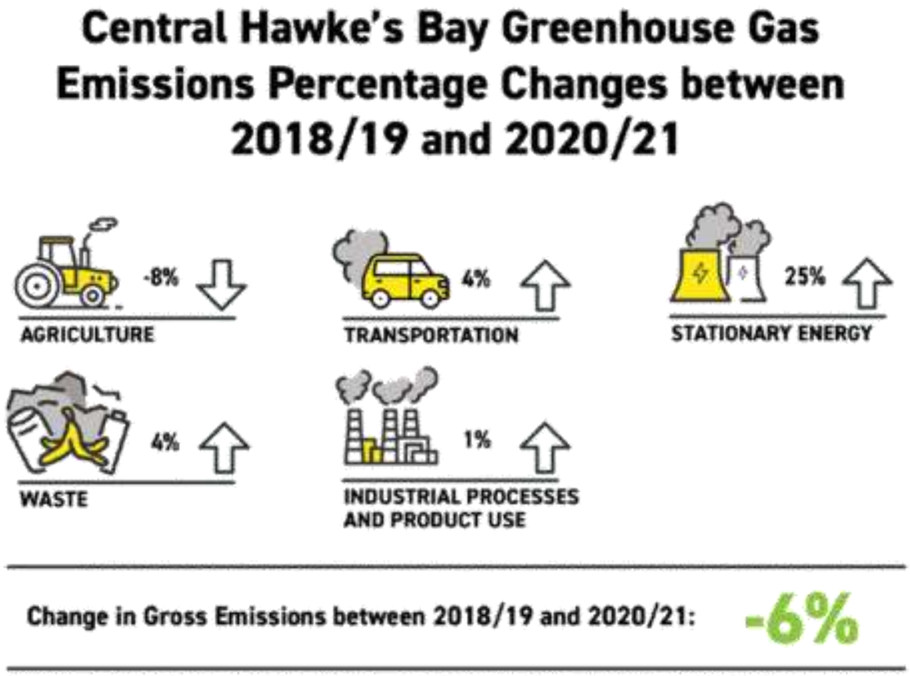


Figure 2: Change in Central Hawke's Bay Emissions Footprint between 2018/19 and 2020/21



1.0 Introduction

AECOM New Zealand Limited (AECOM) was commissioned by the Hawke's Bay Regional Council to assist in the development of community-scale greenhouse gas (GHG) footprints for the Central Hawke's Bay District Territorial Area for the 2018/19, 2019/20, and 2020/21 financial years. This is part of a wider study to develop community carbon footprints for each district within the Hawke's Bay region. Emissions are reported for the period from 1 July to 30 June for the respective years. The study boundary reported in the following pages incorporates the jurisdiction of the Central Hawke's Bay District Council.

The Central Hawke's Bay District Territorial Area is referred to hereafter as Central Hawke's Bay for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

2.0 Approach and Limitations

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

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

This emissions footprint assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the 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. flights) and energy transportation and distribution losses fit into Scope 3.

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

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[2]. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs.
- GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption. Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g. embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.).
- Total emissions are reported as both gross emissions (excluding Forestry) and net emissions (including Forestry).

[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 greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
- Where location specific data were not accessible, information was calculated based on national or regional level data.
- Transport emissions:
  - Transport emissions associated with air travel, rail, and marine fuel were calculated by working out the emissions relating to each journey arriving or departing the area based on data provided by the relevant operators. Emissions for these sources are then split equally between the destination and origin. Emissions relating to a particular point source (e.g. an airport or port) are allocated to the expected users of that source, not just the area that it is located in. For example, in the Hawke's Bay Region, it is expected that all territorial authorities will use the Port of Napier for imported and exported goods, emissions from this source have been allocated to all territorial authorities in the region based on population. It is understood that freight imports moving through the Port of Napier do not exclusively serve the Hawke's Bay Region, and freight exports do not exclusively originate from the Hawke's Bay Region, this should be considered when examining these emissions.
  - All other transport emissions are calculated using the fuel sold in the area (e.g. petrol, diesel, LPG).
- Solid waste emissions:
  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day.
  - Emissions are calculated for waste produced within the geographic boundary, even if they are transported outside the boundary to be entered into landfill. Landfill waste for Central Hawke's Bay is understood to be disposed at Farm Road Landfill, Waipukurau.
- Wastewater emissions:
  - Emissions have been calculated based on the local data provided, following IPCC 2019 guidelines. Where data is missing, IPCC and Ministry for the Environment (MfE) figures have been used. Wastewater emissions from both wastewater treatment plants and 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 Processes and Product Use (IPPU) emissions:
  - IPPU emissions are estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2019 report (MfE 2021). Emissions are estimated on a per capita basis applying a national average per person.
- Forestry emissions:
  - This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e. it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
  - The emissions footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.

Overall sector data and results for the emissions footprint have been provided to Central Hawke's Bay District Council in calculation table spreadsheets. All assumptions made during data collection and analysis have been detailed within **Appendix A – Assumptions**.

It is important to consider the level of uncertainty associated with the results, particularly given the different datasets used. Depending on data availability, national, regional, and local datasets are used across the different calculators. At the national level, New Zealand's Greenhouse Gas Inventory shows that for 2018 (the most recent national level inventory) an estimate of gross emissions uncertainty was +/- 9%, whereas a net emissions uncertainty estimate was +/- 12%. These levels of uncertainty should be considered when interpreting the results of this community carbon footprint (MfE, 2020).

StatsNZ Regional Footprint

Due to differences in emission factors and methodology used between the StatsNZ Regional Footprints and this community carbon footprint (based on the GPC requirements and available data), caution should be taken when making comparison of reported emissions. One example of this is where this footprint used updated emission factors for methane and nitrous oxide following guidance from the IPCC and in line with other district and regional level GHG inventories in New Zealand. This difference is especially relevant for the Agriculture sector.

3.0 Community Carbon Footprint for 2020/21

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

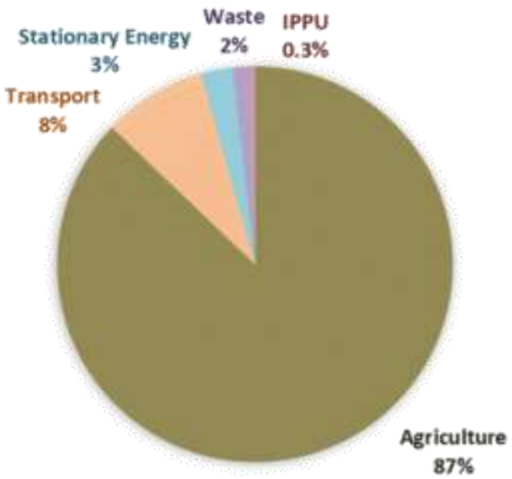
During the 2020/21 reporting period, Central Hawke's Bay emitted **gross** 1,309,347 tCO_2e. Note that gross emissions do not account for Forestry. Agriculture is the largest contributor to total gross emissions for the district.

The population of Central Hawke's Bay in 2020/21 was approximately 15,475 people, resulting in per capita gross emissions of 84.6 tCO_2e/person. Discussion of per capita emissions is limited to when it is useful for comparing emission figures against other territorial authorities. A breakdown of net emissions (i.e. including results from Forestry resources) is reported separately.

Table 1 Total net and gross emissions

Total emissions	tCO_2e
Total Net Emissions (including forestry)	1,217,462
Total Gross emissions (excluding forestry)	1,309,347

Figure 3: Central Hawke's Bay District's total gross GHG emissions split by sector (tCO_2e).



During the 2020/21 reporting period, Central Hawke's Bay emitted **net** 1,217,462 tCO_2e.

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting emissions and sequestration) within an area. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes.

Carbon sequestered by forestry can be viewed as a liability/risk that needs careful consideration. For example, if plantations are not replanted or other land use change occurs to exotic forested areas, then net emissions may rise quickly. Equally, if native forest is not protected from removal, and removal does happen, then net emissions may rise.

The community carbon footprint comprises emissions from six different sectors, summarised below:

3.1 Agriculture

The highest emitting sector in Central Hawke's Bay, Agriculture, emitted 1,141,058 tCO_2e in 2020/21 (Table 2). Agricultural emissions are the result of both livestock and crop farming. Enteric fermentation from livestock produced 78% of Central Hawke's Bay's Agricultural emissions (886,721 tCO_2e). Enteric fermentation GHG emissions are produced by methane (CH_4) released from the digestive process of ruminant animals (e.g. cattle and sheep). The second highest source of agricultural emissions was produced from nitrous oxide (N_2O) released by unmanaged manure from grazing animals on pasture (129,666 tCO_2e or 11% of the Agricultural emissions).

Table 2 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Enteric Fermentation	886,721	67.7%	77.7%
Manure from Grazing Animals	129,666	9.9%	11.4%
Other Agriculture Emissions	54,054	4.1%	4.7%
Atmospheric Deposition	36,933	2.8%	3.2%
Manure Management	22,332	1.7%	2.0%
Agricultural Soils	11,351	0.9%	1.0%
Total	1,141,058	87.1%	**100%**

Livestock were responsible for the majority of the Agriculture sector's GHG emissions (85%, or 1,118,823 tCO_2e) (Table 3). Sheep account for 49% of Agricultural emissions and 42% of gross emissions in Central Hawke's Bay. Non-dairy cattle account for 32% of Agricultural emissions and 28% of gross emissions in Central Hawke's Bay.

Table 3 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Dairy Cattle	172,638	13%	15%
Non-dairy Cattle	361,723	28%	32%
Sheep	555,004	42%	49%
Other livestock	29,458	2%	3%
Fertiliser (other)	22,235	2%	2%
Total	**1,141,058**	**87%**	**100%**

3.2 Transport

Transport produced 110,690 tCO_2e in 2020/21 (8% of Central Hawke's Bay gross total emissions). Table 4 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 4 Transport emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Diesel	64,491	4.9%	58.3%
Petrol	39,003	3.0%	35.2%
Marine Freight	6,728	0.5%	6.1%
Jet Kerosene	226	<0.1%	0.2%
LPG	133	<0.1%	0.1%
Rail	86	<0.1%	0.1%
Aviation Gas	23	<0.1%	<0.1%
Total	**110,690**	**8%**	**100%**

Most of the Transport emissions can be attributed to diesel and petrol, which produced 64,491 tCO_2e and 39,003 respectively (collectively 94% of the sector's emissions and 8% of total gross emissions). Diesel and petrol transport emissions are broken down into on-road and off-road use. On-road transport consists of all standard transportation vehicles used on roads (including cars, trucks, buses, etc.). Off-road transport consists of all fuel used for the movement of machinery and vehicles off roads (including agricultural tractors and vehicles, forklifts, etc.). On-road transport produced 90,928 tCO_2e (82% of Transport emissions) and Off-road transport produced 12,698 tCO_2e (12% of Transport emissions). An extra breakdown of on-road emissions by vehicle type and class is provided separate to this report.

The next largest emission source for Central Hawke's Bay is marine freight, which contributed to 6% of the sectors emissions (6,728 tCO_2e). Marine freight emissions are the result of freight movements to and from the Port of Napier. Emissions from this source have been divided between all territorial authorities in the Hawke's Bay region based on relative population sizes. It is understood that the imports and exports through this port are not exclusively related to activities in the Hawke's Bay region, however, to ensure that these emissions are reflected in community carbon footprints as per the GPC requirements this approach is appropriate.

The remaining transport emissions are attributed to air travel (jet kerosene and aviation gas), rail freight emissions, and LPG use for transport (e.g. forklifts).

3.3 Stationary Energy

Producing 33,714 tCO_2e in 2020/21, Stationary Energy was Central Hawke's Bay's third highest emitting sector (3% of total gross emissions). Table 5 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 5 Stationary Energy emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Electricity Consumption	18,154	1.4%	53.8%
Stationary Petrol & Diesel Use	7,136	0.5%	21.2%
Natural Gas	4,578	0.3%	13.6%
Electricity Transmission and Distribution Losses	1,668	0.1%	4.9%
LPG	1,051	0.1%	3.1%
Biofuel / Wood	467	<0.1%	1.4%
Natural Gas Transmission and Distribution Losses	370	<0.1%	1.1%
Coal	290	<0.1%	0.9%
Total:	**33,714**	**3%**	**100%**

Electricity consumption was the cause of 54% of Stationary Energy emissions (18,154 tCO_2e), and 1% of Central Hawke's Bay's total gross emissions (19,822 tCO_2e when including transmission and distribution losses related to consumption). Natural gas consumption accounted for 15% of the Stationary Energy emissions (4,949 tCO_2e) when including transmission and distribution losses. The industrial sector is the primary consumer of electricity and natural gas in Central Hawke's Bay.

Stationary petrol and diesel consumption generated 21% of the sectors emissions (7,136 tCO_2e). Use of LPG, and the burning of coal, biofuels and biogas produced the remaining Stationary Energy emissions.

Stationary Energy demand can also be broken down by fuel type, and by the sector in which it is consumed. Stationary Energy demand is reported for the following sectors: commercial; residential and industrial. However, emissions from petrol and diesel used for Stationary Energy are not able to be broken down by sector.

- Industrial Stationary Energy consumption accounts for 42% of Stationary Energy emissions (14,252 tCO_2e) and 1% of total gross emissions. Industrial Stationary Energy is energy used within all industrial settings (including agriculture, forestry and fishing, mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities).
- Residential Stationary Energy consumption accounts for 22% of Stationary Energy emissions (7,292 tCO_2e) and 0.6% 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 15% of Stationary Energy emissions (5,035 tCO_2e) and 0.4% 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).
- The remaining 21% of Stationary Energy emissions (7,136 tCO_2e, 0.5% 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 stationary generators and motors and for heating.

3.4 Waste

Waste originating in Central Hawke's Bay (solid waste and wastewater) produced 19,606 tCO_2e in 2020/21, which comprises 1% of Central Hawke's Bay's total gross emissions. Table 6 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 6 Waste emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Waste in open landfill sites	12,858	1.0%	65.6%
Wastewater treatment plants	2,723	0.2%	13.9%
Waste in closed landfill sites	1,707	0.1%	8.7%
Individual septic tanks	1,364	0.1%	7.0%
Composting	954	0.1%	4.9%
Total:	**19,606**	**1%**	**100%**

Solid waste produced the bulk of waste emissions (14,565 tCO_2e in 2020/21), making up 74% of total Waste emissions. Solid waste emissions include emissions from open landfills and closed landfills. Open landfill sites contributed 12,858 tCO_2e and emissions from closed landfill sites produced 1,707 tCO_2e in 2020/21. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill. However, annual emissions from closed landfill sites will decrease over time as no new waste enters these sites.

Wastewater treatment (treatment plants and individual septic tanks) produced 4,087 tCO_2e making up 21% of total Waste emissions. More than half of households in Central Hawke's Bay are connected to wastewater treatments plants, which produced total emissions of 2,723 tCO_2e. Households connected to individual septic tanks produced 1,364 tCO_2e in wastewater emissions. Due to the production of methane, septic tanks have a higher emissions intensity compared to the wastewater treatments plants in Central Hawke's Bay.

Wastewater treatment tends to be a 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.

Composting accounts for 5% of total Waste emissions (954 tCO_2e in 2020/21). Waste diverted from landfill for composting in the Hawke's Bay Region includes horticultural, animal waste products, green waste, bark and sawdust.

3.5 Industrial Processes and Product Use (IPPU)

IPPU in Central Hawke's Bay produced 4,280 tCO_2e in 2020/21, contributing 0.3% to Central Hawke's Bay's total gross emissions. 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. IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g. coal, electricity and/or petrol and diesel). These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to particular geographic locations. Addressing IPPU emissions is typically a national policy issue.

There are no known industrial processes (as defined in the GPC requirements) present in Central Hawke's Bay (e.g. aluminium manufacture).

Table 7 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source. The most significant contributor to IPPU emissions is the use of refrigerants which produced 93% of IPPU emissions (3,979 tCO_2e).

Table 7 Industrial processes and product use emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Refrigerants and air conditioning	3,979	0.3%	93.0%
Aerosols	223	<0.1%	5.2%
SF6 - Electrical Equipment	44	<0.1%	1.0%
Foam Blowing	19	<0.1%	0.4%
SF6 - Other	9	<0.1%	0.2%
Fire extinguishers	7	<0.1%	0.2%
Total	**4,280**	**0.3%**	**100.0%**

3.6 Forestry

Planting of native forest (e.g. mānuka and kānuka) and exotic forest (e.g. pine), sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. Harvesting of forest emits emissions via the release of carbon from organic matters and soils following harvesting. When sequestration by forests exceeds emissions from harvesting in a particular year, the extra quantity of carbon sequestered by forest reduces total gross emissions for that year. Conversely when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then total gross emissions will increase.

Sequestration in 2020/21 was 713,503 tCO_2e (which was mostly from exotic forestry) while harvesting emissions were 621,617 tCO_2e (based on the assumption that all trees of harvestable-age in this year were harvested). This meant that Forestry in Central Hawke's Bay was a net negative source of emissions in 2020/21 (rather than a positive source of emissions, where harvesting exceeds sequestration). Total Forestry emissions in 2020/21 were -91,886 tCO_2e. It is noted that harvesting of exotic forest can be cyclical in nature where some years will have higher sequestration and some years will have higher harvesting emissions determined by age of forests, commercial operators, and the global market.

Table 8 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO_2e
Total harvest emissions	621,617
Native forest sequestration	-78,989
Exotic forest sequestration	-634,514
Total	**-91,886**

3.7 Total Gross Emissions by Greenhouse Gas

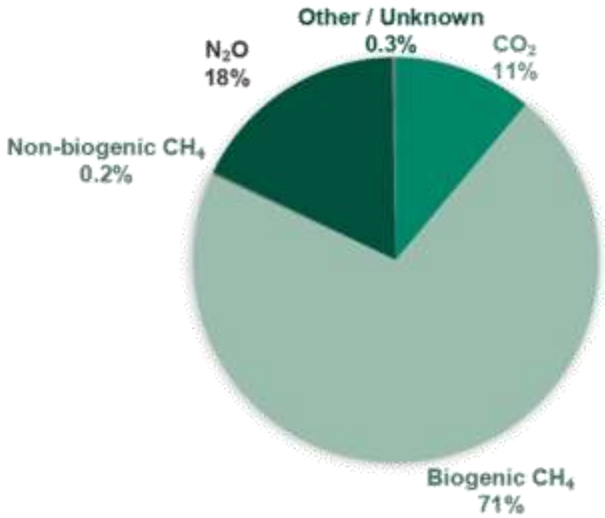
Each greenhouse gas has a different level of impact on climate change, this is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e).

Table 9: Central Hawke's Bay total gross emissions, by greenhouse gas

Greenhouse Gas	Tonnes	Tonnes of CO_2e
Carbon Dioxide (CO_2)	145,205	145,205
Biogenic Methane (CH_4)	27,305	928,371
Non-biogenic Methane (CH_4)	69	2,337
Nitrous Oxide (N_2O)	770	229,594
Other / Unknown Gas (in CO_2e)	3,841	3,841
Total	**177,190**	**1,309,347**

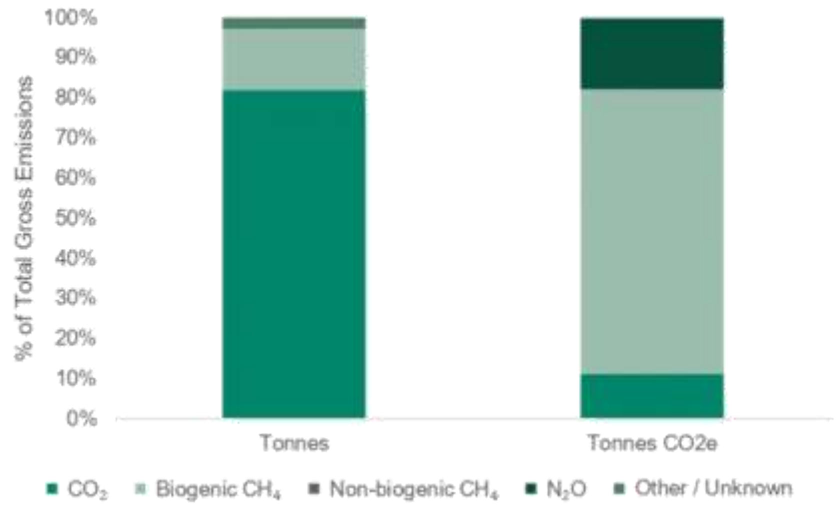
Figure 4 illustrates Central Hawke's Bay's total gross emissions by greenhouse gas in units of carbon dioxide equivalents (CO_2e).

Figure 4: Central Hawke's Bay District's total gross emissions, by greenhouse gas (in tCO_2e)



By far the largest source of emissions in tonnes is carbon dioxide (CO_2) at 145,205 tonnes. Due to the greater global warming impact of methane, methane represents 15% of the total tonnage of GHG emissions from Central Hawke's Bay but represents 71% of CO_2e. Nitrous oxide represents 0.4% of the total tonnage of GHG emissions from Central Hawke's Bay but represents 18% of CO_2e. This effect can be seen in Figure 5.

Figure 5: Central Hawke's Bay District's total gross emissions, by greenhouse gas in tonnes and in tonnes of CO_2e



3.8 Biogenic emissions

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

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

Table 10: Biogenic CO_2 in Central Hawke's Bay (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO_2) (Excluded from gross emissions)		
Biofuel	15,286	t CO_2
Total Biogenic CO_2	**15,286**	**t CO_2**

Biogenic CH_4 emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large impact on global warming relative to biogenic CO_2. Biogenic methane represents 15% of the gross total tonnage of GHG emissions in Central Hawke's Bay but represents 71% of total gross GHG emissions when expressed in CO_2e. This is caused by the higher global warming impact of methane per tonne, compared to carbon dioxide. The total tonnage of each GHG and the contribution of each GHG to total gross emissions when expressed in CO_2e is shown in Table 9.

The importance of biogenic CH_4 is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes specific targets to reduce biogenic CH_4 by between 24% and 47% below 2017 levels by 2050, and by 10% below 2017 levels by 2030. More information on the Act is available here: https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act.

Table 11: Biogenic Methane in Central Hawke's Bay (Included in gross emissions)

Biogenic Methane (CH_4) (Included in gross emissions)		
Enteric Fermentation	26,080	t CH4
Manure Management	657	t CH4
Landfill Gas	428	t CH4
Wastewater Treatment	111	t CH4
Composting	16	t CH4
Biofuel	12	t CH4
Total Biogenic CH_4	**27,305**	**t CH4**

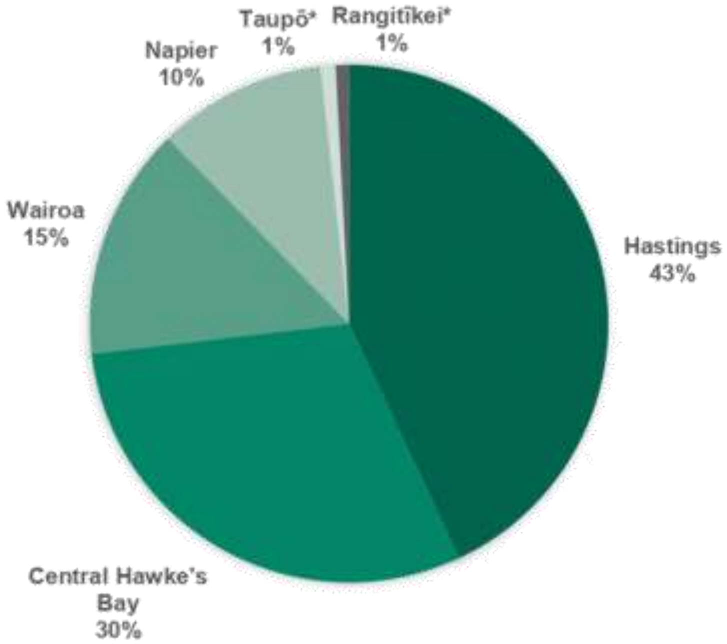
3.9 Territorial Authorities in the Hawke's Bay Region

The Hawke's Bay regional area contains several territorial authorities. Hastings District, Napier City, Central Hawkes Bay District, and Wairoa District are all exclusively within the boundaries of the Hawke's Bay region. Additionally, areas of Taupō District and Rangitīkei District are also part of the Hawke's Bay region. We estimate that 0.1% of Taupō's population and 12% of Taupō's area, and 0.3% of Rangitīkei's population and 14% of Rangitīkei's area are within the Hawke's Bay region.

Figure 6 shows the Hawke's Bay's total gross emissions divided by territorial authority. Figure 7 shows total gross emissions for the territorial authorities in the Hawke's Bay Region, split by sector. Both figures only include the emissions produced within the Hawke's Bay region for Taupō and Rangitīkei.

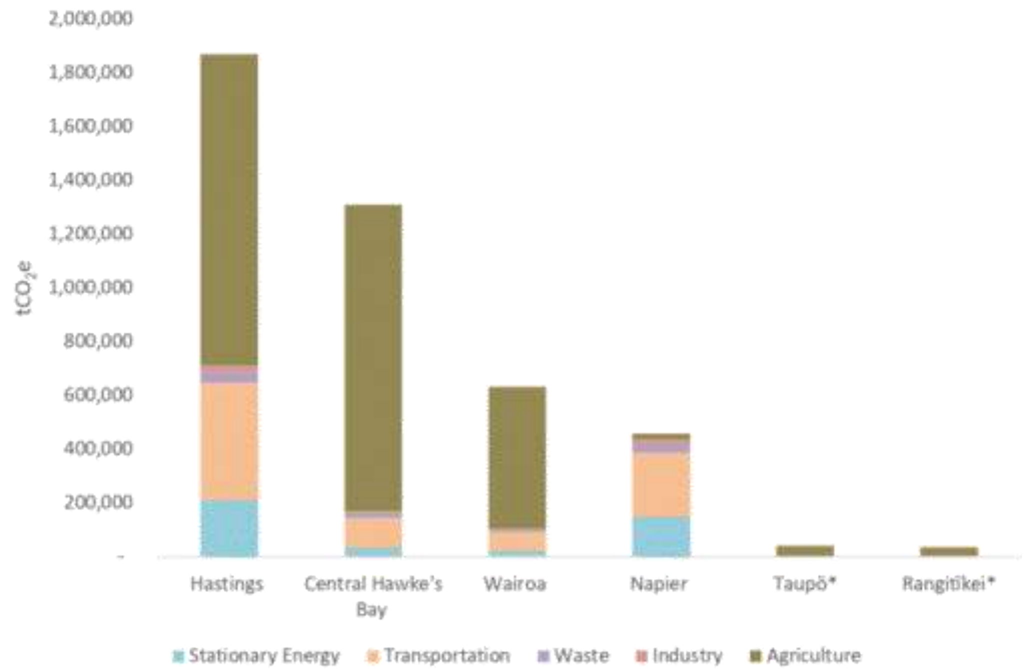
Hastings is the highest emitting territorial authority in the region, representing 43% of the Hawke's Bay's total gross emissions. Hastings' emissions inventory is predominantly agriculture-related emissions with the next largest emitting territorial authorities; Central Hawke's Bay and Wairoa, also containing significant agricultural emissions. Of the four territorial authorities entirely within the Hawke's Bay region, Napier has the lowest total gross emissions, with emissions mostly from Transport and Stationary Energy. The areas of Taupō and Rangitīkei contribute to 2% of the Hawke's Bay region's total gross emissions, almost entirely from Agriculture.

Figure 6 Hawke's Bay's total gross emissions divided by territorial authority (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.



https://aecom.sharepoint.com/sites/HBRCCCFFY19-FY21/Shared Documents/General/4. Deliverables/221129 Final V3 Reports/HBRC_CommunityCarbonFootprint_2022_CentralHawkesBay_221129_FinalV3.docx
Revision 3 – 13-Oct-2022
Prepared for – Hawke's Bay Regional Council – Co No.: N/A

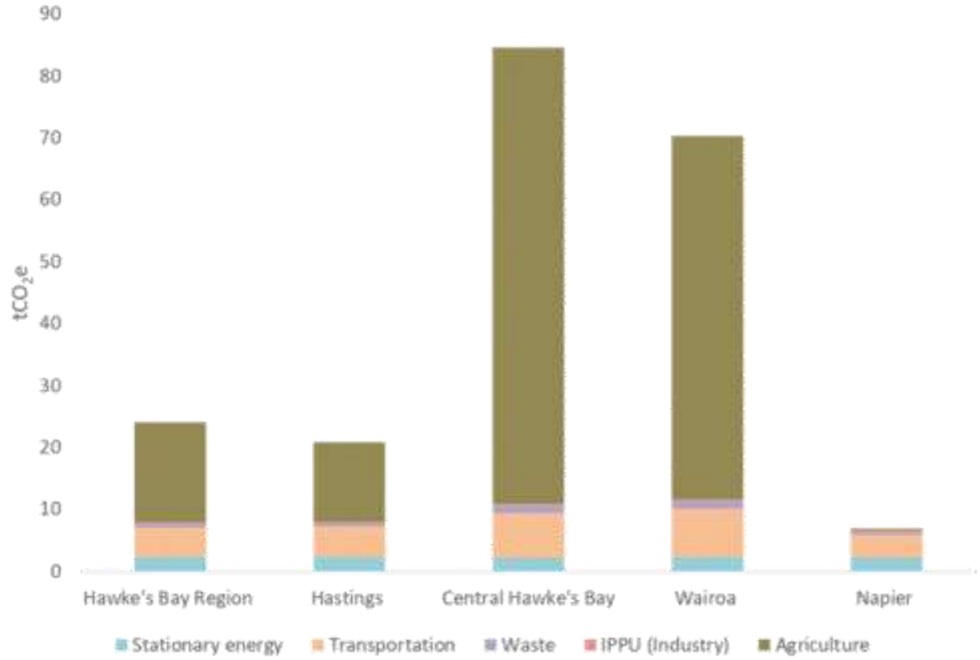
Figure 7 Total gross emissions by territorial authority in the Hawke's Bay region (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.



When comparing emissions inventories from different areas, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. Figure 8 shows emissions per capita for the region and territorial authorities within the region. Taupō and Rangitīkei are excluded from this figure due to the tiny population and large agriculture within the small area in the Hawke's Bay creating very large per capita emissions (this is not the case for the entire Taupō or Rangitīkei district).

The Hawke's Bay region has a 24.1 tCO_2e/per capita figure for total gross emissions which is higher than the national value of 15.7 tCO_2e/per capita. Napier has the lowest per capita total emissions at 6.9 tCO_2e/per capita. Central Hawke's Bay and Wairoa have the largest per capita total gross emissions at 84.6 tCO_2e/per capita and 70.3 tCO_2e/per capita respectively, both due to high Agriculture emissions in the district. Hastings has the third highest per capita emissions at 20.9 tCO_2e/per capita, similar to that of the region. Notably, Central Hawke's Bay and Wairoa have very high per capita Agriculture emissions and the highest per capita Transport emissions of the four districts entirely within the Hawke's Bay region.

