4. Material Flow Analysis

4.1 Describing the flow of PET bottles into, through and out of New Zealand

Plastics are used to package round half of the non-alcoholic beverages in New Zealand (Visy Industrial Plastics Ltd., 2006). Coca-Cola, for example, is packaged in PET plastic, glass and aluminium cans. Of the plastic containers, PET bottles make up the vast majority of carbonated soft drinks, water and isotonics containers (ibid.). There is very limited, or no, use of PET bottles for milk or any other liquid food; HDPE is typically used to manufacture milk and juice bottles. Therefore, in measuring this baseline, any use of "plastic" soft drinks bottles quantities in the literature have been assumed to mean PET; similarly, PET containers of non-alcoholic beverages have been assumed to encompass carbonated soft drinks, water and isotonics.

4.1.1 PET Bottles: import, manufacturing and export

New Zealand does not manufacture PET raw material. New Zealand's plastic raw materials are imported mainly from Asia and North America (Plastics New Zealand, n.d.) but there is no product-specific data available about countries of origin.

New Zealand has over 300 plastics companies (ibid.) who use that raw material – and a small amount of plastic flake from New Zealand recyclers – to shape a range of plastic products. The largest manufacturer of PET packaging is Visy Industrial Plastics, from whom much of the manufacturing information in this section was gained.

Some of the unfilled PET beverage bottles are then exported, particularly some made for isotonics, such as the Powerade Matrix bottle which is manufactured but not sold in New Zealand (Visy Industrial Plastics Ltd., 2006).

4.1.2 Soft drinks in PET bottles: import, manufacturing, consumption and export

New Zealand imports some pre-filled soft drinks but a large majority are filled here in New Zealand by a few large soft drink manufacturers and some smaller soft drinks manufacturers and water bottlers. The two largest fillers in New Zealand are Coca Cola Amatil and Frucor-Danone, both supplied by Visy Industrial Plastics (Denne & Wright, 2016). Neither would provide any quantity-specific information for this project, either in manufacturing or distribution, considering this information commercially sensitive (a situation which was repeatedly commented on in the literature).

New Zealand exports some filled soft drinks products, largely to Australia. For example, Mizone, which is manufactured by Amcor in New Zealand, is exported to Australia in filled form; Coca Cola Amatil exports filled water products to Australia; and Sanitarium exports Water Plus to Australia (Visy Industrial Plastics Ltd., 2006).

4.1.3 Waste PET bottles: disposal, recovery and recycling

There are three main streams of recovered PET in New Zealand (Kelk, 2011):

- Post-consumer – domestic. Council kerbside collections and drop-offs from households
- Pre-consumer – industrial. Largely pre-forms and machine purgings, often recycled in-house.

- Post-consumer – industrial. Mostly consists of bottle waste – including products that have passed their sell-by date (beverages have an estimated 18-month shelf life).

The domestic recycling process follows three stages:

- Recycling collection and waste separation (Material Recovery Facilities remove contamination and sort collected materials into types and grades before transporting to recyclers)
- Production of clean bottle flakes by recyclers, either by Flight Plastics in New Zealand or exported overseas; and
- Conversion of Flight Plastic's PET flakes to final products.

Unlike many other materials, the export of PET bottles for recycling has not been much affected by China's National Sword policies (referred to as the 'National Sword') which banned or restricted the import of low-quality plastics from 2017. For other materials, this change has had a significant impact on the global recycling industry, reducing the sale price for many recyclables and putting financial pressure on recycling operators (Wilson, Eve, & Grant, 2018).

4.2 Quantifying the Material Flows of PET Soft Drinks Bottles in New Zealand

4.2.1 Data Gathering

Table 1 shows the data that was gathered through the literature review, communications with industry actors and requests to Statistics New Zealand staff (referred to below as "StatsNZ").

Table 1: Data to support the quantification of PET soft drinks bottles in New Zealand.

		Tonnes	Bottles	Source	Comments
Bottle Manufacturing	Imports: empty bottles and preforms	2,797		StatsNZ	1. Bottle import and export figures are an overestimation of the number of PET soft drinks bottles being imported and exported, as they reflect the quantity of a wider category entitled "Plastics; carboys, bottles, flasks and similar articles, for the conveyance or packing of goods, of a capacity exceeding 250ml but not exceeding 5 litres."
	NZ bottle manufacture	15,028		(Plastics New Zealand, n.d.)	2. This figure represents the PET imported into New Zealand. 80% of this is estimated to be made into bottles (see comment 7). This percentages will be used to adjust this figure for this baseline.
	Commercial waste to recycling	Part of 900		(Kelk, 2011)	3. This figure includes both pre-consumer and post-consumer commercial waste from manufacturers and retailers. The split is unknown but, given that much bottle manufacturing waste can be recycled in-house, it is assumed that it will be much the lesser of the two and has been ignored for this analysis.
	Export: empty bottles and preforms	1,176		StatsNZ	See comment 1

