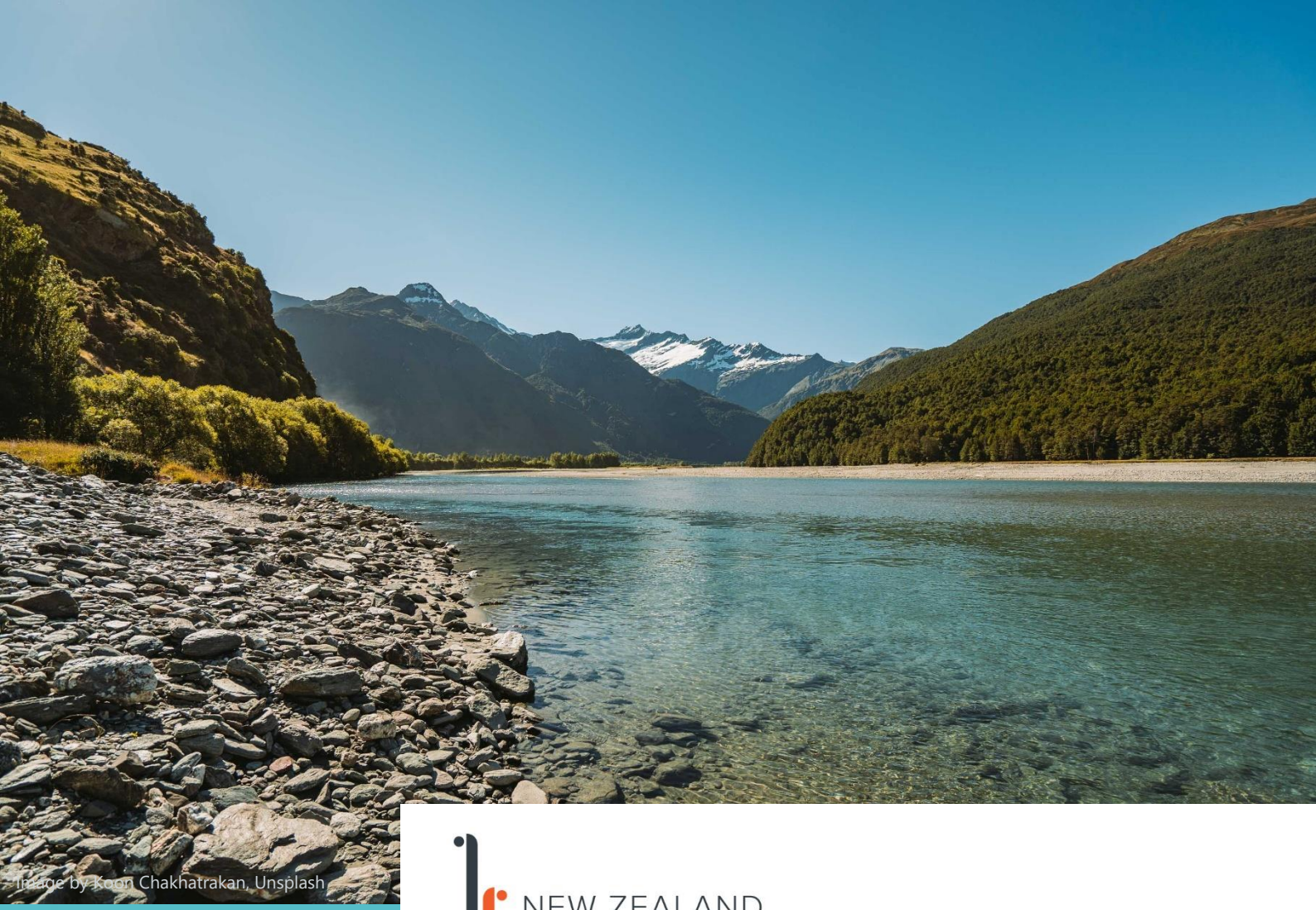

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NEW ZEALAND
INFRASTRUCTURE
COMMISSION
Te Waihanga

Sector State of Play: Resource Recovery and Waste

Discussion Document

Foreword

Takamua

Our wellbeing depends on our infrastructure

Our way of life depends on infrastructure. Whether it's moving freight to keep the supermarket shelves stocked, warming our homes, driving to work or calling our friends, there are few parts of our lives that don't rely on the services provided by infrastructure.

Infrastructure decisions have intergenerational impacts, so it is essential that we take a strategic view of the planning, development and operation of infrastructure in Aotearoa. New Zealand Infrastructure Commission was formed to give infrastructure this strategic voice, and the significance of this task is reflected in our Māori name, Te Waihanga, which means *cornerstone*.

Our first task is to develop a 30-year strategy for infrastructure - this paper is a part of this work. It takes a closer look at the current state of play in New Zealand's resource recovery and waste sector. By understanding where we are now we can set a course for where we want to go and the steps we'll need to take to get there over the next 30 years.

New Zealand faces a range of challenges and opportunities over the next 30 years which will have significant implications for infrastructure. Our changing climate, rapidly growing cities, aging population and evolving global technologies will change what we need from infrastructure in order to maximise the wellbeing of New Zealanders. Each of us has our own experiences of infrastructure, so we look forward to receiving your feedback to ensure this State of Play report accurately reflects the current state.

Ross Copland

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1. Executive Summary

Whakarāpopototanga

This paper seeks to document the state of play in the resource recovery and waste sector in New Zealand with a focus on the infrastructure used to manage New Zealand's waste. This includes landfills, material recovery facilities, and processing facilities.

New Zealanders dispose of ~15 million tonnes of waste[1] every year.[2] This waste comes from a range of sources including: [3,4]

- 1.8 million tonnes (12%) from municipal sources including domestic kerbside and other residential sources;
- 3.6 million tonnes (24%) from commercial and industrial sources;
- 4.4 million tonnes (29%) from construction and demolition sources;
- 1.5 million tonnes (10%) from rural sources.

This equates to around 3,200kg of waste per person per year,[5] of which only approximately 35% is recovered.[6] The rest is sent to landfill,[7] which creates environmental risks and contributes 4.6% of New Zealand's gross greenhouse gas emissions profile.[8] When compared to other members of the OECD, there is room for improvement. Of the available international examples, New Zealanders send the most municipal waste[9] to landfill per capita,[10] and we have the lowest municipal solid waste recovery rate,[11] behind the US, Australia and the UK. This is at least partially due to the location of resource recovery infrastructure and the cost of transportation. Resource recovery assets are predominantly located in urban areas, particularly around Auckland, meaning that in many parts of the country it is not cost-effective to recycle waste.

This could support the conclusion that more recycling infrastructure is needed to divert waste from landfill, and it has been estimated that between $2.1-2.6 billion of additional capital investment is needed,[12] along with an additional $0.9 billion in operational funding over the next 10 years.[13] This

[1] Including Virgin Excavated Natural Material.
[2] Wilson et al., *The New Zealand Waste Disposal Levy: Potential Impacts of Adjustments to the Current Levy Rate and Structure* (Eunomia Research & Consulting, 2017), 79.
[3] Ibid, 79.
[4] Other waste activity sources are landscaping, virgin excavated natural materials and special sources.
[5] "Population", Stats NZ, accessed January 22, 2021, https://www.stats.govt.nz/topics/population
Calculated based on New Zealand's population in December 2015 to align with 2015 waste data provided in Wilson et al.
[6] Wilson et al., *The New Zealand Waste Disposal Levy: Potential Impacts of Adjustments to the Current Levy Rate and Structure*. Eunomia Research & Consulting, 2017, 79.
[7] Including farm dumps.
[8] Ministry for the Environment, *New Zealand's Greenhouse Gas Inventory 1990–2018* (Wellington: Ministry for the Environment, 2020), 349.
[9] The OECD defines municipal waste as waste collected and treated by or for municipalities. It covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, as well as yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste if managed as household waste. The definition excludes waste from municipal sewage networks and treatment, as well as waste from construction and demolition activities.
[10] "Municipal Waste," *OECD*, accessed November 10, 2020, https://www.oecd-ilibrary.org/environment/municipal-waste/indicator/english_89d5679a-en.
[11] Ibid, 3.
[12] Ministry for the Environment, *Regulatory Impact Statement: Increase and Expansion of Waste Disposal Levy* (Ministry for the Environment, 2020), 22.
[13] Ibid, 7.

potential infrastructure gap could be further exacerbated if changes to local and overseas policy mean less of our waste can be sent offshore for processing.

However, while resource recovery and waste infrastructure is a current focus of Te Waihanga, it is important to acknowledge that more processing capacity or capability is not the only way to improve the different components of the waste hierarchy, which prioritises avoiding waste through redesign, reduction, and reuse. Mechanisms for achieving this include legislation; improved procurement practices to incentivise approaches that minimise waste such as prefabrication to avoid construction waste; and extended producer responsibility such as container return schemes. While these mechanisms are beyond the scope of this paper, they impact the resource recovery and waste sector, and the infrastructure that will be required in the future.

Key factors that affect the operation of the resource recovery and waste infrastructure are:

- Policy and legislation that controls the types of waste that can be created or discarded
- Price of disposal at a landfill compared to a recycling facility
- Demand for the recycling outputs either locally or internationally
- Policy in overseas jurisdictions which sets the types and quality of waste that can be imported.

These factors can change relatively quickly. This means that rigid, long-lived infrastructure assets sit in a dynamic system. With most new resource recovery and waste infrastructure operated, and at least partially funded, by the private sector, this uncertainty can result in stalled investment. As such, a consistent waste policy direction is important for investment certainty and ensuring that recovery opportunities are desirable to the market.

A further barrier to investment decision-making is the reported lack of consistent, high-quality data at a national level. While territorial authorities may have good information available locally, there are no nationally agreed data standards or reporting mechanisms, which means New Zealand lacks information to support a fulsome national snapshot for policy, planning or performance measurement purposes.

While the importance of the services provided by resource recovery and waste infrastructure to New Zealander's wellbeing might seem obvious – removing waste from our homes, businesses, and our streets – the short and long-term impacts are more complicated. There are environmental, social and cultural implications associated with how we manage waste today, particularly when we send it to landfill.

Already, we are dealing with the impacts of decisions made in the past. There are at least 110 closed landfills around New Zealand that have been reported to be vulnerable to sea level rise, creating environmental and health risks, as well as ongoing costs for councils.[14] The need to respond to climate change adaptation and mitigation will likely shape the sector in the coming decades.

Finally, if New Zealand is to realise the promise of a circular economy where resources are kept in use for as long as possible, and reduce the impact on the environment from landfilling, then both the supply of waste and demand for recycled material will need to change.

[14] Tom Simonson and Grace Hall, *Vulnerable: The Quantum of Local Government Infrastructure Exposed to Sea Level Rise* (Local Government New Zealand, 2019), 37.

2. Context

Horopaki

2.1. Who we are and what we do?

The New Zealand Infrastructure Commission, Te Waihanga is working to improve New Zealanders' lives through better infrastructure. It aims to lift the level at which infrastructure is planned and delivered, taking a strategic approach so that we maximise the social return on our collective dollar and stand well prepared in the face of an uncertain future.

Our Māori name, Te Waihanga, means a cornerstone, or to make, create, develop, build, construct, generate. Te Waihanga reflects the significance of long-term planning in shaping New Zealand's future.

A major part of this work is the development of a 30-year strategy for infrastructure. The strategy will look ahead to 2050, and consider how infrastructure might support environmental, social, cultural and economic wellbeing for all New Zealanders. This will be delivered to the government in September 2021 and will set out how we can make sure our investment in infrastructure delivers what we need, where we need it and at the right time.

2.2. About our sector State of Plays

We understand that our infrastructure works together - it is a system of systems. Our roads carry pipes and powerlines, and they connect to homes, workplaces and schools. For this reason, our strategy will focus on cross-cutting themes rather than infrastructure sectors in isolation. However, we believe it's important we understand the infrastructure we have today, why we have what we have, and how it's already contributing to New Zealanders' wellbeing.

The sector State of Plays are structured around the components of Te Waihanga's working definition of infrastructure, set out in our discussion document, "Infrastructure Under One Roof".[15] Our definition places wellbeing at the core, while recognising commonalities, including the use of capital such as financial and environmental resources; the interconnectedness of physical structures; and the delivery of shared services, as well as the wellbeing benefits we get from those shared services. In short, Te Waihanga defines infrastructure as follows:

"A system of inter-connected physical structures that employ capital to provide shared services to enhance wellbeing."

Figure 1 illustrates the components of our working definition, showing how they are related to one another in delivering wellbeing services.

[15] NZ Infrastructure Commission, *Infrastructure under one roof: Standardising how we think about the shared services around us (NZ Infrastructure Commission, 2020), 3.*

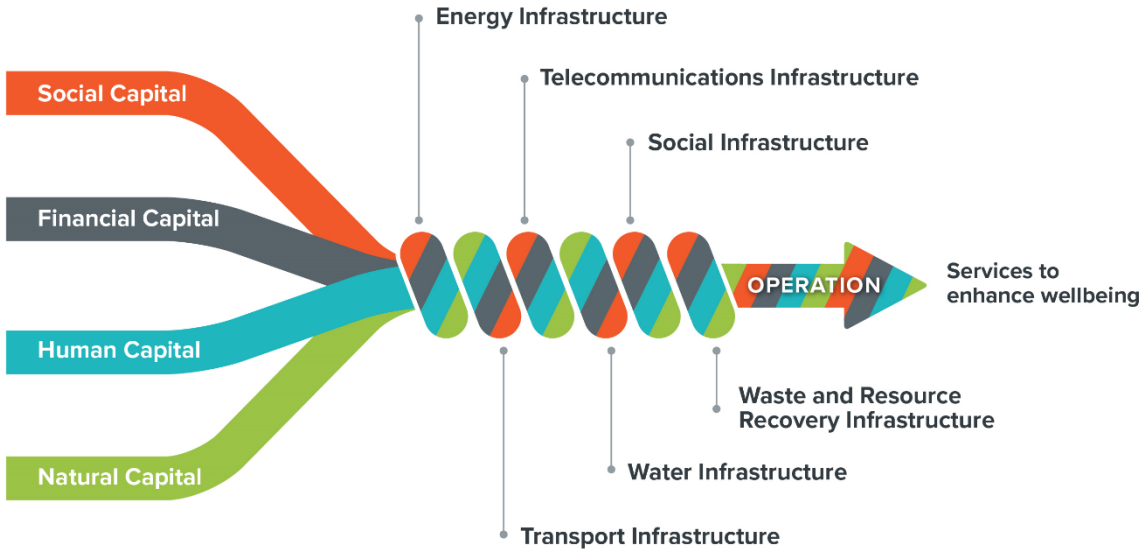

Figure 1: Te Waihanga's definition of infrastructure

By defining infrastructure in this way, we have then been able to develop a common framework to think about the integrated management of infrastructure. This considers the relationship between the enabling environment for our infrastructure, the sustainable use of the capitals employed in its development, the investment management process and the wellbeing benefits created by infrastructure services.