Figure 8 Total gross emissions per capita for the region and territorial authorities within the region (tCO_2e). *Taupō and Rangitīkei areas not included



4.0 Emissions change from 2018/19 to 2020/21

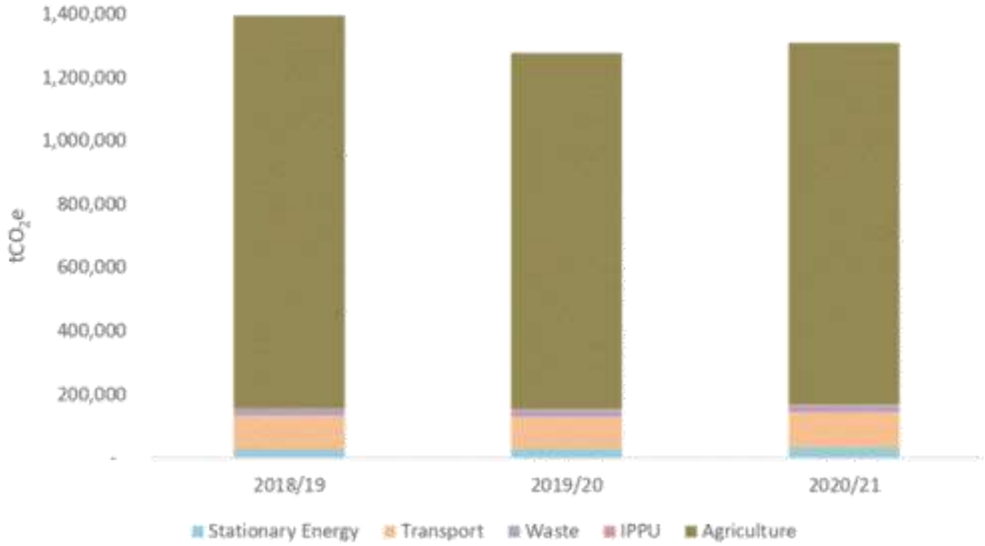
Alongside calculating Central Hawke's Bay's emissions footprint for 2020/21, we have calculated Central Hawke's Bay emissions footprint for 2018/19 and 2019/20. This section displays the results of the 2018/19, 2019/20, and 2020/21 emissions footprints with a focus on gross emissions and documents the change in emissions from 2018/19 to 2020/21.

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

Table 12 Change in Central Hawke's Bay total gross and net emissions from 2018/19 to 2020/21

	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total Net Emissions (including forestry)	1,331,087	1,213,600	1,217,462	-9%
Total Gross Emissions (excluding forestry)	1,395,790	1,277,622	1,309,347	-6%

Figure 9 Change in Central Hawke's Bay total gross emissions from 2018/19 to 2020/21



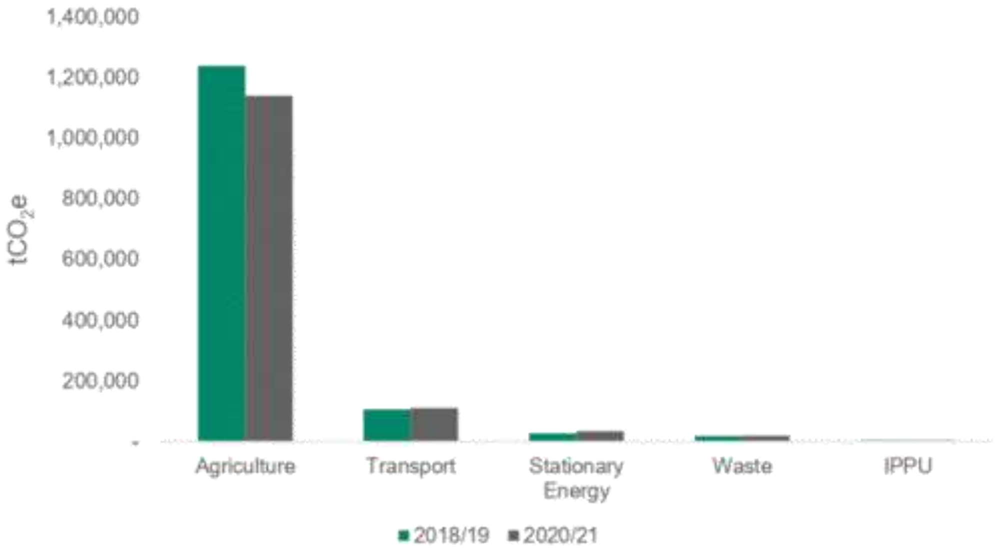
Annual total gross emissions decreased by 6% from 1,395,790 tCO_2e in 2018/19 to 1,309,347 tCO_2e in 2020/21. This was driven by a decrease in Agriculture (number of sheep and non-dairy cattle) and an increase in Stationary Energy (primarily related to the increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).

Total net emissions in Central Hawke's Bay decreased by 9% from 1,331,087 in 2018/19 to 1,217,462 tCO_2e. This decrease was predominantly due to a decrease in annual forest harvesting emissions. This is discussed further below under the 'Forestry' heading.

Whilst total gross emissions decreased by 6%, the population of Central Hawke's Bay grew by 5% during this time. This resulted in a 10% decrease in per capita gross emissions between 2018/19 and 2020/21, from 94.5 to 84.6 tCO_2e per person per year. A discussion of the decoupling of gross emissions from population growth and GDP is found in Section 5.0.

The sections below outline the change in emissions between 2018/19 and 2020/21 for each sector and emissions source, highlighting the changes that have had the largest impact on total gross emissions.

Figure 10 Emissions for each sector of Central Hawke's Bay gross emissions footprint for 2018/19 and 2020/21



4.1 Agriculture

Table 13 Change in Central Hawke's Bay Agriculture emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Enteric Fermentation	958,508	869,607	886,721	-7%
Manure from Grazing Animals	140,596	127,085	129,666	-8%
Other Agriculture Emissions	60,896	54,563	54,054	-11%
Atmospheric Deposition	40,432	36,486	36,933	-9%
Manure Management	24,192	22,565	22,332	-8%
Agricultural Soils	14,873	12,901	11,351	-24%
Total	**1,239,497**	**1,123,206**	**1,141,058**	**-8%**

Agriculture is the most significant contributor to Central Hawke's Bay community carbon footprint. The sector's emissions decreased by 8% between 2018/19 and 2020/21 (98,440 tCO_2e). This decrease is driven by a reduction in total livestock numbers, especially of sheep and non-dairy cattle (see Emissions related to sheep decreased by 58,001 tCO2e due to a reduction in the number of sheep (105,816 sheep). Emissions related to non-dairy cattle decreased by 20,317 tCO2e due to a reduction in the number of non-dairy cattle (10,281 cattle). The number of dairy cattle also reduced, reducing dairy cattle emissions by 12,004 tCO2e.

Table 14).

Emissions related to sheep decreased by 58,001 tCO_2e due to a reduction in the number of sheep (105,816 sheep). Emissions related to non-dairy cattle decreased by 20,317 tCO_2e due to a reduction in the number of non-dairy cattle (10,281 cattle). The number of dairy cattle also reduced, reducing dairy cattle emissions by 12,004 tCO_2e.

Table 14 Change in Hastings livestock numbers from 2018/19 to 2020/21

	Number of animals (2018/19)	Number of animals (2020/21)	Change in number of animals (2018/19 to 2020/21)
Sheep	1,118,349	1,012,533	-105,816
Non-dairy Cattle	151,316	141,035	-10,281
Other livestock	31,131	30,740	-391
Dairy Cattle	45,912	42,501	-3,410
Total livestock	**1,346,707**	**1,226,809**	**-119,898**

Table 15 Change in Central Hawke's Bay's livestock-associated Agriculture emissions from 2018/19 to 2020/21

	2018/19 emissions (tCO_2e)	2020/21 emissions (tCO_2e)	% Change in emissions (2018/19 to 2020/21)
Sheep	613,005	555,004	-9%
Non-dairy Cattle	382,040	361,723	-5%
Dairy Cattle	184,642	172,638	-7%
Other livestock	30,446	29,458	-3%
Total livestock	**1,210,133**	**1,118,123**	**-8%**

4.2 Transport

Table 16 Change in Central Hawke's Bay's Transport emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Diesel	58,849	57,640	64,491	10%
Petrol	39,038	36,533	39,003	-0.1%
Marine Freight	7,721	7,736	6,728	-13%
Jet Kerosene	325	281	226	-31%
LPG	124	126	133	7%
Rail	91	98	86	-5%
Aviation Gas	19	22	23	24%
Total:	**106,168**	**102,436**	**110,690**	**4%**

Transport emissions increased by 4% between 2018/19 and 2020/21 (4,522 tCO_2e). This was driven by a 5% increase in on-road fuel emissions (4,536 tCO_2e).

It is noted that the impact of the COVID-19 pandemic can be seen in Transport emissions where emissions decreased by 4% between 2018/19 and 2019/20 due to reductions in road, marine freight, air transport fuel use. Aviation emissions continued to reduce in the 2020/21 reporting year, reflective of ongoing COVID-19 impacts to the industry.

4.3 Stationary Energy

Table 17 Change in Central Hawke's Bay Stationary Energy emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Electricity Consumption	12,726	13,602	18,154	43%
Stationary Petrol & Diesel Use	6,537	6,390	7,136	9%
Natural Gas	4,397	4,928	4,578	4%
Electricity Transmission and Distribution Losses	1,111	1,192	1,668	50%
LPG	985	999	1,051	7%
Coal	495	543	290	-41%
Biofuel / Wood	461	463	467	1%
Natural Gas Transmission and Distribution Losses	356	399	370	4%
Total:	**27,067**	**28,516**	**33,714**	**25%**

Emissions from Stationary Energy increased by 25% between 2018/19 and 2020/21 (6,647 tCO_2e). This was driven by a 43% increase in electricity consumption emissions (5,428 tCO_2e). This increase in electricity consumption emissions was due to a 1% increase in energy consumption (kWh) and a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh). The emissions intensity of the national grid has increased in recent years due to the increased use of fossil fuels during years with low hydro electricity generation. Emissions from industrial energy use is the largest driver in the increase in Stationary Energy Emissions (2,555 tCO_2e).

4.4 Waste

Table 18 Change in Central Hawke's Bay Waste emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Open Landfill	12,072	12,483	12,858	7%
Wastewater treatment plants	2,593	2,632	2,723	5%
Closed Landfill	1,910	1,805	1,707	-11%
Individual septic tanks	1,292	1,339	1,364	6%
Composting	954	954	954	-
Total	**18,821**	**19,213**	**19,606**	**4%**

Waste emissions increased between 2018/19 and 2020/21, by 4% (785 tCO_2e). This change is in line with the growth in the district's population

Emissions from waste in open landfills increased as the volume of waste entering the landfill, and waste recently deposited in landfill reaches peak emissions per year (this is after approximately two years in landfill). Emissions from closed landfills decreased due to no extra waste being added, the existing waste in landfill releases fewer emissions over time. Due to data only being available for one singular year, no change in composting emissions is recorded.

Total wastewater emissions increased by 5% in line with population growth in Central Hawke's Bay. Better data on the number of households connected to centralized wastewater treatment would improve the accuracy of the emissions calculations. Due to the production of methane, septic tanks have a higher emissions intensity compared to a wastewater treatment plant.

4.5 Industrial Processes and Product Use (IPPU)

Table 19 Change in Central Hawke's Bay IPPU emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Refrigerants and air conditioning	3,919	3,945	3,979	2%
Aerosols	247	231	223	-10%
SF6 - Electrical Equipment	39	42	44	12%
Foam Blowing	17	19	19	9%
SF6 - Other	8	8	9	1%
Fire extinguishers	7	7	7	0.4%
Total	**4,237**	**4,251**	**4,280**	**1%**

IPPU emissions increased between 2018/19 and 2020/21, by 1% (43 tCO_2e). The increase in IPPU emissions is mainly caused by an increase in refrigerants and air conditioning. Note that national level data is used for this sector and is portioned out using a population approach; exact emissions for the district are unknown.

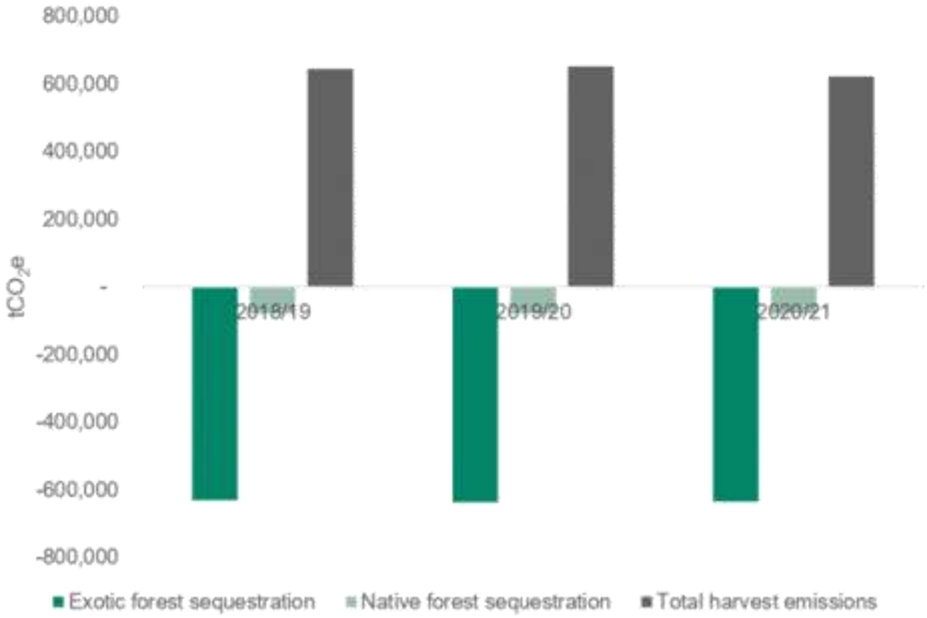
4.6 Forestry

Table 20 Change in Central Hawke's Bay Forestry emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total harvest emissions	644,191	651,458	621,617	-4%
Native forest sequestration	-78,989	-78,989	-78,989	0%
Exotic forest sequestration	-629,905	-636,492	-634,514	1%
Total	**-64,703**	**-64,022**	**-91,886**	**42%**

Forestry emissions decreased by 27,182 tCO_2e (42%) between 2018/19 and 2020/21. This decrease was driven by a decrease in total harvest emissions (22,573 tCO_2e) as less exotic forest is harvested. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes where some years will have higher sequestration and some years will have higher harvesting emissions. This is dependent on age of forests and the demand for lumber and timber. This decrease in Central Hawke's Bay harvesting emissions during this period is reflective a decrease in forestry harvesting across the region. Improved and updated data sources may impact the estimation of emissions from this source in the future. Sequestration by native and exotic forest remained relatively stable during this time.

Figure 11 Forestry sequestration and harvesting emissions from 2018/19 to 2020/21



5.0 Decoupling of GHG emissions from population growth and GDP

Figure 12 shows the changes in gross emissions when compared to changes in other metrics of interest between 2018/19 and 2020/21. For example, total gross emissions have decreased by 6%, whilst population in Central Hawke's Bay has increased by 5%, resulting in a 10% reduction in total gross emissions per capita. Similarly, Gross Domestic Product (GDP) in Central Hawke's Bay has increased by 2%, resulting in a 8% decrease in the GHG emissions ratio to GDP.

When emissions grow less rapidly than GDP (a measure of income) this process is known as decoupling. The term decoupling is an expression of the desire to mitigate emissions without harming economic wellbeing. A full discussion of decoupling of emissions is beyond the scope of this project. However, the changes in emissions and GDP illustrated in Figure 12 and discussed above, suggest at a high-level decoupling has occurred between 2018/19 and 2020/21.

The exact drivers for the decoupling of emissions from GDP are difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transportation and housing will all contribute. In this case, both direct local actions (e.g. landfill gas reductions) and indirect national trends (e.g. changes to emissions from electricity generation) will have contributed to trends noted.

Figure 12 Change in total gross emissions compared to other metrics of interest

6.0 Impact of the COVID-19 pandemic on GHG Emissions

COVID-19 impacted New Zealand and the entire world during 2020 and 2021; causing widespread government-imposed restrictions on businesses and individuals and huge shifts in behaviors and economic markets. Restrictions in New Zealand relating to COVID-19 began in mid-March 2020 with many personal and business restrictions continuing past the end of 2019/20 and throughout 2020/21.[3]

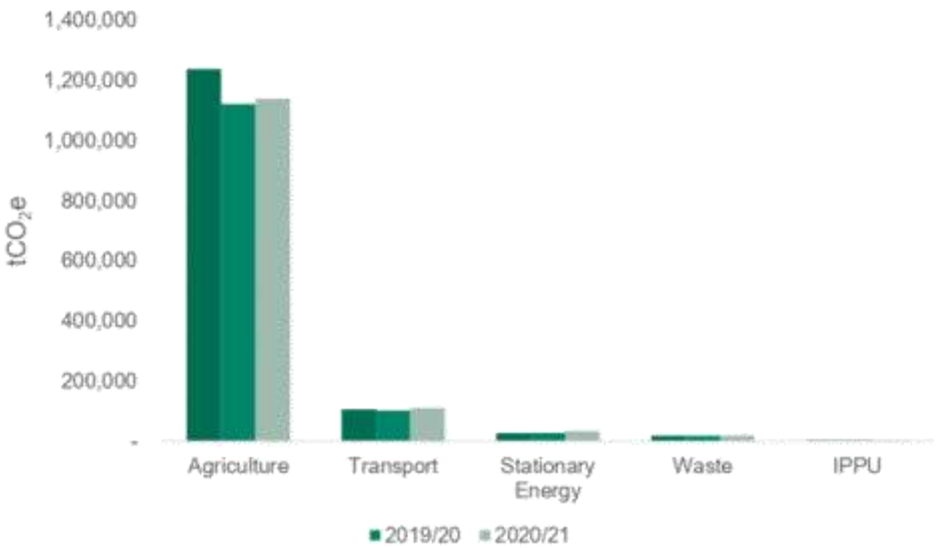
Globally, carbon dioxide emissions from fossil fuels (the largest contributor to greenhouse gas emissions) in 2020 decreased by 7% compared to 2019[4]. Emissions from the transportation sector account for the largest share of this decrease. Surface transport, e.g. car journeys, fell by approximately half at the peak of COVID-19 restrictions in April 2020 (when restrictions were at their maximum, particularly across Europe and the U.S. Globally, emissions recovered to near 2019 levels and are expected to continue to increase.

In New Zealand, national daily carbon dioxide emissions are estimated to have fallen by up to 41% during the level 4 lockdown in April 2020[5]. National gross emissions decreased by 3% from 2018/19 to 2019/20, which was largely driven by a decrease in fuel use in road transport due to COVID-19 pandemic restrictions, a decrease in fuel use in manufacturing industries and construction due to COVID-19 restrictions, and a decrease in fuel use from domestic aviation also due to COVID-19 restrictions.

Total gross emissions in Central Hawke's Bay decreased by 118,168 tCO_2e (8%) between 2018/19 and 2019/20. Total gross emissions then increased by 31,725 tCO_2e (2%) from 2019/20 to 2020/21.

The impact on emissions in different sectors varied. Notably, Transport emissions reduced by 4% between 2018/19 and 2019/20, driven by reduced road and air transport fuel use. Despite changes in Stationary Energy, Agriculture, Waste, and IPPU emissions, these sectors are not judged to have been significantly affected by the COVID-19.

Figure 13 Central Hawke's Bay emissions per sector for 2018/19, 2019/20, and 2020/21 (tCO_2e)



[3] https://covid19.govt.nz/alert-system/history-of-the-covid-19-alert-system/
[4] Pierre Friedlingstein et al. - Global Carbon Budget 2020 (2020)
[5] Corinne Le Quere et al. – Temporary Reduction in Daily Global CO_2 Emissions During the COVID-19 Forced Confinement

7.0 Closing Statement

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

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

Understanding of the extensive and long-lasting effects of climate change is improving all the time. It is recommended that this emissions footprint be updated regularly (every two or three years) to inform ongoing positive decision making to address climate change issues.

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

8.0 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 **June 2022 and September 2022** and is based on the information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time. This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice.

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Appendix A

Assumptions and Data Sources

Sector / Category	Assumption and Data Sources
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied. The emissions footprint for the Hawke's Bay Region covers the entirety of the Hawke's Bay Region (this excludes some of the Rangitikei and Taupō territorial authorities). Emissions footprints for each territorial authority covers the entirety of the territorial authority area.
Population	Population figures are provided by StatsNZ. Financial year populations have been used, these are based on the average population from the two calendar years (e.g. the average of 2018 and 2019 calendar year populations for FY19). The population of Taupo and Rangitikei Districts within the Hawke's Bay geographical boundary has been calculated.
Transport Emissions	
Petrol and Diesel:	Petrol and diesel sales data provided by Napier City Council for Napier, Central Hawkes Bay and Hastings. Combined sales data for Gisborne and Wairoa provided by Gisborne District Council and allocated to a region based on Waka Kotahi emissions data. Sales have been divided between territorial authorities based on the number of kilometres travelled by vehicles on roads (VKT) in each territorial authority. VKT data provided by Waka Kotahi. The division into transport and stationary energy end use (and within transport into on-road and off-road) has been calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) from the 2019 database. Biofuel sales information provided directly by the supplier.
Rail Diesel	Emissions from fuel use have been calculated and provided by Kiwi Rail. The following assumptions were made: - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. 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 district, arrival district and any district the freight stopped at along the way. If the freight travelled through but did not stop within a district, no emissions were allocated. This data is subject to commercial confidentiality.
Jet Kerosene (Scheduled Flights) Aviation Gas (General Aviation)	Calculated from information provided by Hawke's Bay Airport. Aviation fuel and jet kerosene fuel volumes were provided and emissions have been calculated using these volumes. Emissions have been divided between territorial authorities based the relative population of each territorial authority.

Marine Freight	Shipping schedules have been provided by the Port of Napier. Emissions have been calculated based on ship weight and distance from the origin/destination to Napier. This figure does not include fishing vessels, or vessels with destination to be confirmed. Emissions from freight and international shipping are allocated equally between the origin and destination area emissions footprints. It is expected that imports and exports travelling through the Port of Napier service the entire Hawke's Bay Region. Emissions relating to freight and international shipping emissions have been divided between all Hawke's Bay territorial authorities based on population size.
Marine Fuel (Local)	Non-freight marine fuel use has not been included in this study. Fuel use by Port of Napier-controlled vessels has not been included due to a lack of available information. Most private marine vessels use fuel purchased at vehicle fuel stations. Petrol and diesel used in private marine vessels is included in off-road transportation.
LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. Sales have been divided between territorial authorities on a per capita basis.
Stationary Energy Emissions	
Electricity Demand	Electricity demand has been calculated using grid exit point (GXP) data from the EMI website (www.emi.ea.govt.nz). Reconciled demand has been used as per EMI's confirmation. The territorial authorities serviced by each GXP have been confirmed by the respective electricity suppliers. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per Ministry for the Environment (MfE) data.
Electricity Generation	Electricity generation has been calculated using data from the EMI website (www.emi.ea.govt.nz). Small electricity generation has not been included in this data (e.g. domestic solar generation). This figure only includes electricity that is connected to the national electricity grid, direct users of electricity are not included.
Coal Consumption	National coal consumption data has been provided by MBIE. Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis. Regional industrial coal consumption has been divided between territorial authorities on a per capita basis.
Coal Production and Fugitive Emissions	Not Calculated: There are no active coal mines within the region.
Biofuel Consumption	National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE). Biofuel consumption has been divided between territorial authorities on a per capita basis. Biofuel emissions are broken down into Biogenic emissions (CO_2) and Non-Biogenic emissions (CH_4 and N_2O)

LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG. Sales have been divided between territorial authorities on a per capita basis. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.
Natural Gas Consumption	Natural gas consumption data has been provided by FirstGas. Territorial Authorities supplied by gas from each Point of Connection (POC) have been confirmed by FirstGas. Natural gas consumption has been split into residential, commercial, and industrial consumption based on information provided by PowerCo and national statistics from MBIE. Some POCs supply gas to particular industrial users exclusively, these have been taken into account.
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
Agricultural Emissions	
General	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ). The last territorial authority census was in 2017. Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use since 2017. Territorial authority land-use data provided by HBRC covering horticulture land-use.
Solid Waste Emissions	
Waste in Landfill	Landfill waste volume and end location information has been provided by the respective council departments. Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis. Emissions are allocated to territorial authorities based on where the waste was produced, even if the waste is disposed in landfill outside the territorial authority.
Wastewater Emissions	
Wastewater Volume and Treatment Systems	Information on treated wastewater, and treatment plants has been provided by the respective council departments. Where information is not available, reasonable assumptions have been made and the WaterNZ database has been consulted. The population connected to septic tank systems have been estimated by the respective council departments. Where the population covered by Wastewater treatment plants and septic tanks does not account for the entire population, the remaining population is assigned to septic tanks. Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority.
Industrial Emissions	
Industrial processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the Region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g. fire extinguishers, refrigerants) has been provided by the MfE. Emissions have been allocated to territorial authorities on a per capita basis.

Forestry Emissions	
Exotic Forestry Harvested	Harvested forestry, and forest cover information for each territorial authority has been derived from Landcare Research data. 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.
Exotic Forest	Exotic forest land area for each territorial authority has been provided by Landcare Research.
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 EFs have been applied. AR5 Global Warming Potential (GWP) figures for greenhouse gases have been used accounting for climate change feedbacks.

Prepared for
Hawke's Bay Regional Council
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AECOM

Hastings Community Carbon Footprint

29-Nov-2022

aecom.com

Delivering a better world

Hastings Community Carbon Footprint

Client: Hawke's Bay Regional Council

Co No.: N/A

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1	27-Sept-2022	Final	Anthony Hume Team Leader - Sustainability	[signature]
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3	29-Nov-2022	Final - includes updated infographic (Figure 1)	Anthony Hume Team Leader - Sustainability	[signature]

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Executive Summary

Greenhouse Gas (GHG) emissions for the Hastings District Territorial Area (that is covered by the Hastings District Council) have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture and Forestry sectors. This document reports greenhouse gas emissions produced in or resulting from activity or consumption within the geographic boundaries of the Hastings District Territorial Area for the 2020/21 financial reporting year and examines greenhouse gas emissions produced from 2018/19 to 2020/21.

The Hastings District Territorial Area is referred to hereafter as Hastings for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

Major findings of the project include:

2020/21 Emissions Footprint

- In the 2020/21 reporting year (1st July 2020 to 30th June 2021), **total gross emissions** in Hastings were 1,869,526 tCO_2e.
- **Agriculture** (e.g. emissions from livestock and crops) is the largest source of emissions, accounting for 62% of Hastings's total gross emissions, with enteric fermentation from livestock accounting for 48% of gross emissions.
- **Transport** (e.g. emissions from road and air travel) is the second largest emitting sector in Hastings, representing 23% of total gross emissions, with petrol and diesel consumption accounting for 21% of gross emissions.
- **Stationary Energy** (e.g. consumption of electricity and natural gas) is the third highest emitting sector in the region, producing 11% of total gross emissions.
- Net Forestry emissions were -1,316,577 in 2020/21 as carbon sequestration (carbon captured and stored in plants or soil by forests) was higher than emissions from forest harvesting (e.g., the release of carbon from roots and organic matter following harvesting). Net **Forestry** emissions are not included in total gross emissions.
- The **total net emissions** in Hastings were 552,948 tCO_2e. The total net emissions include emissions from Forestry.

Changes in Emissions, 2018/19 to 2020/21

- Between 2018/19 and 2020/21, **total gross emissions** in Hastings decreased from 1,911,938 tCO_2e to 1,869,526 tCO_2e, a decrease of 2% (42,412 tCO_2e).
- Over this time the population of the district increased by 5%, resulting in **per capita gross emissions** in Hastings decreasing by 7% between 2018/19 and 2020/21, from 22.4 to 20.9 tCO_2e per person per year.
- Emissions from **Agriculture** decreased by 8%, between 2018/19 and 2020/21 (95,257 tCO_2e), due to a reduction in livestock numbers, particularly of sheep and non-dairy cattle.
- Emissions from **Stationary Energy** increased by 21% between 2018/19 and 2020/21 (36,479 tCO_2e), driven by a 47% increase in electricity consumption emissions (28,495 tCO_2e). This increase in electricity consumption emissions was due to a 4% increase in energy consumption (kWh) and a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).
- **Transport** emissions increased by 3% between 2018/19 and 2020/21 (14,639 tCO_2e), driven by a 5% increase in on-road fuel emissions (16,826 tCO_2e). Marine freight and air travel emissions reduced during this period, likely due to the impact of the COVID-19 pandemic.
- Emissions from **Waste** increased by 4% between 2018/19 and 2020/21 (1,425 tCO_2e).

- **Forestry** was a net-negative source of emissions this period. Emissions from harvesting decreased by 25% (-474,120 tCO_2e) resulting in the net impact of Forestry changing from -798,819 tCO_2e (2018/19) to -1,316,577 tCO_2e (2020/21).

