A SCOTTISH DEPOSIT REFUND SYSTEM

Appendix to the Final Report for Zero Waste Scotland

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Report for Frazer Scott, Zero Waste Scotland

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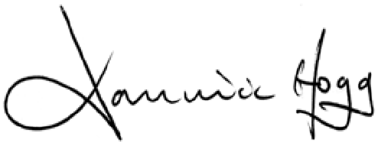

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Contents

A.1.0 Deposit Structure and Levels

This section of the appendix provides the data on deposit structure and levels used to inform the assessment of this design feature.

A.1.1 Denmark

Table A-1: 2013 Prices for Denmark

Deposit Type	Deposit Level
Aluminium Can	10.00 øre per 0.5l
Steel Can	22.00 øre per 0.5l
Plastics	22.00 øre per 0.5l
Glass	45.00 øre per 0.5l

Source: Danskretursystem (2013) Faste Gebyrer 2013, Accessed 22nd July 2014, *http://www.dansk-retursystem.dk/media%28535,1030%29/Driftsgebyrer_i_aar.pdf*

A.1.2 Sweden

Table A-2: Current Prices for Sweden

Deposit Type	Deposit Level
Aluminium Can with alcohol content less than 3.5%	0.89 SEK
Aluminium Can with alcohol content more than 3.5%	0.8 SEK
Steel Can	0.89 SEK
Clear PET bottle with alcohol content less than 3.5%	0.89 SEK
Clear PET bottle with alcohol content more than 3.5% <= 1 litre	0.80 SEK
Clear PET bottle with alcohol content more than 3.5% > 1 litre	1.60 SEK
Coloured PET bottle/Plastic bottle with alcohol content less than 3.5% <= 1 litre	0.89 SEK

Deposit Type	Deposit Level
Coloured PET bottle/Plastic bottle with alcohol content less than 3.5% > 1 litre	1.79 SEK
Coloured PET bottle/Plastic bottle with alcohol content more than 3.5% <= 1 litre	0.80 SEK
Coloured PET bottle/Plastic bottle with alcohol content more than 3.5% > 1 litre	1.60 SEK

Source: Returpack (2014) Appendix 3 – Deposits and Fees, Accessed 22nd July 2014, http://www.pantamera.nu/sites/returpack.se/files/Appendix%203%20-%20Deposit%20and%20Fees.pdf

A.1.3 Finland

Table A-3: 2013 Prices for Finland

Deposit Type	Deposit Level
Aluminium Can	€0.01301
Steel Can	€0.02846

Source: Palpa (2013) Beverage Can Prices Beginning of 1st January 2013, Accessed 22nd July 2014, http://www.palpa.fi/files/palpa2011/pantinmaksajat/Price_list_Beverage_Cans_2013_01_01.pdf

A.1.4 Estonia

Table A-4: Current Prices for Estonia

Deposit Type	Deposit Level
Plastic beverage packaging – non-refillable, up to 0.5l	€0.04
Plastic beverage packaging - non-refillable, above 0.5l	€0.08
Metal beverage packaging – non-refillable	€0.08
Glass beverage packaging – non-refillable	€0.08

Deposit Type	Deposit Level
Glass beverage packaging – refillable	€0.08

Source: Eesti Pandipakend (2014) How Does the Deposit Scheme Work?, Accessed 22nd July 2014, http://www.eestipandipakend.ee/en/how-does-the-deposit-system-work/

A.1.5 Norway

Table A-5: Current Prices for Norway

Deposit Type	Deposit Level
Basic fee per bottle or box	1.1 NOK
Cans – environmental tax	5.24 NOK
Bottles – environmental tax	3.16 NOK

Source: Norsk Resirk (2014) Avgiftssystemet, Accessed 22nd July 2014, http://www.resirk.no/om-oss/avgiftssystemet/

A.1.6 Australia

Table A-6: Current Prices for Australia

Deposit Type	Deposit Level
South Australia	
Most beverage containers are covered except some large containers for certain beverages	10¢
North Australia	
All approved containers, all materials	10¢

Source: Bottle Bill Resource Guide (2014) Australia, Accessed 22nd July 2014, http://www.bottlebill.org/legislation/world/australia.htm

A.1.7 Israel

Table A-7: Current Prices for Israel

Deposit Type	Deposit Level
Deposit on containers over 100mL and under 1.5L, excludes paper & cardboard containers and plastic pouches.	30 agorot

Source: Bottle Bill Resource Guide (2014) Israel, Accessed 22nd July 2014, http://www.bottlebill.org/legislation/world/israel.htm

A.1.8 United States

Table A-8: Current Prices for United States

Deposit Type	Deposit Level
California	
Aluminium, glass and bi-metal beverage containers. Exempts refillables - 24oz or greater	10¢
Aluminium, glass and bi-metal beverage containers. Exempts refillables - under 24oz	5¢
Connecticut	
Any individual, separate, sealed glass, metal or plastic bottle, can, jar or carton containing a beverage. Excluded are containers over 3L containing noncarbonated beverages, and HDPE containers	5¢
Hawaii	
Aluminium, bi-metal, glass, plastic (PET and HDPE only) beverage containers up to 68 oz.	5¢
Iowa	
Any sealed glass, plastic, or metal bottle, can, jar or carton containing a beverage	5¢
Massachusetts	