Our sector State of Plays are the result of desktop research, augmented by insights from our survey of infrastructure asset owners, and engagement with sector experts. These reports will be updated over time. We want to improve the picture as our understanding grows and different elements come in to focus.

2.2.1. About the Resource Recovery and Waste State of Play

This State of Play is the first time that New Zealand's resource recovery and waste disposal sector has been evaluated in New Zealand from an infrastructure perspective. The intention is to characterise how the infrastructure component of the system is contributing to the enhancement of wellbeing for New Zealanders, as well as considering how infrastructure is affected by changing market, regulatory and governance settings.

The State of Play provides a summary of what infrastructure currently exists to deal with New Zealand's waste and how it is performing (to the extent that this information is available). The State of Play also summarises issues the sector is facing in the short and medium, to long-term. The State of Play does not provide a general review of New Zealand's waste policy and regulatory settings, where those settings do not influence existing infrastructure.

Considering this, we would like to acknowledge the Ministry for the Environment's ongoing resource efficiency work policy work programme aiming to incentivise a circular economy and avoid and minimise waste as well, as the projects funded via the Waste Minimisation Fund.

2.3. Our next steps

As well as continuing to build on our picture of the State of Play, next steps include building our understanding of future trends and likely challenges, including climate change, incorporation of Mātauranga Māori, demographic change, and the role of technology. We will look at what our way of life might be 30 years from now. Based on all of this, we will begin to make recommendations as to how infrastructure might support New Zealand's future wellbeing.

We'll share our thinking on what will be included in the strategy, focusing on the cross-cutting themes that affect all sectors, the opportunities and challenges we can expect in the future, as well as our initial recommendations and options for consideration.

This will then be followed by a consultation document the engages stakeholders on the critical questions we face and begin to test recommendations as we develop the draft infrastructure strategy that will presented to the Minister for Infrastructure.

2.4. Have your say

We'll share our work as we go and are keen to hear what you think, starting now. Tell us what you think about our State of Play reports – have we got it right or are there issues, information or problems that we've missed?

You'll also have the opportunity to comment on the draft strategy. We'll be continually refining and assessing our work based on the feedback we get from you and others.

3. About the resource recovery and waste system

E pā ana ki te whakahōu rawa me te pūnaha para

3.1. Waste, resource recovery and the circular economy

Waste is anything disposed of or discarded.[16] It is the by-product of modern life, a growing population, economic activity, and increasing consumption. In New Zealand approximately 15 million tonnes of waste (of all types)[17] was disposed of in 2015.[18] This waste comes from a range of sources including: [19,20]

- 1.8 million tonnes (12%) from municipal sources including domestic kerbside and other residential sources
- 3.6 million tonnes (24%) from commercial and industrial sources
- 4.4 million tonnes (29%) from construction and demolition sources
- 1.5 million tonnes (10%) from rural sources.

However, just because something is thrown away does not mean that it is valueless. Many of the materials that are disposed of in New Zealand have potential value due to their ability to be reused in their existing state, because their composite raw materials can be extracted through recycling or their calorific value can be used to displace other fuel sources through waste-to-energy infrastructure.

The ability to extract value from waste is dependent on the processes and infrastructure available. Recycling and resource recovery relies on proximity and the ability to collect the waste from the point of creation, as well as the availability of the infrastructure required to sort the waste and process it into recyclates that can be used in new manufacturing systems. In 2015, 32% of municipal solid waste,[21] 62% of industrial and commercial waste, and 28% of construction and demolition[22] was recovered.[23] The total recovery rate on a volume basis was estimated to be 35%.[24]

Preventing materials from becoming waste, or processing waste to extract the resources within it, presents economic and environmental benefits, and potentially avoids costs, including:

- Displacing the costs of extracting and manufacturing virgin materials
- Reducing the energy use and carbon emissions associated with the extraction, transportation and fabrication of virgin materials

[16] Waste Minimisation Act 2008, s 5.
[17] Including Virgin Excavated Natural Material.
[18] Wilson et al., *The New Zealand Waste Disposal Levy: Potential Impacts of Adjustments to the Current Levy Rate and Structure* (Eunomia Research & Consulting, 2017), 79.
[19] Ibid.
[20] Other waste activity sources are landscaping, virgin excavated natural materials and special sources.
[21] Including Domestic Kerbside and other residential sources.
[22] Excluding Virgin Excavated Natural Material.
[23] Wilson et al., *The New Zealand Waste Disposal Levy: Potential Impacts of Adjustments to the Current Levy Rate and Structure* (Eunomia Research & Consulting, 2017), 79.
[24] Ibid.

- Avoiding the economic and environmental costs (such as leachates and discharges) associated with the long-term management of waste in landfills.

Recovering the value which exists within waste is consistent with the circular economy model, which aims to keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of their service life.[25,26] When a product is designed for the longest use possible, and can be easily repaired, remanufactured, recycled, or composted, it has a circular lifecycle. Accelerating the adoption of the circular economy is a key outcome of United Nations Sustainable Development Goal 12: Responsible Consumption and Development[27], which aims to decouple economic growth from environmental degradation, and reduce waste generation through prevention, reduction, recycling and reuse.

The waste hierarchy sets out an order of preference for the management of waste materials, with (in descending order of preference):[28]

- Redesign: avoiding the generation of waste through design
- Reduce: making decisions which minimise waste
- Re-use: further use of products for their original or a similar purpose
- Recycling: reprocessing waste materials to produce new products of similar value. In some cases, items will be recycled to a product of higher or lower value. This is referred to as upcycling or downcycling respectively
- Recovery: extraction of materials or energy from waste for further use
- Treatment and disposal: processing the waste so that it can be disposed of to land (in landfill) with reduced or no significant effect on the environment.[29]

3.2. He tirohanga Māori i te para me hangarua | Māori views on waste and recycling[30]

The Māori view of resource recovery and waste is consistent with the principles of a circular economy, as articulated by WasteMINZ:[31]

> *"He tirohanga Māori i te para me te mahi hangarua (Māori views on waste and recycling) emphasise whakapapa (genealogical) connections between humans and the natural world.*
>
> *The respect for natural resources and the materials made from them is demonstrated by maintaining their value for as long as possible before they reach the end of their life, at which point they are disposed of in a way that causes the least harm to Papatūānuku. In this way, he tirohanga Māori i te para precedes the concept of a circular economy (ōhanga āmiomio) but similarly acknowledges the mauri (life force) of natural resources."*

[25]"Circular Economy – Ōhanga āmiomio," Ministry for the Environment, accessed November 10, 2020. https://www.mfe.govt.nz/waste/circular-economy.
[26] "What Is the Circular Economy?," Ellen MacArthur Foundation, accessed November 10, 2020, https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy.
[27]"Sustainable Development Goals," United Nations Development Programme, September 2015. http://www.undp.org/content/undp/en/home/sustainable-development-goals.html.
[28] Auckland Council, *Te Mahere Whakahaere me te Whakaiti Tukunga Para I Tāmaki Makaurau 2018 Auckland Waste Management and Minimisation Plan 2018*, (Auckland Council, 2018), 19.
[29] Note that Section 44 of the Waste Minimisation Act 2008 treats treatment and disposal as two separate stages of the Waste Hierarchy.
[30] Sarah Pritchett and Sunshine Yates, *Recommendations for Standardisation of Kerbside Collections in Aotearoa* (Wellington: Ministry for the Environment, 2020), 9-10.
[31] WasteMINZ, or the Waste Management Institute of New Zealand, is the largest representative body of the waste, resource recovery and contaminated land sectors in New Zealand.

3.3. Physical Infrastructure

New Zealand's waste management infrastructure sits across the waste hierarchy: comprising resource recovery (recycling and recovery) infrastructure and waste disposal (treat and dispose) infrastructure.

These distinct infrastructure systems sit at different levels of the waste hierarchy, and collectively operate to accept and deal with New Zealanders' waste, as demonstrated in Figure 2. We note that in accordance with the waste hierarchy, recycling is preferable to recovery despite the grouping of these two activities from an infrastructure perspective (as per Figure 2).

Figure 2: Waste minimisation hierarchy and resource recovery and disposal infrastructure (Te Waihanga, New Zealand Infrastructure Commission, 2020, adapted from s44 Waste Minimisation Act 2008 and Auckland Council, 2018).

This infrastructure is distinct from actions which sit further up the waste management hierarchy, such as redesigning or reducing, which aims to reduce the amount of waste created, or activities to avoid waste being discarded (i.e. refillaries or repair shops). While these activities are incredibly important to reducing the total waste generated in New Zealand, they are most often components in other manufacturing or product systems and sit outside the scope of physical resource recovery and waste infrastructure for this analysis.[32]

3.3.1. Resource Recovery Infrastructure

In this report we have use the term "Resource Recovery Infrastructure" to describe the systems that extract value from materials at the end-of-life. This includes collection, disaggregation into separate waste types, processing and extraction of recyclates or other resources, such as energy. This approach is aligned to the circular economy model.

Infrastructure within this system includes:

[32] The transition to a circular economy is considered at how is the resource recovery and waste sector responding to what might come next?

- Material recovery facilities, which sort and separate recoverable materials
- Processing plants, which extract materials from waste to the point that the recyclates become suitable to become the input to other manufacturing systems in place of virgin materials
- Facilities such as waste-to-energy plants which, if there is no other value that can be extracted, can recover energy from waste.

Material recovery facilities

Material recovery facilities normally receive waste from municipal sources – typically kerbside and commercial sources, with some also receiving materials from public place recycling – and construction sites. They separate recyclables into baled commodities for sale into recycling markets. Material recovery facilities remove contamination and sort collected materials into types and grades. They can range in operation from simple manual sort lines, to fully automated facilities. The types of processes required at each Material Recovery Facility are dependent on the waste collection methodology used, for example, if the waste is comingled *versus* collected separately.

For the purposes of this assessment, material recovery facilities are categorised into the two main types currently operating in New Zealand: recycling material recovery facilities and construction and demolition material recovery facilities.

Recycling material recovery facilities

There are approximately 15 recycling material recovery facilities of notable size across New Zealand with wide ranging capacity. The facilities in Auckland and Christchurch manage approximately 70% of the total national municipal volume (approximately 200,000t per annum). The remaining 13 material recovery facilities operate at the 1,000-10,000t per annum scale. In 2018, the 15 material recovery facilities had a combined capacity to process 283,000t of materials from municipal sources, producing an estimated 225,000t of recycled commodities for sale.[33]

As part of the Covid-19 Response and Recovery Fund, the Government has committed funding to improve the sorting ability of existing material recovery facilities in Auckland, Thames, New Plymouth and Christchurch, and to support new facilities in Hamilton and Napier.[34]

There is no national data available in the public domain to determine how effective material recovery facilities are at separating out waste streams; however, it is estimated that material recovery facilities processing mixed recycling streams have on average 10-15% contamination with other materials,[35] although post-Covid, Christchurch City Council has recorded a contamination rate of as much as 42%.[36] Contamination reduces the volume of material recycled, and diminishes the overall return per tonne.

Construction and demolition material recovery facilities

Construction and demolition waste includes broken concrete, glass, plasterboard, disused wood products, brick, metal, dirt and plastics. It excludes hazardous waste, such as asbestos and polychlorinated biphenyls. It is estimated that construction and demolition waste makes up about half of the total waste generated in New Zealand.[37]

[33] Duncan Wilson, Lisa Eve, and Andy Grant, *National Resource Recovery Project - Situational Analysis Report* (Ministry for the Environment, 2018), 18-20.
[34] "More Action on Waste – Government Funds Recycling Infrastructure, Moves to Standardise Kerbside Collections'," The Beehive, August 26, 2020. http://www.beehive.govt.nz/release/more-action-waste-%E2%80%93-government-funds-recycling-infrastructure-moves-standardise-kerbside.
[35] Duncan Wilson, Lisa Eve, and Andy Grant, *National Resource Recovery Project - Situational Analysis Report* (Ministry for the Environment, 2018), 47.
[36] Sally Murphy. "Nearly Half of Christchurch Recycling Contaminated, Heads to Landfill." *RNZ*, September 23, 2020, https://www.rnz.co.nz/news/national/426761/nearly-half-of-christchurch-recycling-contaminated-heads-to-landfill.
[37] "Minimising Waste When Building." BRANZ Ltd, accessed November 19, 2020

Just like municipal waste, construction and demolition waste can be disaggregated to specific waste streams, which are separated at sorting facilities. There are four construction and demolition waste sorting facilities in New Zealand, two in Auckland, one in Meremere, and one in Wellington. The combined capacity of these plants is not available in the public domain, although Green Gorilla (Auckland), who operate the most comprehensive construction and demolition material recovery facility, state they divert 75,000t of waste from landfill each year by separating the waste material to allow recycling, including wood products (which are converted to wood chip and used as a fuel), metals, aggregate and plasterboard (from which gypsum can be recovered).[38]

There are also two concrete crushing facilities in Auckland that crush waste concrete into aggregate, which can be reused in the construction sector, as well freeing the re-bar or steel mesh for recycling.