Figure 1: Hastings 2020/21 Emissions Footprint

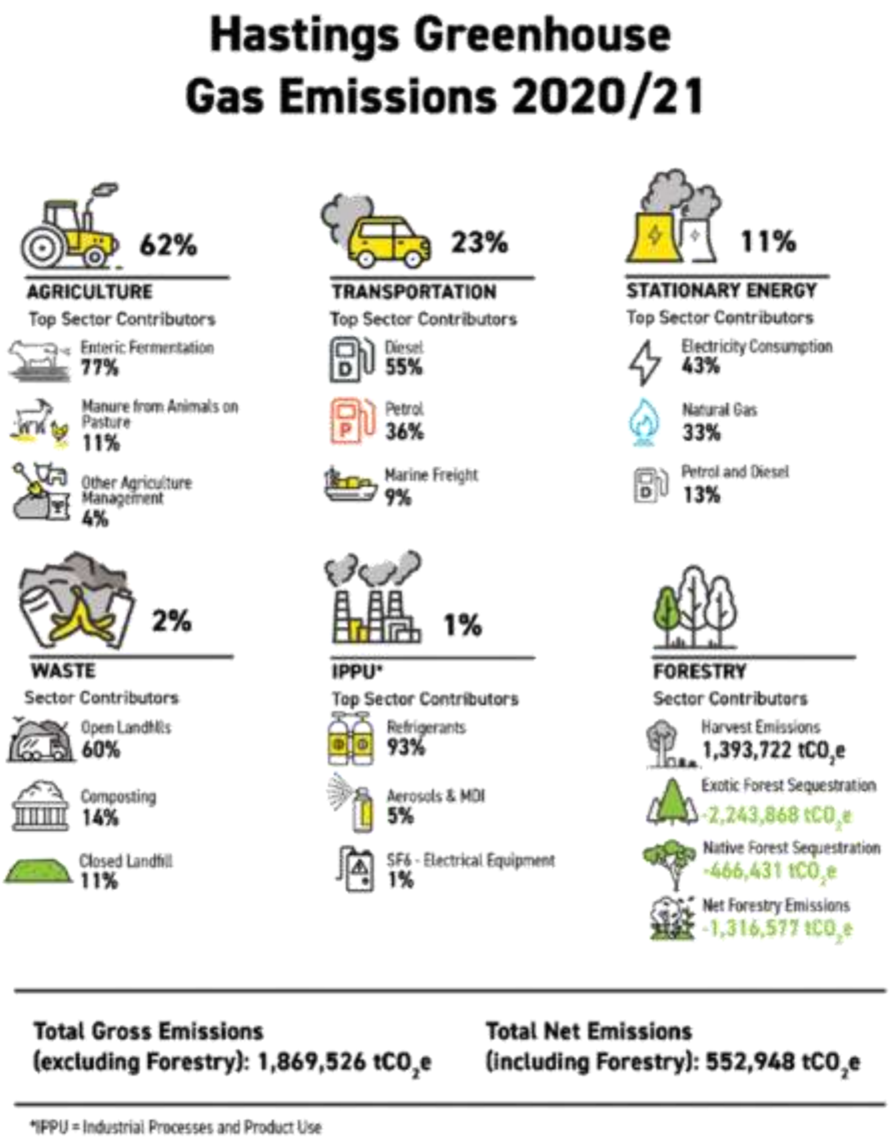
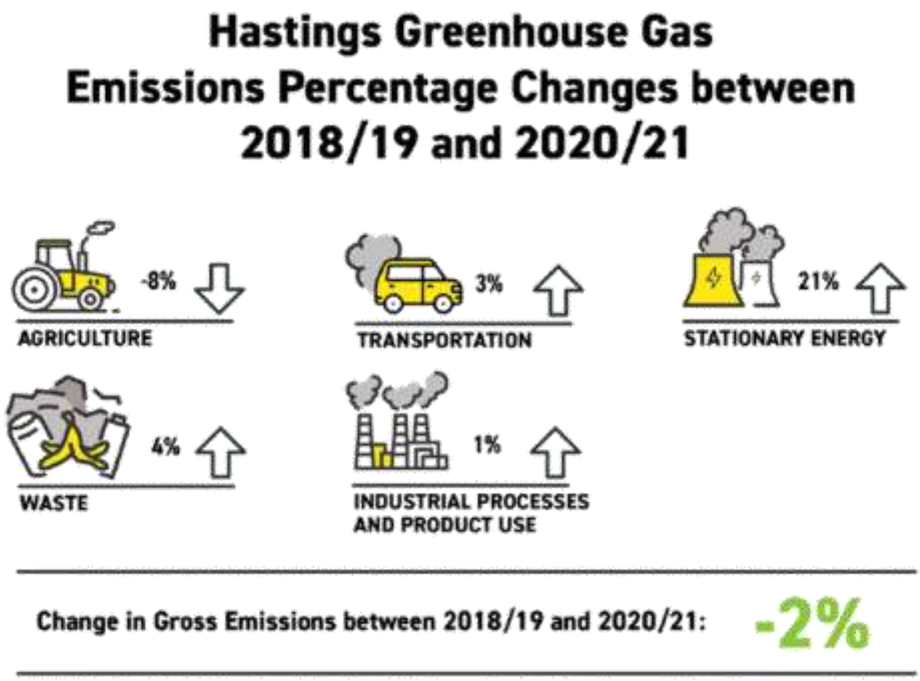


Figure 2: Change in Hastings Emissions Footprint between 2018/19 and 2020/21



1.0 Introduction

AECOM New Zealand Limited (AECOM) was commissioned by the Hawke's Bay Regional Council to assist in the development of community-scale greenhouse gas (GHG) footprints for the Hastings District Territorial Area for the 2018/19, 2019/20, and 2020/21 financial years. This is part of a wider study to develop community carbon footprints for each district within the Hawke's Bay region. Emissions are reported for the period from 1 July to 30 June for the respective years. The study boundary reported in the following pages incorporates the jurisdiction of the Hastings District Council.

The Hastings District Territorial Area is referred to hereafter as Hastings for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

2.0 Approach and Limitations

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

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

This emissions footprint assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the 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. flights) and energy transportation and distribution losses fit into Scope 3.

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

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[2]. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs.
- GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption. Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g. embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.).
- Total emissions are reported as both gross emissions (excluding Forestry) and net emissions (including Forestry).

[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 greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
- Where location specific data were not accessible, information was calculated based on national or regional level data.
- Transport emissions:
  - Transport emissions associated with air travel, rail, and marine fuel were calculated by working out the emissions relating to each journey arriving or departing the area based on data provided by the relevant operators. Emissions for these sources are then split equally between the destination and origin. Emissions relating to a particular point source (e.g. an airport or port) are allocated to the expected users of that source, not just the area that it is located in. For example, in the Hawke's Bay Region, it is expected that all territorial authorities will use the Port of Napier for imported and exported goods, emissions from this source have been allocated to all territorial authorities in the region based on population. It is understood that freight imports moving through the Port of Napier do not exclusively serve the Hawke's Bay Region, and freight exports do not exclusively originate from the Hawke's Bay Region, this should be considered when examining these emissions.
  - All other transport emissions are calculated using the fuel sold in the area (e.g. petrol, diesel, LPG).
- Solid waste emissions:
  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day.
  - Emissions are calculated for waste produced within the geographic boundary, even if they are transported outside the boundary to be entered into landfill. Landfill waste for Hastings is disposed at Omarunui Landfill, jointly owned by the Hastings District Council and Napier City Council. This landfill is located within the Hastings geographic boundary.
- Wastewater emissions:
  - Emissions have been calculated based on the local data provided, following IPCC 2019 guidelines. Where data is missing, IPCC and Ministry for the Environment (MfE) figures have been used. Wastewater emissions from both wastewater treatment plants and 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 Processes and Product Use (IPPU) emissions:
  - IPPU emissions are estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2019 report (MfE 2021). Emissions are estimated on a per capita basis applying a national average per person.
- Forestry emissions:
  - This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e. it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
  - The emissions footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.

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

It is important to consider the level of uncertainty associated with the results, particularly given the different datasets used. Depending on data availability, national, regional, and local datasets are used across the different calculators. At the national level, New Zealand's Greenhouse Gas Inventory shows that for 2018 (the most recent national level inventory) an estimate of gross emissions uncertainty was +/- 9%, whereas a net emissions uncertainty estimate was +/- 12%. These levels of uncertainty should be considered when interpreting the results of this community carbon footprint (MfE, 2020).

StatsNZ Regional Footprint

Due to differences in emission factors and methodology used between the StatsNZ Regional Footprints and this community carbon footprint (based on the GPC requirements and available data), caution should be taken when making comparison of reported emissions. One example of this is where this footprint used updated emission factors for methane and nitrous oxide following guidance from the IPCC and in line with other district and regional level GHG inventories in New Zealand. This difference is especially relevant for the Agriculture sector.

3.0 Community Carbon Footprint for 2020/21

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

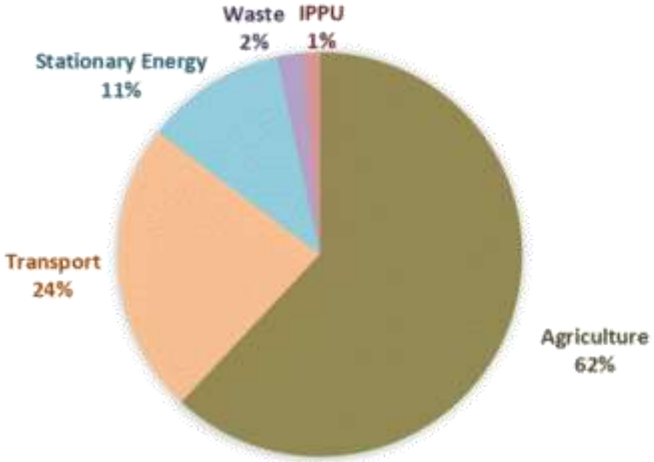
During the 2020/21 reporting period, Hastings emitted **gross** 1,869,526 tCO_2e. Note that gross emissions do not account for Forestry. Agriculture and Transport emissions are the largest contributors to total gross emissions for the district.

The population of Hastings in 2020/21 was approximately 89,600 people, resulting in per capita gross emissions of 20.9 tCO_2e/person. Discussion of per capita emissions is limited to when it is useful for comparing emission figures against other territorial authorities. A breakdown of net emissions (i.e. including results from Forestry resources) is reported separately.

Table 1 Total net and gross emissions

Total emissions	tCO_2e
Total Net Emissions (including forestry)	552,948
Total Gross emissions (excluding forestry)	1,869,526

Figure 3: Hastings District's total gross GHG emissions split by sector (tCO_2e).



During the 2020/21 reporting period, Hastings emitted **net** 552,948 tCO_2e.

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting emissions and sequestration) within an area. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes.

Carbon sequestered by forestry can be viewed as a liability/risk that needs careful consideration. For example, if plantations are not replanted or other land use change occurs to exotic forested areas, then net emissions may rise quickly. Equally, if native forest is not protected from removal, and removal does happen, then net emissions may rise.

The community carbon footprint comprises emissions from six different sectors, summarised below:

3.1 Agriculture

The highest emitting sector in Hastings, Agriculture, emitted 1,158,601 tCO_2e in 2020/21 (Table 2). Agricultural emissions are the result of both livestock and crop farming. Enteric fermentation from livestock produced 77% of Hastings agricultural emissions (893,298 tCO_2e). Enteric fermentation GHG emissions are produced by methane (CH_4) released from the digestive process of ruminant animals (e.g. cattle and sheep). The second highest source of agricultural emissions was produced from nitrous oxide (N_2O) released by unmanaged manure from grazing animals on pasture (130,582 tCO_2e or 11% of the agricultural sector's emissions).

Table 2 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Enteric Fermentation	893,298	47.8%	77.1%
Manure from Grazing Animals	130,582	7.0%	11.3%
Other Agriculture Emissions	50,642	2.7%	4.4%
Atmospheric Deposition	36,365	1.9%	3.1%
Fertiliser used in Horticulture	22,615	1.2%	2.0%
Manure Management	17,625	0.9%	1.5%
Agricultural Soils	7,474	0.4%	0.6%
Total	**1,158,601**	**62%**	**100%**

Livestock were responsible for the majority of the Agriculture sector's GHG emissions (60%, or 1,121,627 tCO_2e) (Table 3). Sheep account for 48% of agricultural emissions and 30% of gross emissions in Hastings. Non-dairy cattle account for 38% of agricultural emissions and 24% of gross emissions in Hastings.

Table 3 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Sheep	559,552	30.0%	48.3%
Non-dairy Cattle	443,183	23.7%	38.3%
Dairy Cattle	94,725	5.1%	8.2%
Other livestock	24,169	1.3%	2.1%
Fertiliser for Horticulture	22,615	1.2%	2.0%
Fertiliser (other)	14,357	0.8%	1.2%
Total	**1,158,601**	**62%**	**100%**

Fertilisers used for livestock and horticulture represent 3% of Agriculture emissions. An additional breakdown of emissions from fertiliser use in horticulture is included based on land-use information provided by HBRC. Fertiliser use in horticulture represented 2% of the sector emissions. The largest contributor to 'Fertiliser for Horticulture' emissions in Hastings was sweetcorn (12,394 tCO_2e, 1.1% of Agricultural emissions) (Table 4). There is some potential for emissions double counting between the 'Fertiliser for Horticulture' and 'Fertiliser (other)' as these emissions have been calculated based on different datasets, where the 'Fertiliser (other)' category may also include some fertilisers used in horticulture. However, it is expected that the majority of the 'Fertiliser (other)' emissions are caused by fertiliser use for livestock land. Changes in soil carbon associated with horticulture have not been quantified due to absence of a defined appropriate method for assessing the carbon footprint associated with soil carbon change over time.

Table 4 Fertiliser used in horticulture emissions by emission source

Sector / Emissions Source	tCO_2e	Hectares (Ha)
Sweetcorn	12,394	3,947
Pipfruit	2,333	4,734
Squash	2,145	1,702
Peas and Beans	1,450	2,736
Stonefruit	1,206	2,446
Beetroot	963	1,818
Grapes	892	5,245
Onions	822	473
Wheat	192	243
Kiwifruit	144	211
Grain	68	86
Tomato	6	80
Total	**22,615**	**23,721**

3.2 Transport

Transport produced 436,382 tCO_2e in 2020/21 (23% of Hastings gross total emissions). Table 5 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 5 Transport emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Diesel	239,108	12.8%	54.8%
Petrol	155,638	8.3%	35.7%
Marine Freight	38,954	2.1%	8.9%
Jet Kerosene	1,307	0.1%	0.3%
LPG	767	<0.1%	0.2%
Rail	473	<0.1%	0.1%
Aviation Gas	134	<0.1%	<0.1%
Total	**436,382**	**23%**	**100%**

Most of the Transport emissions can be attributed to diesel and petrol, which produced 239,108 tCO_2e and 155,638 respectively (collectively 91% of the sector's emissions and 21% of total gross emissions). Diesel and petrol transport emissions are broken down into on-road and off-road use. On-road transport consists of all standard transportation vehicles used on roads (including cars, trucks, buses, etc.). Off-road transport consists of all fuel used for the movement of machinery and vehicles off roads (including agricultural tractors and vehicles, forklifts, etc.). On-road transport produced 348,332 tCO_2e (80% of Transport emissions) and Off-road transport produced 47,182 tCO_2e (11% of Transport emissions). An extra breakdown of on-road emissions by vehicle type and class is provided separate to this report.

The next largest Transport emission source for Hastings is marine freight, which contributed to 9% of the sectors emissions and 2% of total gross emissions (38,954 tCO_2e). Marine freight emissions are the result of freight movements to and from the Port of Napier. Emissions from this source have been divided between all territorial authorities in the Hawke's Bay region based on relative population sizes. It is understood that the imports and exports through this port are not exclusively related to activities in the Hawke's Bay region, however, to ensure that these emissions are reflected in community carbon footprints as per the GPC requirements this approach is appropriate.

The remaining transport emissions are attributed to air travel (jet kerosene and aviation gas), rail freight emissions, and LPG use for transport (e.g. forklifts).

3.3 Stationary Energy

Producing 210,474 tCO_2e in 2020/21, Stationary Energy was Hastings third highest emitting sector (11% of total gross emissions). Table 6 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 6 Stationary Energy emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Electricity Consumption	89,761	4.8%	42.6%
Natural Gas	69,772	3.7%	33.2%
Stationary Petrol & Diesel Use	26,537	1.4%	12.6%
Electricity Transmission and Distribution Losses	8,245	0.4%	3.9%
LPG	6,083	0.3%	2.9%
Natural Gas Transmission and Distribution Losses	5,640	0.3%	2.7%
Biofuel / Wood	2,703	0.1%	1.3%
Coal	1,679	0.1%	0.8%
Biogas	54	<0.1%	<0.1%
Total:	**210,474**	**11%**	**100%**

Electricity consumption was the cause of 43% of Stationary Energy emissions (89,761 tCO_2e), and 4.8% of Hastings's total gross emissions (98,006 tCO_2e when including transmission and distribution losses related to the consumption). Natural gas consumption accounted for 36% of Stationary Energy emissions (75,412 tCO_2e) when including transmission and distribution losses. The industrial sector is the primary consumer of electricity and natural gas in Hastings.

Stationary petrol and diesel consumption generated 13% of the sectors emissions (26,537 tCO_2e). Use of LPG, and the burning of coal, biofuels and biogas produced the remaining Stationary Energy emissions.

Stationary Energy demand can also be broken down by fuel type, and by the sector in which it is consumed. Stationary Energy demand is reported for the following sectors: commercial; residential and industrial. However, emissions from petrol and diesel used for Stationary Energy are not able to be broken down by sector.

- Industrial Stationary Energy consumption accounts for 50% of Stationary Energy emissions (105,970 tCO_2e) and 6% of total gross emissions. Industrial Stationary Energy is energy used within all industrial settings (including agriculture, forestry and fishing, mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities).

- Residential Stationary Energy consumption accounts for 20% of Stationary Energy emissions (41,443 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 (36,470 tCO_2e) and 2.0% 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).
- The remaining 13% of Stationary Energy emissions (26,591tCO_2e, 1% of gross emissions) were produced by diesel and petrol, and the burning of biogas, which were not allocated to the above categories. Stationary Energy uses of diesel and petrol include stationary generators and motors and for heating.

3.4 Waste

Waste originating in Hastings (solid waste and wastewater) produced 39,289 tCO_2e in 2020/21, which comprises 2% of Hastings total gross emissions. Table 7 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 7 Waste emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Waste in open landfill sites	23,671	1.3%	60.2%
Composting	5,521	0.3%	14.1%
Waste in closed landfill sites	4,406	0.2%	11.2%
Individual septic tanks	4,233	0.2%	10.8%
Wastewater treatment plants	1,459	0.1%	3.7%
Total:	**39,289**	**2%**	**100%**

Solid waste produced the bulk of waste emissions (28,077 tCO_2e in 2020/21), making up 72% of total Waste emissions. Solid waste emissions include emissions from open landfills and closed landfills. Open landfill sites contributed 23,671 tCO_2e and emissions from closed landfill sites produced 4,406 tCO_2e in 2020/21. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill. However, annual emissions from closed landfill sites will decrease over time as no new waste enters these sites. Waste from Hastings is sent to Omarunui Landfill located within the Hastings geographic boundary.

Composting is the second largest source of emissions in Hastings, accounting for 14% of total waste emissions (5,521 tCO_2e in 2020/21). Waste diverted from landfill for composting in the Hawke's Bay Region includes horticultural, animal waste products, green waste, bark and sawdust.

Wastewater treatment (treatment plants and individual septic tanks) produced 5,691 tCO_2e making up 15% of total Waste emissions. More than half of households in Hastings are connected to wastewater treatments plants, which produced total emissions of 1,459 tCO_2e. Households connected to individual septic tanks produced 4,233 tCO_2e in wastewater emissions. Due to the production of methane, septic tanks have a higher emissions intensity compared to the wastewater treatments plants in Hastings.

Wastewater treatment tends to be a 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.

3.5 Industrial Processes and Product Use (IPPU)

IPPU in Hastings produced 24,780 tCO_2e in 2020/21, contributing 1% to Hastings total gross emissions. 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. IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g. coal, electricity and/or petrol and diesel). These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to particular geographic locations. Addressing IPPU emissions is typically a national policy issue.

There are no known industrial processes (as defined in the GPC requirements) present in Hastings (e.g. aluminium manufacture).

Table 8 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source. The most significant contributor to IPPU emissions is the use of refrigerants which produced 93% of IPPU emissions (23,039 tCO_2e).

Table 8 Industrial processes and product use emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Refrigerants and air conditioning	23,039	1.2%	93.0%
Aerosols	1,290	0.1%	5.2%
SF6 - Electrical Equipment	252	<0.1%	1.0%
Foam Blowing	109	<0.1%	0.4%
SF6 - Other	49	<0.1%	0.2%
Fire extinguishers	40	<0.1%	0.2%
Total	**24,780**	**1.3%**	**100%**

3.6 Forestry

Planting of native forest (e.g. mānuka and kānuka) and exotic forest (e.g. pine), sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. Harvesting of forest emits emissions via the release of carbon from organic matters and soils following harvesting. When sequestration by forests exceeds emissions from harvesting in a particular year, the extra quantity of carbon sequestered by forest reduces total net emissions for that year. Conversely when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then total net emissions will increase.

Sequestration in 2020/21 was 2,710,299 tCO_2e (which was mostly from exotic forestry) while harvesting emissions were 1,393,722 tCO_2e. This meant that Forestry in Hastings was a net negative source of emissions in 2020/21 (rather than a positive source of emissions, where harvesting emissions exceeds sequestration). Total Forestry emissions in 2020/21 were -1,316,577 tCO_2e. It is noted that harvesting of exotic forest can be cyclical in nature where some years will have higher sequestration and some years will have higher harvesting emissions determined by age of forests, commercial operators, and the global market.

Table 9 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO_2e
Total harvest emissions	1,393,722
Native forest sequestration	-466,431
Exotic forest sequestration	-2,243,868
Total	**-1,316,577**

3.7 Total Gross Emissions by Greenhouse Gas

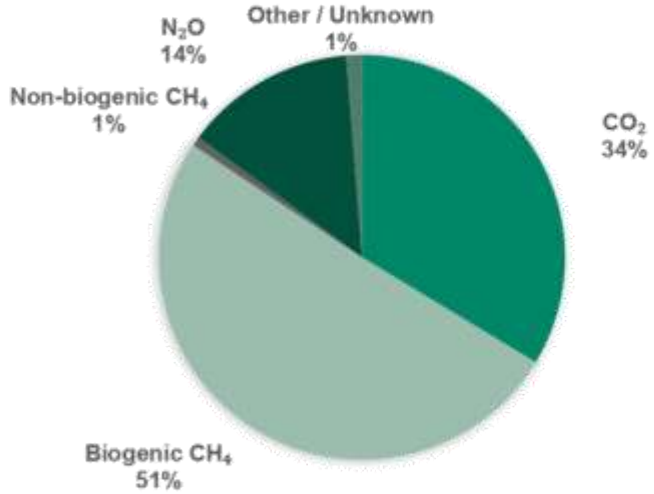
Each greenhouse gas has a different level of impact on climate change, this is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e).

Table 10: Hastings total gross emissions, by greenhouse gas

Greenhouse Gas	Tonnes	Tonnes of CO_2e
Carbon Dioxide (CO_2)	625,039	625,039
Biogenic Methane (CH_4)	27,947	950,199
Non-biogenic Methane (CH_4)	408	13,887
Nitrous Oxide (N_2O)	862	256,958
Other / Unknown Gas (in CO_2e)	23,443	23,443
Total	**677,700**	**1,869,526**

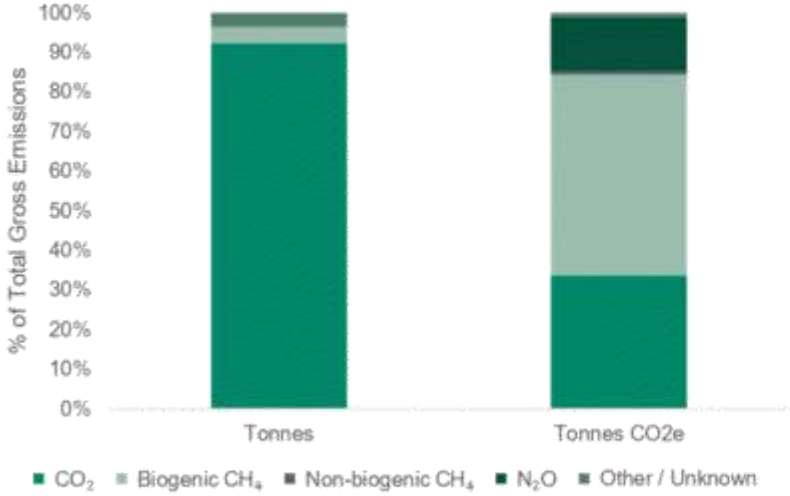
Figure 4 illustrates Hastings total gross emissions by greenhouse gas in units of carbon dioxide equivalents (CO_2e).

Figure 4: Hastings District's total gross emissions, by greenhouse gas (in tCO_2e)



By far the largest source of emissions in tonnes is carbon dioxide (CO_2) at 625,039 tonnes. Due to the greater global warming impact of methane, methane represents 4% of the total tonnage of GHG emissions from Hastings but represents 51% of CO_2e. Nitrous oxide represents 0.1% of the total tonnage of GHG emissions from Hastings but represents 14% of CO_2e. This effect can be seen in Figure 5.

Figure 5: Hastings District's total gross emissions, by greenhouse gas in tonnes and in tonnes of CO_2e



3.8 Biogenic emissions

Biogenic carbon dioxide and methane emissions are stated in Table 11 and Table 12, respectively.

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

Table 11: Biogenic CO_2 in Hastings (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO_2) (Excluded from gross emissions)		
Biofuel	88,504	t CO_2
Landfill Gas	8,334	t CO_2
Total Biogenic CO_2	**96,838**	**t CO_2**

Biogenic CH_4 emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large impact on global warming relative to biogenic CO_2. Biogenic methane represents 4% of the gross total tonnage of GHG emissions in Hastings but represents 51% of total gross GHG emissions when expressed in CO_2e. This is caused by the higher global warming impact of methane per tonne, compared to carbon dioxide. The total tonnage of each GHG and the contribution of each GHG to total gross emissions when expressed in CO_2e is shown in Table 10.

The importance of biogenic CH_4 is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes specific targets to reduce biogenic CH_4 by between 24% and 47% below 2017 levels by 2050, and by 10% below 2017 levels by 2030. More information on the Act is available here: https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act.

Table 12: Biogenic Methane in Hastings (Included in gross emissions)

Biogenic Methane (CH_4) (Included in gross emissions)		
Enteric Fermentation	26,273	t CH4
Landfill Gas	826	t CH4
Manure Management	518	t CH4
Wastewater Treatment	164	t CH4
Composting	94	t CH4
Biofuel	71	t CH4
Total Biogenic CH_4	27,947	**t CH4**

3.9 Territorial Authorities in the Hawke's Bay Region

The Hawke's Bay regional area contains several territorial authorities. Hastings District, Napier City, Central Hawkes Bay District, and Wairoa District are all exclusively within the boundaries of the Hawke's Bay region. Additionally, areas of Taupō District and Rangitīkei District are also part of the Hawke's Bay region. We estimate that 0.1% of Taupō's population and 12% of Taupō's area, and 0.3% of Rangitīkei's population and 14% of Rangitīkei's area are within the Hawke's Bay region.

Figure 6 shows the Hawke's Bay's total gross emissions divided by territorial authority. Figure 7 shows total gross emissions for the territorial authorities in the Hawke's Bay Region, split by sector. Both figures only include the emissions produced within the Hawke's Bay region for Taupō and Rangitīkei.

Hastings is the highest emitting territorial authority in the region, representing 43% of the Hawke's Bay's total gross emissions. Hastings' emissions inventory is predominantly agriculture-related emissions with the next largest emitting territorial authorities; Central Hawke's Bay and Wairoa, also containing significant agricultural emissions. Of the four territorial authorities entirely within the Hawke's Bay region, Napier has the lowest total gross emissions, with emissions mostly from Transport and Stationary Energy. The areas of Taupō and Rangitīkei contribute to 2% of the Hawke's Bay region's total gross emissions, almost entirely from Agriculture.

Figure 6 Hawke's Bay's total gross emissions divided by territorial authority (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.

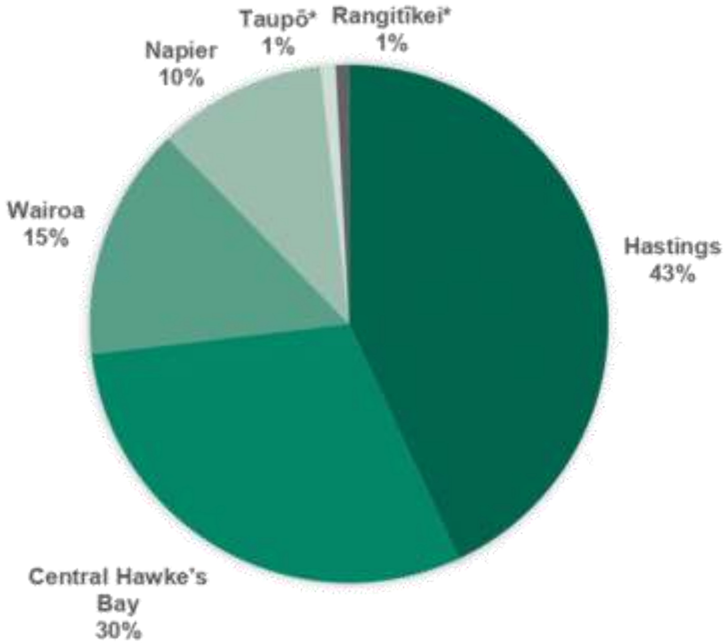
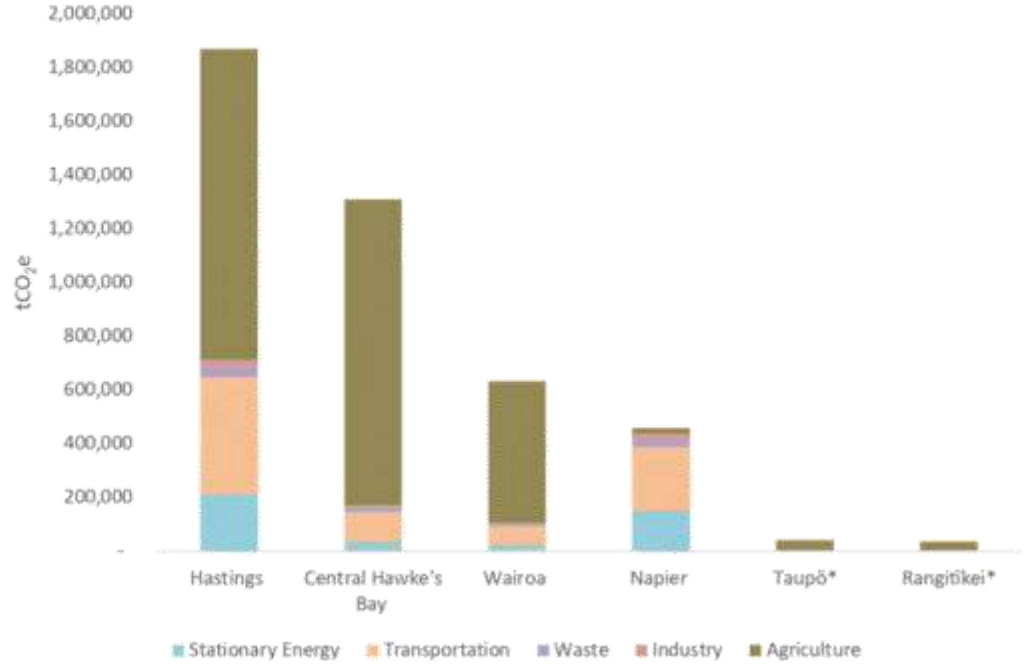


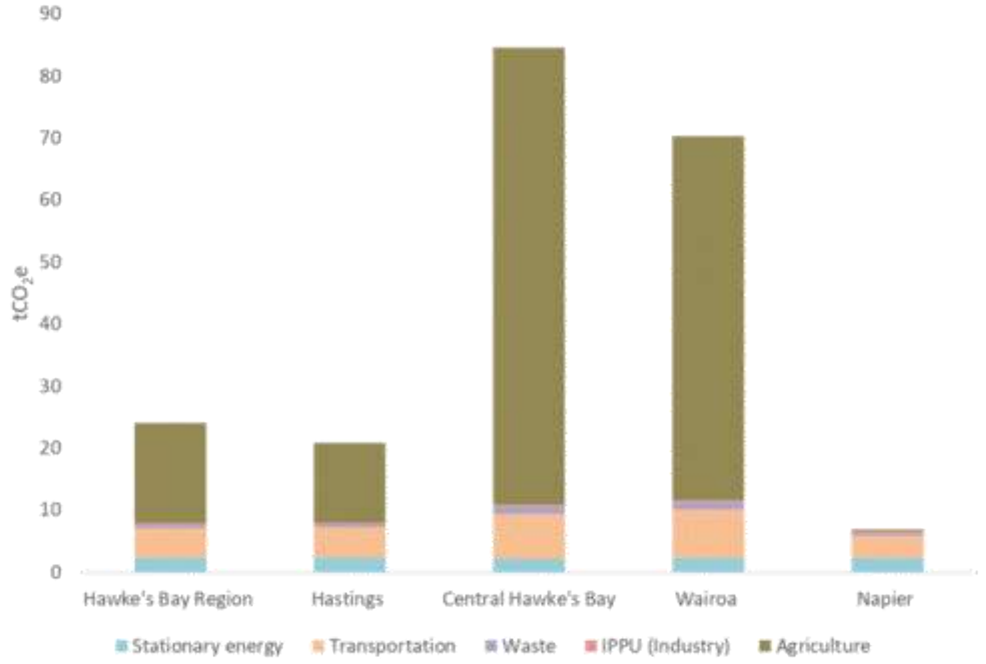
Figure 7 Total gross emissions by territorial authority in the Hawke's Bay region (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.