Deposit Type	Deposit Level
Any sealable bottle, can, jar, or carton of glass, metal, plastic, or combo. Excludes biodegradables.	5¢
Maine	
All sealed containers made of glass, metal or plastic, containing 4 liters or less, excluding aseptics – Wine/liquor	15¢
All sealed containers made of glass, metal or plastic, containing 4 liters or less, excluding aseptics – All others	5¢
New York	
An individual, separate, sealed glass, metal, aluminum, steel or plastic bottle, can or jar less than 1 gallon or 3.78 liters.	5¢
Oregon	
Any individual, separate, sealed glass, metal or plastic bottle, can, jar containing a beverage – standard refillable	2¢
Any individual, separate, sealed glass, metal or plastic bottle, can, jar containing a beverage – all others	5¢
Vermont	
Any bottle, can, jar or carton composed of glass, metal, paper, plastic or any combination (Biodegradables excluded) - liquor	15¢
Any bottle, can, jar or carton composed of glass, metal, paper, plastic or any combination (Biodegradables excluded) – all others	5¢

Source: Bottle Bill Resource Guide (2014) All US Bottle Bills, Accessed 22nd July 2014, http://www.bottlebill.org/legislation/usa/allstates.htm

A.1.9 Canada

Table A-9: Current Prices for Canada

Deposit Type	Deposit Level
Alberta	
All sealed beverage containers – up to 1 litre	10¢
All sealed beverage containers – over 1 litre	25¢
British Columbia	
All containers for accepted beverages – non-alcohol, over 1 litre	5¢
All containers for accepted beverages – alcohol, up to and including 1 litre	20¢
All containers for accepted beverages – non-alcohol, up to and including 1 litre	10¢
All containers for accepted beverages - alcohol, over 1 litre	20¢
Manitoba	
Beer containers	10¢
New Brunswick	
All beverage containers under 5L – non-alcohol, refillable	10¢
All beverage containers under 5L – non-alcohol, non-refillable	5¢
All beverage containers under 5L – alcohol, <500ml	10¢
All beverage containers under 5L – non-alcohol, >500ml	20¢
Newfoundland	
All beverage containers except fountain cups, or those with a greater than 5L capacity – non-alcoholic	8¢
All beverage containers except fountain cups, or those with a greater than 5L capacity – alcoholic	20¢

Deposit Type	Deposit Level
Nova Scotia	
All containers for accepted beverages – non-liquor	10¢
All containers for accepted beverages –liquor, refillable <1L	10¢
All containers for accepted beverages –liquor, refillable, >1L	20¢
All containers for accepted beverages –liquor, non-refillable, <500ml	10¢
All containers for accepted beverages –liquor, non-refillable, >500ml	20¢
Northwest Territories	
Bottle, can, plastic cup or paperboard carton or a package - made of material other than glass, non-alcoholic, <1	10¢
Bottle, can, plastic cup or paperboard carton or a package - made of glass, non-alcoholic, <1	10¢
Bottle, can, plastic cup or paperboard carton or a package – all materials, non-alcoholic, >=1	10¢
Bottle, can, plastic cup or paperboard carton or a package – all materials, alcoholic	25¢
Ontario	
Glass bottles, plastic bottles (PET), Tetra Pak containers, bag-in-box – alcoholic, up to 630ml	10¢
Glass bottles, plastic bottles (PET), Tetra Pak containers, bag-in-box – alcoholic, over 630ml	20¢
Aluminium and steel containers – alcoholic, up to 1L	10¢
Aluminium and steel containers – alcoholic, over 1L	20¢
Prince Edward Island	
All sealed containers holding a qualifying beverage – liquor, up to 500ml	10¢
All sealed containers holding a qualifying beverage – liquor, over 500ml	20¢

Deposit Type	Deposit Level
All sealed containers holding a qualifying beverage – other beverages	10¢
Québec	
All containers for accepted beverages – soft drinks containers	5¢
Aluminium beer cans – <450ml	5¢
Aluminium beer cans – >450ml	20¢
Beer bottles – <450ml	10¢
Beer bottles – >450ml	20¢
Saskatchewan	
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt - aseptic	5¢
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt – polycoat	5¢
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt – metal cans, <1L	10¢
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt – metal cans, >1L	20¢
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt – plastic bottles, <1L	10¢
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt – plastic bottles, >1L	20¢
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt – non-refillable glass, <300ml	1$
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt – non-refillable glass, 300ml – 1L	20¢

Deposit Type	Deposit Level
Refillable bottles, cans, and other paper or plastic beverage containers. One-way containers are exempt – non-refillable glass, >1L	40¢
Yukon Territory	
All beverage containers for accepted beverages – non-liquor, =<1L	10¢
All beverage containers for accepted beverages – non-liquor, >1L	35¢
All beverage containers for accepted beverages – aluminium cans	10¢
All beverage containers for accepted beverages – refillable beer bottles	10¢
All beverage containers for accepted beverages – liquor, 200ml-499ml	15¢
All beverage containers for accepted beverages – liquor, 500ml and more	35¢