Processing plants

Processing plants accept disaggregated waste streams and process them to a level which enables them to be reused as an input in place of (or in addition to) virgin materials in another product system. Each waste stream requires a different type of infrastructure to process. A more detailed analysis of waste streams and their treatment is provided in Appendix 1.

Due to the difficulty in collection, and about commercial sensitivity in reporting, there is limited data about the net onshore capacity of processing plants in New Zealand[39]; however a summary of waste streams, and the infrastructure used to create recyclates in New Zealand is provided in Table 1.

Table 1: Onshore processing capacity by waste stream and product

Waste Product	End Product	Current Processing Infrastructure
Glass	Cullet (for use in new glass products)	One beneficiation plant in Auckland[40]
	Fines (for use in aggregates)	Nine glass crushers (3 North Island and 6 South Island)
Paper and Cardboard (Fibre)	Pulp	Two fibre processing plants, in Auckland and Hawkes Bay
Plastics[41]	Plastic 1: polyethylene terephthalate (PET)	Multiple processors, with more under construction
	Plastic 2: high density polyethylene (HDPE)	Multiple processors

http://www.level.org.nz/material-use/minimising-waste/

[38] "Waste Processing Facility," Green Gorilla, accessed November 24, 2020, https://www.greengorilla.co.nz/processing-facility/.

[39] This issue is discussed in fuller detail at 'Issues the sector is facing today' section.

[40] Beneficiation is a process where items associated with the sorted glass are removed to stop contamination (i.e. bottle tops, metals and labels).

[41] For all plastics, there are no processors that accept recyclates and process them into resin as a saleable product to input into new manufacturing systems in place of virgin materials. All processors that we are aware of integrate recyclate into their production of new plastic products e.g. Flight Plastics.

Waste Product	End Product	Current Processing Infrastructure
	Plastic 5 polypropylene (PP)	Multiple processers
	Plastics 3, 4, 6, 7: polyvinyl chloride (PVC), low density polyethylene (LDPE), polystyrene (PS), all others (including composites).	Very limited infrastructure (some small-scale processors).
Metals	Ferrous metals (steel and iron)	Nine scrap metal recycling centres located throughout the country. Large quantities of unprocessed waste metal are exported directly from Material Recovery Facilities.
	Non-ferrous metals (aluminium, copper and lead)	
Organic Waste	Compost, fertiliser or animal feed, biogas	There are a large number of facilities that process organic waste. There is one anerobic digestion plant under construction in Reporoa which will produce biogas and fertiliser.
E-Waste	Precious metals, metals, glass, plastics	Estimated 19 e-waste processing facilities in New Zealand
Textiles	Textile reuse, rags or recovered fabrics	There is no widescale onshore processing infrastructure for textiles
Tyres and rubber	Crumb rubber, tyre-derived fuel	There is no processing infrastructure with the ability to recover waste rubber. There are two tyre shredders in New Zealand which shred rubber to enable processing into end uses (such as tyre-derived fuel).
Hazardous waste	Limited end uses	There is limited wide-scale recycling or recovery processors. However some product stewardship schemes exist, although these often depend on final reprocessing offshore.

Waste-to-energy infrastructure

Waste-to-energy is a type of waste processing infrastructure where waste (or waste derivatives such as landfill gas) are used to generate electricity, as well as potentially other co-products (such as heat or compost). There are two main types of waste-to-energy technology: thermal and non-thermal.

Non-thermal waste-to-energy includes anaerobic digestion and hydrolysis technology. This is where biogas is captured from the decomposition of organic material and then used to generate electricity. This type of waste-to-energy facility is under development in New Zealand at present, with New Zealand's first food waste-to-energy (and compositing) plant currently being constructed in Reporoa.[42] The facility is co-funded by private finance and a NZ$7 million loan from the Provincial Growth Fund, and will be operational from 2022.

Landfill gas capture is also used for non-thermal waste-to-energy generation. For example, Waste Management extracts approximately 36 million cubic metres of methane out of Auckland's Redvale Landfill per year, which generates enough energy to power the equivalent of 14,000 homes.[43] Once closed, Redvale Energy Park will continue to generate energy, albeit it at a declining rate, over the following 25 to 30 years. This activity however is not considered 'recycling' from a waste hierarchy perspective, due to the gas being a by-product of disposal.

Thermal waste-to-energy is the most common form of waste-to-energy technology internationally. Thermal waste-to-energy is a form of recovery which uses combustion, ranging from incineration (direct combustion or mass burn) and coprocessing, to more advanced methods such as pyrolysis and gasification. There are a number of biomass boilers in use across New Zealand that take pellets generated from wood waste as fuel. These are increasingly viewed as part of the solution for transitioning away from fossil fuels, particularly in industrial manufacturing. However, there are barriers to the establishment of thermal waste-to-energy plants that use municipal waste as fuel, including community perception of potential harm to the environment and human health, threats to cannibalising recycling programmes, and the consistency (quality and quantity) of feedstock.[44, 45] Waste-to-energy using municipal solid waste as a feedstock is popular in jurisdictions overseas where there isn't the space to create landfills, or where it replaces higher carbon intensity energy production, such as coal.

Resource recovery centres

Often, as a result of lack of access to resource recovery infrastructure, councils and community groups have established facilities to collect materials at the end of their useful life, which are then sorted, assessed for resale (typically onsite or in affiliated an second-hand store), or transferred to processors. There are 21 community-run resource recovery centres in New Zealand, but information on the total capacity of these facilities is not publicly available.

3.3.2. Waste disposal infrastructure

Waste disposal infrastructure is used for the treatment and disposal of waste. Its scope includes the collection of residual waste (waste not processed through resource recovery infrastructure) from point of creation, through transfer stations, to the treatment of waste to ensure that it is inert (for example, contaminated soils and hazardous waste) and finally disposal to landfill.

[42] RNZ "First Large-Scale Food Waste-to-Bioenergy Facility Construction Begins," *RNZ*, August 4, 2020. https://www.rnz.co.nz/news/national/422742/first-large-scale-food-waste-to-bioenergy-facility-construction-begins.
[43] PMCSA, *Rethinking Plastics in Aotearoa New Zealand* (Office of the Prime Minister's Chief Science Advisor, 2019), 151.
[44] Nick Robertson and Merewyn Groom, *Waste to Energy: The Incineration Option*, (BERL, 2019), 23.
[45] Ministry for the Environment, *A waste to energy guide for New Zealand* (Wellington: Ministry for the Environment, 2020), 10.

Disposing of waste requires decades of ongoing management of disposal sites to control environmental and human health risks, including greenhouse gas emissions, leachates and risks from severe weather events and sea level rise which can compromise the integrity of landfills.

Landfills

Landfills are divided into classes depending on the types of waste they accept (see Table 2). Most municipal (Class 1) landfills are owned by territorial authorities, while just five are privately owned and three are owned by a joint venture between councils and the private sector.

Municipal landfills are operated either by territorial authorities, under contract to a private operator or in public-private partnership. Other types of landfill are mostly operated by the private sector.

Table 2: Description and number of different landfill types in New Zealand[46]

Class	Waste Types Accepted	Number
Class 1 Landfill – Municipal Solid Waste Landfill	Solid wastes that could discharge contaminants/emissions, from households as well as commercial, institutional and/or industrial sources disposed of at facilities that accept household waste.	41
Class 1 Landfill – Industrial Monofill	Solid wastes that could discharge contaminants/emissions, from a range of industrial sources including steel- or aluminium-making and pulp and papermaking.	14
Class 2 Landfill – Construction & Demolition Landfill	Solid wastes with lower potential for environmental harm, including rubble, plasterboard and other construction and demolition materials.	22
Class 3 Landfills – Managed Fill	Contaminated but non-hazardous soils and other inert materials (e.g. rubble) that allow the site to be used for a restricted purpose on closure.	56
Class 4 Landfills – Controlled Fill	Soils and other inert materials with low levels of contamination relative to receiving environment, which allow the site to be used for an unrestricted purpose on closure.	226
Class 5 Landfills – Clean Fill	Virgin excavated natural materials such as clay, soil and rock.	Unknown

[46] Ministry for the Environment, *Reducing Waste: A More Effective Levy* (Wellington: Ministry for the Environment, 2019), 25.

Farm dumps

It is estimated that there are roughly 47,000, private dumps for disposal on farmland where the waste comes only from that property.[47] These dumps are generally a permitted activity in council plans if they meet specified criteria (i.e. not on a floodplain, and not containing hazardous substances or sewage).

Historically, farm dumps existed due to geographic boundaries to waste services and the cost associated with transporting waste off-farm to the correct landfill or recycling facility. Due to the types of waste, it is possible that farm dumps have a similar, if not greater, collective environmental liability as managed landfills.

Closed landfills

The exact number of closed landfills is not known, however in 1999 it was estimated that it was in excess of 1000 (excluding farm dumps).[48] In 2014 Tonkin and Taylor, reported that there were approximately 460 closed non-municipal landfills, and another 324 non-municipal landfills which were 'unknown' as to whether they were open or closed.[49]

3.4. Services

The core service provided by the sector is the collection and management of waste, and in the case of resource recovery infrastructure, the extraction and processing of materials to enter new product systems. However, access to these services is not uniform across New Zealand. This section aims to explore, and characterise, the gaps in service provision through an infrastructure lens.

3.4.1. Access to resource recovery infrastructure

Access to resource recovery services is not standard across the country and can vary between and within regions. Proximity to urban centres and areas of economic activity currently determine the location of resource recovery infrastructure. This can create barriers to accessing the services provided by this infrastructure due to transportation costs, particularly the cost of collection from the point that waste is created. As a result, rural centres are likely to have greater barriers to accessing resource recovery services than their urban counterparts.

Municipal collections

Forty-seven percent of New Zealand households have access to co-mingled (where different types of waste is collected together) recycling services.[50] In 2018, 57 council areas provided council-funded kerbside recycling collection, and 10 had a drop-off or private recycling collection service. Provision of collection services can create a significant barrier to consumer access to resource recovery infrastructure compared to waste disposal infrastructure (landfill).[51] For example, Upper Hutt City Council offers a council waste kerbside disposal scheme to its landfill, but only offers a drop off service for recycling, with consumers being able to contract with a private (fee paying) kerbside recycling collection service if they wish.[52]

[47] Ministry for the Environment, *Reducing Waste: A More Effective Levy* (Wellington: Ministry for the Environment, 2019), 25.
[48] Ministry for the Environment, *A Guide for the Management of Closing and Closed Landfills in New Zealand* (Wellington: Ministry for the Environment, 2001), 1.
[49] Tonkin & Taylor, *New Zealand Non-Municipal Landfill Database* (Wellington: Ministry for the Environment, 2014), 27.
[50] Sarah Pritchett and Sunshine Yates, *Recommendations for Standardisation of Kerbside Collections in Aotearoa* (Wellington: Ministry for the Environment, 2020), 13-14.
[51] Duncan Wilson, Lisa Eve, and Andy Grant, *National Resource Recovery Project - Situational Analysis Report* (Ministry for the Environment, 2018), 71.
[52] "Choosing a Waste and Recycling Service," Upper Hutt City Council, accessed November 10, 2020, https://www.upperhuttcity.com/Services/Waste-and-recycling/Choosing-a-waste-and-recycling-service.

There are further variations in what each council accepts in its recycling collection, which reflects varied access to resource recovery infrastructure. For example, different key councils accept different plastic types, and not all take aerosol cans and aluminium foil.

Additionally, there is no standardisation of recycling collection methodology in New Zealand. Councils determine what is collected, how clean the waste must be and whether glass is separated out or not. Co-mingling, especially with glass, tends to lead to higher levels of contamination due to the cost and effort required to separate the component waste streams, and the disintegration of products during collection, which lowers the value of the sorted end product. [53] For example, broken glass mixed with paper/cardboard will damage the fibres leading to a less valuable end product, as well as potentially damaging the machinery at reprocessing plants.[54]

High levels of contamination of recyclates caused by depositing non-recyclable waste in the wrong bins, either unintentionally or deliberately, or by 'wish-cycling'[55] also decreases the end value of recylcates and the costs of collection and processing. It has been estimated that in Auckland about 12% of each household recycling bin is contaminated.[56] This creates an additional burden on the resource recovery sector, making it less economic to deliver services commercially.

3.5. Wellbeing

Effective resource recovery and waste disposal systems play a critical role in supporting New Zealanders' wellbeing by ensuring that waste, once produced, does not accumulate in our homes, streets and unregulated dumps, degrading our environment and health.

Resource recovery and waste disposal infrastructure protect environmental, cultural and social wellbeing, as well as potentially creating positive economic outcomes when resources are recovered.

Conversely, if our waste management infrastructure is operated sub-optimally, or fails outright, particularly landfills, negative impacts on wellbeing are potentially realised, including:

- ***Environmental***: negative impacts on land, water and air – including dust, leachate and greenhouse gas emissions.
- ***Cultural:*** consequential impacts on the Mauri or health of ecosystems, which negatively impacts cultural wellbeing. Reduced Mauri may be the result of where waste infrastructure is situated, as well as any releases from the infrastructure into the environment.
- ***Social:*** consequential negative impacts on human health, particularly if waterways or aquifers used for potable water supply are impacted.
- ***Economic:*** the cost of remediating any incident may have significant financial implications, as well as the loss of potential revenue if resource recovery is sub-optimal.

It must be remembered that even though there are environmental, cultural and social implications of the resource recovery and waste disposal system operating in a business-as-usual capacity, these impacts are significantly less than if the infrastructure was not available. Furthermore, negative impacts can be lessened if we move closer towards a circular economy.

[53] Auckland Council, "The Cost of Recycling Contamination," OurAuckland, accessed November 10, 2020, https://ourauckland.aucklandcouncil.govt.nz/articles/news/2020/06/the-cost-of-recycling-contamination/.
[54] Duncan Wilson, Lisa Eve, and Andy Grant, National Resource Recovery Project - Situational Analysis Report (Ministry for the Environment, 2018), 47.
[55] Wishcycling or aspirational recycling is trying to recycle a waste item that isn't recyclable in the hope that it will be recycled.
[56] Susan Edmunds, '"Wishful Thinking about What Can Be Recycled Is an Expensive Mistake." *Stuff*, July 28, 2018. https://www.stuff.co.nz/business/105739224/wishful-thinking-about-what-can-be-recycling-is-an-expensive-mistake.