When comparing emissions inventories from different areas, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. Figure 8 shows emissions per capita for the region and territorial authorities within the region. Taupō and Rangitīkei are excluded from this figure due to the tiny population and large agriculture within the small area in the Hawke's Bay creating very large per capita emissions (this is not the case for the entire Taupō or Rangitīkei district).

The Hawke's Bay region has a 24.1 tCO_2e/per capita figure for total gross emissions which is higher than the national value of 15.7 tCO_2e/per capita. Napier has the lowest per capita total emissions at 6.9 tCO_2e/per capita. Central Hawke's Bay and Wairoa have the largest per capita total gross emissions at 84.6 tCO_2e/per capita and 70.3 tCO_2e/per capita respectively, both due to high Agriculture emissions in the district. Hastings has the third highest per capita emissions at 20.9 tCO_2e/per capita, similar to that of the region. Notably, Hastings' per capita transport emissions are lower than Central Hawke's Bay and Wairoa, but higher than Napier.

Figure 8 Total gross emissions per capita for the region and territorial authorities within the region (tCO_2e). *Taupō and Rangitīkei areas not included



4.0 Emissions change from 2018/19 to 2020/21

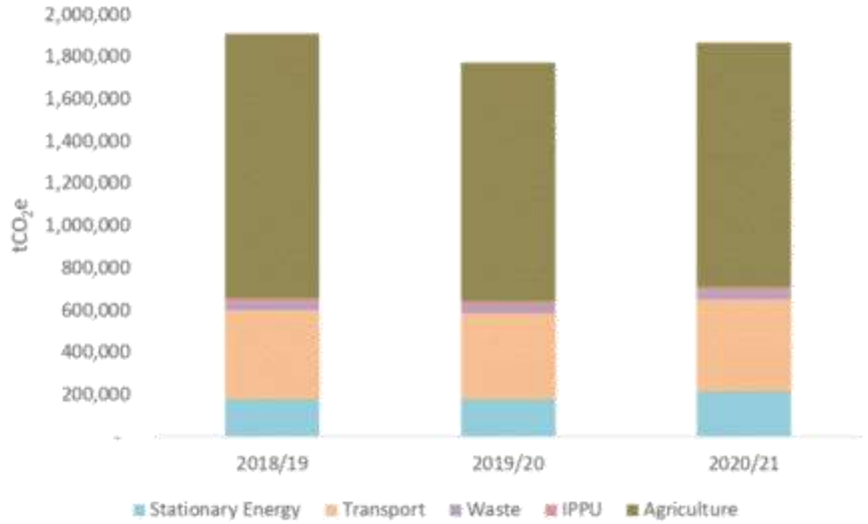
Alongside calculating Hastings' emissions footprint for 2020/21, we have calculated Hastings' emissions footprint for 2018/19 and 2019/20. This section displays the results of the 2018/19, 2019/20, and 2020/21 emissions footprints with a focus on Gross emissions and documents the change in emissions from 2018/19 to 2020/21.

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

Table 13 Change in Hastings total gross and net emissions from 2018/19 to 2020/21

	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total Net Emissions (including forestry)	1,113,118	603,120	552,948	-50%
Total Gross Emissions (excluding forestry)	1,911,938	1,776,377	1,869,526	-2%

Figure 9 Change in Hastings total gross emissions from 2018/19 to 2020/21



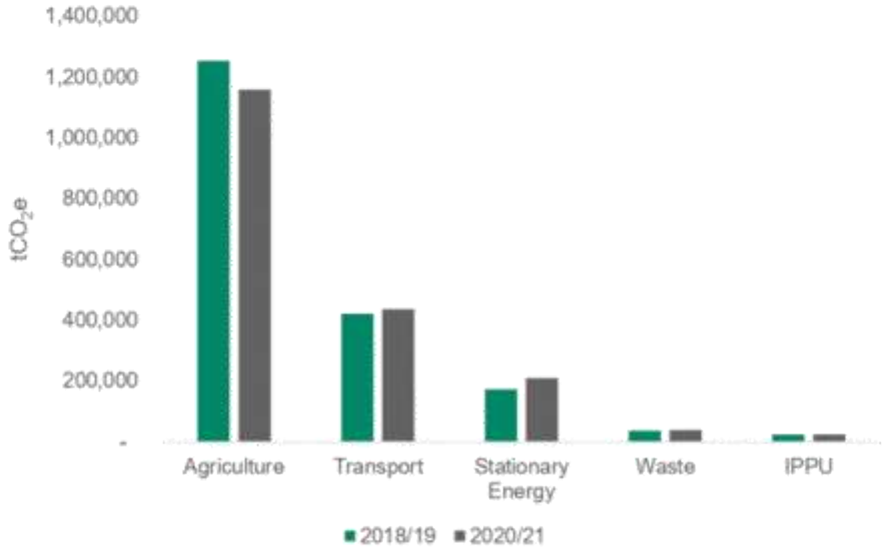
Annual total gross emissions decreased by 2% from 1,911,938 tCO_2e in 2018/19 to 1,869,526 tCO_2e in 2020/21. This was driven by a decrease in Agriculture emissions (due to a decrease in the number of sheep and non-dairy cattle) and an increase in Stationary Energy emissions (primarily related to the increase in the emissions intensity of the national electricity grid).

Total net emissions in Hastings decreased by 50% from 1,113,118 in 2018/19 to 552,948 tCO_2e. This decrease was predominantly due to a decrease in annual forest harvesting emissions. This is discussed further below under the 'Forestry' heading.

Whilst total gross emissions decreased by 2%, the population of Hastings grew by 5% during this time. This resulted in a 7% decrease in per capita emissions between 2018/19 and 2020/21, from 22.4 to 20.9 tCO_2e per person per year. A discussion of the decoupling of gross emissions from population growth and GDP is found in Section 5.0.

The sections below outline the change in emissions between 2018/19 and 2020/21 for each sector and emissions source, highlighting the changes that have had the largest impact on total gross emissions.

Figure 10 Emissions for each sector of Hastings gross emissions footprint for 2018/19 and 2020/21



4.1 Agriculture

Table 14 Change in Hastings Agriculture emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Enteric Fermentation	964,879	870,217	893,298	-7%
Manure from Grazing Animals	141,496	127,196	130,582	-8%
Other Agriculture Emissions	56,335	50,376	50,642	-10%
Atmospheric Deposition	39,639	35,603	36,365	-8%
Fertiliser used in Horticulture	22,615	22,615	22,615	0%
Manure Management	19,098	17,578	17,625	-8%
Agricultural Soils	9,796	8,496	7,474	-24%
Total	**1,253,858**	**1,132,080**	**1,158,601**	**-8%**

Agriculture is the most significant contributor to Hastings community carbon footprint. The sector's emissions decreased by 8% between 2018/19 and 2020/21 (95,257 tCO_2e). This decrease is driven by a reduction in total livestock numbers, especially of sheep and non-dairy cattle (see Table 15).

Emissions related to sheep decreased by 58,476 tCO_2e due to a reduction in the number of sheep (106,683 sheep). Emissions related to non-dairy cattle decreased by 24,980 tCO_2e due to a reduction in the number of non-dairy cattle (12,596 cattle). The number of dairy cattle also reduced, reducing dairy cattle emissions by 6,586 tCO_2e.

Table 15 Change in Hastings livestock numbers from 2018/19 to 2020/21

	Number of animals (2018/19)	Number of animals (2020/21)	Change in number of animals (2018/19 to 2020/21)
Sheep	1,127,513	1,020,830	-106,683
Non-dairy Cattle	185,391	172,796	-12,596
Other livestock	26,639	26,472	-167
Dairy Cattle	25,191	23,320	-1,871
Total livestock	**1,364,734**	**1,243,418**	**-121,316**

Table 16 Change in Hastings's livestock-associated Agriculture emissions from 2018/19 to 2020/21

	2018/19 emissions (tCO_2e)	2020/21 emissions (tCO_2e)	% Change in emissions (2018/19 to 2020/21)
Sheep	618,028	559,552	-9%
Non-dairy Cattle	468,073	443,183	-5%
Dairy Cattle	101,311	94,725	-7%
Other livestock	24,872	24,169	-3%
Total livestock	**1,212,284**	**1,121,628**	**-7%**

4.2 Transport

Table 17 Change in Hastings's Transport emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Diesel	218,190	213,706	239,108	10%
Petrol	155,779	145,783	155,638	<0.1%
Marine Freight	44,603	44,777	38,954	-13%
Jet Kerosene	1,878	1,626	1,307	-30%
LPG	718	730	767	7%
Rail	468	717	473	1%
Aviation Gas	108	130	134	25%
Total:	**421,744**	**407,469**	**436,382**	**3%**

Transport emissions increased by 3% between 2018/19 and 2020/21 (14,639 tCO_2e). This was driven by a 5% increase in on-road fuel emissions (16,826 tCO_2e), particularly from diesel.

It is noted that the impact of the COVID-19 pandemic can be seen in Transport emissions where emissions decreased by 4% between 2018/19 and 2019/20 due to reductions in road and air transport fuel use. Aviation emissions continued to reduce in the 2020/21 reporting year, reflective of ongoing COVID-19 impacts to the industry.

4.3 Stationary Energy

Table 18 Change in Hastings Stationary Energy emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Natural Gas	66,437	64,443	69,772	5%
Electricity Consumption	61,265	63,108	89,761	47%
Stationary Petrol & Diesel Use	24,315	23,766	26,537	9%
LPG	5,688	5,784	6,083	7%
Natural Gas Transmission and Distribution Losses	5,370	5,209	5,640	5%
Electricity Transmission and Distribution Losses	5,349	5,532	8,245	54%
Coal	2,857	3,142	1,679	-41%
Biofuel / Wood	2,661	2,679	2,703	2%
Biogas (landfill)	52	53	54	4%
Total:	**173,995**	**173,715**	**210,474**	**21%**

Emissions from Stationary Energy increased by 21% between 2018/19 and 2020/21 (36,479 tCO_2e). This was driven by a 47% increase in electricity consumption emissions (28,495 tCO_2e). This increase in electricity consumption emissions was due to a 4% increase in energy consumption (kWh) and a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh). The emissions intensity of the national grid has increased in recent years due to the increased use of fossil fuels during years with low hydro electricity generation. Emissions from industrial energy use is the largest driver in the increase in stationary emissions (15,236 tCO_2e).

4.4 Waste

Table 19 Change in Hastings Waste emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Open Landfill	22,695	23,087	23,671	4%
Composting	5,521	5,521	5,521	-
Closed Landfill	4,891	4,641	4,406	-10%
Individual septic tanks	3,293	3,780	4,233	29%
Wastewater treatment plants	1,465	1,476	1,459	-0.4%
Total	**37,865**	**38,504**	**39,289**	**4%**

Waste emissions increased between 2018/19 and 2020/21, by 4% (1,425 tCO_2e).

Total solid waste in landfill emissions increased by 2% (491 tCO_2e). Emissions from waste in open landfills increased as the volume of waste entering the landfill increased and waste recently deposited in landfill reaches peak emissions per year (this is after approximately two years in landfill). Emissions from closed landfills decreased due to no extra waste being added, the existing waste in landfill releases fewer emissions over time. Due to data only being available for one singular year, no change in composting emissions is recorded.

Total wastewater emissions increased by 20%, this is due to an increase in septic tank emissions likely driven by an increase in the number of households not connected to centralized wastewater treatment. Due to the production of methane, septic tanks have a higher emissions intensity compared to a wastewater treatment plant. Better data on the number of households connected to centralized wastewater treatment would improve the accuracy of the emissions calculations.

4.5 Industrial Processes and Product Use (IPPU)

Table 20 Change in Hastings IPPU emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Refrigerants and air conditioning	22,639	22,833	23,039	2%
Aerosols	1,425	1,336	1,290	-9%
SF6 - Electrical Equipment	225	244	252	12%
Foam Blowing	99	108	109	10%
SF6 - Other	48.7	49.0	49.5	2%
Fire extinguishers	39	40	40	1%
Total	**24,476**	**24,609**	**24,780**	**1%**

IPPU emissions increased between 2018/19 and 2020/21, by 1% (304 tCO_2e). The increase in IPPU emissions is mainly caused by an increased in SF6 associated with electrical equipment. Note that national level data is used for this sector and is portioned out using a population approach; exact emissions for the district are unknown.

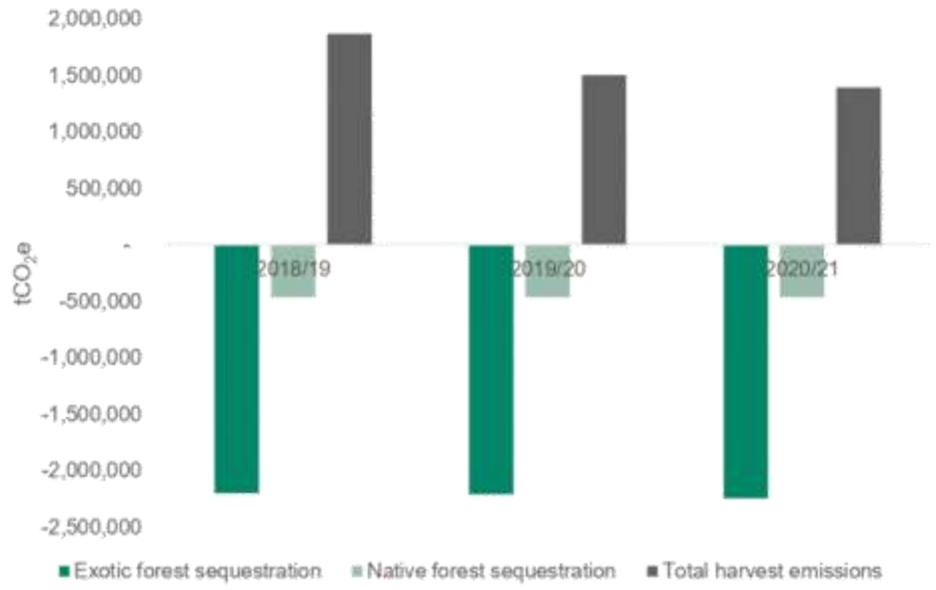
4.6 Forestry

Table 21 Change in Hastings Forestry emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total harvest emissions	1,867,841	1,502,952	1,393,722	-25%
Native forest sequestration	-466,431	-466,431	-466,431	0%
Exotic forest sequestration	-2,200,230	-2,209,778	-2,243,868	2%
Total	**-798,819**	**-1,173,257**	**-1,316,577**	**65%**

Forestry emissions decreased by 517,758 tCO_2e (65%) between 2018/19 and 2020/21, this is the largest real and proportional change in emissions for Hastings. This decreased was driven by a decrease in total harvest emissions (474,120 tCO_2e) as less exotic forest is harvested. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes where some years will have higher sequestration and some years will have higher harvesting emissions. This is dependent on age of forests and the demand for lumber and timber. This decrease in Hastings harvesting emissions during this period is reflective a decrease in forestry harvesting across the region. Improved and updated data sources may impact the estimation of emissions from this source in the future. Sequestration by native and exotic forest remained relatively stable during this time.

Figure 11 Forestry sequestration and harvesting emissions from 2018/19 to 2020/21



5.0 Decoupling of GHG emissions from population growth and GDP

Figure 12 shows the changes in gross emissions when compared to changes in other metrics of interest between 2018/19 and 2020/21. For example, total gross emissions have decreased by 2%, whilst population in Hastings has increased by 5%, resulting in a 7% reduction in total gross emissions per capita. Similarly, Gross Domestic Product (GDP) in Hastings has increased by 5%, resulting in a 7% decrease in the GHG emissions ratio to GDP.

When emissions grow less rapidly than GDP (a measure of income) this process is known as decoupling. The term decoupling is an expression of the desire to mitigate emissions without harming economic wellbeing. A full discussion of decoupling of emissions is beyond the scope of this project. However, the changes in emissions and GDP illustrated in Figure 12 and discussed above, suggest at a high-level decoupling has occurred between 2018/19 and 2020/21.

The exact drivers for the decoupling of emissions from GDP are difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transportation and housing will all contribute. In this case, both direct local actions (e.g. landfill gas reductions) and indirect national trends (e.g. changes to emissions from electricity generation) will have contributed to trends noted.

Figure 12 Change in total gross emissions compared to other metrics of interest

6.0 Impact of the COVID-19 pandemic on GHG Emissions

COVID-19 impacted New Zealand and the entire world during 2020 and 2021; causing widespread government-imposed restrictions on businesses and individuals and huge shifts in behaviors and economic markets. Restrictions in New Zealand relating to COVID-19 began in mid-March 2020 with many personal and business restrictions continuing past the end of 2019/20 and throughout 2020/21.[3]

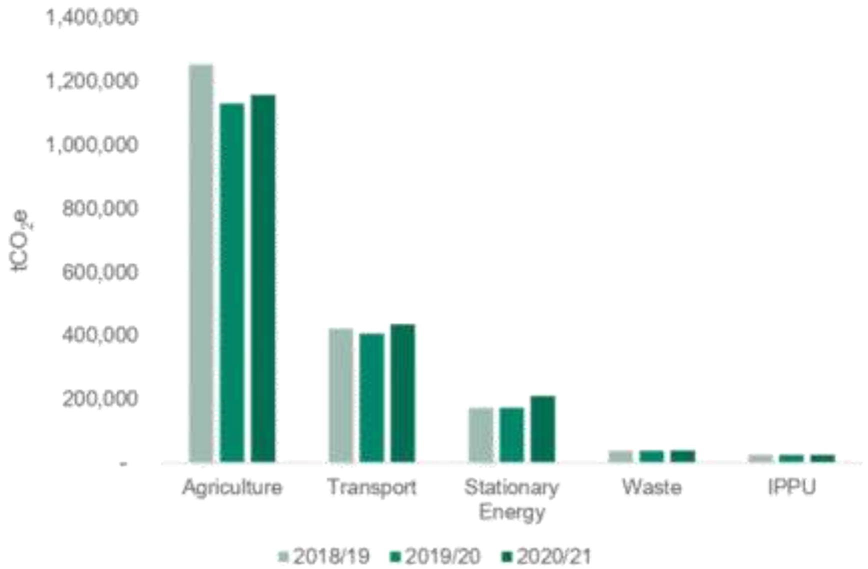
Globally, carbon dioxide emissions from fossil fuels (the largest contributor to greenhouse gas emissions) in 2020 decreased by 7% compared to 2019[4]. Emissions from the transportation sector account for the largest share of this decrease. Surface transport, e.g. car journeys, fell by approximately half at the peak of COVID-19 restrictions in April 2020 (when restrictions were at their maximum, particularly across Europe and the U.S. Globally, emissions recovered to near 2019 levels and are expected to continue to increase.

In New Zealand, national daily carbon dioxide emissions are estimated to have fallen by up to 41% during the level 4 lockdown in April 2020[5]. National gross emissions decreased by 3% from 2018/19 to 2019/20, which was largely driven by a decrease in fuel use in road transport due to COVID-19 pandemic restrictions, a decrease in fuel use in manufacturing industries and construction due to COVID-19 restrictions, and a decrease in fuel use from domestic aviation also due to COVID-19 restrictions.

Total gross emissions in Hastings decreased by 135,560 tCO_2e (7%) between 2018/19 and 2019/20. Total gross emissions then increased by 93,149 tCO_2e (5%) from 2019/20 to 2020/21.

The impact on emissions in different sectors varied. Notably, Transport emissions reduced by 4% between 2018/19 and 2019/20, driven by reduced road and air transport fuel use. Agricultural emissions decreased between 2018/19 and 2019/20, possibly due to COVID-related impacts on global supply chains. Despite changes in Stationary Energy, Waste, and IPPU emissions, these sectors are not judged to have been significantly affected by the COVID-19.

Figure 13 Hastings emissions per sector for 2018/19, 2019/20, and 2020/21 (tCO_2e)



[3] https://covid19.govt.nz/alert-system/history-of-the-covid-19-alert-system/
[4] Pierre Friedlingstein et al. - Global Carbon Budget 2020 (2020)
[5] Corinne Le Quere et al. – Temporary Reduction in Daily Global CO_2 Emissions During the COVID-19 Forced Confinement

7.0 Closing Statement

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

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

Understanding of the extensive and long-lasting effects of climate change is improving all the time. It is recommended that this emissions footprint be updated regularly (every two or three years) to inform ongoing positive decision making to address climate change issues.

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

8.0 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 **June 2022 and September 2022** and is based on the information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time. This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice.

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Appendix A

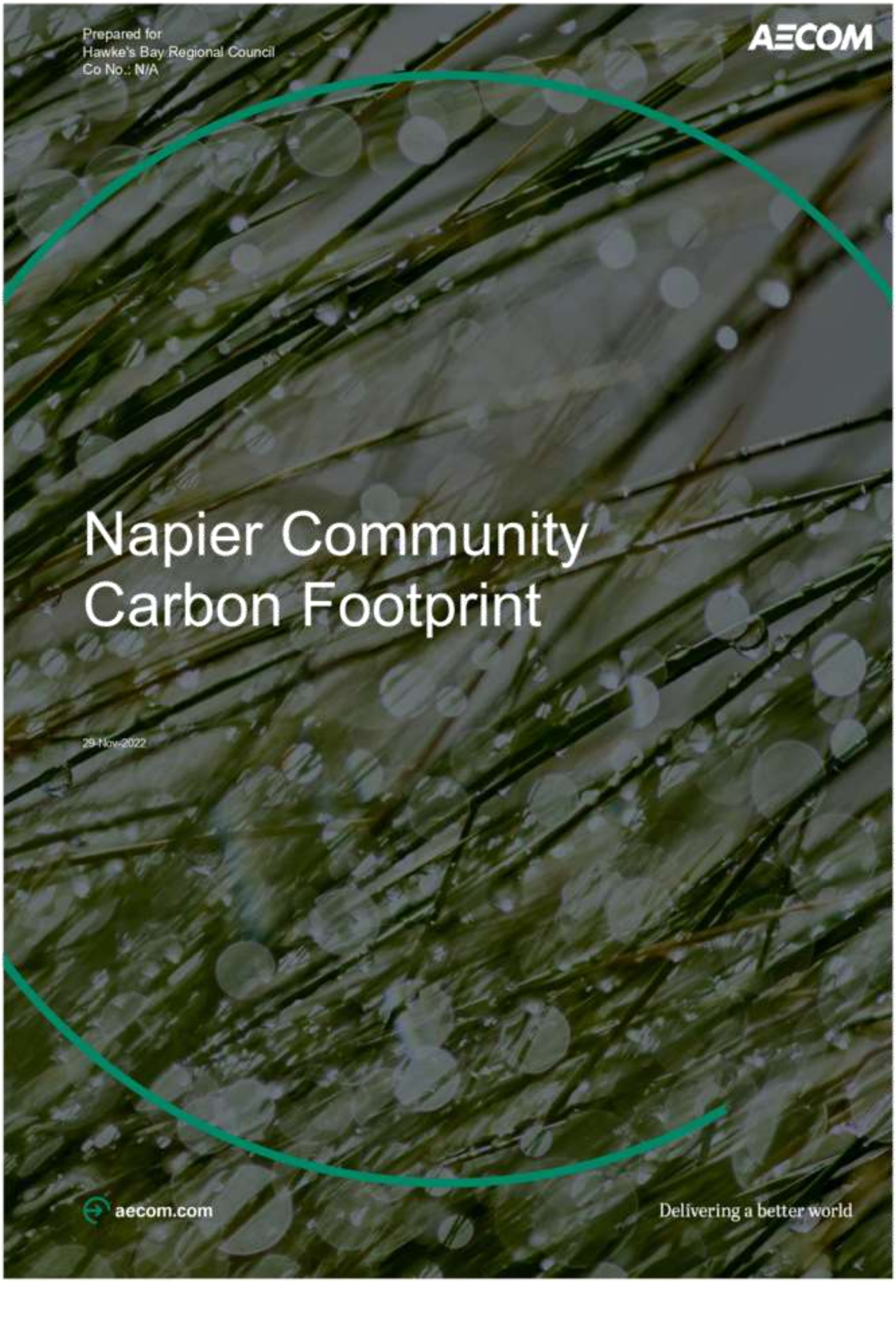
Assumptions and Data Sources

Sector / Category	Assumption and Exclusions
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied. The emissions footprint for the Hawke's Bay Region covers the entirety of the Hawke's Bay Region (this excludes some of the Rangitikei and Taupō territorial authorities). Emissions footprints for each territorial authority covers the entirety of the territorial authority area.
Population	Population figures are provided by StatsNZ. Financial year populations have been used, these are based on the average population from the two calendar years (e.g. the average of 2018 and 2019 calendar year populations for FY19). The population of Taupo and Rangitikei Districts within the Hawke's Bay geographical boundary has been calculated.
Transport Emissions	
Petrol and Diesel:	Petrol and diesel sales data provided by Napier City Council for Napier, Central Hawkes Bay and Hastings. Combined sales data for Gisborne and Wairoa provided by Gisborne District Council and allocated to a region based on Waka Kotahi emissions data. Sales have been divided between territorial authorities based on the number of kilometres travelled by vehicles on roads (VKT) in each territorial authority. VKT data provided by Waka Kotahi. The division into transport and stationary energy end use (and within transport into on-road and off-road) has been calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) from the 2019 database. Biofuel sales information provided directly by the supplier.
Rail Diesel	Emissions from fuel use have been calculated and provided by Kiwi Rail. The following assumptions were made: - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. 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 district, arrival district and any district the freight stopped at along the way. If the freight travelled through but did not stop within a district, no emissions were allocated. This data is subject to commercial confidentiality.
Jet Kerosene (Scheduled Flights) Aviation Gas (General Aviation)	Calculated from information provided by Hawke's Bay Airport. Aviation fuel and jet kerosene fuel volumes were provided and emissions have been calculated using these volumes. Emissions have been divided between territorial authorities based the relative population of each territorial authority.

Marine Freight	Shipping schedules have been provided by the Port of Napier. Emissions have been calculated based on ship weight and distance from the origin/destination to Napier. This figure does not include fishing vessels, or vessels with destination to be confirmed. Emissions from freight and international shipping are allocated equally between the origin and destination area emissions footprints. It is expected that imports and exports travelling through the Port of Napier service the entire Hawke's Bay Region. Emissions relating to freight and international shipping emissions have been divided between all Hawke's Bay territorial authorities based on population size.
Marine Fuel (Local)	Non-freight marine fuel use has not been included in this study. Fuel use by Port of Napier-controlled vessels has not been included due to a lack of available information. Most private marine vessels use fuel purchased at vehicle fuel stations. Petrol and diesel used in private marine vessels is included in off-road transportation.
LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. Sales have been divided between territorial authorities on a per capita basis.
Stationary Energy Emissions	
Electricity Demand	Electricity demand has been calculated using grid exit point (GXP) data from the EMI website (www.emi.ea.govt.nz). Reconciled demand has been used as per EMI's confirmation. The territorial authorities serviced by each GXP have been confirmed by the respective electricity suppliers. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per Ministry for the Environment (MfE) data.
Electricity Generation	Electricity generation has been calculated using data from the EMI website (www.emi.ea.govt.nz). Small electricity generation has not been included in this data (e.g. domestic solar generation). This figure only includes electricity that is connected to the national electricity grid, direct users of electricity are not included.
Coal Consumption	National coal consumption data has been provided by MBIE. Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis. Regional industrial coal consumption has been divided between territorial authorities on a per capita basis.
Coal Production and Fugitive Emissions	Not Calculated: There are no active coal mines within the region.
Biofuel Consumption	National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE). Biofuel consumption has been divided between territorial authorities on a per capita basis. Biofuel emissions are broken down into Biogenic emissions (CO_2) and Non-Biogenic emissions (CH_4 and N_2O)

LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG. Sales have been divided between territorial authorities on a per capita basis. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.
Natural Gas Consumption	Natural gas consumption data has been provided by FirstGas. Territorial Authorities supplied by gas from each Point of Connection (POC) have been confirmed by FirstGas. Natural gas consumption has been split into residential, commercial, and industrial consumption based on information provided by PowerCo and national statistics from MBIE. Some POCs supply gas to particular industrial users exclusively, these have been taken into account.
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
Agricultural Emissions	
General	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ). The last territorial authority census was in 2017. Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use since 2017. Territorial authority land-use data provided by HBRC covering horticulture land-use.
Solid Waste Emissions	
Waste in Landfill	Landfill waste volume and end location information has been provided by the respective council departments. Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis. Emissions are allocated to territorial authorities based on where the waste was produced, even if the waste is disposed in landfill outside the territorial authority.
Wastewater Emissions	
Wastewater Volume and Treatment Systems	Information on treated wastewater, and treatment plants has been provided by the respective council departments. Where information is not available, reasonable assumptions have been made and the WaterNZ database has been consulted. The population connected to septic tank systems have been estimated by the respective council departments. Where the population covered by Wastewater treatment plants and septic tanks does not account for the entire population, the remaining population is assigned to septic tanks. Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority.
Industrial Emissions	
Industrial processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the Region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g. fire extinguishers, refrigerants) has been provided by the MfE. Emissions have been allocated to territorial authorities on a per capita basis.

Forestry Emissions	
Exotic Forestry Harvested	Harvested forestry, and forest cover information for each territorial authority has been derived from Landcare Research data. 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.
Exotic Forest	Exotic forest land area for each territorial authority has been provided by Landcare Research.
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 EFs have been applied. AR5 Global Warming Potential (GWP) figures for greenhouse gases have been used accounting for climate change feedbacks.



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AECOM

Napier Community Carbon Footprint

29-Nov-2022

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Delivering a better world

Napier Community Carbon Footprint

Client: Hawke's Bay Regional Council

Co No.: N/A

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1	27-Sep-2022	Final	Anthony Hume Team Leader - Sustainability	
2	13-Oct-2022	Final - includes updated infographics	Anthony Hume Team Leader - Sustainability	
3	29-Nov-2022	Final - includes updated infographic (Figure 1)	Anthony Hume Team Leader - Sustainability	

Table of Contents

Executive Summary

Greenhouse Gas (GHG) emissions for Napier City Territorial Area (that is covered by the Napier City Council) have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture and Forestry sectors. This document reports greenhouse gas emissions produced in or resulting from activity or consumption within the geographic boundaries of the Napier City Territorial Area for the 2020/21 financial reporting year and examines greenhouse gas emissions produced from 2018/19 to 2020/21.