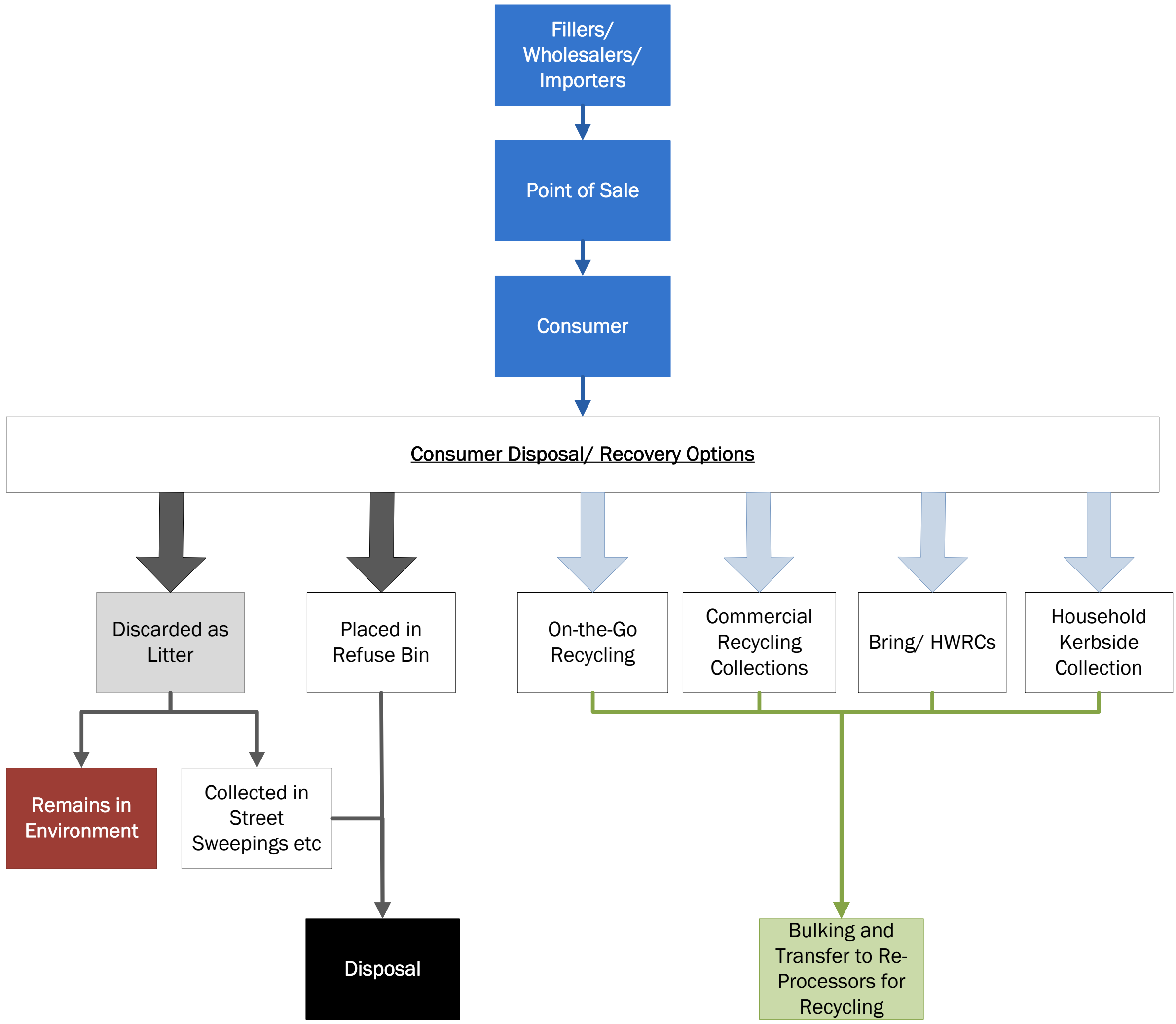
Source: Bottle Bill Resource Guide (2014) Bottle Bills and Recycling in Canada, Accessed 22nd July 2014, http://www.bottlebill.org/legislation/canada.htm

A.2.0 Mass Flows

A.2.1 Baseline

The first step in estimating the financial implications of a DRS was to consider the material flows in Scotland, how many beverages are sold, and how the empty containers are managed through the waste stream once the beverage has been consumed. For example, how much of the waste is sent for recycling compared to how much is disposed of at landfill sites. Figure A-1 indicates the possible material flows within scope (before the DRS).

Figure A-1: Possible Container Material Flows (Pre-DRS)



One important factor to consider when looking at the potential costs of a DRS is the assumption about when the analysis takes place. This study is a reflection of the likely operating costs of a Scottish DRS, so considering the costs over only one year is appropriate. In addition, it is very difficult to predict future changes in other assumptions, such as beverage consumption, material values, labour costs etc., and therefore to use a constant figure for future years would also be a pragmatic approach to take.

In this case the specific year is not critically important, but is at least post 2014 when the landfill tax escalator will have reached £80 per tonne. In addition discussions with Andy Dick from Zero waste Scotland concluded that the direction of travel of kerbside recycling services, which capture beverage containers, would not see significant changes from the current situation. Therefore, using the latest performance data was deemed accurate enough to reflect the representative collection services modelled (see Section A.4.0) over the coming years.

The main change in collection systems that will be seen in Scotland over the next 5 years will be related to the collection of food waste, and this will not affect the mass flows for beverage containers.

A.2.1.1 Total Products Placed on the Market / Total Waste Arisings

The figures for 'Total Containers Placed on Market' are calculated using a top down approach, from known estimates for the total number of containers placed on the market and the average weight of a container. Detailed information from Canadean® (beverage industry information specialists), pertaining to the quantities of different beverages by container type sold on the UK market, was available for 2009. High level figures obtained for 2014 indicate very minor differences in sales from 2009, so the 2009 detailed dataset was considered acceptable. Where more recent information at the required level of detail was publically available this was used. For example, the data for wine and spirits was taken from a 2013 market survey for the Wine and Spirit Trade Association – quantities were calculated assuming an average volume of a wine or spirit bottle of 0.7 litres.[1] Figures for Scotland only were estimated using the relative proportion of the population – circa 8.34%.

[1] WSTA (2014) *UK Wine and Spirits: Market Overview 2013*, http://www.wsta.co.uk/publications-useful-documents/11-wsta-market-overview-2013/file

Table A-10: Total Placed on the Market in Scotland

Container	Million Units	Source
Soft/Beer & Cider Bottles	250	Canadean
Wine / Spirit bottles	187	WSTA
PET Bottles	744	Canadean
HDPE Bottles	300	Est. from Total Weight
Ferrous Cans	148	Canadean
Aluminium Cans	526	Canadean
Beverage Cartons	237	ACE UK
Total	**2,391**	

The weights of beverage containers were determined through actual measurements of sample products, from existing studies, and from websites such as The Environmental Register of Packaging PYR Ltd.[2,3] The average weights for different container types used in the study are given in Table A-11. This data allowed us to calculate the total weight of containers placed on the Scottish market every year. By subtracting the tonnages of beverage container waste collected for recycling and disposal from the total weight of containers placed on the Scottish market, the resultant figure indicates the tonnage of beverage containers that would remain in the environment as litter. The overall number and tonnages of containers placed on the market and the amount of containers found in the environment are given in Table A-12.