3.5.1. Economic and environmental potential of resource recovery

The economic potential of resource recovery is twofold: there is the potential to extract value from recyclates as inputs in place of virgin materials, as well as the economic benefits of employment in the sector presents the extractable raw materials and products from different waste types.[57]

Table 3: Potential extractable materials by key waste type

Waste type	Potential Extractable Raw Materials and Product Uses
Organic waste	Fertilisers, soil conditioners, mulches, biochar, and biogas
Paper and cardboard	Pulp or recycled cardboard
Plastics	Plastics sorted by resin type (1-7) and processed uses (e.g. flakes and pellets). Can be used in a wide range of new plastic items (for example food and beverage containers, fence posts, rubbish bins).
Metals	Ferrous and non-ferrous metals
Glass	Glass cullet (used in glass making), filtration media, aggregates and other construction uses
E-waste	Metals including precious metals (gold, silver, platinum, palladium, iridium, rhodium, indium)
Tyres	Crumb rubber (playground surfaces, conveyor belts, road-base), tyre-derived fuel
Construction and demolition waste	Aggregate for use in road and pavement sub-base, drainage, irrigation and landscaping. Gypsum from plasterboard has fertiliser uses. Wood waste to be used as fuel, as well as extracted metals.
Textiles	Rag or fibre recovery

Following the recycling process, recovered materials can be comparable in quality to virgin materials and sold to manufacturers to replace or supplement virgin materials in manufacturing. For example, using glass cullet to supplement virgin materials can reduce the energy required to manufacture new glass products – reducing manufacturing costs and the associated carbon emissions.[58] In some cases, recyclates (such as metals) compete with virgin materials on international commodity markets, and offset domestic demand for virgin products. For example, through increasing onshore PET (type 1

[57] Godfrey et al., Victorian *Waste Flows*. Infrastructure Victoria, 2019.
[58] "The Glass Story: Infinitely Recyclable," Glass Packaging Forum, accessed November 10, 2020, https://www.glassforum.org.nz/the-glass-story/.

plastics) recycling capacity, in 2017 the import of virgin PET imports in New Zealand decreased for the first time in a decade.[59]

When waste is disposed of to landfill, the potential value of recovering and reusing materials, compared with the economic and environmental cost of extracting, manufacturing and transporting virgin materials, is lost.

3.5.2. Wellbeing impacts of waste disposal

Disposing of waste to landfill also presents long-term risks from leachate, which has the potential to impact human and environmental health. There is also the production of landfill gas, which if not captured, is a contributor to climate change, which means that are ongoing operational costs and liabilities.

Landfills create leachate, a fluid mix that is produced through the anaerobic decomposition of organic matter, which can accelerate the decomposition of other non-organic materials, and can therefore include:[60]

- Dissolved toxic materials (endocrine disrupting chemicals and persistent organic pollutants) which can accumulate in the food chain, and potentially disrupt biological functioning.[61]
- Dissolved solids and suspended solids that can contaminate ground water and deoxygenate water bodies affecting aquatic life.
- Oils and solvents can create surface films, or be toxic to human, stock or aquatic life.
- Organic matter and nutrients which can contaminate water bodies.

Although all modern landfills in New Zealand must be designed to high standards to control leachate, continued use of landfills degrades the environment, impacting the cultural value created in the environment, including the mauri of the awa (waterways), moana (oceans) and whenua (land).

Solid waste disposal produces greenhouse gasses due to the anaerobic decomposition of organic matter in landfills. In 2018, it was calculated that solid waste disposal to landfill produced 3,651.8 kt CO_2-e – 4.6% of New Zealand's gross emissions profile and 90% of total emissions from the waste sector.[62] Additionally, disposal of recyclables to landfill, has indirect emissions impacts due to the additional need to extract and manufacture new raw materials instead of reusing existing waste materials. The direct emissions profile of the solid waste sector has been trending down since 2005, and has declined 1.6% since 1990[63] due to improved landfill management practices, particularly landfill gas recovery in Class 1 landfills, which has offset the increased volumes of waste sent to landfill as a result of increased construction activity, consumption and population growth.[64] This does however point to the opportunity to better manage organic waste to avoid landfill, as well as the value of capturing and utilising landfill gas as part of New Zealand's response to climate change.

Finally, landfills create a burden for future generations, especially those disused landfills that are increasingly vulnerable to the impacts of climate change. For example, in 2019, rain washed out a disused landfill near Fox Glacier and contaminated 2100ha of riverbed and coastline with plastic, with

[59] PMCSA, *Rethinking Plastics in Aotearoa New Zealand* (Office of the Prime Minister's Chief Science Advisor, 2019), 128.
[60] Ministry for the Environment, *A Guide for the Management of Closing and Closed Landfills in New Zealand* (Wellington: Ministry for the Environment, 2001), 19.
[61] PMCSA, *Rethinking Plastics in Aotearoa New Zealand* (Office of the Prime Minister's Chief Science Advisor, 2019), 178.
[62] Ministry for the Environment, *New Zealand's Greenhouse Gas Inventory 1990–2018* (Wellington: Ministry for the Environment, 2020), 349.
[63] Ministry for the Environment, *New Zealand's Greenhouse Gas Inventory 1990–2018* (Wellington: Ministry for the Environment, 2020), 349.
[64] Wilson et al., *The New Zealand Waste Disposal Levy: Potential Impacts of Adjustments to the Current Levy Rate and Structure* (Eunomia Research & Consulting, 2017), 92-94.

65,000kg of waste being collected by volunteers, which covers an estimated 30% of the affected area.[65] Furthermore, similar landfill inundations occurred in 2020 in Gore and Gisborne Districts.[66,67] It is estimated that there are more than 110 closed landfills which will be vulnerable with 0.5m of sea level rise, creating an increasing environmental and health risks and ongoing financial liabilities for councils.[68]

3.6. Capitals

Resource recovery and waste disposal infrastructure draws on natural, human, social and financial/physical capitals to provide services to New Zealanders that support our wellbeing. However, the capital flows differ depending on the infrastructure type. At a high level, capital flows associated with resource recovery infrastructure trend towards net-neutral while waste infrastructure operations tend to be net consumers of capital.

3.6.1. Resource recovery infrastructure

While natural capital is consumed to build, maintain and operate resource recovery plant and equipment, resources are produced as a result, which helps avoids the use of natural capital by other production systems.

A range of human capital is required to build, maintain and operate the infrastructure, and there is the potential for harm to some of this workforce due to interaction with hazards, particularly in facilities where sorting is undertaken by hand. However, overall this capital flow is generally net-neutral in New Zealand.

The resource recovery system is very dependent on social capital in the form of governance frameworks which have the potential to change the quality, quantity and types of waste that is produced. This can happen though legislation (see *Issues the sector is facing today* below), as well as societal norms, which can also change the quality and quantity of input materials.

Financial capital for investment in resource recovery infrastructure comes predominantly from the private sector (see *Market Structure and Funding* below). Financial capital is created though the provision of services (to both the public and private sectors) and the sale of recyclates, meaning the sector tends towards neutral or net-positive financial capital flows.

3.6.2. Waste disposal infrastructure

Waste disposal infrastructure is a net consumer of natural capital. Resources are used in constructing, operating and closing (or in the ongoing management) of landfills. This includes the potential impacts on the land, air and water from operation (as outlined above).

A range of human capital is also required to build, maintain, operate and remediate landfills, and there is the potential for harm to some of this workforce due to hazards such as landfill gas, contaminated waste and heavy machinery.[69] Additionally, landfills present long term health risks to the community through exposure to leachate and contribution to climate change. Therefore, waste disposal infrastructure can be considered a net consumer of human capital.

[65] Katie Todd, "Operation Fox: River clean-up in full force with added support," *RNZ*, June 23, 2019, https://www.rnz.co.nz/news/national/394993/operation-fox-river-clean-up-in-full-force-with-added-support
[66] RNZ, "Awatere River Strewn with Rubbish after Flooding into Old Landfill," *RNZ*, July 09, 2020, https://www.rnz.co.nz/news/national/420711/awatere-river-strewn-with-rubbish-after-flooding-into-old-landfill.
[67] RNZ "Truckloads of Rubbish Cleared from Old Gore Landfill Exposed by Recent Floods.'." *RNZ*, February 28, 2020. https://www.rnz.co.nz/news/national/410617/truckloads-of-rubbish-cleared-from-old-gore-landfill-exposed-by-recent-floods.
[68] Tom Simonson and Grace Hall, *Vulnerable: The Quantum of Local Government Infrastructure Exposed to Sea Level Rise* (Local Government New Zealand, 2019), 37.
[69] WasteMINZ, *Health and Safety Guidelines: For the Solid Waste and Resource Recovery Sector*, (Waste Management Institute New Zealand Incorporated, 2017)

The waste disposal system is dependent on social capital from a governance and regulation perspective, but perhaps most importantly, the system can be considered to be driven by the societal norms of "take-make-throw" and "single use". Without a culture of disposal, landfill infrastructure would be in less demand.

Finally, while funding historically came from the public sector, more recently there has been increasing investment from the private sector (see *Market Structure and Funding* section below). While revenue is generated from disposal fees, there are financial (as well as environmental) liabilities associated with landfill closure and historic landfill management (which will be further exacerbated by climate change) which have the potential to create significant costs over the long-term.

4. What shapes the resource recovery and waste disposal sector today?

He aha ngā āhuatanga e pā ana ki te rāngai mahi pare i te rangi nei?

This section provides a discussion of the regulatory, funding and financing, ownership and governance of the resource recovery and waste disposal sector, and how this influences the operation of resource recovery and waste disposal infrastructure. It also discusses the current issues that the sector is facing in the short term.

4.1. Regulatory environment

The regulatory framework for the resource recovery and waste disposal sector is comprised of a number of pieces of legislation, but most importantly, the Waste Minimisation Act 2008 and Resource Management Act 1991.

4.1.1. Waste Minimisation Act 2008

The Waste Minimisation Act encourages the reduction of the amount of waste generated and disposed of in New Zealand. The act has powers aimed at reducing the generation of waste and discouraging disposal of waste to landfill. Specifically, the Act has powers to:

- Require councils to develop a Waste Minimisation and Management Plan every six years.
- Allow for regulations to be made to control the disposal of products, materials or waste, and require take-back services, deposit fees or labelling of products.
- Accredit voluntary product stewardship schemes or require product stewardship schemes to be developed for certain 'priority products' where there is a high risk of environmental harm from the waste, or significant benefits from recovering the product.
- Impose a levy on all waste disposed of in landfills that meet the definition of 'disposal facility' under the Waste Minimisation Act and distribute the funds received to territorial authorities and projects approved by the Minister to fund waste minimisation activities.

4.1.2. Resource Management Act 1991

The Resource Management Act regulates discharges to the environment, discharges of waste to land, and the residual effects of those activities, such as leachate and landfill gas discharges.

Implementation of the Resource Management Act is delegated primarily to local and regional councils and the Environmental Protection Authority. The Ministry for the Environment has an overall system stewardship role.

National Policy Statements and National Environmental Standards enable central government to set direction in relation to some key environmental management issues, which must be considered through Resource Management Plans and consent decisions. There are currently no National Policy Statements or National Environmental Standards which set standards for the processing or treatment of solid waste

and mitigating the impacts this has on the land. There are national standards regulating leachate discharges to freshwater and the sea, and discharge of landfill gas.[70]

4.1.3. Other Legislation

There are several other pieces of legislation which influence the design, construction and operation of the resource recovery system. These are:

Litter Act 1979

The Litter Act was established to help reduce and control litter. The Act is a mechanism for local government to prevent littering and enforce regulations.

Local Government Act 2002

The Local Government Act defines waste collection and disposal as a core service to be considered by local authorities and empowers local councils to charge for waste services through rates.

Climate Change Response Act 2002

This Act establishes New Zealand's 2050 net zero emissions target[71] and establishes the New Zealand Emissions Trading Scheme. As net positive emitter, operators of some waste disposal facilities have specific obligations under the New Zealand Emissions Trading Scheme. This includes the need to purchase credits to offset their carbon emissions.

4.2. Ownership and governance

4.2.1. Ownership of resource recovery and waste disposal infrastructure

Historically, most landfills were owned and operated by local government. However, over the last 40 years, the private sector has invested significantly in waste and resource recovery infrastructure, to the point where most local authorities contract these services from the private sector.

There is now a mixture of public and private ownership of resource recovery and waste disposal infrastructure. While the exact proportion of infrastructure in public *versus* private ownership is in the public domain, it is inferred that:

- Local government is more likely to fund and invest in material recovery facilities and landfills than other infrastructure in the resource recovery and waste value chain
- There has been significant investment by the private sector in both resource recovery and waste infrastructure, including landfills and material recovery facilities
- The majority of waste processing infrastructure is privately owned.

4.2.2. Governance of the waste sector

The Waste Minimisation Act is the overarching governing legislation for the waste sector and provides the Minister for the Environment with several policy levers for controlling waste creation and processing, including reducing waste. However, local government is charged with day-to-day provision and management of waste services.

[70] National Environmental Standards for Air Quality regulates the discharge of gas from landfills (with over 1 million tonnes of waste).
[71] Enacted through the Climate Change Response (Zero Carbon) Amendment Act 2019.

The Waste Minimisation Act sets up a hierarchal structure of legal powers. These allow the Minister for the Environment to set a national waste management policy through the New Zealand Waste Strategy, which local councils must have regard to in preparing their Waste Management and Minimisation Plans. The current New Zealand Waste Strategy 2010 sets no specific targets, timelines, actions, or responsibilities for waste minimisation or coordination of the processing of waste streams. This means it does not provide national level guidance for the sector in developing local policy and programmes.[72] This also means there is no national level policy guiding local councils' approaches to resource recovery and waste disposal. The existing New Zealand Waste Strategy is under review providing the opportunity to set ambitious waste reduction targets and supporting policy. Public consultation on the revised strategy is expected to be held in the second half of 2021.