The Napier City Territorial Area is referred to hereafter as Napier for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

Major findings of the project include:

2020/21 Emissions Footprint

- In the 2020/21 reporting year (1st July 2020 to 30th June 2021), **total gross emissions** in Napier were 457,725 tCO_2e.
- **Transport** (e.g. emissions from road and air travel) is the largest emitting sector in Napier, representing 52% of total gross emissions, with petrol and diesel consumption accounting for 46% of gross emissions.
- **Stationary Energy** (e.g. consumption of electricity and natural gas) is the second highest emitting sector in the region, producing 33% of total gross emissions.
- **Waste** is the third highest emitting sector in the city, producing 6% of total gross emissions.
- Net **Forestry** emissions were 432 in 2020/21 as carbon sequestration (carbon captured and stored in plants or soil by forests) was less than emissions from forest harvesting (e.g., the release of carbon from roots and organic matter following harvesting). Net **Forestry** emissions are not included in total gross emissions.
- The **total net emissions** in Napier were 458,157 tCO_2e. The total net emissions include emissions and sequestration from forestry.

Changes in Emissions, 2018/19 to 2020/21

- Between 2018/19 and 2020/21, **total gross emissions** in Napier increased from 432,811 tCO_2e to 457,725 tCO_2e, an increase of 6% (24,914 tCO_2e).
- Over this time the population of the city increased by 3%, resulting in **per capita gross emissions** in Napier increasing by 3% between 2018/19 and 2020/21, from 6.7 to 6.9 tCO_2e per person per year.
- Emissions from **Stationary Energy** increased by 19% between 2018/19 and 2020/21 (24,274 tCO_2e), driven by a 43% increase in electricity consumption emissions (20,163 tCO_2e). This increase in electricity consumption emissions was due to a 2% increase in energy consumption (kWh) and a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).
- Emissions from **Agriculture** decreased by 8%, between 2018/19 and 2020/21 (1,878 tCO_2e), due to a reduction in livestock numbers, particularly of sheep and non-dairy cattle.
- Emissions from **Transport**, **Waste** and **IPPU** between 2018/19 and 2020/21 remained relatively stable.
- **Forestry** emissions decreased by 453 tCO_2e (51%) between 2018/19 and 2020/21. Exotic forest harvesting and exotic forest sequestration both decreased during this time.

Figure 1: Napier 2020/21 Emissions Footprint

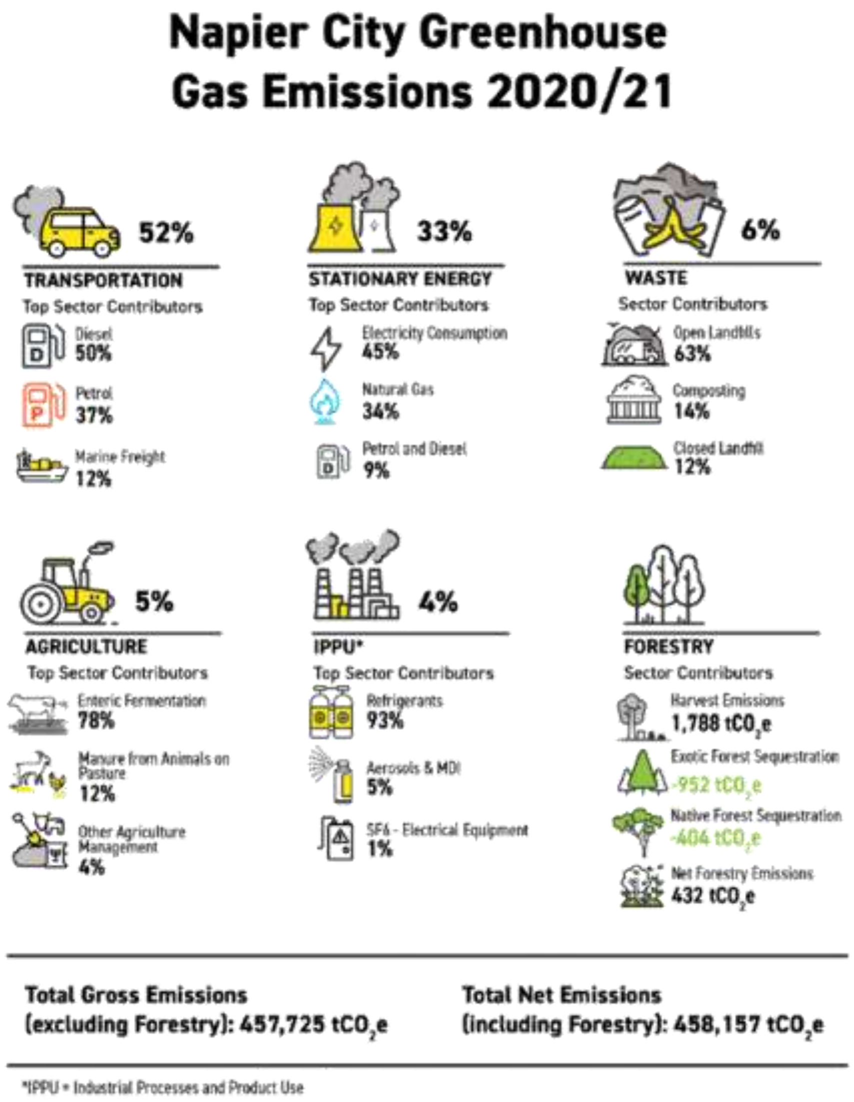
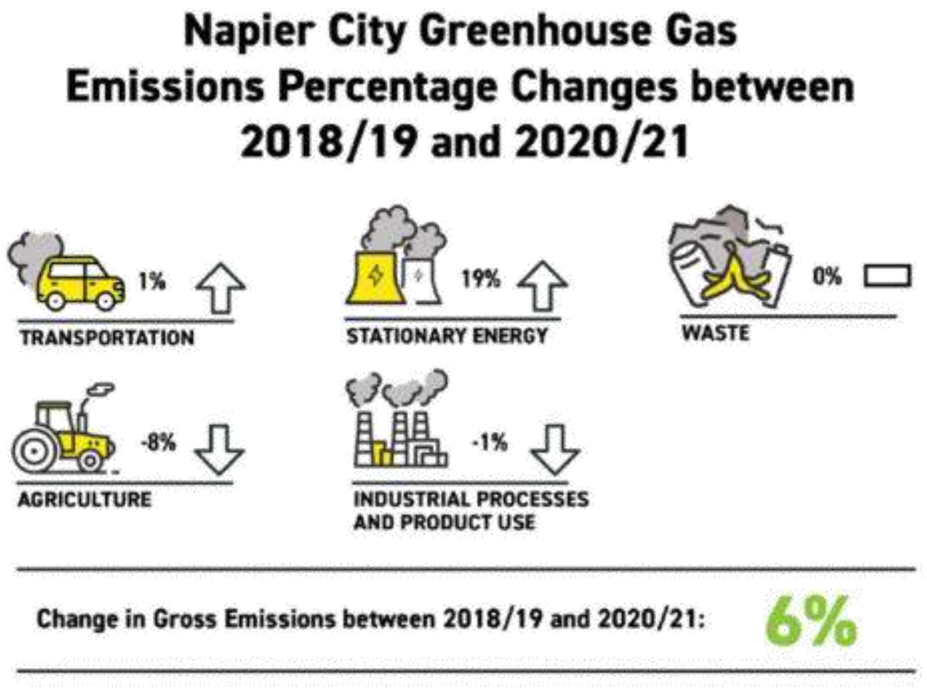


Figure 2: Change in Napier Emissions Footprint between 2018/19 and 2020/21



1.0 Introduction

AECOM New Zealand Limited (AECOM) was commissioned by the Hawke's Bay Regional Council to assist in the development of community-scale greenhouse gas (GHG) footprints for the Napier City Territorial Area for the 2018/19, 2019/20, and 2020/21 financial years. This is part of a wider study to develop community carbon footprints for each district within the Hawke's Bay region. Emissions are reported for the period from 1 July to 30 June for the respective years. The study boundary reported in the following pages incorporates the jurisdiction of the Napier City Council.

The Napier City Territorial Area is referred to hereafter as Napier for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

2.0 Approach and Limitations

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

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

This emissions footprint assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the 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. flights) and energy transportation and distribution losses fit into Scope 3.

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

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[2]. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs.
- GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption. Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g. embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.).
- Total emissions are reported as both gross emissions (excluding Forestry) and net emissions (including Forestry).

[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 greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
- Where location specific data were not accessible, information was calculated based on national or regional level data.
- Transport emissions:
  - Transport emissions associated with air travel, rail, and marine fuel were calculated by working out the emissions relating to each journey arriving or departing the area based on data provided by the relevant operators. Emissions for these sources are then split equally between the destination and origin. Emissions relating to a particular point source (e.g. an airport or port) are allocated to the expected users of that source, not just the area that it is located in. For example, in the Hawke's Bay Region, it is expected that all territorial authorities will use the Port of Napier for imported and exported goods, emissions from this source have been allocated to all territorial authorities in the region based on population. It is understood that freight imports moving through the Port of Napier do not exclusively serve the Hawke's Bay Region, and freight exports do not exclusively originate from the Hawke's Bay Region, this should be considered when examining these emissions.
  - All other transport emissions are calculated using the fuel sold in the area (e.g. petrol, diesel, LPG).
- Solid waste emissions:
  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day.
  - Emissions are calculated for waste produced within the geographic boundary, even if they are transported outside the boundary to be entered into landfill. Landfill waste for Napier is disposed at Omarunui Landfill, jointly owned by the Hastings District Council and Napier City Council. This landfill is located within the Hastings geographic boundary.
- Wastewater emissions:
  - Emissions have been calculated based on the local data provided, following IPCC 2019 guidelines. Where data is missing, IPCC and Ministry for the Environment (MfE) figures have been used. Wastewater emissions from both wastewater treatment plants and 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 Processes and Product Use (IPPU) emissions:
  - IPPU emissions are estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2019 report (MfE 2021). Emissions are estimated on a per capita basis applying a national average per person.
- Forestry emissions:
  - This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e. it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
  - The emissions footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.

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

It is important to consider the level of uncertainty associated with the results, particularly given the different datasets used. Depending on data availability, national, regional, and local datasets are used across the different calculators. At the national level, New Zealand's Greenhouse Gas Inventory shows that for 2018 (the most recent national level inventory) an estimate of gross emissions uncertainty was +/- 9%, whereas a net emissions uncertainty estimate was +/- 12%. These levels of uncertainty should be considered when interpreting the results of this community carbon footprint (MfE, 2020).

StatsNZ Regional Footprint

Due to differences in emission factors and methodology used between the StatsNZ Regional Footprints and this community carbon footprint (based on the GPC requirements and available data), caution should be taken when making comparison of reported emissions. One example of this is where this footprint used updated emission factors for methane and nitrous oxide following guidance from the IPCC and in line with other district and regional level GHG inventories in New Zealand. This difference is especially relevant for the Agriculture sector.

3.0 Community Carbon Footprint for 2020/21

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

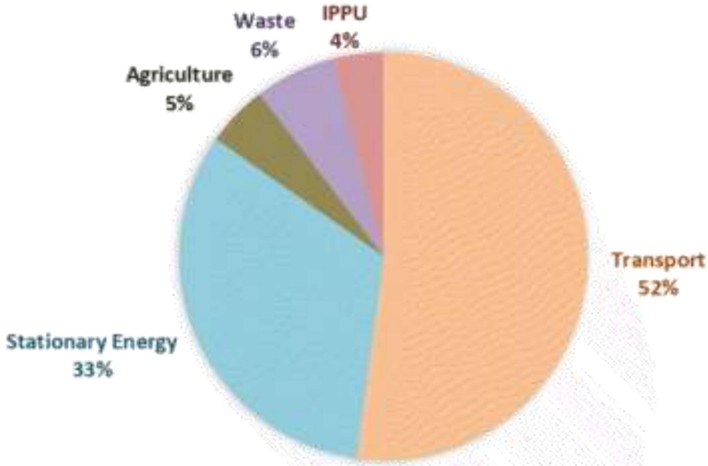
During the 2020/21 reporting period, Napier emitted **gross** 457,725 tCO_2e. Note that gross emissions do not account for Forestry. Transport and Stationary emissions are the largest contributors to total gross emissions for the city.

The population of Napier in 2020/21 was approximately 66,450 people, resulting in per capita gross emissions of 6.9 tCO_2e/person. Discussion of per capita emissions is limited to when it is useful for comparing emission figures against other territorial authorities. A breakdown of net emissions (i.e. including results from Forestry resources) is reported separately.

Table 1 Total net and gross emissions

Total emissions	tCO_2e
Total Net Emissions (including forestry)	458,157
Total Gross emissions (excluding forestry)	457,725

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



During the 2020/21 reporting period, Napier emitted **net** 458,157 tCO_2e.

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting emissions and sequestration) within an area. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes.

The community carbon footprint comprises emissions from six different sectors, summarised below:

3.1 Transport

The highest emitting sector in Napier, Transport, produced 238,626 tCO_2e in 2020/21 (52% of Napier's gross total emissions). Table 2 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 2 Transport energy emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Diesel	120,362	26.3%	50.4%
Petrol	87,710	19.2%	36.8%
Marine Freight	28,890	6.3%	12.1%
Jet Kerosene	969	0.2%	0.4%
LPG	569	0.1%	0.2%
Aviation Gas	100	<0.1%	<0.1%
Rail	26	<0.1%	<0.1%
Total	**238,626**	**52%**	**100%**

Most of Transport emissions can be attributed to diesel and petrol, which produced 120,362 tCO_2e and 87,710 respectively (collectively 87% of the sector's emissions and 46% of total gross emissions). Diesel and petrol transport emissions are broken down into on-road and off-road use. On-road transport consists of all standard transportation vehicles used on roads (including cars, trucks, buses, etc.). Off-road transport consists of all fuel used for the movement of machinery and vehicles off roads (including agricultural tractors and vehicles, forklifts, etc.). On-road transport produced 184,805 tCO_2e (77% of Transport emissions) and Off-road transport produced 23,836 tCO_2e (10% of Transport emissions). An extra breakdown of on-road emissions by vehicle type and class is provided separate to this report.

The next largest emission source for Napier is marine freight, which contributed to 12% of the sectors emissions and 6% of total gross emissions (28,890 tCO_2e). Marine freight emissions are the result of freight movements to and from the Port of Napier. Emissions from this source have been divided between all territorial authorities in the Hawke's Bay region based on relative population sizes. It is understood that the imports and exports through this port are not exclusively related to activities in the Hawke's Bay region, however, to ensure that these emissions are reflected in community carbon footprints as per the GPC requirements this approach is appropriate.

The remaining Transport emissions are attributed to air travel (jet kerosene and aviation gas), rail freight emissions, and LPG use for transport (e.g. forklifts).

3.2 Stationary Energy

Producing 149,151 tCO_2e in 2020/21, Stationary Energy was Napier's second highest emitting sector (33% of total gross emissions). Table 3 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 3 Stationary Energy emissions by emission source

Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Electricity Consumption	66,569	14.5%	44.6%
Natural Gas	51,095	11.2%	34.3%
Stationary Petrol & Diesel Use	13,426	2.9%	9.0%
Electricity Transmission & Distribution Losses	6,115	1.3%	4.1%
LPG	4,511	1.0%	3.0%
Natural Gas Transmission & Distribution Losses	4,130	0.9%	2.8%
Biofuel / Wood	2,004	0.4%	1.3%
Coal	1,259	0.3%	0.8%
Biogas	42	<0.1%	<0.1%
Total:	**149,151**	**33%**	**100%**

Electricity consumption was the cause of 45% of Stationary Energy emissions (66,569 tCO_2e), and 15% of Napier's total gross emissions (72,684 tCO_2e when including transmission and distribution losses related to the consumption). Natural gas consumption accounted for 34% of the Stationary Energy emissions (55,225 tCO_2e) when including transmission and distribution losses. The industrial sector is the primary consumer of electricity and natural gas in Napier.

Stationary petrol and diesel consumption generated 9% of Stationary Energy emissions (13,426 tCO_2e). Use of LPG, and the burning of coal, biofuels and biogas produced the remaining Stationary Energy emissions.

Stationary Energy demand can also be broken down by the sector in which it is consumed. Stationary Energy demand is reported for the following sectors: commercial; residential and industrial. However, emissions from petrol and diesel used for Stationary Energy are not able to be broken down by sector.

- Industrial Stationary Energy consumption accounts for 53% of Stationary Energy emissions (78,604 tCO_2e) and 17% of total gross emissions. Industrial Stationary Energy is energy used within all industrial settings (including agriculture, forestry and fishing, mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities).
- Residential Stationary Energy consumption accounts for 21% of Stationary Energy emissions (30,735 tCO_2e) and 7% 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 18% of Stationary Energy emissions (26,334 tCO_2e) and 6% 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).
- The remaining 9% of Stationary Energy emissions (13,467 tCO_2e, 3% of gross emissions) were produced by diesel and petrol, and the burning of biogas, which were not allocated to the above categories. Stationary Energy uses of diesel and petrol include stationary generators and motors and for heating.

3.3 Waste

Waste originating in Napier (solid waste, wastewater and compost) produced 29,110 tCO_2e in 2020/21, which comprises 6% of Napier's total gross emissions. Table 4 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 4 Waste emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Waste in open landfill sites	18,334	4.0%	63.0%
Composting	4,095	0.9%	14.1%
Waste in closed landfill sites	3,552	0.8%	12.2%
Wastewater treatment plants	2,689	0.6%	9.2%
Individual septic tanks	440	0.1%	1.5%
Total:	**29,110**	**6%**	**100%**

Solid waste produced the bulk of waste emissions (21,885 tCO_2e in 2020/21), making up 75% of total Waste emissions. Solid waste emissions include emissions from open landfills and closed landfills. Open landfill sites produced 18,334 tCO_2e and emissions from closed landfill sites produced 3,552 tCO_2e in 2020/21. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill. However, annual emissions from closed landfill sites will decrease over time as no new waste enters these sites. Waste from Napier is sent to Omarunui Landfill which is located within the Hastings geographic boundary but these emissions are still included in Napier's footprint.

Composting is the second largest source of emissions in Napier, accounting for 14% of total waste emissions (4,095 tCO_2e in 2020/21). Waste diverted from landfill for composting in the Hawke's Bay Region includes horticultural, animal waste products, green waste, bark and sawdust.

Wastewater treatment (treatment plants and individual septic tanks) produced 3,130 tCO_2e making up 11% of total Waste emissions. More than half of households in Napier are connected to wastewater treatments plants, which produced total emissions of 2,689 tCO_2e. Households connected to individual septic tanks produced 440 tCO_2e in wastewater emissions. Due to the production of methane, septic tanks have a higher emissions intensity compared to the wastewater treatments plants in Napier.

Wastewater treatment tends to be a 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.

3.4 Agriculture

Agriculture emitted 22,462 tCO_2e in 2020/21 (5% of Napier's gross emissions). Table 5 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emissions source.

Agricultural emissions are the result of both livestock and crop farming. Enteric fermentation from livestock produced 78% of Napier's agricultural emissions (17,511 tCO_2e). Enteric fermentation GHG emissions are produced by methane (CH_4) released from the digestive process of ruminant animals (e.g. cattle and sheep). The second highest source of Agricultural emissions was produced from nitrous oxide (N_2O) released by unmanaged manure from grazing animals on pasture (2,604 tCO_2e or 12% of the agricultural sector's emissions).

Table 5 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Enteric fermentation	17,511	3.8%	78.0%
Manure from Grazing Animals	2,604	0.6%	11.6%
Other Agriculture Emissions	912	0.2%	4.1%
Atmospheric Deposition	709	0.2%	3.2%
Fertiliser used in Horticulture	454	0.1%	2.0%
Manure Management	222	<0.1%	1.0%
Agricultural Soils	49	<0.1%	0.2%
Total	**22,462**	**5%**	**100%**

Livestock were responsible for the majority of the Agriculture sector's GHG emissions (97%, or 21,920 tCO_2e) (Table 6). Sheep account for 57% of agricultural emissions and non-dairy cattle account for 40% of agricultural emissions in Napier.

Table 6 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Sheep	12,898	2.8%	57.4%
Non-dairy Cattle	8,951	2.0%	39.8%
Fertiliser for Horticulture	454	0.1%	2.0%
Fertiliser (other)	87	<0.1%	0.4%
Other Livestock	71	<0.1%	0.3%
Total	**2,462**	**5%**	**100%**

Fertilisers used for livestock and horticulture represent 2.4% of Agriculture emissions. An additional breakdown of emissions from fertiliser use in horticulture is included based on land-use information provided by HBRC. Fertiliser use in horticulture represented 2% of the sector emissions. The largest contributor to 'Fertiliser for Horticulture' in Napier was sweetcorn (249 tCO_2e, 55% of Fertiliser for Horticulture emissions). There is some potential for emissions double counting between the 'Fertiliser for Horticulture' and 'Fertiliser (other)' as these emissions have been calculated based on different datasets, where the 'Fertiliser (other)' category may also include some fertilisers used in horticulture. However, it is expected that the majority of the 'Fertiliser (other)' emissions are caused by fertiliser use for livestock land. Changes in soil carbon associated with horticulture have not been quantified due to absence of a defined appropriate method for assessing the carbon footprint associated with soil carbon change over time.

3.5 Industrial Processes and Product Use (IPPU)

IPPU in Napier produced 18,377 tCO_2e in 2020/21, contributing 4% to Napier's total gross emissions. 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. IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g. coal, electricity and/or petrol and diesel). These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to particular geographic locations. Addressing IPPU emissions is typically a national policy issue.

There are no known industrial processes (as defined in the GPC requirements) present in Napier (e.g. aluminium manufacture).

Table 7 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source. The most significant contributor to IPPU emissions is the use of refrigerants which produced 93% of IPPU emissions (17,086 tCO_2e).

Table 7 Industrial processes and product use emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Refrigerants and air conditioning	17,086	3.7%	93.0%
Aerosols	957	0.2%	5.2%
SF6 - Electrical Equipment	187	<0.1%	1.0%
Foam Blowing	81	<0.1%	0.4%
SF6 - Other	37	<0.1%	0.2%
Fire extinguishers	29	<0.1%	0.2%
Total	**18,377**	**4.0%**	**100.0%**

3.6 Forestry

Planting of native forest (e.g. mānuka and kānuka) and exotic forest (e.g. pine), sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. Harvesting of forest emits emissions via the release of carbon from organic matters and soils following harvesting. When sequestration by forests exceeds emissions from harvesting in a particular year, the extra quantity of carbon sequestered by forest reduces total gross emissions for that year. Conversely when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then total gross emissions will increase.

Sequestration in 2020/21 was 1,356 tCO_2e (which was mostly from exotic forestry) while harvesting emissions were 1,788 tCO_2e. This meant that Forestry in Napier was a net positive source of emissions in 2020/21 (rather than a negative source of emissions, where sequestration exceeds harvesting). Total Forestry emissions in 2020/21 were 432 tCO_2e. It is noted that harvesting of exotic forest can be cyclical in nature where some years will have higher sequestration and some years will have higher harvesting emissions determined by age of forests, commercial operators, and the global market.

Table 8 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO_2e
Total harvest emissions	1,788
Native forest sequestration	-404
Exotic forest sequestration	-952
Total	**432**

3.7 Total Gross Emissions by Greenhouse Gas

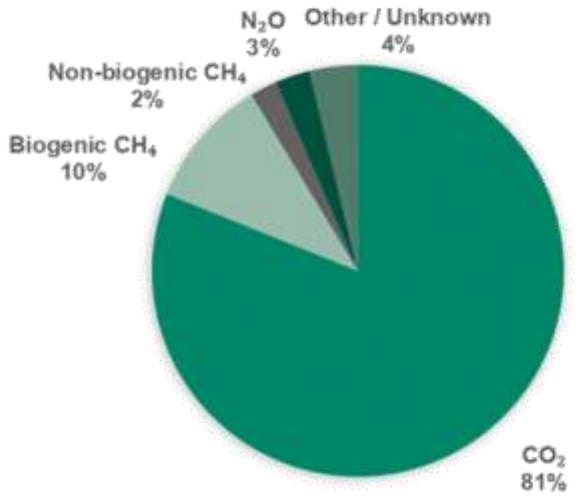
Each greenhouse gas has a different level of impact on climate change, this is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e).

Table 9: Napier's total gross emissions, by greenhouse gas

Greenhouse Gas	Tonnes	Tonnes of CO_2e
Carbon Dioxide (CO_2)	371,206	371,206
Biogenic Methane (CH_4)	1,379	46,881
Non-biogenic Methane (CH_4)	287	9,761
Nitrous Oxide (N_2O)	42	12,543
Other / Unknown Gas (in CO_2e)	17,334	17,334
Total	**390,248**	**457,725**

Figure 4 illustrates Napier's total gross emissions by greenhouse gas in units of carbon dioxide equivalents (CO_2e).

Figure 4: Napier's total gross emissions, by greenhouse gas (in tCO_2e)



By far the largest source of emissions in tonnes is carbon dioxide (CO_2) at 371,206 tonnes. Due to the greater global warming impact of methane, methane represents 0.4% of the total tonnage of GHG emissions from Napier but represents 12% of CO_2e. Nitrous oxide represents <0.1% of the total tonnage of GHG emissions from Napier but represents 3% of CO_2e.

3.8 Biogenic emissions

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

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

Table 10: Biogenic CO_2 in Napier (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO_2) (Excluded from gross emissions)		
Biofuel	65,637	t CO_2
Landfill Gas	6,455	t CO_2
Total Biogenic CO_2	**72,092**	**t CO_2**

Biogenic CH_4 emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large impact on global warming relative to biogenic CO_2. Biogenic methane represents 0.4% of the gross total tonnage of GHG emissions in Napier but represents 10% of total gross GHG emissions when expressed in CO_2e. This is caused by the higher global warming impact of methane per tonne, compared to carbon dioxide. The total tonnage of each GHG and the contribution of each GHG to total gross emissions when expressed in CO_2e is shown in Table 9.

The importance of biogenic CH_4 is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes specific targets to reduce biogenic CH_4 by between 24% and 47% below 2017 levels by 2050, and by 10% below 2017 levels by 2030. More information on the Act is available here: https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act.

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

Biogenic Methane (CH_4) (Included in gross emissions)		
Landfill Gas	644	t CH4
Enteric fermentation	515	t CH4
Wastewater Treatment	91	t CH4
Composting (Green Waste)	70	t CH4
Biofuel	53	t CH4
Manure Management	7	t CH4
Total Biogenic CH_4	**1,379**	**t CH4**

3.9 Territorial Authorities in the Hawke's Bay Region

The Hawke's Bay regional area contains several territorial authorities. Hastings District, Napier City, Central Hawkes Bay District, and Wairoa District are all exclusively within the boundaries of the Hawke's Bay region. Additionally, areas of Taupō District and Rangitīkei District are also part of the Hawke's Bay region. We estimate that 0.1% of Taupō's population and 12% of Taupō's area, and 0.3% of Rangitīkei's population and 14% of Rangitīkei's area are within the Hawke's Bay region.

Figure 5 shows the Hawke's Bay's total gross emissions divided by territorial authority. Figure 6 shows total gross emissions for the territorial authorities in the Hawke's Bay Region, split by sector. Both figures only include the emissions produced within the Hawke's Bay region for Taupō and Rangitīkei.

Hastings is the highest emitting territorial authority in the region, representing 43% of the Hawke's Bay's total gross emissions. Hastings' emissions inventory is predominantly agriculture-related emissions with the next largest emitting territorial authorities; Central Hawke's Bay and Wairoa, also containing significant agricultural emissions. Of the four territorial authorities entirely within the Hawke's Bay region, Napier has the lowest total gross emissions, with emissions mostly from Transport and Stationary Energy. The areas of Taupō and Rangitīkei contribute to 2% of the Hawke's Bay region's total gross emissions, almost entirely from Agriculture.

Figure 5 Hawke's Bay's total gross emissions divided by territorial authority (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.

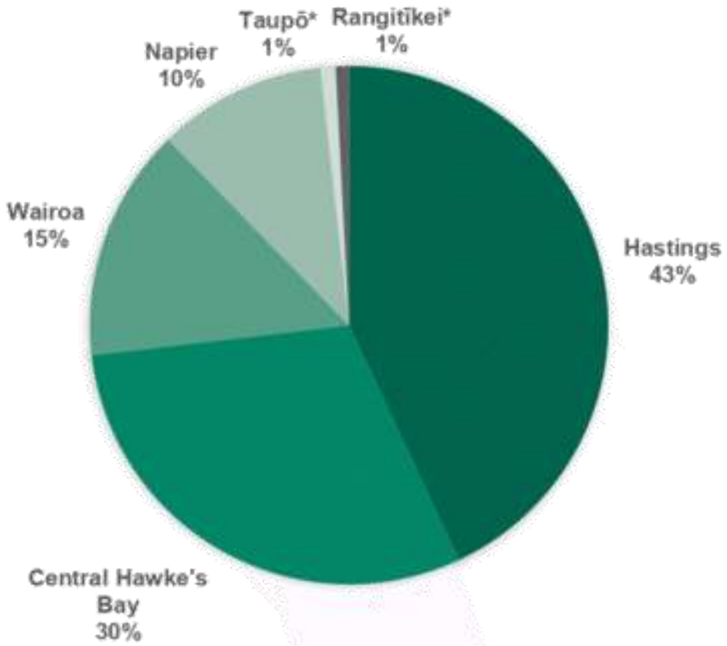
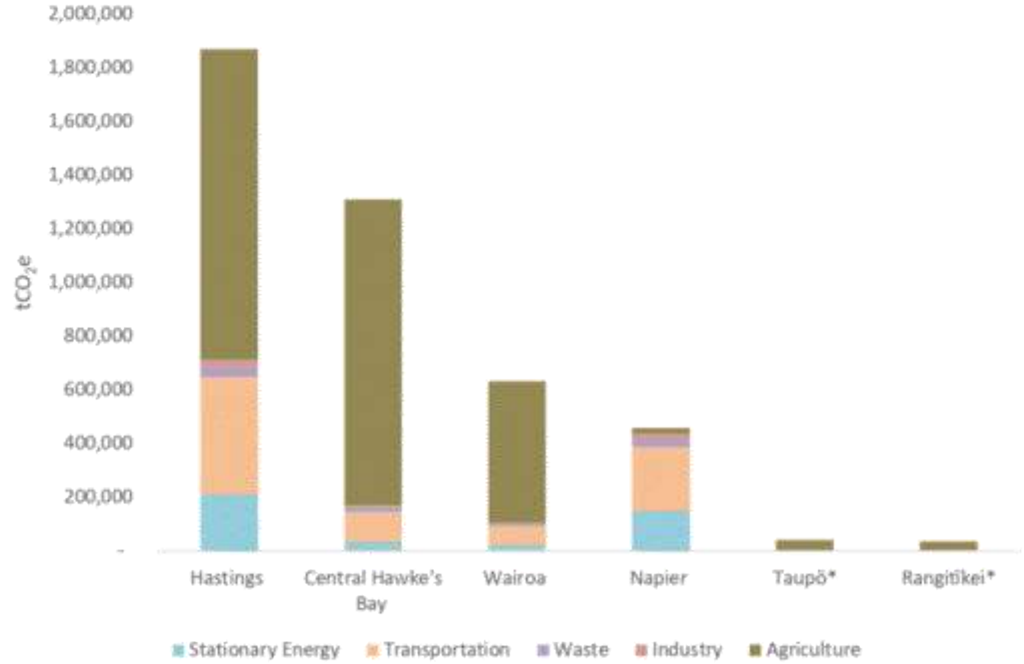


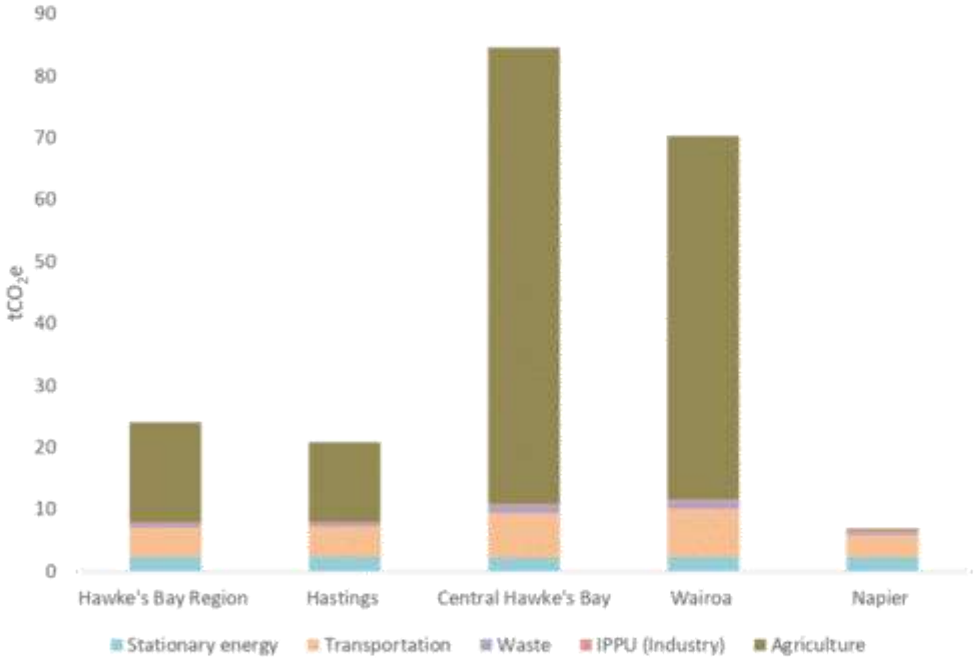
Figure 6 Total gross emissions by territorial authority in the Hawke's Bay region (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.