[2] WRAP (2008) *Bulk Shipping of Wine and its Implications for Product Quality*, Final Report: GlassRite: Wine, May 2008, http://www.wrap.org.uk/downloads/Bulk_shipping_wine_quality_May_08.1be9881a.5386.pdf

[3] PYR (n/a) *Packaging Weight Units*, Accessed 25th March 2014, http://www.pyr.fi/eng/forms/packaging-data-declaration-form/packaging-weight-units.html

Table A-11: Average Weight per Container Type, grammes

Container	kg
Soft/Beer & Cider Bottles	300
Wine bottles	500
PET Bottles	33
HDPE Bottles	56
Ferrous Cans	35
Aluminium Cans	17
Beverage Cartons ≤50 cl	28
Beverage Cartons >50 cl	12

Source: WRAP, PYR

The total calculated weight of containers in the modelled DRS is given in Table A-12.

Table A-12: Total Weight of Beverage Containers

Container	Thousand tonnes
Glass Bottles	165
Plastic Bottles (PET and HDPE)	39
Ferrous Cans	5.2
Aluminium Cans	8.9
Beverage Cartons	5

Source: Eunomia

A.2.1.2 Household Kerbside Mass flows

One of the most important inputs to the kerbside modelling is the quantity of material collected for recycling and also the quantity of material suitable for the DRS that resides within the collected residual waste. For this model, the tonnages were based upon the WasteDataFlow (WDF). The relevant questions within WDF are:

Question 10: Kerbside Recycling Collection

Question 23: Collected household waste Regular Collection

Recycling data from all 32 Scottish authorities was compiled and the relevant categories pertaining to DRS materials were summed to provide a tonnage value for the material that could potentially be removed from the kerbside collection and into the DRS. This was based on the following assumptions:

- All of 'brown glass' is beverage containers;
- All of 'green glass' is beverage containers;
- 35% of 'clear glass' is beverage containers (the remaining 65% is jars and a small quantity of other clear glass such as broken pint glasses); and
- 80% of mixed cans are ferrous metals / 20% are aluminium.

The basis of the assumptions are mixed, but includes the 2002 study by Julian Parfitt and WRAP household waste composition (no more recent studies which include categories referring to beverage containers are available), data from the metal packaging industry and internal expertise from staff previously working in waste collection companies.[4] Table A-13 also shows the assumptions used for the percentage of DRS material that is expected within the four waste streams. For example, 80% of the glass found in recycling is beverage glass to which the DRS could apply, whereas only 55% of the glass in the residual waste stream is expected to be beverage glass. These assumptions were developed in reference to some confidential residual waste compositional analyses, and estimates of the amount of beverage containers in recycling.

[4] Parfitt, J. (WRAP) *Analysis of Household Waste Composition and Factors Driving Waste Increases*, Final Report December 2002

Table A-13: Material Assumptions

Material	% DRS in Recycling	% DRS in Residual
Mixed Glass	80%	55%
Ferrous metal	18%	6%
Non-ferrous metal	80%	31%
Dense plastic	22%	9%

Recycled commingled materials are disaggregated using average compositions for each authority based upon the type of commingled collection they run e.g. whether glass is included or excluded. These compositions were derived from Defra's 'Review of Municipal Waste Component Analyses' 2009 and can be found in the WDF guidance.[5] An average reject rate of 10.85% also specified in the guidance was applied to all commingled materials.

The residual waste is disaggregated by applying the Scottish national composition study.[6] A total waste arisings composition was derived from this as it is assumed that the overall composition would have changed little since the study even if recycling has increased. This composition was then applied to the overall waste arisings. For each material the recycling tonnages were subtracted with the remainder being the residual waste-

Residual Waste = Total Waste Collected at Kerbside – Waste Captured for Recycling

These resulting materials were then categorised in the same way as the recycling to produce the overall tonnages available to the DRS from kerbside collections as found in Table A-15.

A.2.1.3 Bring Sites / Household Waste Recycling Centres (HWRCs)

WasteDataFlow (WDF) was interrogated and data for all 32 Scottish authorities was compiled. The relevant questions in WDF are:

[5] Defra *GN15: Recording of co-mingled tonnages via a MRF or kerbside.*
[6] AEA, and Wasteworks (2010) *The composition of municipal solid waste in Scotland*, Report for Zero Waste Scotland, 2010

Question 16: Civic Amenity (CA) sites: Tonnes of material collected for recycling/reuse at CA Sites operated by local authority or its contractors

Question 17: Bring sites: Tonnes of material collected for recycling/reuse at bring sites operated by local authority or its contractors

Question 23: Civic amenity sites waste: Household Residual

The following assumptions, based upon the rationale described above (but using the composition of residual HWRC waste), were required to estimate the quantities of beverage containers currently being recycled through these sources:

- All of 'brown glass' is beverage containers;
- All of 'green glass' is beverage containers;
- 35% of 'clear glass' is beverage containers (the remaining 65% is jars and a small quantity of other clear glass such as broken pint glasses);
- 75% of 'mixed glass' is beverage containers;
- 50% of Plastics are PET beverage containers;
- 80% of mixed cans are ferrous metals / 20% are aluminium;
- Commingled materials are disaggregated using the average composition estimated in the WRAP MRF Quality Assessment Study[7] from 2009; and
- HWRC residual waste is disaggregated using the same method as the kerbside residual waste, but for the substitution of an HWRC specific composition.[8]

See Table A-15 for estimates of the tonnages of beverage containers from bring sites and HWRCs.