Additionally, section 49 of the Waste Minimisation Act allows the Minister for Environment to set performance standards for territorial authorities' implementation of Waste Minimisation and Management Plans, which could potentially include:

- Standards for spending waste levy income
- Targeted resource recovery rates
- Targets for (re)invigorating community-based recycling
- Best-practice minimum standards for waste and recycling services, including baseline contract conditions and adequate weighting of social/environmental outcomes when evaluating tenders.[73]

This power has not been used to date. The cumulative effect of not using performance standards is twofold:

- Circularity has not been mandated in waste management decisions which leads to conflicting infrastructure outcomes, such as continued investment in landfills, as opposed to resource recovery infrastructure.
- Councils develop and implement their own waste management policies either for themselves or jointly with neighbouring councils. However, this can lead to different waste outcomes across territorial or regional boundaries, which creates barriers to obtaining the benefits which could accrue from economies of scale if waste management policies were coordinated a national level.

[72] "The New Zealand Waste Strategy: Reducing Harm, Improving Efficiency." Ministry for the Environment., accessed November 19, 2020, https://www.mfe.govt.nz/publications/waste/new-zealand-waste-strategy-reducing-harm-improving-efficiency."
[73] Hannah Blumhardt, "Trashing Waste: Unlocking the Wasted Potential of New Zealand's Waste Minimisation Act", 16Act." *Policy Quarterly* 14, no. 4 (March, 2020). https://doi.org/10.26686/pq.v14i4.6545.

4.3. Market structure and funding

Although local government has a responsibility to ensure that there is adequate resource recovery and waste disposal services within their boundaries, there is a mixed approach to waste infrastructure ownership and service delivery, which means that the types of financial capital consumed by the sector are from both private and public sources.

The major sources of resource and recovery infrastructure and service funding are:

- Council rates
- User charges
- Waste disposal levy
- Waste commodity markets
- The Provincial Growth Fund and other one-off grants.

It is estimated that for the recycling and resource recovery sector, there is an infrastructure funding need of approximately $2.1 to $2.6 billion.[74] Additionally, it has been estimated that approximately $0.9 billion is needed in operational funding over the next 10 years.[75]

4.3.1. Waste contracting

The way waste contracts are structured has a large effect on market structure and competition. Further, contracts focussed at a municipal level impact the ability to coordinate waste management across territorial boundaries and across different sources of waste. Eunomia identified the advantages and disadvantages of this approach to market structure:[76]

> *"If a single operator is responsible for all elements of the recycling service, they can make decisions on where resources are best directed to maximise recovery rates and value. This could include how materials are collected at kerbside, compaction rates, and contamination management, etc.*
>
> *Where specialist operators [to provide one or more services] are used, this can have advantages in terms of their expertise and focus on optimising their part of the service. However there need to be clear, enforceable, contractual standards relating to input contamination, compaction ratios, and operating procedures for the transfer of material between the collector and the Material Recovery Facility. The level of service integration also impacts where risk is allocated in the contracts."*

From a waste processing perspective, the use of mixed contracting models and longer contract terms (sometimes up to 10 years) create barriers to entry for market participants, increase the difficulty for cross-regional solutions, and make it more difficult to obtain optimal outcomes at a national level.

4.3.2. Waste Disposal Levy

A key source of funding is the Waste Disposal Levy enacted through the Waste Minimisation Act 2008. The Waste Minimisation Act sets a base levy on waste disposal going to class 1 landfills at $10/tonne. Currently, it is estimated that the levy raises $36m per annum.[77]

The levy proceeds are distributed as set out in legislation:

[74] Ministry for the Environment, *Regulatory Impact Statement: Increase and Expansion of Waste Disposal Levy* (Ministry for the Environment, 2020), 22.
[75] Ibid, 7.
[76] Duncan Wilson, Lisa Eve, and Andy Grant, *National Resource Recovery Project - Situational Analysis Report* (Ministry for the Environment, 2018), 21.
[77] Ministry for the Environment, *Reducing Waste: A More Effective Levy* (Wellington: Ministry for the Environment, 2019), 11.

- The Waste Minimisation Act 2008 requires that half of the levy proceeds are distributed to territorial authorities for the purpose of promoting or achieving the waste minimisation activities set out in their Waste Minimisation and Management Plans.
- The balance of funds (after administration costs) are used to fund projects that promote or achieve waste minimisation at a national level, allocated through the Waste Minimisation Fund.[78]

The most recent review of the levy in 2017 stated that of the total $190 million raised by the levy to date, 49% of funds have gone to territorial authorities, 45% to Waste Minimisation Fund projects and 7% to administration of the levy.[79]

Of the funds distributed directly to councils, the 2017 report[80] found that 30% were unspent initially, and that nearly half of the revenue allocated is reportedly spent on existing waste services, rather than new initiatives. However, it is difficult to ascertain accurate allocation of funds by councils, as reporting on levy spending by councils is currently voluntary.

The portion of levy proceeds administered by the Ministry for the Environment is placed into a ring-fenced Waste Minimisation Fund. The monies are distributed through contestable grants funds to projects that promote or achieve waste minimisation, which covers the reduction of waste and the reuse, resource recovery of waste and diverted material.[81] Funding is not typically for the ongoing financial support of existing activities, nor is it for the running costs of the existing activities of organisations, individuals, councils or firms.[82]

This funding source is expected to grow as the waste levy will be increased from 1 July 2021 and expand to a broader range of landfills (classes 1-4). As a result, revenue is expected to increase from $30 million to $240 million per year.[83] The effect of this could be that there will be more funding available for waste infrastructure, albeit not exclusively, and that the cost of landfilling will exceed the cost of recycling, which may impact volumes sent to landfill and revenue over time (noting this would be a positive outcome).

The nature of a contestable fund process creates cost and uncertainty for applicants looking for funding for infrastructure. That being said, the Ministry for the Environment is currently undertaking policy work as to how future revenue will be in administered.

4.3.3. Waste commodity markets (post collection)

A further source of resource recovery infrastructure funding is through the sale of sorted recyclates to reprocessors. Recyclates are sold both domestically and internationally.

This on-selling exposes the funding of the domestic resource recovery sector to the international commodities market. This exposure is material where income is used to subsidise the operational costs of the service. There is no standardised approach to risk sharing in relation to commodity price fluctuations, and in some cases, providers or councils may be exposed to funding risks when commodity prices drop. Some typical models include:[84]

[78] "Government Steps up Action on Waste - Funds Recycling Infrastructure and Expands Levy Scheme", The Beehive, July 15, 2020, http://www.beehive.govt.nz/release/government-steps-action-waste-funds-recycling-infrastructure-and-expands-levy-scheme
[79] Wilson et al., *The New Zealand Waste Disposal Levy: Potential Impacts of Adjustments to the Current Levy Rate and Structure* (Eunomia Research & Consulting, 2017), 15.
[80] Ibid.
[81] Projects funded through the Waste Minismiation Fund are published on the Ministry for the Environment's website.
[82] "Waste Minimisation Fund Eligibility and Assessment Criteria," Ministry for the Environment, accessed November 10, 2020, https://www.mfe.govt.nz/more/funding/waste-minimisation-fund/waste-minimisation-fund-eligiblity-and-assessment-criteria
[83] Ministry for the Environment, *Regulatory Impact Statement: Increase and Expansion of Waste Disposal Levy* (Ministry for the Environment, 2020)
[84] Duncan Wilson, Lisa Eve, and Andy Grant, *National Resource Recovery Project - Situational Analysis Report* (Ministry for the Environment, 2018), 22 – 23.

- Contractor owns all materials and takes all income from sale of materials
- Council owns materials and/or receives all income from sale of materials
- Contractor and council split income, or include some income sharing above a specific level.

In 2018, a large price contraction was caused by a series of import bans on low quality recyclates by countries led by China. This has presented significant liquidity, viability and profitability issues to recycling operations, both due to a drop in sale income, but also increased disposal and stockpiling costs due to the inability to sell certain collected materials (especially plastics 3-7 and fibre) offshore.

4.4. Issues the sector is facing today

The resource recovery and waste sector is facing a number of challenges over the next ~10 years, particularly with regards to ensuring that New Zealand has sufficient infrastructure, located in the right places to meet demand, as well as operating in the most efficient and sustainable way possible. Key issues identified include:

- ***The lack of data*** makes it hard to measure success and plan future infrastructure interventions.
- ***Changing or emerging waste streams*** undermines certainty in long-term investments or have the potential to create stranded assets. For example, waste stream bans, export permit allocations, stewardship schemes, and standardised kerbside recycling.
- ***End markets*** need to be profitable and stable to ensure there is the case for investment in recourse recovery infrastructure.
- Future reliance on ***onshore vs offshore processing*** and the level of investment required to meet that demand.
- ***Responding to climate change*** in terms of remediating vulnerable landfills and reducing emissions from the sector.

4.4.1. Lack of quality data

Lack of quality data hinders effective resource recovery and waste infrastructure decision-making, including decisions pertaining to infrastructure investment and service delivery needs. It is difficult to compare volumes or performance across waste streams or regions, and this is a major issue for future waste policy and infrastructure planning.

Currently, there are no statutory requirements under the Waste Minimisation Act for councils to report waste data within a specific data framework, or to report externally. There is also no coordinated or standardised methodology to measure or report on waste generation or disposal by type. Therefore, there are gaps in our understanding of the flow of waste from generation (i.e. where and how waste is generated) to how waste is treated, whether recycled, recovered, exported or disposed of. Further, it is not possible to determine the amount of waste that is not accounted for due to littering and illegal dumping.

The Waste Minimisation Act requires territorial authorities to prepare a Waste Minimisation and Management Plan. As part of their Waste Minimisation and Management Plans councils should state which data should be collected on waste quantities, projection of quantities, composition, sources of waste, and destination of waste and diverted materials. However, the level of data collection is determined by a council's own circumstances and available resources, and it not consistent between councils. Additionally, as noted by the Prime Minister's Chief Science Advisor:[85]

[85] PMCSA, *Rethinking Plastics in Aotearoa New Zealand* (Office of the Prime Minister's Chief Science Advisor, 2019), 221.

> *"Councils may also be limited in the data they can access if they contract out collection and recovery services to private operators due to how contracts are set up. Where private operators manage facilities and collection services under contract, some data may be obtained through key performance indicators in the contract they have with council or through bylaws. As the Waste Minimisation Act only covers waste (and not recovered materials), bylaws can only be used to obtain data on plastic to landfill and not plastic for recycling."*

Further, there is very limited publicly available data as to the capacity on different types of resource recovery infrastructure. This is because of commercial sensitivity around processing capacity, and the competitive market for higher value waste (i.e. waste that has lower levels of contamination or is of higher quality). This lack of data limits the ability to ascertain whether there is a deficit in capacity (or the size of any deficit) of existing infrastructure, either at a regional or national level.[86]

In 2013, WasteMINZ was granted funding to develop a national waste data framework in partnership with local government. The framework was completed in 2015, but it has never been fully implemented.[87] Proposals to improve waste data were also included in planned changes to the Waste Disposal Levy and these are expected to be progressed by the Ministry for the Environment in 2021.

4.4.2. Current policy changes and emerging waste streams

There are several policy interventions under development which are intended to reduce waste that may trigger a change in investment in resource recovery infrastructure. These include:

- **Product bans:** the Government has recently consulted on proposals to ban the sale of some PVC or polystyrene packaging, oxo-degradable plastics and seven single-use items.
- **Regulated product stewardship schemes:** the Government has announced that plastic packaging, tyres, e-waste, agrichemicals and their containers, refrigerants, and farm plastics will be 'priority products' and required to participate in compulsory product stewardship programmes that seek to ensure that there are viable alternatives to disposing of these products to landfill.
- **Container return scheme:** the Government is currently investigating options for a possible scheme where consumers will pay a deposit on beverage containers (aluminium, glass, plastic and paper) which will be included in the purchase price. The deposit will be refunded if the empty container is returned to designated drop-off points.
- **Import and export permits**: for the import and export of mixed plastic waste (except for PE, PP and PET) permission from both the importing and exporting governments will be required. This is consistent with an amendment to the Basel Convention which came into force on 1 January 2021 which will restrict the export of plastic waste by requiring exporters of hard-to-recycle mixed plastic waste to obtain consent from the governments of receiving countries[88.]
- **Standardised kerbside collections:** the Government is exploring options for standardising kerbside collections, following on from report recommendations.[89] This is intended to create consistency for processors and enable the amalgamation and standardisation of processing infrastructure. This policy will be beneficial for the resource recovery sector as it will increase the amount of waste that can be recovered and reduce the levels of contamination in recycling, leading to a higher value sorted

[86] The Ministry for the Environment is progressing a project (infrastructure and services stocktake and gap analysis) which will improve data as to the size of the infrastructure gap.
[87] "National Waste Data Framework Project," WasteMINZ, accessed November 10, 2020, https://www.wasteminz.org.nz/projects/national-waste-data-framework-project/.
[88] "Importing and Exporting Plastic Waste" Environmental Protection Agency, accessed January 22, 2021, https://www.epa.govt.nz/industry-areas/hazardous-substances/hazardous-waste/importing-and-exporting-plastic-waste/
[89] Sarah Pritchett and Sunshine Yate, "Recommendations for Standardisation of Kerbside Collections in Aotearoa" (Wellington: Ministry for the Environment, August 2020) https://www.mfe.govt.nz/sites/default/files/media/Waste/recommendations-for-standardisation-of-kerbside-collections-in-Aotearoa.pdf.

recyclate. Evidence from a similar policy in Wales demonstrates that source separated collection leads to far less loss of material due to contamination than a comingled collection.[90]

Together, these interventions will significantly reduce some waste streams, which are hard to recycle, and conversely, increase demand for other recycling services (plastics and paper) as producers change their products and packaging to comply with the new regulations. Additionally, new processing infrastructure may be required to deal with the volume of waste that will be covered by mandatory product stewardship schemes, as well as the levy changes which are predicted to increase the proportion of construction and demolition, and organics waste recovered.