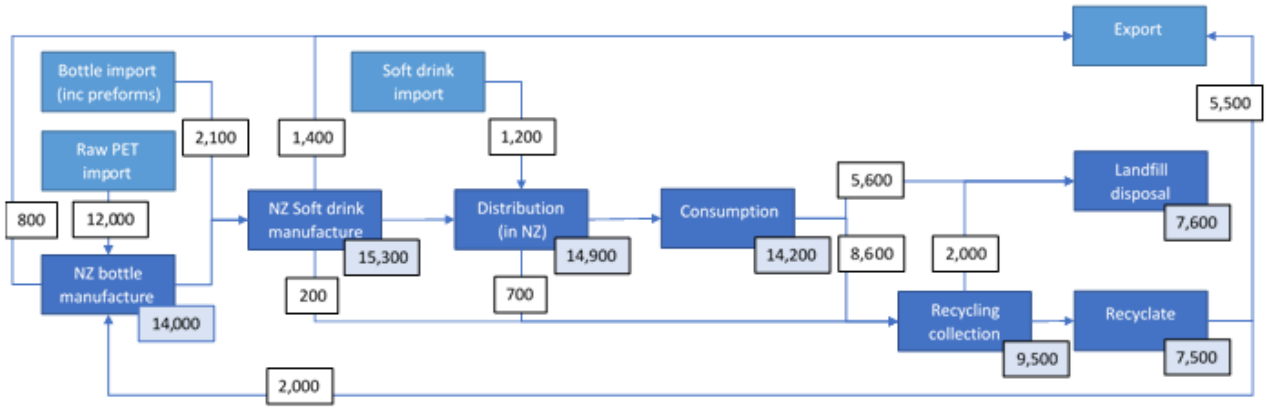
Soft Drinks Manufacturing, Distribution and Consumption	Imports: filled bottles	70,550 (1,764)		StatsNZ	4. Import and export of filled bottles figures, supplied by Statistics New Zealand, represents all imported bottled water and soft drinks, and only excludes those in metal packaging. It is a gross overestimation of the weight of PET – the liquid itself, and glass packaging, would make up a large portion of this weight. Assuming that imports share the same characteristics as the industry as a whole, half of these imports are packaged in plastic. Estimating that 5% of the weight of a full bottle is its packaging, 1,764 tonnes of the total is plastic bottles. This is still an overestimation, however, as glass bottles would make up much more of the total than has been considered here – approximately 40% of the weight of those bottles.
	NZ Manufacture				5. All beverage manufacturers contacted refused to divulge their manufacturing quantities as privileged commercial information. The same has been noted in other studies (Denne & Wright, 2016; Kelk, 2011). This figure will be extrapolated from the other data that has been gathered.
	Commercial waste to recycling	Part of 900[2]		(Kelk, 2011)	See comment 3.
	Export: filled bottles	86,209 (2,155)		StatsNZ	See comment 4. The same method calculates 2,155 tonnes of plastic bottles.
Total Consumption	Total consumption	14,274	413 million	Envision	6. These figures was estimated on a per capita basis using data from British Columbia and Western Australia.
		13600		(Kelk, 2011)	7. Denise Chapman, the Chair of Plastics New Zealand, estimated (according to Kelk (2011)) that around 80% of PET packaging would be bottles. This was used to estimate the quantity of PET bottles using data from The Mass Balance Survey.
			410 million	Nutrition Survey 2008/9	8. This is a calculated estimate using survey data about how often New Zealanders drink carbonated soft drinks. It does not correspond to a number of PET soft drinks bottles or even a number of containers of any material; it includes, for instance, drinks purchased from a bulk dispenser in pubs, drinks from large (e.g. 3l) containers that contribute to several drinks, and no serving size guildeline was given in the survey.
		25,753	641 million	(Denne & Wright, 2016)	9. This figure far exceeded the quantities from the other three sources. It was discarded for this reason and because the paper had obtained the data from a source which this author could not access so could not evaluate its methodology.
Post-consumer waste	Recovery: recycling collection	9,403 total 8,563[1] curbside		(Kelk, 2011)	10. The curbside figure was for all PET collected from domestic curbside schemes. However, it is a suitable figure for this project to use because Kelk (2011) argues that it is likely that the vast majority was bottles, citing Plastic New Zealand data from 2004 in which 99.8% of recovered PET products were bottles.
		12,058	300 million	(Denne & Wright, 2016)	See comment 9
		6770			11. PET is 20% of the total curbside recycling collected. Comment 10 is also relevant here.

	Disposal: landfill	23,786		(Ministry for the Environment, 2009)	12. This figure is for all #1-7 plastic packaging entering landfill from the household sector. It is therefore an overestimation of the weight of PET bottles.
	Sorting: Into Recyclate	21% is lost to landfill		(Denne & Wright, 2016)	This percentage is an estimate, calculated using the means of the given upper and lower bounds estimated for a container deposit scheme for transport cost analysis purposes
	Reuse: Recyclate	2,000		(Wilson et al., 2018)	This figure is the clear PET processed by Flight Plastics in New Zealand.
	Export: Recyclate	16,391		StatsNZ	Includes all waste and scrap ethylene products, not just PET recyclate, so is an overestimation.

4.2.2 Estimating PET material flows

Extrapolating from and adjusting those data in the directions suggested above, the quantities in Figure 2 were estimated for the flow of PET bottles through the system.

Figure 2: Estimated quantities (tonnes) of PET in soft drinks bottles in the New Zealand economy



These figures are a loose estimate, representing a rough approximation of the flows of PET material into, through and out of the New Zealand economy. However, it is assumed that the error margin is similar throughout the system and therefore sufficient for the comparison purposes of this project (to compare the carbon footprints of this system with alternative systems).