A.2.1.4 Commercial Wastes

The definition of commercial wastes in this study includes all waste from non-household sources. This includes beverage containers deposited in refuse or recycling schemes from commercial or industrial enterprises.

Data on the management of the commercial waste stream in Scotland is limited, and no data on beverage containers, specifically, is available. However, data on total arisings and household waste management is better. Therefore, the approach was to assume

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[7] WRAP (2009) *MRF Quality Assessment Study*, November 2009

[8] AEA, and Wasteworks (2010) *The composition of municipal solid waste in Scotland*, Report for Zero Waste Scotland, 2010

any containers not managed through the kerbside, bring/HWRC or street cleaning services, or left uncollected in the environment as litter, are managed in the commercial waste stream.

Taking this approach results in on overall proportion of 26% of beverage containers managed by the commercial sector. This total would include any empty beverage containers consumed at work, or from pubs/ clubs and the HoReCa sector. This proportion seems reasonable given the large quantities of bottle beer, cider and wine consumed through the on-trade.

It terms of the recycling of the different container types little information is available. Estimates were made based upon experience of the performance of commercial waste collection services across the UK.

Table A-14: Beverage Container Recycling Rates in the Commercial Sector

Container Type	Recycling Rate
Glass Bottles	60%
Plastic Bottles (PET and HDPE)	30%
Cans (Fe.)	40%
Cans (Al.)	40%
Beverage Cartons	30%

Source: Eunomia

See Table A-15 for estimates of the tonnages of beverage containers from businesses.

A.2.1.5 Street Cleaning / Litter

No Scottish authorities currently record the amount of litter collected, so this has been estimated using the Street Cleaning waste reported to WasteDataFlow. The calculation for this is based upon previous work carried out into the direct costs of litter by Eunomia for Zero Waste Scotland in 2013.[9] The total tonnage estimated for ground litter in Scotland was around 27,000 tonnes, which is around 27% of the total reported Street Cleaning tonnage.

The ground litter tonnage was estimated according to the following equation:

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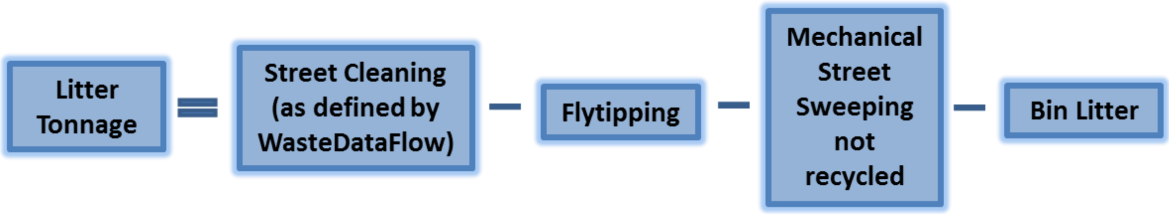
[9] Eunomia Research & Consulting (2013) *Quantifying Direct Costs of Litter to Scottish Local Authorities and other Duty Bodies*, March 2013



For each authority, tonnages estimated for fly tipping were subtracted, as it was established from the interviews that a potentially significant amount of fly tipping was lifted as a matter of course by Street Cleansing teams and hence would be aggregated with the Street Cleaning waste.

A proportion of the tonnage was also subtracted to account for mechanical sweepings, from authorities' estimates of what proportion of Street Cleansing waste was mechanical sweepings as opposed to litter.

Then a proportion was subtracted for the amount of litter estimated by the authorities to be legitimately disposed of in public bins, rather than discarded on the ground.

Litter tonnages from waste reported in WasteDataFlow under Highways, Grounds or Beaches were not included in the tonnage estimate.

The litter composition from Zero Waste Scotland's 2009 study[10] was applied to the estimated litter tonnage. Out of the categories in the composition, plastic bottles, packaging glass and metal cans were identified as potential DRS materials. It was also assumed that 100% of these categories could be considered beverage containers as it is unlikely that many other kinds of packaging, of these material types, would find their way outside of the home and be littered.

A conservative estimate has been made that 1% of the total containers placed on the market will remain in the environment as litter and left uncollected. This equates to around 2.2 thousand tonnes per annum.

A.2.1.6 Beverage Carton Recycling

Collected tonnages of beverage cartons were not reported within WDF by local authorities within Scotland for the year 2011. Beverage cartons also do not appear in any of the national compositions as a separate category. Consequently it is difficult to ascertain where and how beverage cartons are disposed of with Scotland. The Alliance for Beverage Cartons and the Environment (ACE) UK[11] estimate that 60,000 tonnes of cartons are sold within the UK. As of 2014 62.5% of Scottish authorities collect beverage cartons at the kerbside. Only 9% provide no collection at all with the remainder collecting via bring banks. Of those that provide some form of recycling services, only

[10] AEA, and Wasteworks (2010) *The composition of municipal solid waste in Scotland*, Report for Zero Waste Scotland, 2010

[11] All beverage carton data was supplied by personal communication with ACE UK

35% send the cartons to the UK based recycling facility. The remainder is sent abroad. This means that it is very difficult to ascertain the recycling rate unless authorities report what they are sending abroad. The situation may change as more authorities decide to send their cartons to the UK facility and therefore more data would be available from ACE.

Overall carton recycling rates for the EU currently stand at around 40%. For Scotland we expect this to be less due to the relatively new introduction of kerbside recycling of cartons (compared with other streams) and that Scotland's overall recycling rate is only around 40% in total. For this model we have conservatively estimated an overall recycling rate across all collections of 32% which is mostly split evenly between bring banks and kerbside collections as seen in Table A-15. We believe that if Scotland has not already achieved this rate then it will in the near future as more authorities decide to introduce kerbside collection.