Policy approaches needing to be cognisant of existing facilities and how they are impacted by programmes such as the container return scheme and standardised collections. Impact on the viability of collections and material recovery facilities could be positive or negative, depending on how such programmes are implemented. For example, there could be a risk to material recovery facilities if the collective value of the waste they receive is reduced by programmes such as the container return scheme and standardised collections. If the waste stream is disaggregated at source, in full or in part, it could reduce the return on investment in the facility.

Conversely, standardising kerbside collections has the potential to significantly improve the economics of operating a material recovery facility if it is effective in reducing contamination and reducing the amount of sorting required. Additionally, a scheme such as a container return scheme could make it easier for members of the public to recycle high value recyclates such as (PET, HDPE and aluminium), and therefore could reduce the overall value of the municipal waste collected and processed though material recovery facilities. Or, if material recovery facilities are able to gain the unclaimed deposits in kerbside collections as they do in Australia, this could offset any losses. Working through potential costs and benefits and how they are shared will be critical to the successful implementation of these programmes in the current waste and resource recovery system.

Further, there are new waste streams developing that require processing infrastructure investment if they are to be diverted from landfill. The time it takes to change regulations, means that when resource recovery infrastructure does not exist for new types of waste it has to be sent to landfill. A recent example of this are plastic bladders or 'flexibladders', which has attracted press coverage.[91]

It is necessary to ensure that there is coordination between the policy and regulatory system to support planning, funding and financing new resource recovery infrastructure. Increased certainty in the composition of the future waste stream will increase confidence for investment in recycling infrastructure. Without certainty about the types and volumes of waste that is likely to be created in certain regions, the appropriate investment in resource recovery infrastructure may not occur. Or investment may occur in areas which might not be required if the quantity of waste is reduced, leading to a risk of stranded assets.

4.4.3. Viable markets for outputs

New Zealand's market-based resource recovery system requires stable and profitable end-markets for the recyclates produced to support the case for investment in additional infrastructure. If recyclates are considered as valuable, or even more valuable, than virgin materials then the resource recovery value chain will likely respond.

[90] AlphaBeta. *Recycling and Resource Recovery Infrastructure in Victoria: International and Australian Comparisons*, Infrastructure Victoria, 2019, 53.
[91] Phil Pennington, '"Hidden Story" of Industrial-Sized Plastic Bladders Going to Landfills,' *RNZ*, October 14, 2020

The investment that has already occurred in resource recovery infrastructure in New Zealand, particularly in processors, is typically in areas where a strong end-market exists e.g. glass and plastics 1.[92] Where there is no end-market for the recyclate, or the end-market is volatile, this sends a negative investment signal, and in the absence of regulation or subsidies, investment is unlikely to be made solely on commercial merit.

4.4.4. Onshore vs offshore processing of waste

In the in the absence of a mandated approach/direction, New Zealand deals with its processing needs by exporting a proportion of the sorted waste for processing offshore. This creates vulnerabilities in New Zealand's resource recovery and waste management value chain, as demonstrated by the 2018 waste import bans. Sorted recyclates which are exported and processed offshore (including ferrous and nonferrous metals, PET, HDPE and PP as well as pulp and paper), and other waste (including hazardous waste), continue to be vulnerable to future policy changes in international jurisdictions as well as international commodity markets.

Actively coordinating regulatory and market signals in relation to the accessibility and desirability of offshore processing would create greater certainty for onshore resource recovery and waste infrastructure investment. The long-term effect of this could be a more effective and efficient resource recovery and waste sector, scaled to New Zealand's needs. However, due to the fragmented sector governance, sub optimal data and the reliance on international commodities markets, there is no strategic direction on what the optimal onshore/offshore processing mix is. This was noted by the Prime Minister's Chief Science Advisor who recommended that the government strategically invest in or incentivise development of systems and infrastructure to deal with our own plastic waste onshore, specifically in relation to PET, HDPE, PP and possibly LDPE.[93]

Furthermore, there are ethical aspects that should be taken into account when deciding on the right mix of onshore *versus* offshore processing. The increased risk of environmental or human rights incidents should be considered when pursuing an offshore processing solution, especially when relying on infrastructure in developing nations. This was the rationale behind the Council of Australian Governments agreeing to ban waste plastic, paper, glass and tyres exported.[94]

4.4.5. Adaption to climate change and remediation of vulnerable landfills

There are approximately 112 open and closed landfills which will be vulnerable with 0.5m of sea level rise.[95] This increases to 129 landfills when 1.0m of sea level rise occurs. These are all at risk of increased erosion and inundation and will require some form of remediation to mitigate the risk of an event similar to the failure of the Fox Glacier landfill. This risk was identified as part of the National Climate Change Risk Assessment (NCCRA) and has been assessed as being of major consequence in the future [96]. The failure of landfills and contaminated sites across New Zealand may release pollutants (such as

[92] The one exception to this is metals where a strong international commodities market for the unprocessed waste product has limited the development of onshore processors.
[93] PMCSA, *Rethinking Plastics in Aotearoa New Zealand* (Office of the Prime Minister's Chief Science Advisor, 2019), 15.
[94] Department of the Environment and Energy, *Banning Exports of Waste Plastic, Paper, Glass and Tyres Discussion Paper on Implementing the August 2019 Decision of the Council of Australian Governments*, (Department of the Environment and Energy, 2019), 3.
[95] Tom Simonson and Grace Hall. *Vulnerable: The Quantum of Local Government* exposed. *Infrastructure Exposed to Sea Level Rise*, 37.
[96] Ministry for the Environment, *National Climate Change Risk Assessment for New Zealand. Technical Report. Arotakenga Tūraru Mō Te Huringa Āhuarangi* o*O Āotearoa. (Pūrongo Whaihanga*, 2020), 149.

dissolved nitrogen and heavy metals) and solid waste, including glass, metal, plastics and asbestos.[97] The NCCRA noted:[98]

> "For Māori, the potential pollution and contamination of food-gathering areas (mahinga kai) from landfill damage, and effects on taonga species are likely to have significant consequences for Māori cultural practices and the wider Māori economy."

There is significant work required to determine the location of landfills, and the exposure, vulnerability and consequence for these sites across New Zealand, before the future cost of adaptation can be estimated. Research on the extent of this risk has been commissioned by the Ministry for the Environment.[99]How is the resource recovery and waste disposal sector performing today?

New Zealand lacks a comprehensive waste dataset, which limits the ability to fully assess the performance of the resource recovery and waste disposal sector. However, on the basis of available data, it is possible to infer that:

- New Zealand's municipal waste to landfill per capita is the highest in the OECD
- New Zealand's municipal resource recovery rate is the low when compared to other countries.

4.5. Waste to Landfill

In 2019, 3.5 million tonnes of waste were disposed of in Class 1 landfills. Waste to Class 1 landfills has increased by 38 per cent since 2010.

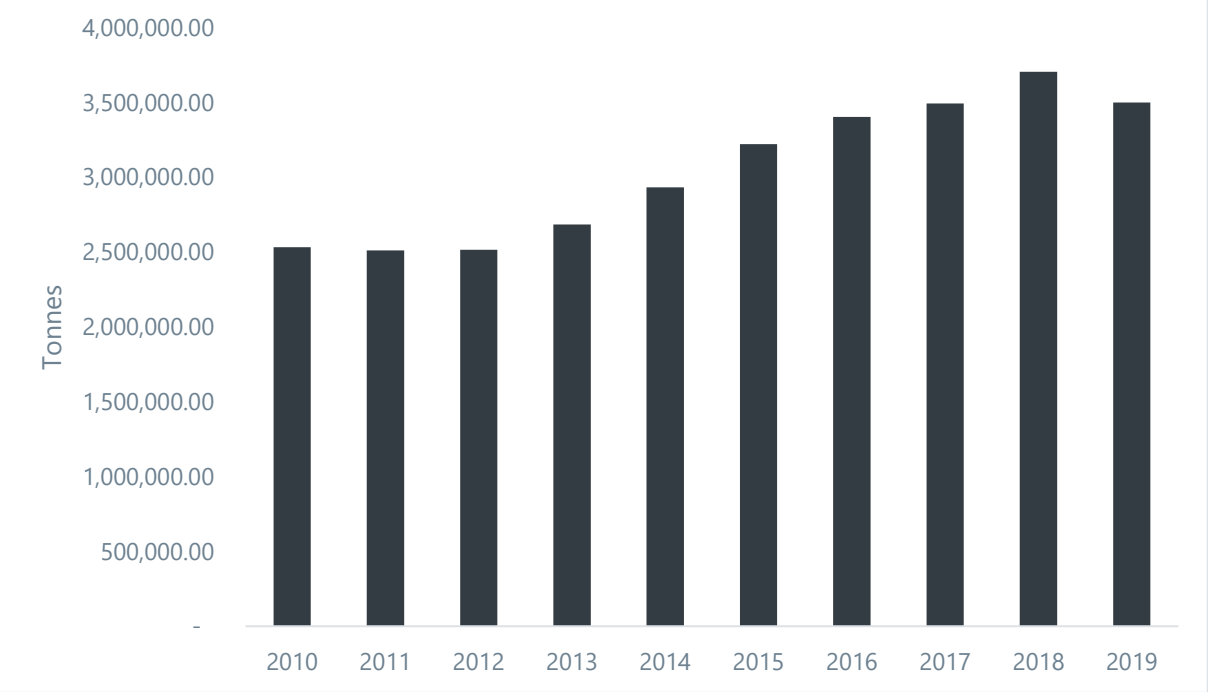

Figure 3: Waste (tonnes) disposed of in Class 1 Landfills 2010 - 2019[100]

[97] Brand, James, Kate Spencer, Francis O'Shea, and John Lindsay. *et al.* "Potential Pollution Risks of Historic Landfills on Low-Lying Coasts and Estuaries." *WIREs Water* 5, no. 1 (2018): e1264.
[98] Ministry for the Environment, *National Climate Change Risk Assessment for New Zealand. Technical Report. Arotakenga Tūraru Mō Te Huringa Āhuarangi o Āotearoa* (Pūrongo Whaihanga, 2020), 149.
[99] "Minister Announces Multi-Agency Response to Identify Risks from Legacy Landfills." The Beehive, September 11, 2019. http://www.beehive.govt.nz/release/minister-announces-multi-agency-response-identify-risks-legacy-landfills.
[100] "Monthly Levy Graph," Ministry for the Environment, accessed November 10, 2020, https://www.mfe.govt.nz/waste/waste-guidance-and-technical-information/waste-disposal-levy/monthly-levy-graph.

When compared to international data, New Zealanders send the most municipal waste[101] to landfill per capita in the OECD (see Figure 4).[102]

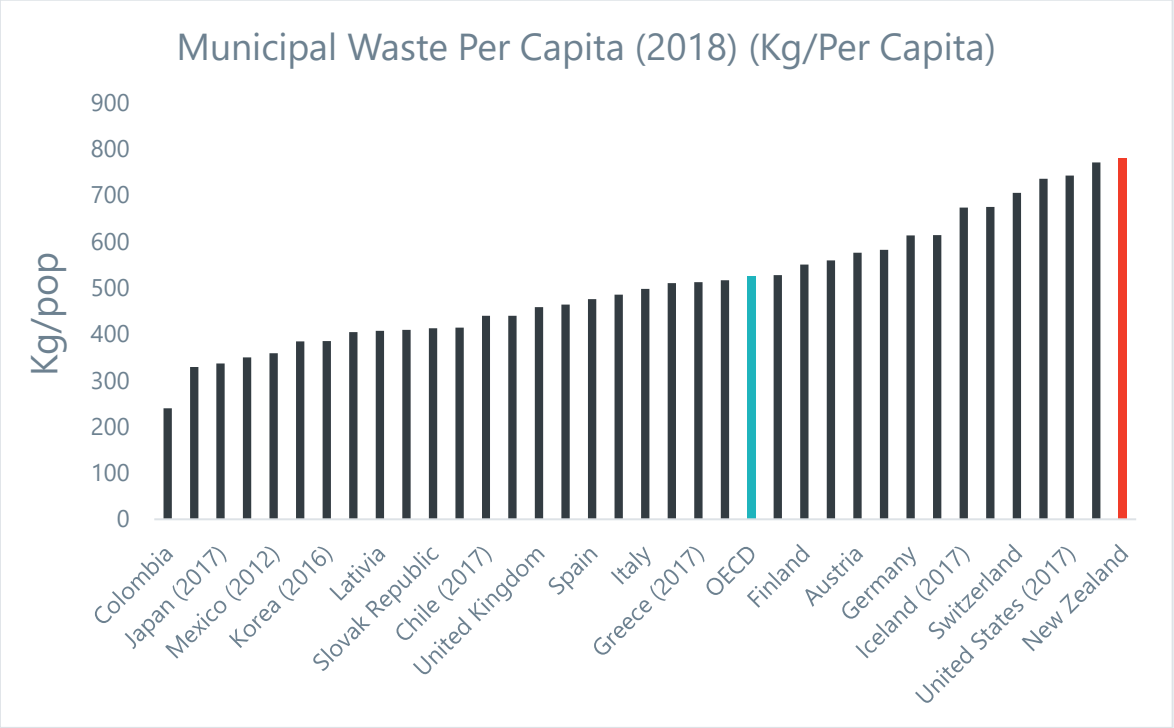

Figure 4: OECD Indicator: municipal waste to landfill per capita (kg/pop), 2018[103]

4.6. Resource recovery rates by activity source

New Zealand does not report total resource recovery rates for municipal, commercial and industrial, and construction and demolition waste. However, the estimated recovery rates for different activity sources in 2015 is set out in Table 4.

Table 4: New Zealand's estimated 2015 recovery rate by activity source[104]

Activity Source	**Recovery Rate**
Municipal Solid Waste[105]	32%

[101] The OECD defines municipal waste as waste collected and treated by or for municipalities. It covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, as well as yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste if managed as household waste. The definition excludes waste from municipal sewage networks and treatment, as well as waste from construction and demolition activities.