When comparing emissions inventories from different areas, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. Figure 7 shows emissions per capita for the region and territorial authorities within the region. Taupō and Rangitīkei are excluded from this figure due to the tiny population and large agriculture within the small area in the Hawke's Bay creating very large per capita emissions (this is not the case for the entire Taupō or Rangitīkei district).

The Hawke's Bay region has a 24.1 tCO_2e/per capita figure for total gross emissions which is higher than the national value of 15.7 tCO_2e/per capita. Napier has the lowest per capita total emissions at 6.9 tCO_2e/per capita. Central Hawke's Bay and Wairoa have the largest per capita total gross emissions at 84.6 tCO_2e/per capita and 70.3 tCO_2e/per capita respectively, both due to high Agriculture emissions in the district. Hastings has the third highest per capita emissions at 20.9 tCO_2e/per capita, similar to that of the region. Notably, Napier's per capita emissions for Transport, Stationary Energy and Waste are the lowest of the four districts entirely within the Hawke's Bay region.

Figure 7 Total gross emissions per capita for the region and territorial authorities within the region (tCO_2e). *Taupō and Rangitīkei areas not included



4.0 Emissions change from 2018/19 to 2020/21

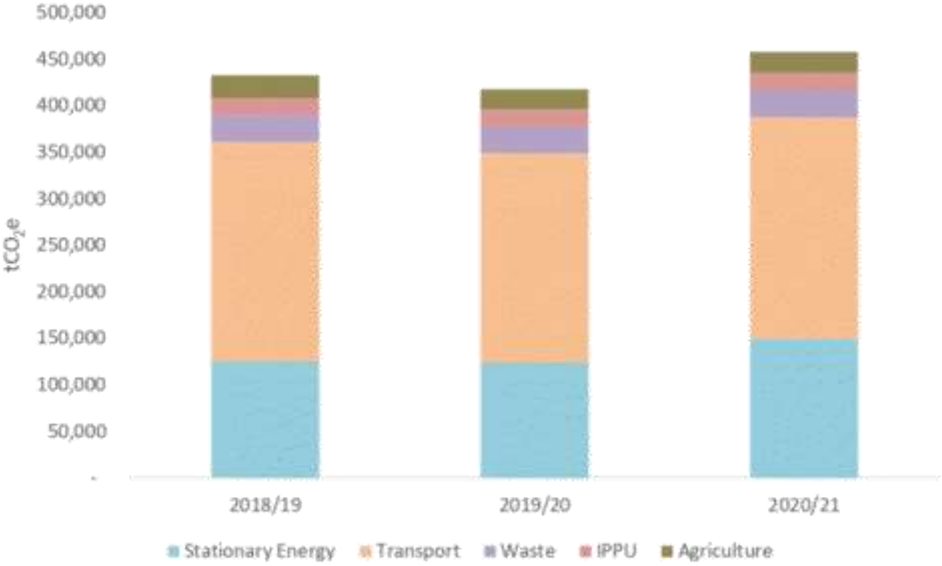
Alongside calculating Napier's emissions footprint for 2020/21, we have calculated Napier's emissions footprint for 2018/19 and 2019/20. This section displays the results of the 2018/19, 2019/20, and 2020/21 emissions footprints with a focus on gross emissions and documents the change in emissions from 2018/19 to 2020/21.

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

Table 12 Change in Napier's Total Gross and Net emissions from 2018/19 to 2020/21

	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total Net Emissions (including forestry)	433,696	418,384	458,157	6%
Total Gross Emissions (excluding forestry)	432,811	417,678	457,725	6%

Figure 8 Change in Napier's total gross emissions from 2018/19 to 2020/21

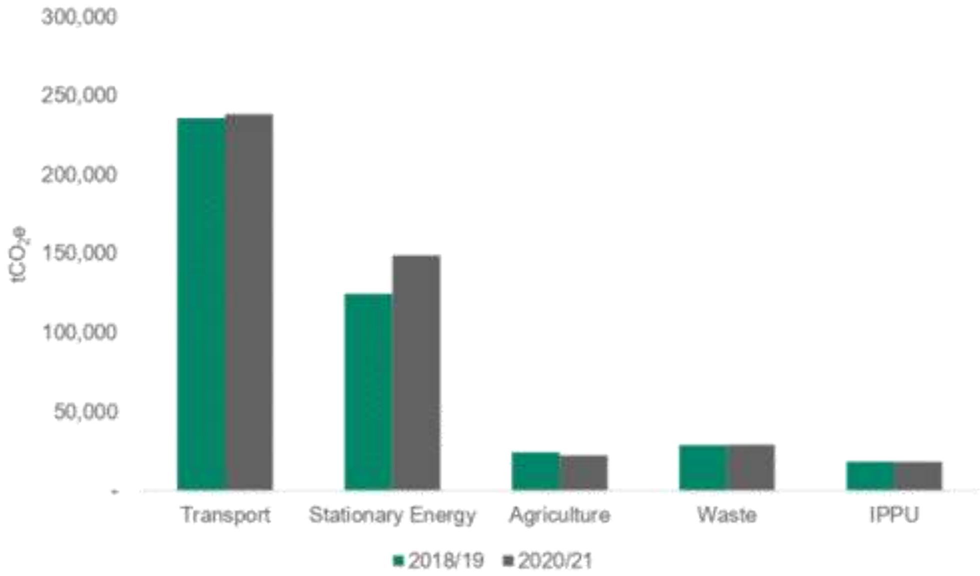


Annual total gross emissions increased by 6% from 432,811 tCO_2e in 2018/19 to 457,725 tCO_2e in 2020/21. Annual total net emissions in Napier increased by 6% from 433,696 in 2018/19 to 458,157 tCO_2e. The increase in both total gross and total net emissions was driven by an increase in Stationary Energy primarily related to the increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).

The population of Napier grew by 3% between 2018/19 and 2020/21. This resulted in a 3% increase in per capita emissions between 2018/19 and 2020/21, from 6.7 to 6.9 tCO_2e per person per year. A discussion of the decoupling of gross emissions from population growth and GDP is found in Section 5.0.

The sections below outline the change in emissions between 2018/19 and 2020/21 for each sector and emissions source, highlighting the changes that have had the largest impact on total gross emissions.

Figure 9 Emissions for each sector of Napier's gross emissions footprint for 2018/19 and 2020/21



4.1 Transport

Table 13 Change in Napier's Transport emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Diesel	109,832	107,575	120,362	10%
Petrol	87,790	82,157	87,710	-0.1%
Marine Freight	33,786	33,576	28,890	-14%
Rail	2,599	42	26	-99%
Jet Kerosene	1,423	1,220	969	-32%
LPG	544	547	569	5%
Aviation Gas	82	97	100	22%
Total:	**236,054**	**225,213**	**238,626**	**1%**

Transport emissions increased by 1% between 2018/19 and 2020/21 (2,572 tCO_2e). This was driven by a 5% increase in on-road fuel emissions (8,462 tCO_2e).

It is noted that the impact of the COVID-19 pandemic can be seen in Transport emissions where emissions decreased by 5% between 2018/19 and 2019/20 due to reductions in road, marine freight, air transport fuel use. Aviation emissions continued to reduce in the 2020/21 reporting year, reflective of ongoing COVID-19 impacts to the industry.

4.2 Stationary Energy

Table 14 Change in Napier's Stationary Energy emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Natural Gas	49,575	47,629	51,095	3%
Electricity Consumption	46,407	47,322	66,569	43%
Stationary Petrol & Diesel Use	12,307	12,027	13,426	9%
LPG	4,308	4,337	4,511	5%
Electricity Transmission and Distribution Losses	4,052	4,148	6,115	51%
Natural Gas Transmission and Distribution Losses	4,007	3,850	4,130	3%
Coal	2,164	2,367	1,259	-42%
Biofuel / Wood	2,016	2,009	2,004	-1%
Biogas (landfill)	40	41	42	4%
Total:	**124,877**	**123,729**	**149,151**	**19%**

Emissions from Stationary Energy increased by 19% between 2018/19 and 2020/21 (24,274 tCO_2e). This was driven by a 43% increase in electricity consumption emissions (20,163 tCO_2e). The increase in electricity consumption emissions was due to a 2% increase in energy consumption (kWh) and a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh). The emissions intensity of the national grid has increased in recent years due to the increased use of fossil fuels during years with low hydro electricity generation. Emissions from industrial energy use is the largest driver in the increase in stationary emissions (9,875 tCO_2e).

4.3 Waste

Table 15 Change in Napier's Waste emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Open Landfill	17,679	17,941	18,334	4%
Composting	4,095	4,095	4,095	*NA*
Closed Landfill	3,943	3,741	3,552	-10%
Wastewater treatment plants	2,856	2,354	2,689	-6%
Individual septic tanks	429	435	440	3%
Total	**29,001**	**28,566**	**29,110**	**0.4%**

Total Waste emissions remained relatively unchanged between 2018/19 and 2020/21.

Total solid waste in landfill emissions changed by just 0.4% (264 tCO_2e). Emissions from waste in open landfills increased as the volume of waste entering the landfill increased up until 2020, and waste recently deposited in landfill reaches peak emissions per year (this is after approximately two years in landfill). Emissions from closed landfills decreased due to no extra waste being added, the existing waste in landfill releases fewer emissions over time. Due to data only being available for one singular year, no change in composting emissions is recorded.

Total wastewater emissions decreased by 5% (155 tCO_2e), this is due to a slight decrease in emissions from centralised wastewater treatment (167 tCO_2e).

4.4 Agriculture

Table 16 Change in Napier's Agriculture emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Enteric Fermentation	18,978	16,905	17,511	-8%
Manure from Grazing Animals	2,830	2,514	2,604	-8%
Other Agriculture Emissions	999	887	912	-9%
Atmospheric Deposition	772	686	709	-8%
Fertiliser used in Horticulture	454	454	454	0%
Manure Management	241	214	222	-8%
Agricultural Soils	64	56	49	-24%
Total	**24,339**	**21,716**	**22,462**	**-8%**

The Agriculture sector's emissions decreased by 8% between 2018/19 and 2020/21 (1,878 tCO_2e). This decrease is driven by a reduction in total livestock numbers, especially of sheep and non-dairy cattle (see Table 17).

Emissions related to sheep decreased by 1,348 tCO_2e due to a reduction in the number of sheep (2,459 sheep). Emissions related to non-dairy cattle decreased by 503 tCO_2e due to a reduction in the number of non-dairy cattle (254 cattle).

Table 17 Change in Napier livestock numbers from 2018/19 to 2020/21

	Number of animals (2018/19)	Number of animals (2020/21)	Change in number of animals (2018/19 to 2020/21)
Sheep	25,990	23,531	-2,459
Non-dairy Cattle	3,744	3,490	-254
Other livestock	87	86	-1
Total livestock	**29,821**	**27,107**	**-2,714**

Table 18 Change in Napier's livestock-associated Agriculture emissions from 2018/19 to 2020/21

	2018/19 emissions (tCO_2e)	2020/21 emissions (tCO_2e)	% Change in emissions (2018/19 to 2020/21)
Sheep	14,246	12,898	-9%
Non-dairy Cattle	9,454	8,951	-5%
Other livestock	70	71	1%
Total livestock	**23,770**	**21,920**	**-8%**

4.5 Industrial Processes and Product Use (IPPU)

Table 19 Change in Napier's IPPU emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Refrigerants and air conditioning	17,148	17,121	17,086	-0.4%
Aerosols	1,079	1,002	957	-11%
SF6 - Electrical Equipment	170	183	187	10%
Foam Blowing	75	81	81	7%
SF6 - Other	36.9	36.8	36.7	-1%
Fire extinguishers	30	30	29	-1%
Total	**18,540**	**18,453**	**18,377**	**-1%**

IPPU emissions decreased between 2018/19 and 2020/21, by 1% (162 tCO_2e). The decrease in IPPU emissions is mainly caused by a decrease in aerosols. Note that national level data is used for this sector and is portioned out using a population approach; exact emissions for the city are unknown.

4.6 Forestry

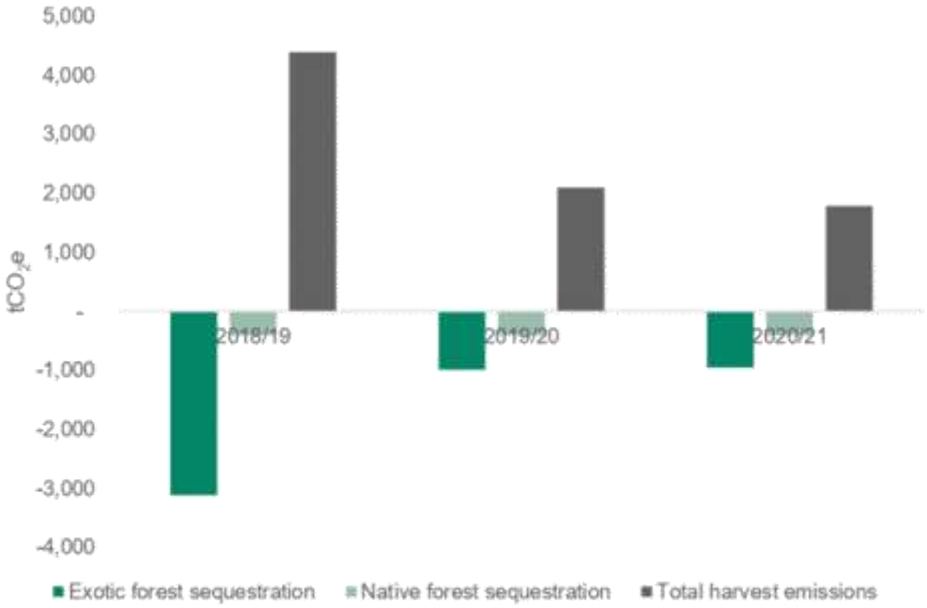
Table 20 Change in Napier's Forestry emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total harvest emissions	4,401	2,099	1,788	-59%
Native forest sequestration	-404	-404	-404	0%
Exotic forest sequestration	-3,112	-990	-952	-69%
Total	**885**	**705**	**432**	**-51%**

Forestry emissions decreased by 453 tCO_2e (51%) between 2018/19 and 2020/21. This decrease was driven by a decrease in total harvest emissions (2,613 tCO_2e) as less exotic forest is harvested. During this time, sequestration also decreased due to a reduction in the extent of exotic forest.

Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes where some years will have higher sequestration and some years will have higher harvesting emissions. This is dependent on age of forests and the demand for lumber and timber. This decrease in Napier harvesting emissions during this period is reflective a decrease in forestry harvesting across the region. Improved and updated data sources may impact the estimation of emissions from this source in the future. Sequestration by native forest remained relatively unchanged during this time.

Figure 10 Forestry sequestration and harvesting emissions from 2018/19 to 2020/21



5.0 Decoupling of GHG emissions from population growth and GDP

Figure 11 shows the changes in gross emissions when compared to changes in other metrics of interest between 2018/19 and 2020/21. For example, total gross emissions have increased by 6%, whilst population in Napier has increased by 3%, resulting in a 3% increase in total gross emissions per capita. Similarly, Gross Domestic Product (GDP) in Napier has increased by 5%, resulting in a 0.5% increase in the GHG emissions ratio to GDP.

When emissions grow less rapidly than GDP (a measure of income) this process is known as decoupling. The term decoupling is an expression of the desire to mitigate emissions without harming economic wellbeing. A full discussion of decoupling of emissions is beyond the scope of this project. However, the changes in emissions and GDP illustrated in Figure 11 and discussed above, suggest at a high-level decoupling has occurred between 2018/19 and 2020/21.

The exact drivers for the decoupling of emissions from GDP are difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transportation and housing will all contribute. In this case, both direct local actions (e.g. landfill gas reductions) and indirect national trends (e.g. changes to emissions from electricity generation) will have contributed to trends noted.

Figure 11 Change in total gross emissions compared to other metrics of interest

6.0 Impact of the COVID-19 pandemic on GHG Emissions

COVID-19 impacted New Zealand and the entire world during 2020 and 2021; causing widespread government-imposed restrictions on businesses and individuals and huge shifts in behaviours and economic markets. Restrictions in New Zealand relating to COVID-19 began in mid-March 2020 with many personal and business restrictions continuing past the end of 2019/20 and throughout 2020/21.[3]

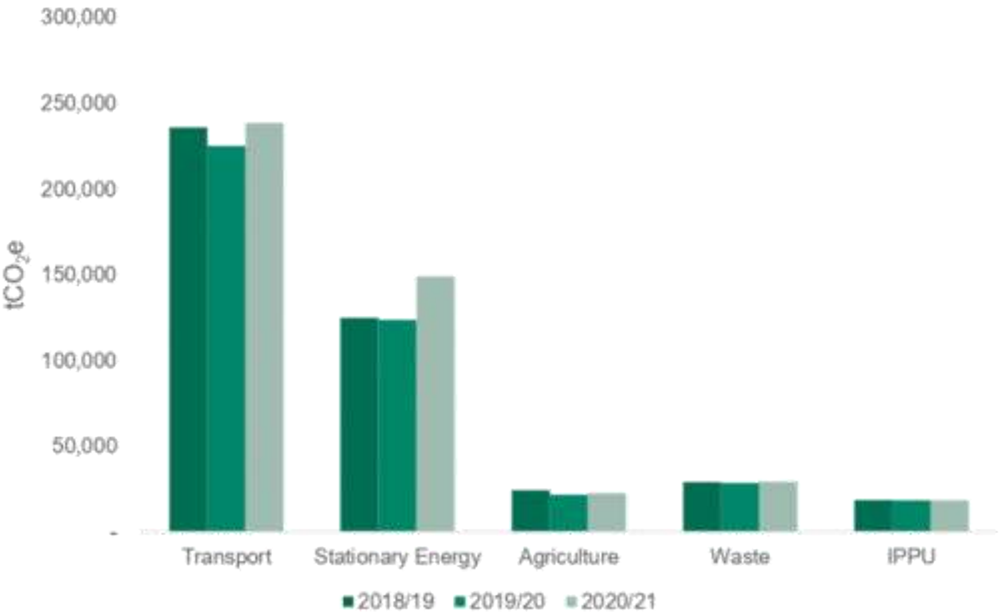
Globally, carbon dioxide emissions from fossil fuels (the largest contributor to greenhouse gas emissions) in 2020 decreased by 7% compared to 2019[4]. Emissions from the transportation sector account for the largest share of this decrease. Surface transport, e.g. car journeys, fell by approximately half at the peak of COVID-19 restrictions in April 2020 (when restrictions were at their maximum, particularly across Europe and the U.S. Globally, emissions recovered to near 2019 levels and are expected to continue to increase.

In New Zealand, national daily carbon dioxide emissions are estimated to have fallen by up to 41% during the level 4 lockdown in April 2020[5]. National gross emissions decreased by 3% from 2018/19 to 2019/20, which was largely driven by a decrease in fuel use in road transport due to COVID-19 pandemic restrictions, a decrease in fuel use in manufacturing industries and construction due to COVID-19 restrictions, and a decrease in fuel use from domestic aviation also due to COVID-19 restrictions.

Total gross emissions in Napier decreased by 15,132 tCO_2e (3%) between 2018/19 and 2019/20. Total gross emissions then increased by 40,047 tCO_2e (10%) between 2019/20 and 2020/21.

The impact on emissions in different sectors varied. Notably, Transport emissions reduced by 5% between 2018/19 and 2019/20, driven by reduced road and air transport fuel use. Despite changes in Stationary Energy, Agriculture, Waste, and IPPU emissions, these sectors are not judged to have been significantly affected by the COVID-19.

Figure 12 Napier emissions per sector for 2018/19, 2019/20, and 2020/21 (tCO_2e)



[3] https://covid19.govt.nz/alert-system/history-of-the-covid-19-alert-system/
[4] Pierre Friedlingstein et al. - Global Carbon Budget 2020 (2020)
[5] Corinne Le Quere et al. – Temporary Reduction in Daily Global CO_2 Emissions During the COVID-19 Forced Confinement

7.0 Closing Statement

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

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

Understanding of the extensive and long-lasting effects of climate change is improving all the time. It is recommended that this emissions footprint be updated regularly (every two or three years) to inform ongoing positive decision making to address climate change issues.

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

8.0 Limitations

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Appendix A

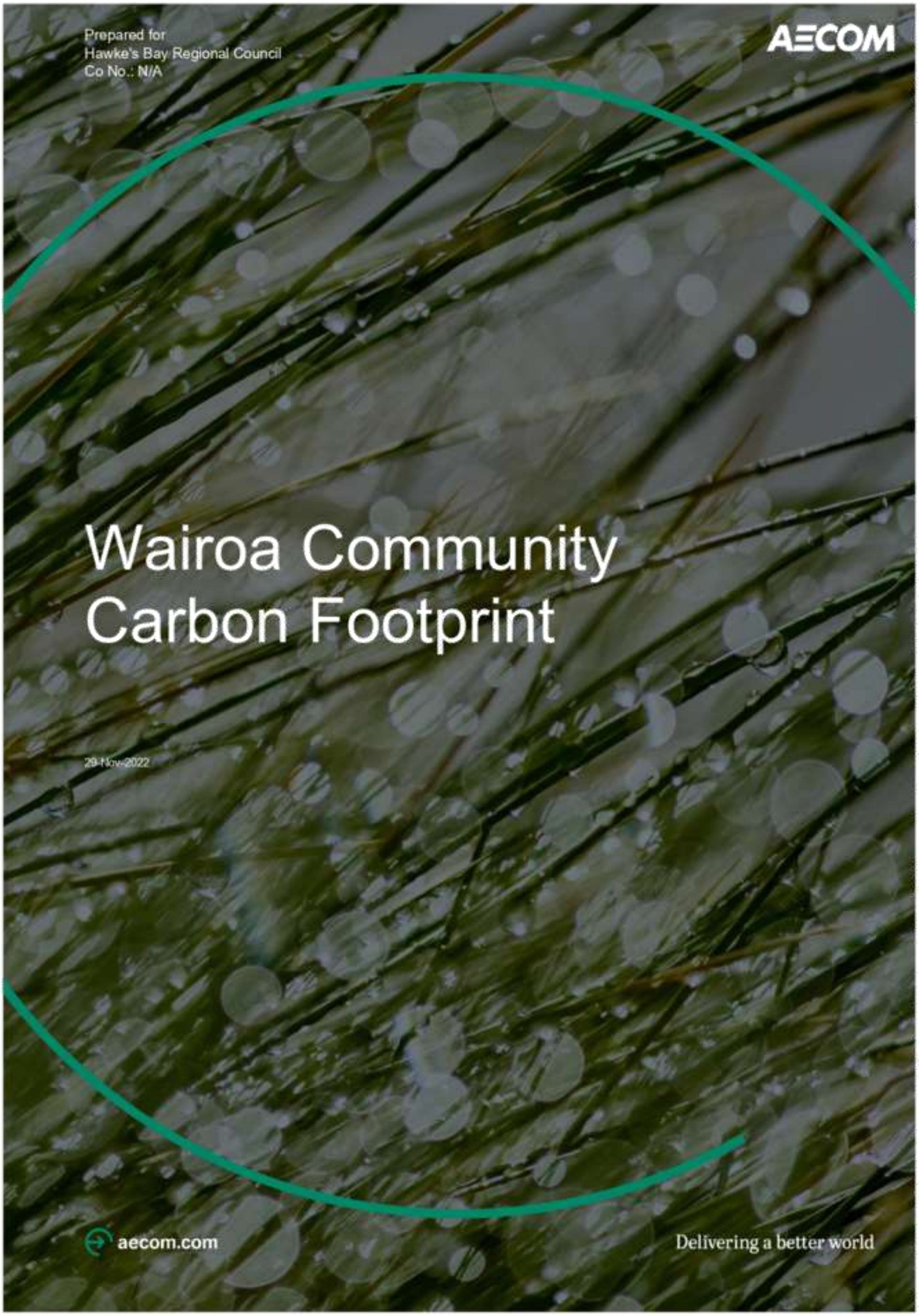
Assumptions and Data Sources

Sector / Category	Assumption and Data Sources
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied. The emissions footprint for the Hawke's Bay Region covers the entirety of the Hawke's Bay Region (this excludes some of the Rangitikei and Taupō territorial authorities). Emissions footprints for each territorial authority covers the entirety of the territorial authority area.
Population	Population figures are provided by StatsNZ. Financial year populations have been used, these are based on the average population from the two calendar years (e.g. the average of 2018 and 2019 calendar year populations for FY19). The population of Taupo and Rangitikei Districts within the Hawke's Bay geographical boundary has been calculated.
Transport Emissions	
Petrol and Diesel:	Petrol and diesel sales data provided by Napier City Council for Napier, Central Hawkes Bay and Hastings. Combined sales data for Gisborne and Wairoa provided by Gisborne District Council and allocated to a region based on Waka Kotahi emissions data. Sales have been divided between territorial authorities based on the number of kilometres travelled by vehicles on roads (VKT) in each territorial authority. VKT data provided by Waka Kotahi. The division into transport and stationary energy end use (and within transport into on-road and off-road) has been calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) from the 2019 database. Biofuel sales information provided directly by the supplier.
Rail Diesel	Emissions from fuel use have been calculated and provided by Kiwi Rail. The following assumptions were made: - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. 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 district, arrival district and any district the freight stopped at along the way. If the freight travelled through but did not stop within a district, no emissions were allocated. This data is subject to commercial confidentiality.
Jet Kerosene (Scheduled Flights) Aviation Gas (General Aviation)	Calculated from information provided by Hawke's Bay Airport. Aviation fuel and jet kerosene fuel volumes were provided and emissions have been calculated using these volumes. Emissions have been divided between territorial authorities based the relative population of each territorial authority.

Marine Freight	Shipping schedules have been provided by the Port of Napier. Emissions have been calculated based on ship weight and distance from the origin/destination to Napier. This figure does not include fishing vessels, or vessels with destination to be confirmed. Emissions from freight and international shipping are allocated equally between the origin and destination area emissions footprints. It is expected that imports and exports travelling through the Port of Napier service the entire Hawke's Bay Region. Emissions relating to freight and international shipping emissions have been divided between all Hawke's Bay territorial authorities based on population size.
Marine Fuel (Local)	Non-freight marine fuel use has not been included in this study. Fuel use by Port of Napier-controlled vessels has not been included due to a lack of available information. Most private marine vessels use fuel purchased at vehicle fuel stations. Petrol and diesel used in private marine vessels is included in off-road transportation.
LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. Sales have been divided between territorial authorities on a per capita basis.
Stationary Energy Emissions	
Electricity Demand	Electricity demand has been calculated using grid exit point (GXP) data from the EMI website (www.emi.ea.govt.nz). Reconciled demand has been used as per EMI's confirmation. The territorial authorities serviced by each GXP have been confirmed by the respective electricity suppliers. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per Ministry for the Environment (MfE) data.
Electricity Generation	Electricity generation has been calculated using data from the EMI website (www.emi.ea.govt.nz). Small electricity generation has not been included in this data (e.g. domestic solar generation). This figure only includes electricity that is connected to the national electricity grid, direct users of electricity are not included.
Coal Consumption	National coal consumption data has been provided by MBIE. Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis. Regional industrial coal consumption has been divided between territorial authorities on a per capita basis.
Coal Production and Fugitive Emissions	Not Calculated: There are no active coal mines within the region.
Biofuel Consumption	National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE). Biofuel consumption has been divided between territorial authorities on a per capita basis. Biofuel emissions are broken down into Biogenic emissions (CO_2) and Non-Biogenic emissions (CH_4 and N_2O)

LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG. Sales have been divided between territorial authorities on a per capita basis. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.
Natural Gas Consumption	Natural gas consumption data has been provided by FirstGas. Territorial Authorities supplied by gas from each Point of Connection (POC) have been confirmed by FirstGas. Natural gas consumption has been split into residential, commercial, and industrial consumption based on information provided by PowerCo and national statistics from MBIE. Some POCs supply gas to particular industrial users exclusively, these have been taken into account.
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
Agricultural Emissions	
General	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ). The last territorial authority census was in 2017. Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use since 2017. Territorial authority land-use data provided by HBRC covering horticulture land-use.
Solid Waste Emissions	
Waste in Landfill	Landfill waste volume and end location information has been provided by the respective council departments. Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis. Emissions are allocated to territorial authorities based on where the waste was produced, even if the waste is disposed in landfill outside the territorial authority.
Wastewater Emissions	
Wastewater Volume and Treatment Systems	Information on treated wastewater, and treatment plants has been provided by the respective council departments. Where information is not available, reasonable assumptions have been made and the WaterNZ database has been consulted. The population connected to septic tank systems have been estimated by the respective council departments. Where the population covered by Wastewater treatment plants and septic tanks does not account for the entire population, the remaining population is assigned to septic tanks. Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority.
Industrial Emissions	
Industrial processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the Region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g. fire extinguishers, refrigerants) has been provided by the MfE. Emissions have been allocated to territorial authorities on a per capita basis.