A.2.1.7 Summary Baseline Figures

Table A-15 shows the mass flow baseline upon which subsequent calculations were undertaken on the costs and benefits associated with the introduction of a DRS. Due to the high-level nature of this study, a full analysis of the ranges and uncertainties in the modelling could not be accomplished. However, it is believed that the estimates provided in Table A-15 are plausible, being, as they are, based on reasoned argument, and rationalised to the greatest extent possible. Furthermore, the tonnages were cross-checked with packaging data available from various sources.[12,13] The figures were within acceptable error margins, especially when considering data in the waste sector (often of low quality).

From the figures provided in Table A-15 to Table A-17 it can be seen that:

- A significant quantity of containers will be sold in Scotland every year (around 2.3 billion);
- The implied commercial recycling rate is relatively high at around 57%. Although there is uncertainty due to limited data, it appears reasonable as the landfill tax has escalated to £80 per tonne, and Scotland's Waste Regulations will also be a driver;
- The bring / HWRC recycling rate is high, as there are limited beverage containers in residual waste at HWRCs; and
- A significant quantity of waste (around 2, thousand tonnes) is left uncollected in the environment every year. It is important to re-iterate the limitations of this study in estimating the amount of beverage container litter that is present in the

[12] David Davies Associates (2009) *PackFlow 2012: UK Compliance with the European Packaging & Packaging Waste Directive, Volume 1: Summary Report & Recommendations*, November 2009.
[13] Advisory Committee on Packaging (2008) *Packaging in Perspective,* November 2008.

environment. Unfortunately, no studies or research could be found that have previously tried to estimate this figure with which to compare the estimates

The overall recovery rate for the containers in scope in this study, under the baseline system (pre-DRS), is calculated as 54%. There is, therefore, scope to increase the benefits associated with greater recovery of these materials.

Table A-15: Mass Flow Baseline

		(thousand tonnes)										
Products	Placed on Market, million	Total Modelled	hhld Kerbside		HWRCs		Commercial		Street Cleaning / Litter Bin Collections / Remaining in Environment			via DR System
			Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Env.	
Glass Bottles	436	165	38	30	36.2	5.5	31	20	1.0	1.2	1.6	
Plastic Bottles	1,044	39	9	17	2.0	2.7	1.7	4.0	0.9	1.2	0.4	
Cans (Fe.)	148	5.2	2	2	0.4	0.2	0.1	0.2	0.1	0.2	0.1	
Cans (Al.)	526	8.9	2	5	0.6	0.1	0.1	0.1	0.3	0.4	0.1	
Beverage Cartons	237	5.0	0.5	2.5	1.0	0.5	0.1	0.3	0	0	0.1	
Total	2,391	222	51	57	40	9	33	25	2.3	2.9	2.2	
% Contribution		100%	23%	26%	18%	4%	15%	11%	1%	1%	1%	

Table A-16: Baseline Recycling Rates by Container Type

Container Type	Recycling Rate
Glass Bottles	61%
Plastic Bottles (PET and HDPE)	34%
Cans (Fe.)	48%
Cans (Al.)	35%
Beverage Cartons	33%
Total	**54%**

Table A-17: Baseline Recycling Rates by Service

Service	Recycling Rate
Hhld Kerbside	47%
Bring / HWRCs	82%
Commercial	57%

A.2.2 DRS Scenario

Under the DRS scenario a number of assumptions were made to estimate the change in mass flows from the baseline, and therefore the change in costs. The key assumptions were as follows:

1) Each of the beverage container types are captured at 90%;
2) Out of the remaining 10% the management of the materials is split in the following way:
    a. Kerbside Recycling 5%
    b. Kerbside Refuse 40%
    c. HWRCs, Commercial, Litter (Recyc) 5%
    d. HWRCs, Commercial, Litter (Refuse) 49%

e. Litter in environment 1%

This distribution reflects the fact if consumers are unwilling to use the DRS they are less likely to put the containers in the existing recycling services, and therefore put the containers in refuse. Moreover, in recycling collection receptacles it is easier for other consumers or collection operatives to take out the containers and redeem the deposits themselves. Hence the remaining material is predominantly in the refuse collections.

The scenario mass flows and changes from the baseline are given in Table A-18 to Table A-21.

Table A-18: High Return Rate Scenario Mass Flows

		(thousand tonnes)											
Products	Placed on Market, million	Total Modelled	hhld Kerbside		HWRCs		Commercial		Street Cleaning / Litter Bin Collections / Remaining in Environment			via DR System
			Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Env.	
Glass Bottles	436	165	0.4	3.3	0.2	0.8	0.2	3.0	0.01	0.2	0.1	156
Plastic Bottles	1,044	39	0.1	0.8	0.04	0.3	0.04	0.5	0.02	0.1	0.02	37
Cans (Fe.)	148	5	0.01	0.1	0.01	0.04	0.002	0.05	0.002	0.04	0.003	5
Cans (Al.)	526	9	0.02	0.2	0.01	0.05	0.001	0.03	0.01	0.1	0.004	8
Beverage Cartons	237	5	0.01	0.1	0.01	0.1	0.00	0.05	0.0	0.0	0.003	5
Total	2,391	222	1	4	0	1	0	4	0	1	0	211
% Contribution			0%	2%	0%	1%	0%	2%	0%	0%	0%	95%