[102] "Municipal Waste," *OECD*, accessed November 10, 2020, https://www.oecd-ilibrary.org/environment/municipal-waste/indicator/english_89d5679a-en.

[103] Where 2018 data was not available the most recent publicly available figure was reported.

[104] Wilson et al., *The New Zealand Waste Disposal Levy: Potential Impacts of Adjustments to the Current Levy Rate and Structure*. Eunomia Research & Consulting, 2017, 79.

[105] Including Domestic Kerbside and other residential sources.

Activity Source	Recovery Rate
Industrial and Commercial Waste	62%
Construction and Demolition[106]	28%
Total[107]	**35%**

New Zealand's total recovery rate is estimated at 35% of total waste (Table 4). This is low when compared to available international comparators.[108] The highest reported recovery rates within the peer group selected in a recent study undertaken by Eumomia are Germany (66.1%), Wales (63.1%) and Singapore (61%). Australia reported a total recovery rate of 41.6% (Figure 5).[109]

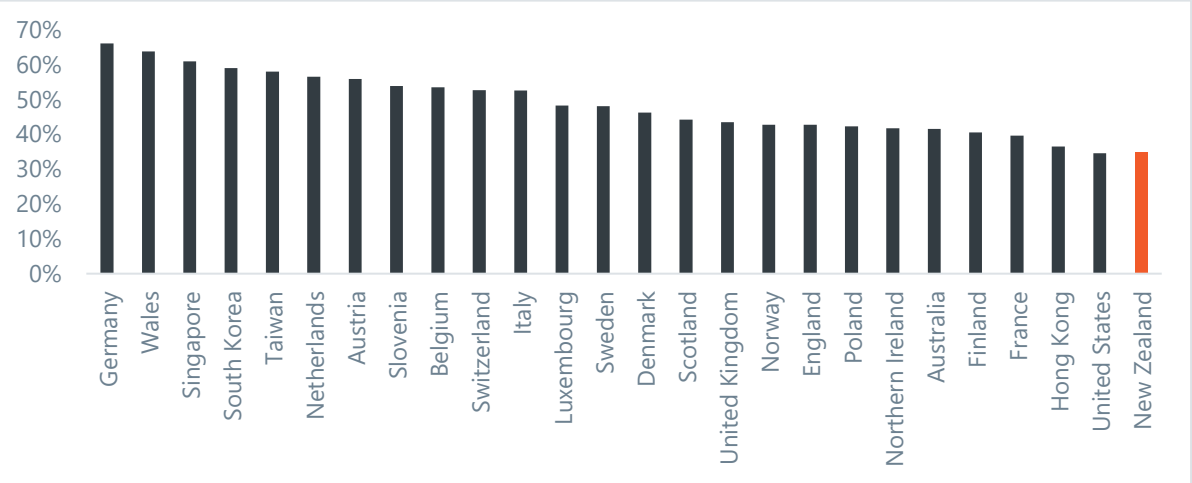

Figure 5: Total recovery rate by country[110]

New Zealand's estimated municipal solid waste recovery rate is low when compared to international peers (Figure 6) including South Australia (54%), New South Wales (42%) and Victoria (40%).[111] Further, for construction and demolition waste, Victoria's recovery rate is almost three times New Zealand's rate at 82%.[112]

[106] Excluding Virgin Excavated Natural Material.
[107] Excluding Virgin Excavated Natural Material.
[108] Eunomia, *Recycling – Who Really Leads the World? Identifying the World's Best Municipal Waste Recyclers*, European Environmental Bureau, 2019, 3.
[109] Ibid.
[110] Ibid.
[111] AlphaBeta, *Recycling and Resource Recovery Infrastructure in Victoria*, (International and Australian Comparisons, 2019), 12.
[112] Ibid.

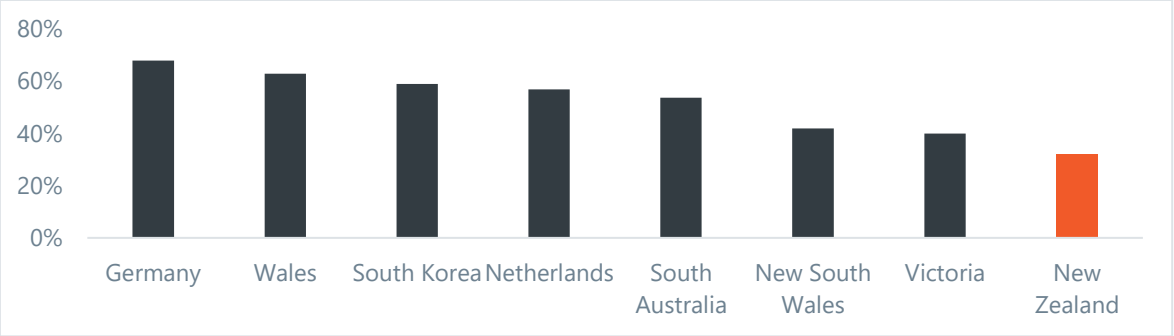

Figure 6: International municipal solid waste recovery rates (2016-2017) compared to New Zealand's 2015 estimated rate[113]

[113] AlphaBeta, *Recycling and Resource Recovery Infrastructure in Victoria*, (International and Australian Comparisons, 2019), 12.

5. How is the resource recovery and waste sector responding to what might come next?

E aha ana te rāngai whakahōu rawa me te mahi pare e takatū ai te rāngai mō te anamata?

There is little publicly available information about how the resource recovery and waste sector is planning for future challenges. However, a number of observations can be made based on emerging trends or issues that are likely to shape the sector in the next 10-30 years.

5.1. Transition to a circular economy

The need for investment in future resource recovery and waste infrastructure is based on the assumption that waste will continue to be created at significant volumes over the coming decades.

However, this is not consistent with the goal of a circular economy or with interventions which reduce waste generation, such as designing out waste or reusing potential waste products. If New Zealand is able to reduce its total waste footprint the future need for resource recovery and waste disposal infrastructure will also decrease.

The potential for the development and investment in reuse systems and infrastructure in New Zealand is significant. Reuse is one of the highest levels on the waste hierarchy and these systems that support reuse are inherently circular and reduce emissions. For example, refillable glass beverage containers have a significant carbon emission reduction potential over single use recyclable glass containers. Recycled content glass containers in turn have a lower carbon footprint than bottles made from virgin extracted materials. There are options including standardised bottles and bottle washing infrastructure that could support New Zealand's transition to a circular economy.

Regarding the waste generated through infrastructure construction and operation, there is scope to encourage the reduction of waste generation through better design and procurement practices, as well as encouraging increasing use of recovered materials in construction.

5.2. Climate change mitigation and adaptation

The Climate Change Response (Zero Carbon) Amendment Act 2019 commits New Zealand to reaching net zero emissions of long-lived greenhouse gases by 2050, and to reducing biogenic methane emissions by between 24-47% by 2050. While further advice on targets and emissions pathways will be provided shortly by He Pou a Rangi, the Climate Change Commission, there are three aspects that will be important to reducing emissions linked to the resource recovery and waste sector, and the infrastructure that supports it.

Firstly, as per above, reducing this waste by implementing circular economy principles so that less material enters the waste treatment and disposal pathway, and more material is reused or recovered to replace virgin material production will support reducing the carbon intensity of many aspects of the economy, as well as that of the waste sector. New infrastructure, such as refilleries, may have a role to play in this as the economy moves up the waste hierarchy. There also may be the opportunity to increase the scale of resource recovery in New Zealand, or to develop targeted resource recovery infrastructure to collect waste that can't be avoided from the most material sectors or regions. The work that the Ministry for the Environment are undertaking to quantify waste flows in New Zealand (the National Resource Recovery Stocktake) will be a key input to inform a strategic approach to developing additional resource recovery infrastructure, but it should be acknowledged that this is less optimal than reducing waste generation.

Secondly, ensuring that as much organic waste material as possible is diverted from landfill will be key to reducing the biogenic methane emissions that are emitted from landfills. Composting, anaerobic digestion and thermal waste-to-energy approaches may all have a role to play in the low-carbon management of organic waste that can't be avoided. Infrastructure has a critical role to play in this, but needs to be supported by good strategic planning, so the right approach is implemented in each community or region.

Finally, leading-practice landfill management, including landfill gas capture, will need to become standard.

5.3. Waste-to-energy

In the future, it is possible that larger-scale waste-to-energy plants may be considered as an alternative to sending waste to landfill, with co-benefits including heat or electricity generation. Waste-to-energy should only progress in a way that is consistent with the waste hierarchy. This means that waste-to-energy infrastructure systems should be established to replace disposal to landfill, not replace resource recovery, distort recyclate end markets, or disincentivise efforts to redesign and reduce waste.

Further, the adoption of waste-to-energy, as an energy generation method needs to be considered within the context of New Zealand's current renewable energy goals, and thermal waste to energy of some materials (plastics) can release greenhouse gasses during incineration. That being said, other technology such as anaerobic digestion presents an opportunity to reduce the amount of biogenic methane produced from organic waste in addition to electricity generation.

5.4. Landfill mining

Landfill mining is a process by which closed landfills are excavated and their contents processed, and any usable waste recovered and on-sold. This activity is being explored by several parties as an option to remediate closed landfills, or landfill cells that are vulnerable to climate change, or pose a persistent environmental risk. This option may be particularly suited to monofil landfills rather than general municipal landfills.

6. Conclusion

Whakatepenga

Based on data available in the public domain, our resource recovery and waste sector is not performing as well as international comparators. New Zealand's municipal waste to landfill per capita is the highest in the OECD, and New Zealand's municipal resource recovery rate is the lowest of international comparators.

Key issues facing the sector over the next 10 years include a lack of data about the waste sector, fragmented sector governance, onshore processing capacity gaps, changing or emerging waste streams creating investment uncertainty and adaptation to climate change. All of these factors are potentially barriers to the resource recovery and waste sector improving wellbeing.

In spite of this, broader consideration ought to be given to New Zealand's future approach to waste generation, and the potential need for future resource recovery and waste infrastructure. If New Zealand is able to reduce its waste through redesign or reuse, the future demand for new investment in resource recovery and waste disposal infrastructure will be displaced by interventions higher up the waste hierarchy.

The infrastructure system has a large role in embedding the circular economy into general practice through better design and procurement to reduce waste, and greater use of recycled materials as part of construction. This is something that Te Waihanga is actively considering as we continue to build on this Resource Recovery and Waste Infrastructure State of Play and consider how the infrastructure system as a whole can better embody sustainable production and consumption and the circular economy.

7. Appendix 1: Waste Material Flows

Āpitihanga 1: Te Rere o ngā Para

This appendix provides additional context for waste flows and potential end uses of each product. The data in the following sections is the most up-to-date in the public domain at the time of writing, we do however note that these data may be improved on when the Ministry for the Environment publish the National Resource Recovery Stocktake later in 2021.

Glass

Glass resulting from packaging (bottles, jars and other containers) is theoretically recyclable in perpetuity if the infrastructure is available to process it. Primarily sourced from municipal and commercial sources, waste glass, after being separated out at a material recovery facility, is crushed into cullet at a glass beneficiation plant, before being processed into recycled glass at a glass manufacturer.

Beneficiation is the process where items like bottle tops and labels are removed from sorted glass to stop contamination. The glass beneficiation plant in Auckland is owned and operated by Australian company Visy Ltd. The plant is part of the Onehunga Material Recovery Facility and is able to sort glass on optical sorting lines into composite colours (clear, greens and browns).

Once the glass is beneficiated it is sent to New Zealand's only glass manufacturing plant in Auckland, also operated by Visy Ltd, for processing into new glass bottles. The Glass Packaging Forum estimates that 51% of glass packaging sold in New Zealand is recovered and recycled into new bottles or other glass packaging.[114]

The rest of the glass recovered is used for other purposes (such as water filtration) or downcycled – used for purposes of a lesser value than the original product – such as aggregate replacement, and insulation. There are nine glass crushers in New Zealand, with three in the North Island and six in the South Island, which can crush glass into fines for use in aggregate. The capacity for waste glass to be used as roading aggregate annually is not publicly available.[115]

Paper and cardboard (fibre)

Paper and cardboard (fibre) including mixed paper and cardboard, office paper, and newspapers and magazines, can be recycled on average 5-7 times before the fibres become too short to be reused.

The main fibre recycling facility in New Zealand is the OJI Fibre plant in Auckland, which has capacity to recycle approximately half of the fibre recovered in New Zealand annually.[116] This limited capacity, along with international fibre export restrictions, means that OJI is able to target high quality fibre, as opposed to the lower quality material which is separated from kerbside collections. This separation avoids contamination with other materials received from material recovery facilities, in particular glass fragments, which damage the fibre processors.[117] Despite this , OJI still takes fibre from kerbside collections, most notably from the Material Recovery Facilities they operate in Wellington and Dunedin.

[114] Glass Packaging Forum, Product Stewardship Scheme Accreditation Report 2018-2019, 12.
[115] Duncan Wilson, Lisa Eve, and Andy Grant, *National Resource Recovery Project - Situational Analysis Report* (Ministry for the Environment, 2018), 48 – 49.
[116] Ibid, 47.
[117] Duncan Wilson, Lisa Eve, and Andy Grant, National Resource Recovery Project - Situational Analysis Report (Ministry for the Environment, 2018), 47.

Historically, the remaining fibre that has not been able to be processed onshore has been exported. However, the impact of international import bans, and ongoing impacts of Covid-19 internationally, has meant that some paper waste collected through recycling collections has been diverted to landfill.[118,119] This has an impact on the total carbon footprint of the sector, as paper and cardboard produce methane in the anaerobic landfill environment.

Furthermore, it is likely that even if onshore processing capacity were increased, there would not be demand to match the volume of the recyclate, and it would still need to be exported or risk being sent to landfill.