Forestry Emissions	
Exotic Forestry Harvested	Harvested forestry, and forest cover information for each territorial authority has been derived from Landcare Research data. 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.
Exotic Forest	Exotic forest land area for each territorial authority has been provided by Landcare Research.
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 EFs have been applied. AR5 Global Warming Potential (GWP) figures for greenhouse gases have been used accounting for climate change feedbacks.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Wairoa Community Carbon Footprint

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1	27-Sept-2022	Final	Anthony Hume Team Leader - Sustainability	
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3	29-Nov-2022	Final - includes updated infographic (Figure 1)	Anthony Hume Team Leader - Sustainability	

Table of Contents

Executive Summary

Greenhouse Gas (GHG) emissions for the Wairoa District Territorial Area (that is covered by the Wairoa District Council) have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture and Forestry sectors. This document reports greenhouse gas emissions produced in or resulting from activity or consumption within the geographic boundaries of the Wairoa District Territorial Area for the 2020/21 financial reporting year and examines greenhouse gas emissions produced from 2018/19 to 2020/21.

The Wairoa District Territorial Area is referred to hereafter as Wairoa for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

Major findings of the project include:

2020/21 Emissions Footprint

- In the 2020/21 reporting year (1st July 2020 to 30th June 2021), **total gross emissions** in Wairoa were 632,319 1 tCO_2e.
- **Agriculture** (e.g. emissions from livestock and crops) is the largest source of emissions, accounting for 84% of Wairoa's total gross emissions, with enteric fermentation from livestock accounting for 66% of gross emissions.
- **Transport** (e.g. emissions from road and air travel) is the second largest emitting sector in Wairoa, representing 11% of total gross emissions, with petrol and diesel consumption accounting for 10% of gross emissions.
- **Stationary Energy** (e.g. consumption of electricity and natural gas) is the third highest emitting sector in the region, producing 3% of total gross emissions.
- Net **Forestry** emissions were -974,028 in 2020/21 as carbon sequestration (carbon captured and stored in plants or soil by forests) was higher than emissions from forest harvesting (e.g., the release of carbon from roots and organic matter following harvesting).
- The **total net emissions** in Wairoa were -341,709 tCO_2e. Total net emissions include emissions and sequestration from Forestry.

Changes in Emissions, 2018/19 to 2020/21

- Between 2018/19 and 2020/21, **total gross emissions** in Wairoa decreased from 672,467 tCO_2e to 632,319 tCO_2e, a decrease of 6% (40,148 tCO_2e).
- Over this time the population of the district increased by 3%, resulting in **per capita gross emissions** in Wairoa decreasing by 8% between 2018/19 and 2020/21, from 76.8 to 70.3 tCO_2e per person per year.
- Emissions from **Agriculture** decreased by 8%, between 2018/19 and 2020/21 (43,323 tCO_2e), due to a reduction in livestock numbers, particularly of sheep and non-dairy cattle.
- Emissions from **Stationary Energy** increased by 13% between 2018/19 and 2020/21 (2,450 tCO_2e), driven by a 45% increase in electricity consumption emissions (2,118 tCO_2e). This increase in electricity consumption emissions was due to a 3% increase in energy consumption (kWh) and a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).
- **Transport** emissions increased by 1% between 2018/19 and 2020/21 (546 tCO_2e), driven by a 2% increase in on-road fuel emissions (946 tCO_2e). Marine freight and air travel emissions reduced during this period, likely due to the impact of COVID-19.
- Emissions from **Waste** increased by 2% between 2018/19 and 2020/21 (204 tCO_2e).
- Emissions from forest harvesting increased by 52% (499,306 tCO_2e) resulting in the net impact of **Forestry** changing from -1,408,899 tCO_2e to -947,028 tCO_2e.

Figure 1: Wairoa 2020/21 Emissions Footprint

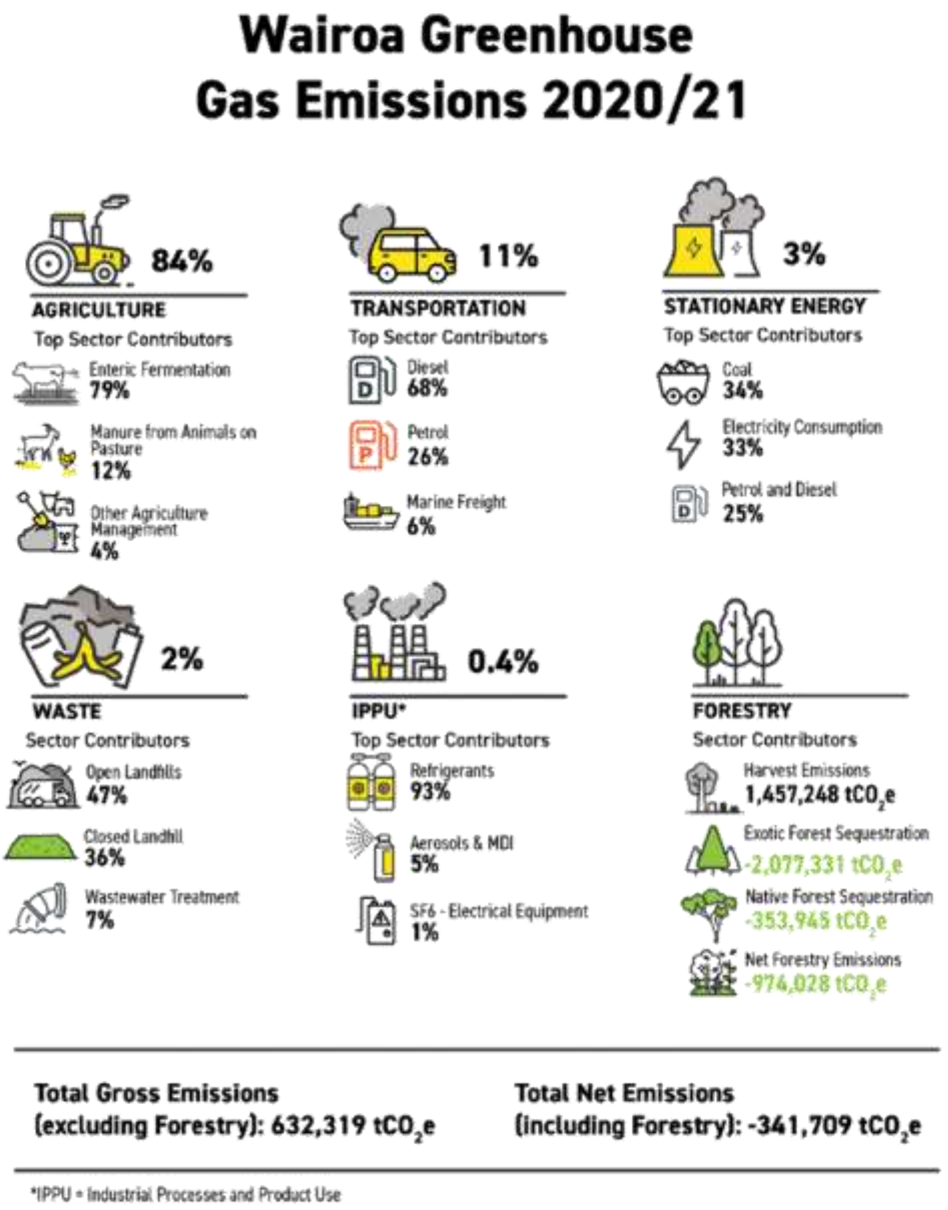
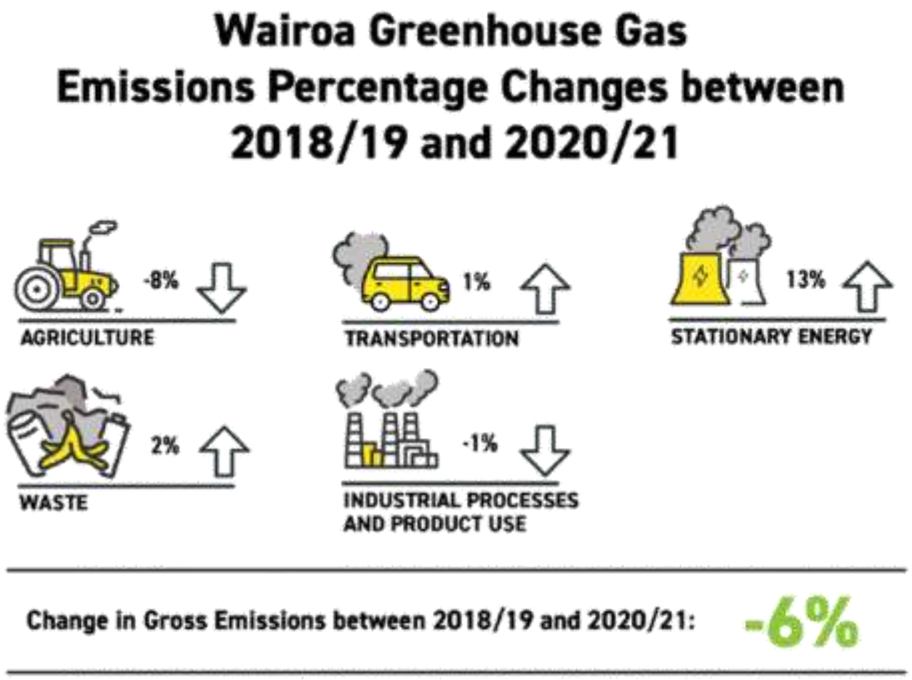


Figure 2: Change in Wairoa Emissions Footprint between 2018/19 and 2020/21



1.0 Introduction

AECOM New Zealand Limited (AECOM) was commissioned by the Hawke's Bay Regional Council to assist in the development of community-scale greenhouse gas (GHG) footprints for the Wairoa District Territorial Area for the 2018/19, 2019/20, and 2020/21 financial years. This is part of a wider study to develop community carbon footprints for each district within the Hawke's Bay region. Emissions are reported for the period from 1 July to 30 June for the respective years. The study boundary reported in the following pages incorporates the jurisdiction of the Wairoa District Council.

The Wairoa District Territorial Area is referred to hereafter as Wairoa for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

2.0 Approach and Limitations

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

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

This emissions footprint assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the 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. flights) and energy transportation and distribution losses fit into Scope 3.

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

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[2]. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs.
- GPC reporting is predominately production-based (as opposed to consumption-based) but includes indirect emissions from energy consumption. Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g. embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.).
- Total emissions are reported as both gross emissions (excluding Forestry) and net emissions (including Forestry).

[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 greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
- Where location specific data were not accessible, information was calculated based on national or regional level data.
- Transport emissions:
  - Transport emissions associated with air travel, rail, and marine fuel were calculated by working out the emissions relating to each journey arriving or departing the area based on data provided by the relevant operators. Emissions for these sources are then split equally between the destination and origin. Emissions relating to a particular point source (e.g. an airport or port) are allocated to the expected users of that source, not just the area that it is located in. For example, in the Hawke's Bay Region, it is expected that all territorial authorities will use the Port of Napier for imported and exported goods, emissions from this source have been allocated to all territorial authorities in the region based on population. It is understood that freight imports moving through the Port of Napier do not exclusively serve the Hawke's Bay Region, and freight exports do not exclusively originate from the Hawke's Bay Region, this should be considered when examining these emissions.
  - All other transport emissions are calculated using the fuel sold in the area (e.g. petrol, diesel, LPG).
- Solid waste emissions:
  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day.
  - Emissions are calculated for waste produced within the geographic boundary, even if they are transported outside the boundary to be entered into landfill.
- Wastewater emissions:
  - Emissions have been calculated based on the local data provided, following IPCC 2019 guidelines. Where data is missing, IPCC and Ministry for the Environment (MfE) figures have been used. Wastewater emissions from both wastewater treatment plants and 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 Processes and Product Use (IPPU) emissions:
  - IPPU emissions are estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2019 report (MfE 2021). Emissions are estimated on a per capita basis applying a national average per person.
- Forestry emissions:
  - This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e. it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
  - The emissions footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.

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

It is important to consider the level of uncertainty associated with the results, particularly given the different datasets used. Depending on data availability, national, regional, and local datasets are used across the different calculators. At the national level, New Zealand's Greenhouse Gas Inventory shows that for 2018 (the most recent national level inventory) an estimate of gross emissions uncertainty was +/- 9%, whereas a net emissions uncertainty estimate was +/- 12%. These levels of uncertainty should be considered when interpreting the results of this community carbon footprint (MfE, 2020).

StatsNZ Regional Footprint

Due to differences in emission factors and methodology used between the StatsNZ Regional Footprints and this community carbon footprint (based on the GPC requirements and available data), caution should be taken when making comparison of reported emissions. One example of this is where this footprint used updated emission factors for methane and nitrous oxide following guidance from the IPCC and in line with other district and regional level GHG inventories in New Zealand. This difference is especially relevant for the Agriculture sector.

3.0 Community Carbon Footprint for 2020/21

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

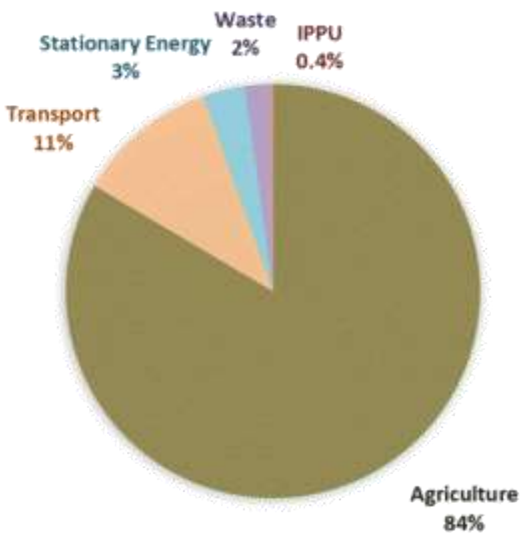
During the 2020/21 reporting period, Wairoa emitted **gross** 632,319 tCO_2e. Note that gross emissions do not account for Forestry. Agriculture and Transport emissions are the largest contributors to total gross emissions for the district.

The population of Wairoa in 2020/21 was approximately 8,995 people, resulting in per capita gross emissions of 70.3 tCO_2e/person. Discussion of per capita emissions is limited to when it is useful for comparing emission figures against other territorial authorities. A breakdown of net emissions (i.e. including results from Forestry resources) is reported separately.

Table 1 Total net and gross emissions

Total emissions	tCO_2e
Total Net Emissions (including forestry)	-341,709
Total Gross emissions (excluding forestry)	632,319

Figure 3: Wairoa District's total gross GHG emissions split by sector (tCO_2e).



During the 2020/21 reporting period, Wairoa emitted **net** -341,709 tCO_2e.

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting emissions and sequestration) within an area. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes.

Carbon sequestered by forestry can be viewed as a liability/risk that needs careful consideration. For example, if plantations are not replanted or other land use change occurs to exotic forested areas, then net emissions may rise quickly. Equally, if native forest is not protected from removal, and removal does happen, then net emissions may rise.

The community carbon footprint comprises emissions from six different sectors, summarised below:

3.1 Agriculture

The highest emitting sector in Wairoa, Agriculture, emitted 527,999 tCO_2e in 2020/21 (Table 2). Agricultural emissions are the result of both livestock and crop farming. Enteric fermentation from livestock produced 79% of Wairoa agricultural emissions (418,083 tCO_2e). Enteric fermentation GHG emissions are produced by methane (CH_4) released from the digestive process of ruminant animals (e.g. cattle and sheep). The second highest source of agricultural emissions was produced from nitrous oxide (N_2O) released by unmanaged manure from grazing animals on pasture (61,099 tCO_2e or 11% of the agricultural sector's emissions).

Table 2 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Enteric fermentation	418,083	66.1%	79.2%
Manure from Grazing Animals	61,099	9.7%	11.6%
Other Agriculture Emissions	22,693	3.6%	4.3%
Atmospheric Deposition	16,878	2.7%	3.2%
Manure Management	6,274	1.0%	1.2%
Agricultural Soils	2,972	0.5%	0.6%
Total	**527,999**	**84%**	**100%**

Livestock were responsible for the majority of the Agriculture sector's GHG emissions (99%, or 522,711 tCO_2e) (Table 3). Sheep account for 50% of agricultural emissions and 42% of gross emissions in Wairoa. Non-dairy cattle account for 44% of agricultural emissions and 37% of gross emissions in Wairoa.

Table 3 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Sheep	262,139	41.5%	49.6%
Non-dairy Cattle	234,354	37.1%	44.4%
Dairy Cattle	15,941	2.5%	3.0%
Other livestock	10,277	1.6%	1.9%
Fertiliser (other)	5,288	0.8%	1.0%
Total	**527,999**	**84%**	**100%**

3.2 Transport

Transport produced 69,785 tCO_2e in 2020/21 (11% of Wairoa gross total emissions). Table 4 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 4 Transport energy emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Diesel	47,574	7.5%	68.2%
Petrol	18,018	2.8%	25.8%
Marine Freight	3,911	0.6%	5.6%
Jet Kerosene	131	<0.1%	0.2%
LPG	77	<0.1%	0.1%
Rail	61	<0.1%	0.1%
Aviation Gas	13	<0.1%	<0.1%
Total	**69,785**	**11%**	**100%**

Most of Transport emissions can be attributed to diesel and petrol, which produced 47,574 tCO_2e and 18,018 respectively (collectively 94% of the sector's emissions and 10% of total gross emissions). Diesel and petrol transport emissions are broken down into on-road and off-road use. On-road transport consists of all standard transportation vehicles used on roads (including cars, trucks, buses, etc.). Off-road transport consists of all fuel used for the movement of machinery and vehicles off roads (including agricultural tractors and vehicles, forklifts, etc.). On-road transport produced 56,400 tCO_2e (81% of Transport emissions) and Off-road transport produced 9,269 tCO_2e (13% of Transport emissions). An extra breakdown of on-road emissions by vehicle type and class is provided separate to this report.

The next largest emission source for Wairoa is marine freight, which contributed to 6% of the sectors emissions (3,911 tCO_2e). Marine freight emissions are the result of freight movements to and from the Port of Napier. Emissions from this source have been divided between all territorial authorities in the Hawke's Bay region based on relative population sizes. It is understood that the imports and exports through this port are not exclusively related to activities in the Hawke's Bay region, however, to ensure that these emissions are reflected in community carbon footprints as per the GPC requirements this approach is appropriate.

The remaining transport emissions are attributed to air travel (jet kerosene and aviation gas), rail freight emissions, and LPG use for transport (e.g. forklifts).

3.3 Stationary Energy

Producing 20,662 tCO_2e in 2020/21, Stationary Energy was Wairoa's third highest emitting sector (3% of total gross emissions). Table 5 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Table 5 Stationary energy emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Coal	7,111	1.1%	34.4%
Electricity Consumption	6,854	1.1%	33.2%
Stationary Petrol & Diesel Use	5,186	0.8%	25.1%
Electricity Transmission and Distribution Losses	630	0.1%	3.0%
LPG	611	0.1%	3.0%
Biofuel / Wood	271	<0.1%	1.3%
Total:	**20,662**	**3%**	**100%**

The burning of coal is the largest Stationary Energy emission source in Wairoa, emitting 34% of the sector's emissions, and 1% of Wairoa's total gross emissions (7,111 tCO_2e). The industrial sector is the primary consumer of coal in Wairoa.

Electricity consumption was the cause of 33% of Stationary Energy emissions (6,854 tCO_2e), and 1% of Wairoa's total gross emissions (7,483 tCO_2e when including transmission and distribution losses related to the consumption). There is no natural gas supply to the Wairoa geographical region.

Stationary petrol and diesel consumption generated 25% of the sectors emissions (5,186 tCO_2e). Use of LPG, biofuels produced the remaining Stationary Energy emissions.

Stationary Energy demand can also be broken down by fuel type, and by the sector in which it is consumed. Stationary Energy demand is reported for the following sectors: commercial; residential and industrial. However, emissions from petrol and diesel used for Stationary Energy are not able to be broken down by sector.

- Industrial Stationary Energy consumption accounts for 51% of Stationary Energy emissions (10,624 tCO_2e) and 2% of total gross emissions. Industrial Stationary Energy is energy used within all industrial settings (including agriculture, forestry and fishing, mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities).
- Residential Stationary Energy consumption accounts for 14% of Stationary Energy emissions (2,881 tCO_2e) and 0.5% 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 10% of Stationary Energy emissions (1,971 tCO_2e) and 0.3% 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).
- The remaining 25% of Stationary Energy emissions (5,186 tCO_2e, 0.8% 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 stationary generators and motors and for heating.

3.4 Waste

Waste originating in Wairoa (solid waste, wastewater and compost) produced 11,385 tCO_2e in 2020/21, which comprises 2% of Wairoa's total gross emissions. Table 6 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source.

Note that it is likely that emissions from solid waste have been overestimated here, due to new data provided which was not available at the time of calculation indicating lower emissions from solid waste. A separate calculation of solid waste emissions with the new data using this methodology will be provided to Wairoa District Council separately.

Table 6 Waste emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Waste in open landfill sites	5,392	0.9%	47.4%
Waste in closed landfill sites	4,069	0.6%	35.7%
Wastewater treatment plants	788	0.1%	6.9%
Individual septic tanks	582	0.1%	5.1%
Composting	554	0.1%	4.9%
Total:	**11,385**	**2%**	**100%**

Solid waste produced the bulk of waste emissions (9,461 tCO_2e in 2020/21), making up 83% of total Waste emissions. Solid waste emissions include emissions from open landfills and closed landfills. Open landfill sites contributed 5,392 tCO_2e and emissions from closed landfill sites produced 4,069 tCO_2e in 2020/21. Both open and closed landfills emit landfill (methane) gas from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill. Annual emissions from closed landfill sites will decrease over time as no new waste enters these sites.

Wastewater treatment (treatment plants and individual septic tanks) produced 1,370 tCO_2e making up 12% of total Waste emissions. More than half of households in Wairoa are connected to wastewater treatments plants, which produced total emissions of 788 tCO_2e. Households connected to individual septic tanks produced 582 tCO_2e in wastewater emissions. Wastewater treatment tends to be a 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.

Composting accounts for 5% of total waste emissions (554 tCO_2e in 2020/21). Waste diverted from landfill for composting in the Hawke's Bay Region includes horticultural, animal waste products, green waste, bark and sawdust.

3.5 Industrial Processes and Product Use (IPPU)

IPPU in Wairoa produced 2,488 tCO_2e in 2020/21, contributing 0.4% to Wairoa's total gross emissions. 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. IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g. coal, electricity and/or petrol and diesel). These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to particular geographic locations. Addressing IPPU emissions is typically a national policy issue.

There are no known industrial processes (as defined in the GPC requirements) present in Wairoa (e.g. aluminium manufacture).

Table 7 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emission source. The most significant contributor to IPPU emissions is the use of refrigerants which produced 93% of IPPU emissions (2,313 tCO_2e).

Table 7 Industrial processes and product use emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Refrigerants and air conditioning	2,313	0.4%	93.0%
Aerosols	130	<0.1%	5.2%
SF6 - Electrical Equipment	25	<0.1%	1.0%
Foam Blowing	11	<0.1%	0.4%
SF6 - Other	5	<0.1%	0.2%
Fire extinguishers	4	<0.1%	0.2%
Total	**2,488**	**0.4%**	**100.0%**

3.6 Forestry

Planting of native forest (e.g. mānuka and kānuka) and exotic forest (e.g. pine), sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. Harvesting of forest emits emissions via the release of carbon from organic matters and soils following harvesting. When sequestration by forests exceeds emissions from harvesting in a particular year, the extra quantity of carbon sequestered by forest reduces total gross emissions for that year. Conversely when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then total gross emissions will increase.

Sequestration in 2020/21 was 2,431,276 tCO_2e (which was mostly from exotic forestry) while harvesting emissions were 1,457,248 tCO_2e. This meant that Forestry in Wairoa was a net negative source of emissions in 2020/21 (rather than a positive source of emissions, where harvesting exceeds sequestration). Total Forestry emissions in 2020/21 were -974,028 tCO_2e. It is noted that harvesting of exotic forest can be cyclical in nature where some years will have higher sequestration and some years will have higher harvesting emissions determined by age of forests, commercial operators, and the global market.

Table 8 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO_2e
Total harvest emissions	1,457,248
Native forest sequestration	-353,945
Exotic forest sequestration	-2,077,331
Total	**-974,028**

3.7 Total Gross Emissions by Greenhouse Gas

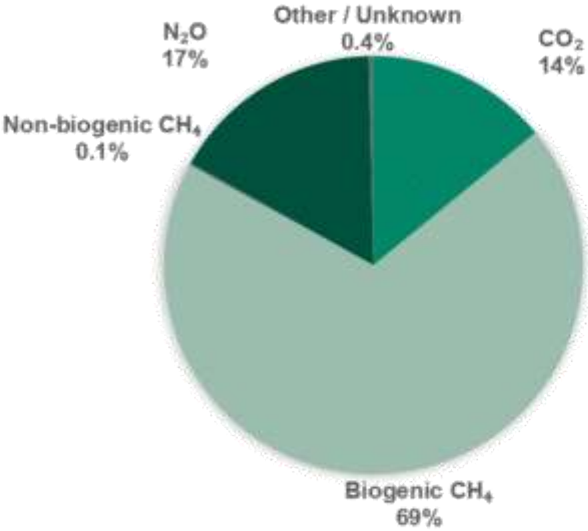
Each greenhouse gas has a different level of impact on climate change, this is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e).

Table 9: Wairoa total gross emissions, by greenhouse gas

Greenhouse Gas	Tonnes	Tonnes of CO_2e
Carbon Dioxide (CO_2)	89,010	89,010
Biogenic Methane (CH_4)	12,814	435,667
Non-biogenic Methane (CH_4)	26	868
Nitrous Oxide (N_2O)	351	104,455
Other / Unknown Gas (in CO_2e)	2,320	2,320
Total	**104,519**	**632,319**

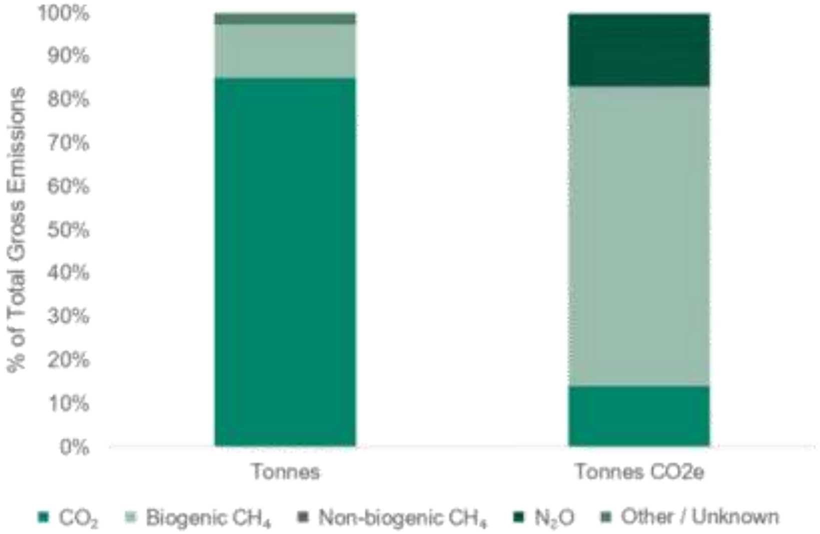
Figure 4 illustrates Wairoa total gross emissions by greenhouse gas in units of carbon dioxide equivalents (CO_2e).

Figure 4: Wairoa District's total gross emissions, by greenhouse gas (in tCO_2e)



By far the largest source of emissions in tonnes is carbon dioxide (CO_2) at 89,010 tonnes. Due to the greater global warming impact of methane, methane represents 12% of the total tonnage of GHG emissions from Wairoa but represents 69% of CO_2e. Nitrous oxide represents 0.3% of the total tonnage of GHG emissions from Wairoa but represents 17% of CO_2e. This effect can be seen in Figure 5.

Figure 5: Wairoa District's total gross emissions, by greenhouse gas in tonnes and in tonnes of CO_2e



3.8 Biogenic emissions

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

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

Table 10: Biogenic CO_2 in Wairoa (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO_2) (Excluded from gross emissions)		
Biofuel	8,885	t CO_2
Total Biogenic CO_2	**8,885**	**t CO_2**

Biogenic CH_4 emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large impact on global warming relative to biogenic CO_2. Biogenic methane represents 12% of the gross total tonnage of GHG emissions in Wairoa but represents 69% of total gross GHG emissions when expressed in CO_2e. This is caused by the higher global warming impact of methane per tonne, compared to carbon dioxide. The total tonnage of each GHG and the contribution of each GHG to total gross emissions when expressed in CO_2e is shown in Table 9.

The importance of biogenic CH_4 is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes specific targets to reduce biogenic CH_4 by between 24% and 47% below 2017 levels by 2050, and by 10% below 2017 levels by 2030. More information on the Act is available here: https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act.

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

Biogenic Methane (CH_4) (Included in gross emissions)		
Enteric Fermentation	12,297	t CH4
Landfill Gas	278	t CH4
Manure Management	185	t CH4
Wastewater Treatment	38	t CH4
Composting	9	t CH4
Biofuel	7	t CH4
Total Biogenic CH_4	**12,814**	**t CH4**

3.9 Territorial Authorities in the Hawke's Bay Region

The Hawke's Bay regional area contains several territorial authorities. Hastings District, Napier City, Central Hawkes Bay District, and Wairoa District are all exclusively within the boundaries of the Hawke's Bay region. Additionally, areas of Taupō District and Rangitīkei District are also part of the Hawke's Bay region. We estimate that 0.1% of Taupō's population and 12% of Taupō's area, and 0.3% of Rangitīkei's population and 14% of Rangitīkei's area are within the Hawke's Bay region.

Figure 6 shows the Hawke's Bay's total gross emissions divided by territorial authority. Figure 7 shows total gross emissions for the territorial authorities in the Hawke's Bay Region, split by sector. Both figures only include the emissions produced within the Hawke's Bay region for Taupō and Rangitīkei.

Hastings is the highest emitting territorial authority in the region, representing 43% of the Hawke's Bay's total gross emissions. Hastings' emissions inventory is predominantly agriculture-related emissions with the next largest emitting territorial authorities; Central Hawke's Bay and Wairoa, also containing significant agricultural emissions. Of the four territorial authorities entirely within the Hawke's Bay region, Napier has the lowest total gross emissions, with emissions mostly from Transport and Stationary Energy. The areas of Taupō and Rangitīkei contribute to 2% of the Hawke's Bay region's total gross emissions, almost entirely from Agriculture.

Figure 6 Hawke's Bay's total gross emissions divided by territorial authority (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.