Table A-19: Change in Mass Flows High Return Rate Scenario vs Baseline

		(thousand tonnes)										
Products	Placed on Market, million	Total Modelled	hhld Kerbside		HWRCs		Commercial		Street Cleaning / Litter Bin Collections / Remaining in Environment			via DR System
			Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Env.	
Glass Bottles	436	165	-37	-27	-36	-5	-30	-17	-1	-1	-2	156
Plastic Bottles	1,044	39	-9	-16	-2	-2	-2	-4	-1	-1	0	37
Cans (Fe.)	148	5	-2	-2	0	0	0	0	0	0	0	5
Cans (Al.)	526	9	-2	-5	-1	0	0	0	0	0	0	8
Beverage Cartons	237	5	0	-2	-1	0	0	0	0	0	0	5
Total	2,391	222	-50	-53	-40	-8	-32	-21	-2	-2	-2	211
% Contribution			-23%	-24%	-18%	-3%	-15%	-10%	-1%	-1%	-1%	95%

Table A-20: Low Return Rate Scenario Mass Flows

		(thousand tonnes)										
Products	Placed on Market, million	Total Modelled	hhld Kerbside		HWRCs		Commercial		Street Cleaning / Litter Bin Collections / Remaining in Environment			via DR System
			Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Env.	
Glass Bottles	436	165	1.2	9.9	0.7	2.5	0.6	9.1	0.02	0.5	0.2	140
Plastic Bottles	1,044	39	0.3	2.3	0.13	1.0	0.11	1.5	0.06	0.4	0.06	33
Cans (Fe.)	148	5	0.04	0.3	0.02	0.12	0.007	0.14	0.007	0.12	0.008	4
Cans (Al.)	526	9	0.07	0.5	0.04	0.14	0.004	0.09	0.02	0.4	0.013	8
Beverage Cartons	237	5	0.04	0.3	0.03	0.2	0.00	0.14	0.0	0.0	0.008	4
Total	2,391	222	2	13	1	4	1	11	0	2	0	189
% Contribution			1%	6%	0%	2%	0%	5%	0%	1%	0%	85%

Table A-21: Change in Mass Flows Low Return Rate Scenario vs Baseline

		(thousand tonnes)										
Products	Placed on Market, million	Total Modelled	hhld Kerbside		HWRCs		Commercial		Street Cleaning / Litter Bin Collections / Remaining in Environment			via DR System
			Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Recycling	Refuse	Env.	
Glass Bottles	436	165	-37	-21	-36	-3	-30	-11	-1	-1	-1	140
Plastic Bottles	1,044	39	-8	-15	-2	-2	-2	-3	-1	-1	0	33
Cans (Fe.)	148	5	-2	-2	0	0	0	0	0	0	0	4
Cans (Al.)	526	9	-2	-5	-1	0	0	0	0	0	0	8
Beverage Cartons	237	5	0	-2	-1	0	0	0	0	0	0	4
Total	2,391	222	-49	-44	-39	-5	-32	-14	-2	-1	-2	189
% Contribution			-22%	-20%	-18%	-2%	-14%	-6%	-1%	-1%	-1%	85%

A.3.0 The Deposit Refund System Model

A.3.1 Handling, Collection, Logistics, and Processing

The costs of handling the containers at retail outlets are borne by the retailers themselves, and the costs of transport and collection by the central system. This Section outlines the determination of these costs.

A *handling fee* is included in DRSs to compensate the retail industry for the additional cost realised through having to handle returned beverage containers. In the current economic climate, many retailers would be opposed to an additional *uncompensated* cost on their business. The approach was mindful of how the system would operate in Scotland and what costs retailers were likely to incur. The assumptions were set to realistic figures, not too optimistic, thus the collection, handling and processing costs should be a relatively good estimate of what they would be in practice.

In determining the handling fee, the key considerations centre on the collection of returned beverage containers e.g. where are the containers returned to, and how are they transferred back to the retailer during the redemption of the deposit? Both these aspects clearly affect the nature of the collection logistics required. It is therefore important to understand first the retail landscape, prior to determining the system specification. This is described in the first of the sections below, along with the outline design of the container take back and collection system.

Interestingly in other systems the handling fee is not directly linked to the costs incurred by businesses.[14] The handling fee appears to be negotiated on an annual basis. However, for this study it was felt appropriate to base the initial handling fee on some rational considerations of the costs incurred. Moreover, calculating the handling fees in this way enables a more straightforward calculation.

It is important to note some of the characteristics of Scotland that are important to consider when assessing take-back and logistics infrastructure (and therefore costs):

1) There are very few deposit systems left operating in Scotland (especially for alcoholic beverages, beer bottles etc.); most containers are one-way and will be eligible for inclusion in the system. A.G. Barr is one exception;
2) Modern behavioural attitudes appear to place a premium on personal time - thus take-back ought to be quick and locations easily accessible;

[14] Personal communications with TOMRA, May 2010

3) There is a relatively high proportion of the population in close proximity (the central belt), although a large area of the country has a very low population density in the outlying areas; and

4) Despite the number of large supermarkets, that characterise retail landscape, there are still relatively large numbers of small outlets operating in a decentralised manner.

All of these points mean that the system must have the ability to 1) ensure that take back is possible through easily accessible locations, thereby minimising the time taken by consumers to take-back the empty containers; 2) collect large quantities of glass bottles from alcoholic beverages, especially from pubs and bars; and 3) collect containers from a large number of dispersed outlets.

Following establishment of the retail landscape, the handling fee was calculated by ensuring the following elements were included in the cost calculations:

- RVMs (reverse vending machines);
- Reduction in available retail space;
- Labour;
    - Pickup / Unloading;
    - Take Back; and
- Bags and crates for containment.

These elements are costed in the sections below.

Following this, the determination of *logistics and processing* costs, financed by the central system, are provided.

Finally the elements of the handling fee are brought together and the per unit fee calculated.