Plastics

Plastics products are often marked with a number from 1 to 7 to indicate the base polymer the plastics is made from. Different types of plastic have different uses and markets. Typically, Material Recovery Facilities separate plastics into bales of clear (PET) (1), natural HDPE (2), mixed bales of plastics 3-7, coloured PET (1), and coloured HDPE (2).[120] Business-to-business commercial collections represent almost half of the plastics collected in New Zealand, and these large volumes of relatively clean and homogenous plastics are sold straight to reprocessors or offshore without going via a Material Recovery Facility.[121]

Kerbside collections recover approximately 25,000 tonnes of plastics, other commercial collections collect about 20,000 tonnes of mostly low-density polyethylene film (e.g. pallet wrap).[122]

Plastic 1: polyethylene terephthalate (PET)

There is capacity for onshore processing of Plastic 1: (PET), as well as a domestic market for contamination free PET recyclates. PET can be recycled multiple times and is referred to, once recycled, as rPET.

Flight Plastics Ltd, in Lower Hutt, has sufficient capacity to process all of the clear PET currently recovered in New Zealand, and has the ability to expand capacity without further investment. In her report, the Prime Minister's Chief Science Advisor considers that New Zealand now has the infrastructure to deal with all of the PET being recovered currently, and has the capacity to deal with a growing volume of PET.[123] Since the commencement of Flight's operation, the Prime Minister's Chief Science Advisor notes that virgin PET imports have decreased.[124]

Additional capacity exists in other organisations too. Custom-Pak operate two PET recycling plants, and PACT Group are establishing PET reprocessing capabilities, which in the future will have the capacity to convert 10,000t of PET a year into food packaging, including meat and bakery trays.[125]

[118] Auckland Council, "Looming Paper Recycling Issues Require an Urgent Onshore Solution," *OurAuckland*, August 1, 2019, https://ourauckland.aucklandcouncil.govt.nz/articles/news/2019/08/looming-paper-recycling-issues-require-an-urgent-onshore-solution/.
[119] Todd Niall, "Coronavirus: Paper Recycling Sent to Dump in Auckland as Export Doors Close," *Stuff,* April 01, 2020, https://www.stuff.co.nz/environment/120727520/coronavirus-paper-recycling-sent-to-dump-in-auckland-as-export-doors-close.
[120] PMCSA, *Rethinking Plastics in Aotearoa New Zealand* (Office of the Prime Minister's Chief Science Advisor, 2019), 122.
[121] Duncan Wilson, Lisa Eve, and Andy Grant, National Resource Recovery Project - Situational Analysis Report (Ministry for the Environment, 2018).
[122] Ibid.
[123] PMCSA, *Rethinking Plastics in Aotearoa New Zealand* (Office of the Prime Minister's Chief Science Advisor, 2019), 128.
[124] Ibid.
[125] Anuja Nadkarni, "Pact Group Gets $3m Grant for 100% Recycled Plastic Food Packaging Plant," *Stuff*, July 15, 2019, https://www.stuff.co.nz/business/114235949/pact-group-gets-3m-grant-for-100-recycled-plastic-food-packaging-plant.

Capacity exists to recycle coloured PET. However, due to the limited end-market for coloured PET, it is less in demand than clear PET. This is because the plastic turns grey when processed, so can only be used to make grey or black plastic products, limiting the value of the recyclate.[126]

Plastic 2: high density polyethylene (HDPE)

Plastics 2 (HDPE), used for milk bottles, food containers, and chemical containers, are recyclable and have value as a recyclate. The current onshore HPDE processing capacity is not available in the public domain, but there are multiple processers of recyclate HDPE in New Zealand. It is known that existing infrastructure does not currently have the capacity to process all the HPDE waste created in New Zealand.[127] Additionally, where infrastructure does exist, HPDE is typically downcycled to make road furniture, fence posts and rubbish bins, and not recycled into the same use it previously had.

Plastic 5 polypropylene (PP)

Historically, Plastic 5 (PP) was not targeted for onshore processing. Due to low volumes in the waste stream it was not considered economic to separate it out. However, as PP volumes are increasing, and it has relatively high value as a recyclate, the investment case for onshore recovery is improving[128]. That being said, currently only two-thirds of councils accept PP as part of their recycling collections. Recycled PP can be manufactured into building materials, gardening supplies, clothing, and packaging[129]

There are multiple processers that recycle PP in New Zealand. However, the current onshore processing capacity of New Zealand's infrastructure is not publicly available.

Plastics 3, 4, 6, 7: polyvinyl chloride (PVC), low density polyethylene (LDPE), polystyrene (PS), all others (including composites).

There is limited onshore processing capacity or markets for plastics 3, 4, 6 and 7, and prior to 2018 waste import bans these plastics were exported for offshore processing. However, as the offshore market for mixed plastics is currently limited and low value, some local councils are beginning to stop collecting these plastics as part of their recycling collections and they are being sent directly to landfill.[130] LDPE collected in business-to-business arrangements may be the exception to this, as offshore demand for clean, homogeneous, high quality product continues to be stable.

As discussed above, the Ministry for The Environment is planning to phase out some PVC or polystyrene packaging, oxo-degradable plastics and seven single-use items.

Organic waste

Organic waste is any material that is biodegradable and comes from either a plant or an animal (including food waste, garden waste, biosolids, and timber). This also includes sludge from wastewater treatment plants.

The current onshore processing capacity of organics infrastructure is not available in the public domain, but there are a large number of facilities that process organic waste into products which recover the residual nutrients or energy in the waste, for example, as compost or fertiliser. Additionally, processing waste in this way can reduce carbon emissions when compared to disposal in landfill.

[126] WasteMINZ, *The Truth about Plastic Recycling in Aotearoa New Zealand in 2020* (Waste Management Institute New Zealand Incorporated, 2020), 8.
[127] PMCSA, *Rethinking Plastics in Aotearoa New Zealand* (Office of the Prime Minister's Chief Science Advisor, 2019), 128.
[128] WasteMINZ, *The Truth about Plastic Recycling in Aotearoa New Zealand in 2020* (Waste Management Institute New Zealand Incorporated, 2020), 6.
[129] "Recycle It!" Packit, accessed November 10, 2020, https://recycling.nz/.
[130] Wellington City Council, '"Council to Stop Collecting Low Grade Plastic for Good," *OurWellington*, October 5, 2020, https://wellington.govt.nz/your-council/news/2020/06/recycling-collection-changes.

Metals

Metals can be separated into two subgroups: ferrous metals (steel, tinned iron and cast iron) and non-ferrous metals (aluminium, copper and lead). Metals can theoretically be recycled infinitely, and because of their quality, traded on international commodities markets, and compete with virgin materials.

Material Recovery Facility operators separate metals out, and on-sell these directly to domestic or international traders. For other sources of metal (e.g. cars, appliances, industrial metals), SIMS Pacific Metals operates nine scrap metal recycling centres located throughout the country that process scrap metal for the domestic and international manufacturing market. There are also additional independent scrap metal processors throughout the country that accept waste metals. It is estimated that the total capacity of metal processors is 208,000t per annum.[131]

Textiles

Textiles includes fashion and textile industry waste created during fibre, textile and clothing production, and post-consumer waste created as a result of consumer disposal at end-of-life.

Most textile resource recovery is centred around options for reuse (i.e. through donations to second-hand clothing shops). Additionally, there are small scale programmes that divert fabrics from landfill to downcycled uses like shopping bags, moving blankets and rags.[132].

Some clothing companies offer take-back schemes as part of their approach to product stewardship, but New Zealand's distance from processing locations and comparatively small volume mean that these are not as widely available as in overseas jurisdictions. There are also a number of entrepreneurs working to bring textile recycling capability to New Zealand including the Formary and Āio Clothing.

Despite these initiatives, overall, there is no widescale onshore processing infrastructure for textiles, and most waste textiles are sent to landfill.[133]

E-waste

E-waste covers a wide range of electronic items, essentially anything with a battery or a plug, and often contains valuable materials in trace amounts, such as gold and rare earth metals, as well as larger amounts of other materials, such as steel, aluminium, copper, plastic resins and glass. Additionally, e-waste can contain toxic substances, including lead, cadmium, mercury, and brominated flame retardants.

The capacity of e-waste processing facilities is not publicly available, but is estimated that the e-waste recycling rate is less currently than 2%.[134]

Waste tyres and rubber

Waste tyres and rubber from vehicles and industrial processes are a significant waste issue for New Zealand due to the risk of harm from fire and toxic materials entering air, soil and water.[135] An estimated

[131] Duncan Wilson and Lisa Eve, *Metals Recycling in NZ: Painting the Picture of the Impacts of An Increase in the Waste Levy (New Zealand Association of Metal Recyclers, 2019)*, 7.
[132] NZ Textile Reuse Programme, *Wellington Zoo Case Study*, (NZ Textile Reuse Programme, 2018), 6.
[133] Amber-Leigh Woolf, "New Zealand Landfills Are Becoming Full of Unloved Clothes as 'Fast Fashion' Grows," *Stuff*, July 21, 2019, https://www.stuff.co.nz/environment/114298459/new-zealand-landfills-are-becoming-full-of-unloved-clothes-as-fast-fashion-grows.
[134]Ministry for the Environment, *Proposed Priority Products and Priority Product Stewardship Scheme Guidelines* (Wellington: Ministry for the Environment, 2019), 39.
[135] Ibid, 22.

one-third of tyres are currently diverted from landfill at end-of-life, and of these, 13% are processed onshore. [136]

There is limited recycling infrastructure with the ability to recover waste rubber for use in new rubber products. There are energy recovery options, which shred the waste into tyre-derived fuel, which can be exported and used as a fuel source in industrial processes. The current capacity of these tyre reprocessing facilities is not currently available in the public domain. However, Golden Bay Cement is working to accept Tyre-Derived Fuel as its fuel source in its plant near Whangarei. It is predicted to accept up to 60% of New Zealand's waste tyres, and was due to start operating in late 2020, but has been delayed by Covid-19.[137]

Construction and demolition waste

Construction and demolition waste may include broken concrete, glass, plasterboard, disused wood products, brick, metal, dirt and plastics. It excludes hazardous waste, such as asbestos and Polychlorinated Biphenyls. It is estimated that construction and demolition waste makes up about 40-50% of the total waste going to landfill in New Zealand.[138]

Just like municipal waste, construction and demolition waste can be disaggregated to specific waste streams, which can be separated at sorting facilities. There are four Construction and Demolition waste sorting facilities in New Zealand, two in Auckland, one in Meremere, and one in Wellington. The combined capacity of these plants is not available in the public domain, although Green Gorilla states it diverts 75,000t of waste from landfill each year by separating waste material to allow recycling, including wood products (which are converted to wood chip and used as a fuel), metals, aggregate and plasterboard (from which gypsum can be recycled).[139] There are also two concrete crushing facilities in Auckland which crush waste concrete into aggregate which can be reused in the construction sector, as well freeing the re-bar or steel mesh for recycling.

There are large regional variations in access to construction and demolition recycling, with few wide-scale recycling options outside Auckland. As a result, without specific forward planning, most construction and demolition waste outside these centres is sent to landfill.

Hazardous waste

Hazardous waste comprises a broad range of waste products, including paint, medical wastes, solvents and chemicals, which are potentially hazardous to the environment and/or human health without being treated. There is limited wide-scale recycling or recovery opportunities, and this waste is primarily treated until it is in an inert state, or it poses a reduced threat to the environment and human health and disposed of to landfill.

However, there are schemes for certain goods which are being established as part of product stewardship initiatives. For example, Resene PaintWise provides collection centres for unused paints, which are then donated to community groups (if high quality), reprocessed to recover the solvents (solvent based paints), or used in alternative applications such as graffiti abatement (waterborne paints).[140]

[136] Ibid, 39.
[137] "Waste Tyres to Be Used in Cement Manufacture," The Beehive, June 22, 2017, https://www.beehive.govt.nz/release/waste-tyres-be-used-cement-manufacture.
[138] "Minimising Waste When Building," BRANZ Ltd, accessed November 19, 2020, http://www.level.org.nz/material-use/minimising-waste/.
[139] "Waste Processing Facility," Green Gorilla, accessed November 24, 2020, https://www.greengorilla.co.nz/processing-facility/
[140] Responsible Resource Recovery Lt, *Product Stewardship Study Unused/Unwanted Paint and Paint Packaging in New Zealand*, (Wellington: Ministry for the Environment, 2006), 11.

There are other product stewardship schemes which deal with other hazardous wastes such as used oils (R.O.S.E)[141], refrigerant gas (Recovery)[142] and agricultural chemicals (Agrecovery)[143].

[141] "Recovering Oil Saves the Environment," R.O.S.E, accessed December 2, 2020, https://rosenz.co.nz/
[142] "Refrigerant Gas Disposal," Recovery, accessed December 2, 2020, https://www.refrigerantrecovery.co.nz/
[143] "Agrecovery Rural Recycling Programme," Agrecovery, accessed December 2, 2020 https://www.agrecovery.co.nz/

8. Appendix 2: Process, assumptions and limitations

Āpitihanga 2: Te tukanga, ngā whakapae me ngā herenga

8.1. Our process

This State of Play was developed between August 2020 and February 2021 drawing on publicly available information. Key data sources include confidential data provided by the Ministry for the Environment.

A full list of all literature cited can be found in the reference list (Appendix 3).

Findings were cross-checked against the results of a survey of infrastructure asset owners, carried out by Mobius Research and Strategy Limited on behalf of Te Waihanga between September and October 2020, which asked about the issues, risks, and opportunities as perceived by asset owners across the sector.

On completion of the initial draft, we met with individuals from a range of organisations across the sector to get their views on a high-level summary of our findings, and to understand their thoughts on current challenges. A draft of the complete report was also peer reviewed by Te Waihanga's Board of Directors; Duncan Wilson, Director, Eunomia Research and Consulting Limited; and officials within the Waste and Resource Efficiency Division, Ministry for the Environment.

Limitations

While every effort is made to ensure the accuracy of the information contained herein, Te Waihanga, its officers, employees and agents accept no liability for any errors or omissions or any opinion expressed, and no responsibility is accepted with respect to the standing of any firms, companies or individuals mentioned. Te Waihanga reserves the right to reuse any general market information contained in its reports.

9. Appendix 3: References

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