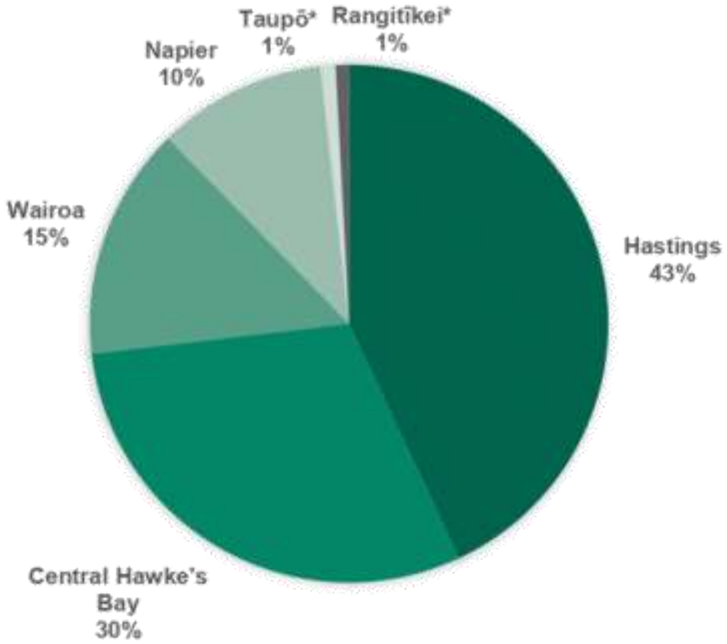
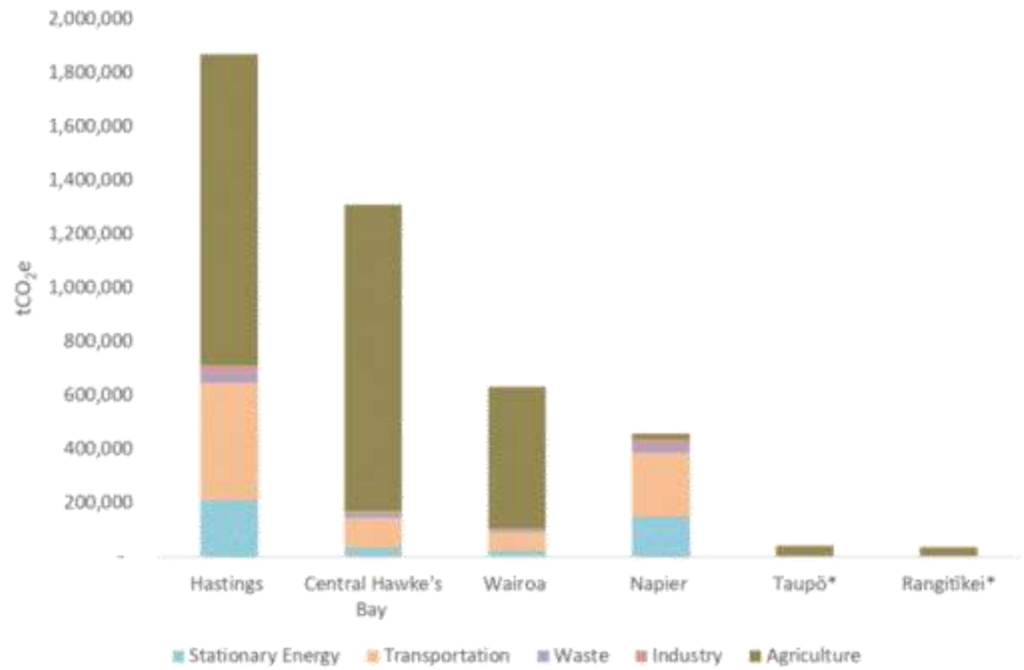


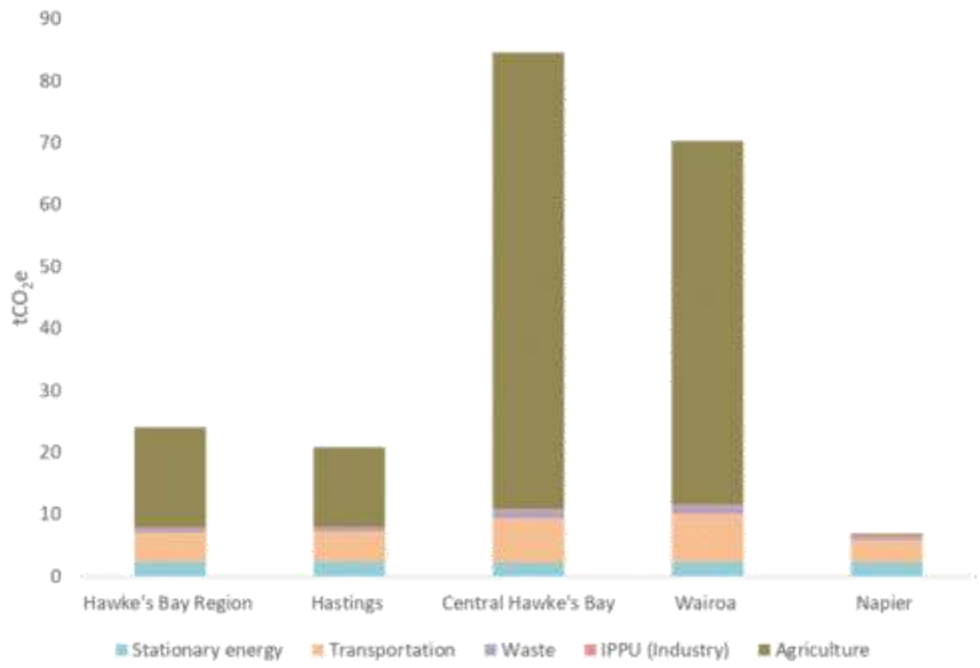
Figure 7 Total gross emissions by territorial authority in the Hawke's Bay region (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.



When comparing emissions inventories from different areas, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. Figure 8 shows emissions per capita for the region and territorial authorities within the region. Taupō and Rangitīkei are excluded from this figure due to the tiny population and large agriculture within the small area in the Hawke's Bay creating very large per capita emissions (this is not the case for the entire Taupō or Rangitīkei district).

The Hawke's Bay region has a 24.1 tCO_2e/per capita figure for total gross emissions which is higher than the national value of 15.7 tCO_2e/per capita. Notably, Napier has the lowest per capita total emissions at 6.9 tCO_2e/per capita. Central Hawke's Bay and Wairoa have the largest per capita total gross emissions at 84.6 tCO_2e/per capita and 70.3 tCO_2e/per capita respectively, both due to high Agriculture emissions in the district. Hastings has the third highest per capita emissions at 20.9 tCO_2e/per capita, similar to that of the region. Notably, Central Hawke's Bay and Wairoa have very high per capita Agriculture emissions and the highest per capita Transport emissions of the four districts entirely within the Hawke's Bay region.

Figure 8 Total gross emissions per capita for the region and territorial authorities within the region (tCO_2e). *Taupō and Rangitīkei areas not included



4.0 Emissions change from 2018/19 to 2020/21

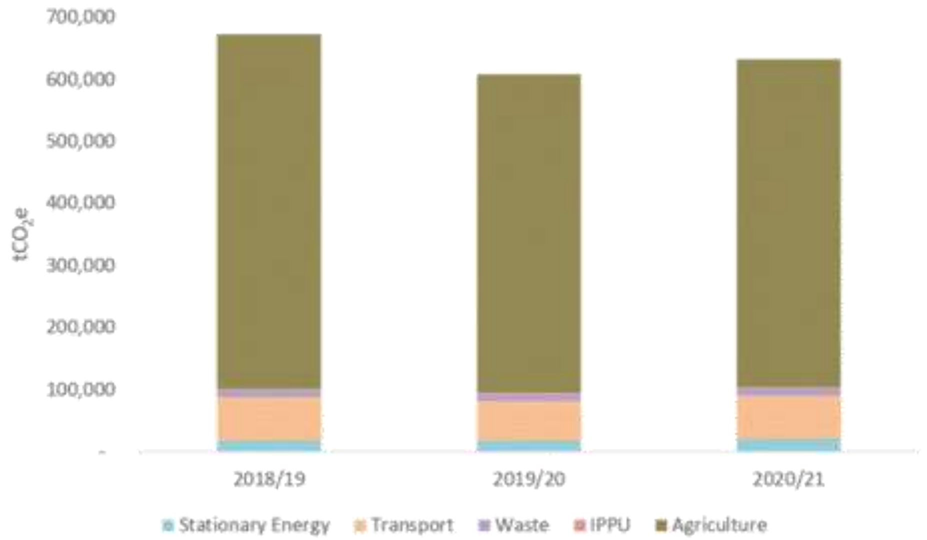
Alongside calculating Wairoa's emissions footprint for 2020/21, we have calculated Wairoa's emissions footprint for 2018/19 and 2019/20. This section displays the results of the 2018/19, 2019/20, and 2020/21 emissions footprints with a focus on Gross emissions and documents the change in emissions from 2018/19 to 2020/21.

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

Table 12 Change in Wairoa total gross and net emissions from 2018/19 to 2020/21

	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total Net Emissions (including forestry)	-736,431	-452,781	-341,709	54%
Total Gross Emissions (excluding forestry)	672,467	608,018	632,319	-6%

Figure 9 Change in Wairoa total gross emissions from 2018/19 to 2020/21



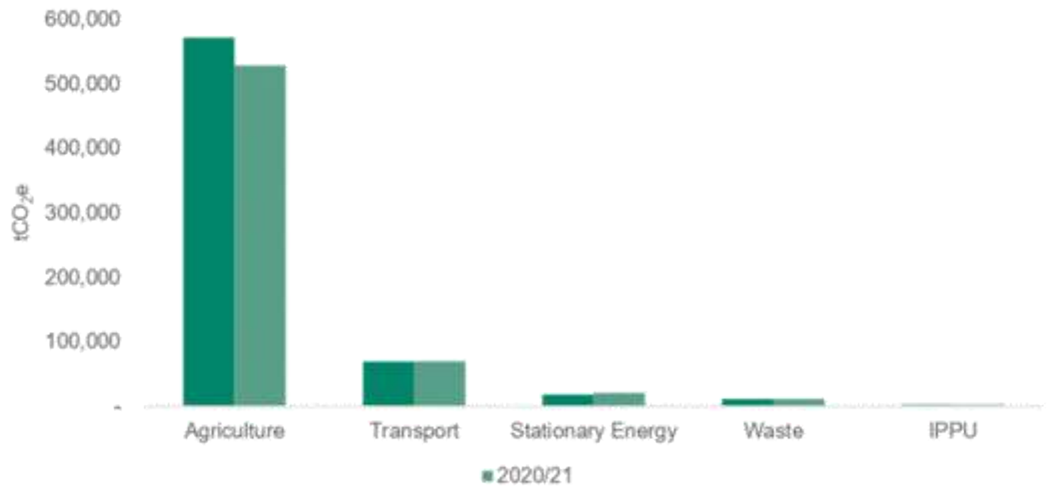
Annual total gross emissions per year decreased by 6% from 672,467 tCO_2e in 2018/19 to 632,319 tCO_2e in 2020/21. This was driven by a decrease in agriculture (number of sheep and non-dairy cattle) and an increase in stationary energy (primarily related to the increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).

Total net emissions in Wairoa increased by 54% from -736,431 in 2018/19 to -341,709 tCO_2e. This increase was predominantly due to an increase in annual forest harvesting emissions. This is discussed further below under the 'Forestry' heading.

Whilst total gross emissions decrease by 6%, the population of Wairoa grew by 3% during this time. This resulted in a 8% decrease in per capita emissions between 2018/19 and 2020/21, from 76.8 to 70.3 tCO_2e per person per year. A discussion of the decoupling of gross emissions from population growth and GDP is found in Section 5.0.

The sections below outline the change in emissions between 2018/19 and 2020/21 for each sector and emissions source, highlighting the changes that have had the largest impact on total gross emissions.

Figure 10 Emissions for each sector of Wairoa gross emissions footprint for 2018/19 and 2020/21



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4.1 Agriculture

Table 13 Change in Wairoa Agriculture emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Enteric Fermentation	451,077	405,217	418,083	-7%
Manure from Grazing Animals	66,138	59,240	61,099	-8%
Other Agriculture Emissions	25,033	22,343	22,693	-9%
Atmospheric Deposition	18,363	16,434	16,878	-8%
Manure Management	6,798	6,145	6,274	-8%
Agricultural Soils	3,913	3,386	2,972	-24%
Total	**571,322**	**512,765**	**527,999**	**-8%**

Agriculture is the most significant contributor to Wairoa community carbon footprint. The sector's emissions decreased by 8% between 2018/19 and 2020/21 (43,323 tCO_2e). This decrease is driven by a reduction in total livestock numbers, especially of sheep and non-dairy cattle (see Table 14).

Emissions related to sheep decreased by 27,395 tCO_2e due to a reduction in the number of sheep (49,979 sheep). Emissions related to non-dairy cattle decreased by 13,163 tCO_2e due to a reduction in the number of non-dairy cattle (6,661 cattle). The number of dairy cattle also reduced, reducing dairy cattle emissions by 1,108 tCO_2e.

Table 14 Change in Wairoa livestock numbers from 2018/19 to 2020/21

	Number of animals (2018/19)	Number of animals (2020/21)	Change in number of animals (2018/19 to 2020/21)
Sheep	528,219	478,240	-49,979
Non-dairy Cattle	98,035	91,374	-6,661
Other livestock	11,643	12,394	751
Dairy Cattle	4,239	3,924	-315
Total livestock	**642,136**	**585,932**	**-56,204**

Table 15 Change in Wairoa's livestock-associated Agriculture emissions from 2018/19 to 2020/21

	2018/19 emissions (tCO_2e)	2020/21 emissions (tCO_2e)	% Change in emissions (2018/19 to 2020/21)
Sheep	289,534	262,139	-9%
Non-dairy Cattle	247,517	234,354	-5%
Dairy Cattle	17,049	15,941	-7%
Other livestock	10,239	10,277	0.4%
Total livestock	**564,339**	**522,711**	**-7%**

4.2 Transport

Table 16 Change in Wairoa's Transport emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Diesel	46,182	42,175	47,574	3%
Petrol	18,201	16,459	18,018	-1%
Marine Freight	4,578	4,539	3,911	-15%
Jet Kerosene	193	165	131	-32%
LPG	74	74	77	5%
Rail	-	4	61	*N/A*
Aviation Gas	11	13	13	22%
Total:	**69,239**	**63,428**	**69,785**	**1%**

Transport emissions increased by 1% between 2018/19 and 2020/21 (546 tCO_2e). This was driven by a 2% increase in on-road fuel emissions (946 tCO_2e).

It is noted the impact of the COVID-19 pandemic can be seen in Transport emissions where emissions decreased by 8% between 2018/19 and 2019/20 due to reductions in road, marine freight, air transport fuel use. Aviation emissions continued to reduce in the 2020/21 reporting year, reflective of ongoing COVID-19 impacts to the industry.

4.3 Stationary Energy

Table 17 Change in Wairoa Stationary Energy emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Coal	7,166	7,200	7,111	-1%
Stationary Petrol & Diesel Use	5,040	4,601	5,186	3%
Electricity Consumption	4,736	4,923	6,854	45%
LPG	584	586	611	5%
Electricity Transmission and Distribution Losses	414	432	630	52%
Biofuel / Wood	273	272	271	-1%
Total:	**18,212**	**18,013**	**20,662**	**13%**

Emissions from Stationary Energy increased by 13% between 2018/19 and 2020/21 (2,450 tCO_2e). This was driven by a 45% increase in electricity consumption emissions (2,118 tCO_2e). This increase in electricity consumption emissions was due to a 3% increase in energy consumption (kWh) and a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh). The emissions intensity of the national grid has increased in recent years due to the increased use of fossil fuels during years with low hydro electricity generation.

4.4 Waste

Table 18 Change in Wairoa Waste emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Open Landfill	4,623	5,029	5,392	17%
Closed Landfill	4,620	4,333	4,069	-12%
Wastewater treatment plants	747	760	788	5%
Individual septic tanks	636	640	582	-8%
Composting	554	554	554	*NA*
Total	**11,181**	**11,317**	**11,385**	**2%**

Waste emissions increased between 2018/19 and 2020/21, by 2% (204 tCO_2e). Total solid waste in landfill emissions increased by 2% (204 tCO_2e). Emissions from waste in open landfills increased as the volume of waste entering the landfill increased, and waste recently deposited in landfill reaches peak emissions per year (this is after approximately two years in landfill). Emissions from closed landfills decreased due to no extra waste being added, the existing waste in landfill releases fewer emissions over time. Due to data only being available for one singular year, no change in composting emissions is recorded.

Total wastewater emissions remained relatively stable. There was an increase in wastewater treatment plant emissions and a decrease in individual septic tank emissions. This is likely driven by an increase in the number of households connected to centralised wastewater treatment. Better data on the number of households connected to centralized wastewater treatment would improve the accuracy of the emissions calculations.

4.5 Industrial Processes and Product Use (IPPU)

Table 19 Change in Wairoa IPPU emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Refrigerants and air conditioning	2,324	2,315	2,313	-0.5%
Aerosols	146	135	130	-11%
SF6 - Electrical Equipment	23	25	25	10%
Foam Blowing	10	11	11	7%
SF6 - Other	5.0	4.8	4.8	-1%
Fire extinguishers	4.1	4.0	4.0	-2%
Total	**2,512**	**2,495**	**2,488**	**-1%**

IPPU emissions decreased between 2018/19 and 2020/21, by -1% (24 tCO_2e). The decrease in IPPU emissions is mainly caused by a decrease in aerosols. Note that national level data is used for this sector and is portioned out using a population approach; exact emissions for the district are unknown.

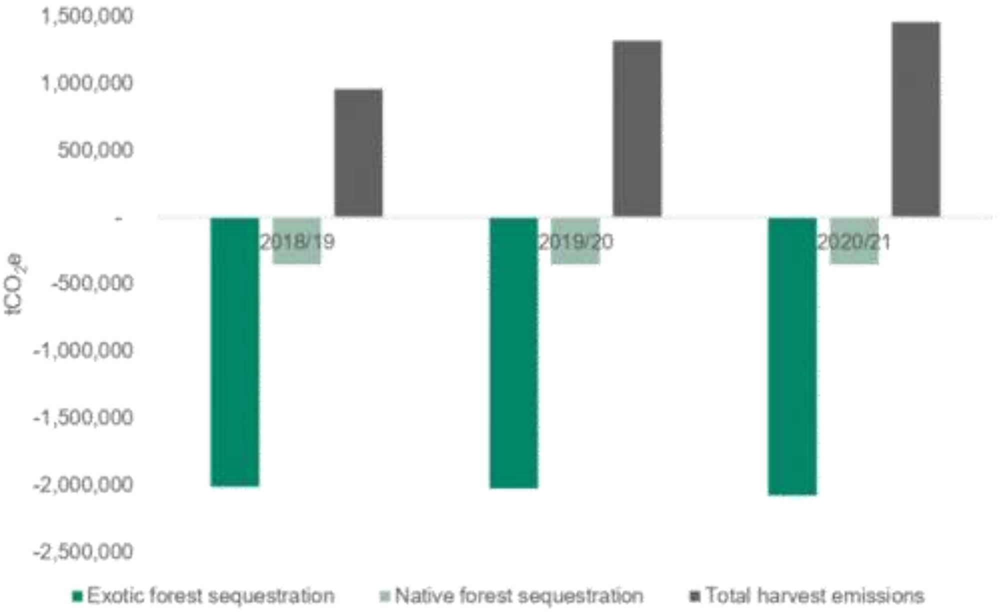
4.6 Forestry

Table 20 Change in Wairoa Forestry emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total harvest emissions	957,943	1,317,867	1,457,248	52%
Native forest sequestration	-353,945	-353,945	-353,945	0%
Exotic forest sequestration	-2,012,896	-2,024,721	-2,077,331	3%
Total	**-1,408,899**	**-1,060,799**	**-974,028**	**31%**

Net Forestry emissions changed by 434,871 tCO_2e between 2018/19 and 2020/21 from -1,408,899 tCO_2e to -974,028 tCO_2e. This change was driven by an increase in total harvest emissions (499,306 tCO_2e) as more exotic forest is harvested. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes where some years will have higher sequestration and some years will have higher harvesting emissions. This is dependent on age of forests and the demand for lumber and timber. Improved and updated data sources may impact the estimation of emissions from this source in the future. Sequestration by native and exotic forest remained relatively stable during this time.

Figure 11 Forestry sequestration and harvesting emissions from 2018/19 to 2020/21



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5.0 Decoupling of GHG emissions from population growth and GDP

Figure 12 shows the changes in gross emissions when compared to changes in other metrics of interest between 2018/19 and 2020/21. For example, total gross emissions have decreased by 6%, whilst population in Wairoa has increased by 3%, resulting in an 8% reduction in total gross emissions per capita. Similarly, Gross Domestic Product (GDP) in Wairoa has increased by 1%, resulting in a 7% decrease in the GHG emissions ratio to GDP.

When emissions grow less rapidly than GDP (a measure of income) this process is known as decoupling. The term decoupling is an expression of the desire to mitigate emissions without harming economic wellbeing. A full discussion of decoupling of emissions is beyond the scope of this project. However, the changes in emissions and GDP illustrated in Figure 12 and discussed above, suggest at a high-level decoupling has occurred between 2018/19 and 2020/21.

The exact drivers for the decoupling of emissions from GDP are difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transportation and housing will all contribute. In this case, both direct local actions (e.g. landfill gas reductions) and indirect national trends (e.g. changes to emissions from electricity generation) will have contributed to trends noted.

Figure 12 Change in total gross emissions compared to other metrics of interest

6.0 Impact of the COVID-19 pandemic on GHG Emissions

COVID-19 impacted New Zealand and the entire world during 2020 and 2021; causing widespread government-imposed restrictions on businesses and individuals and huge shifts in behaviors and economic markets. Restrictions in New Zealand relating to COVID-19 began in mid-March 2020 with many personal and business restrictions continuing past the end of 2019/20 and throughout 2020/21.[3]

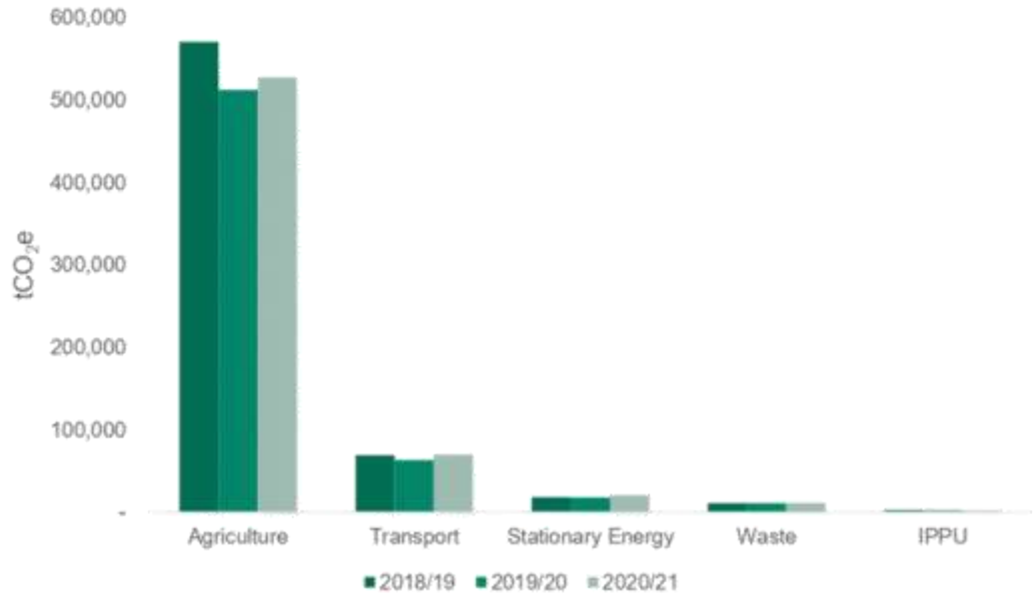
Globally, carbon dioxide emissions from fossil fuels (the largest contributor to greenhouse gas emissions) in 2020 decreased by 7% compared to 2019[4]. Emissions from the transportation sector account for the largest share of this decrease. Surface transport, e.g. car journeys, fell by approximately half at the peak of COVID-19 restrictions in April 2020 (when restrictions were at their maximum, particularly across Europe and the U.S. Globally, emissions recovered to near 2019 levels and are expected to continue to increase.

In New Zealand, national daily carbon dioxide emissions are estimated to have fallen by up to 41% during the level 4 lockdown in April 2020[5]. National gross emissions decreased by 3% from 2018/19 to 2019/20, which was largely driven by a decrease in fuel use in road transport due to COVID-19 pandemic restrictions, a decrease in fuel use in manufacturing industries and construction due to COVID-19 restrictions, and a decrease in fuel use from domestic aviation also due to COVID-19 restrictions.

Total gross emissions in Wairoa decreased by 64,449 tCO_2e (10%) between 2018/19 and 2019/20. Total gross emissions then increased by 24,301 tCO_2e (4%) from 2019/20 to 2020/21.

The impact on emissions in different sectors varied. Notably, Transport emissions reduced by 8% between 2018/19 and 2019/20, driven by reduced road and air transport fuel use. Agriculture emissions reduced between 2018/19 and 2019/20, potentially due to impacts on shipping movements. Despite changes in Stationary Energy, Waste, and IPPU emissions, these sectors are not judged to have been significantly affected by the COVID-19.

Figure 13 Wairau emissions per sector for 2018/19, 2019/20, and 2020/21 (tCO_2e)



[3] https://covid19.govt.nz/alert-system/history-of-the-covid-19-alert-system/
[4] Pierre Friedlingstein et al. - Global Carbon Budget 2020 (2020)
[5] Corinne Le Quere et al. – Temporary Reduction in Daily Global CO_2 Emissions During the COVID-19 Forced Confinement

7.0 Closing Statement

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

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

Understanding of the extensive and long-lasting effects of climate change is improving all the time. It is recommended that this emissions footprint be updated regularly (every two or three years) to inform ongoing positive decision making to address climate change issues.

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

8.0 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 **June 2022 and September 2022** and is based on the information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time. This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice.

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Appendix A

Assumptions and Data Sources

Sector / Category	Assumption and Data Sources
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied. The emissions footprint for the Hawke's Bay Region covers the entirety of the Hawke's Bay Region (this excludes some of the Rangitikei and Taupō territorial authorities). Emissions footprints for each territorial authority covers the entirety of the territorial authority area.
Population	Population figures are provided by StatsNZ. Financial year populations have been used, these are based on the average population from the two calendar years (e.g. the average of 2018 and 2019 calendar year populations for FY19). The population of Taupo and Rangitikei Districts within the Hawke's Bay geographical boundary has been calculated.
Transport Emissions	
Petrol and Diesel:	Petrol and diesel sales data provided by Napier City Council for Napier, Central Hawkes Bay and Hastings. Combined sales data for Gisborne and Wairoa provided by Gisborne District Council and allocated to a region based on Waka Kotahi emissions data. Sales have been divided between territorial authorities based on the number of kilometres travelled by vehicles on roads (VKT) in each territorial authority. VKT data provided by Waka Kotahi. The division into transport and stationary energy end use (and within transport into on-road and off-road) has been calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) from the 2019 database. Biofuel sales information provided directly by the supplier.
Rail Diesel	Emissions from fuel use have been calculated and provided by Kiwi Rail. The following assumptions were made: - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. 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 district, arrival district and any district the freight stopped at along the way. If the freight travelled through but did not stop within a district, no emissions were allocated. This data is subject to commercial confidentiality.
Jet Kerosene (Scheduled Flights) Aviation Gas (General Aviation)	Calculated from information provided by Hawke's Bay Airport. Aviation fuel and jet kerosene fuel volumes were provided and emissions have been calculated using these volumes. Emissions have been divided between territorial authorities based the relative population of each territorial authority.

Marine Freight	Shipping schedules have been provided by the Port of Napier. Emissions have been calculated based on ship weight and distance from the origin/destination to Napier. This figure does not include fishing vessels, or vessels with destination to be confirmed. Emissions from freight and international shipping are allocated equally between the origin and destination area emissions footprints. It is expected that imports and exports travelling through the Port of Napier service the entire Hawke's Bay Region. Emissions relating to freight and international shipping emissions have been divided between all Hawke's Bay territorial authorities based on population size.
Marine Fuel (Local)	Non-freight marine fuel use has not been included in this study. Fuel use by Port of Napier-controlled vessels has not been included due to a lack of available information. Most private marine vessels use fuel purchased at vehicle fuel stations. Petrol and diesel used in private marine vessels is included in off-road transportation.
LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. Sales have been divided between territorial authorities on a per capita basis.
Stationary Energy Emissions	
Electricity Demand	Electricity demand has been calculated using grid exit point (GXP) data from the EMI website (www.emi.ea.govt.nz). Reconciled demand has been used as per EMI's confirmation. The territorial authorities serviced by each GXP have been confirmed by the respective electricity suppliers. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per Ministry for the Environment (MfE) data.
Electricity Generation	Electricity generation has been calculated using data from the EMI website (www.emi.ea.govt.nz). Small electricity generation has not been included in this data (e.g. domestic solar generation). This figure only includes electricity that is connected to the national electricity grid, direct users of electricity are not included.
Coal Consumption	National coal consumption data has been provided by MBIE. Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis. Regional industrial coal consumption has been divided between territorial authorities on a per capita basis.
Coal Production and Fugitive Emissions	Not Calculated: There are no active coal mines within the region.
Biofuel Consumption	National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE). Biofuel consumption has been divided between territorial authorities on a per capita basis. Biofuel emissions are broken down into Biogenic emissions (CO_2) and Non-Biogenic emissions (CH_4 and N_2O)

LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG. Sales have been divided between territorial authorities on a per capita basis. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.
Natural Gas Consumption	Natural gas consumption data has been provided by FirstGas. Territorial Authorities supplied by gas from each Point of Connection (POC) have been confirmed by FirstGas. Natural gas consumption has been split into residential, commercial, and industrial consumption based on information provided by PowerCo and national statistics from MBIE. Some POCs supply gas to particular industrial users exclusively, these have been taken into account.
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
Agricultural Emissions	
General	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ). The last territorial authority census was in 2017. Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use since 2017. Territorial authority land-use data provided by HBRC covering horticulture land-use.
Solid Waste Emissions	
Waste in Landfill	Landfill waste volume and end location information has been provided by the respective council departments. Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis. Emissions are allocated to territorial authorities based on where the waste was produced, even if the waste is disposed in landfill outside the territorial authority.
Wastewater Emissions	
Wastewater Volume and Treatment Systems	Information on treated wastewater, and treatment plants has been provided by the respective council departments. Where information is not available, reasonable assumptions have been made and the WaterNZ database has been consulted. The population connected to septic tank systems have been estimated by the respective council departments. Where the population covered by Wastewater treatment plants and septic tanks does not account for the entire population, the remaining population is assigned to septic tanks. Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority.
Industrial Emissions	
Industrial processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the Region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g. fire extinguishers, refrigerants) has been provided by the MfE. Emissions have been allocated to territorial authorities on a per capita basis.

Forestry Emissions	
Exotic Forestry Harvested	Harvested forestry, and forest cover information for each territorial authority has been derived from Landcare Research data. 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.
Exotic Forest	Exotic forest land area for each territorial authority has been provided by Landcare Research.
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 EFs have been applied. AR5 Global Warming Potential (GWP) figures for greenhouse gases have been used accounting for climate change feedbacks.