A.3.1.1 Retail Landscape and System Design

In order to determine the types and total numbers of retail outlets in Scotland that might accept returned containers, data was amalgamated from numerous sources.[15,16,17,18,19,20] It is estimated that there are over 31,000 outlets currently

[15] Wetherill, Paul (2009) UK Business: Activity, Size and Location – 2009, An Office for National Statistics Publication, September 2009, http://www.statistics.gov.uk/downloads/theme_commerce/PA1003_2009/UK_Business_2009.pdf

[16] NCBS (2005) Chapter 2: The UK food and drink industry, in Ethical trading in the UK food and drink industry, a final report for Defra, August 2005, https://statistics.defra.gov.uk/esg/reports/Ethical%20trading/chapter2.pdf

operating in Scotland that are likely to sell beverages (excluding kiosks).[21] The types of retail outlet considered were:

- Hypermarkets (>60,000 sq ft);
- Superstores (25-60,000 sq ft);
- Medium Stores (3-25,000 sq ft);
- Convenience Stores (<3,000 sq ft);
- Pubs;
- Restaurants;
- Hotels/B&Bs;
- Food Retailer;
- Leisure; and
- Canteens/cafes in workplace.

From this data, the proportion of glass bottles, plastic bottles and cans returned to each type of retail outlet was estimated (Table A-22). The key assumption being that the majority of containers will be returned to the same type of retail establishment as they were sold.

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[17] Frewin, Angela (2010) Number of Hospitality and Catering outlets – Industry Data, Accessed May 2010, http://www.caterersearch.com/Articles/2010/05/07/317292/number-of-hospitality-and-catering-outlets-industry-data.htm

[18] Nicholls, Luke (2012) Molson Coors welcomes beer tax milestone after report reveals scale of pub closures in Scotland, Accessed March 2014, http://www.bighospitality.co.uk/Trends-Reports/Molson-Coors-welcomes-beer-tax-milestone-after-report-reveals-scale-of-pub-closures-in-Scotland

[19] Frewin, Angela (2008) Number of pubs in the UK- Industry data, Accessed March 2014, http://www.catererandhotelkeeper.co.uk/Articles/2008/10/06/53051/number-of-pubs-in-the-uk-industry-data.html

[20] The Association of Convenience Stores (2013) *The Local Shop Report 2013*, 2013

[21] No data on the number of small retail kiosks operating in the UK was available.

Table A-22: Total Containers Returned to Retail Outlets (High Return Rate Scenario)

Type of Retailer	Glass Bottles	Plastics Bottles	Cans	Bev. Cartons	Total (million)	Total (%)
Hypermarkets	21	79	51	18	169	7%
Superstores	83	317	205	72	677	30%
Small Supermarkets	50	228	147	52	477	21%
convenience stores	70	149	96	34	349	15%
Pubs	83	50	32	11	176	8%
Restaurants	62	50	32	11	155	7%
Hotels/B&Bs	21	50	32	11	114	5%
Fast Food	8	10	6	2	27	1%
Leisure	8	10	6	2	27	1%
Canteens/cafes in workplace	8	50	32	11	101	4%
Total Collected	414	992	641	225	2,272	
Total Placed on Market	436	1,044	674	237	2,391	
Return Rate	95%	95%	95%	95%	95%	

Source: Canadean / Eunomia

Table A-23 shows the proportion of each retail category that is likely to pay a joining fee and form part of the DRS, and that would be able to accept the return of *all containers*. It should be noted that, in this model, it is assumed that any type of container can be taken back to any of the participating retailers. Although this is eminently possible via RVMs or manual take back of commingled plastics and cans, glass bottles accepted manually would need to be placed in dedicated boxes. In practice, it would not be recommended that all retailers store all sizes of boxes 'just in case' a take back is required. However, in small volumes, glass would not restrict the retailer from accepting the container. It is

expected the bottles would most likely be placed in the bag with commingled plastics and cans – this is the current procedure in Germany and Denmark.[22]

Table A-23: Percentage of each Retail Type Joining the Deposit System and Requiring a Collection of Containers

Type of Retailer	Retailers in System	Rationale
Hypermarkets	100%	Large sales / return volumes, so all will join.
Superstores	100%	Large sales / return volumes, so all will join.
Small Supermarkets	100%	Large sales / return volumes, so all will join.
Convenience Stores	70%	Half with small number of employees, and lower beverage sales.
Pubs	90%	High sales volume relates to nature of business. Most will have too many containers to take to a supermarket etc.
Restaurants	50%	Beverage sales will be lower, enabling smaller restaurants to opt out of the system.
Hotels/B&Bs	50%	Split based on hotels with >10 employees.
Food Retailer	10%	Small sales volumes and small size will mean many retailers will opt out of the system and take stored containers to local return points.
Leisure	25%	Less information known about the large variation in 'Leisure' activities / sites. 50% split deemed a neutral assumption.
Canteens/cafes in workplace	10%	Most have low numbers of employees (<10).
Kiosks	0%	All kiosks will be too small to join the system, and therefore will take containers to local convenience stores and supermarkets etc.

Source: Eunomia

Furthermore, we assumed that all small kiosks would opt not to participate in the system, and would instead take returned containers to the nearest convenience store, supermarket or counting depot –this is common practice in other countries, and may be supported by a policy for granting (particularly) small businesses exemptions from the

[22] Personal communication with TOMRA.

requirement to take-back any containers other than those sold by the particular business. As noted in the 2009 communication from the Commission on DRSs, consideration should be given to small businesses as follows:[23]

> *"Exemptions for small businesses - Member States may reduce some of the operational obligations concerning deposit systems for participating small businesses, based e.g. on de minimis considerations. To give an example: Small kiosks may not have the storage space necessary for meeting their take-back obligations. Therefore, it might be considered reasonable to grant them certain exemptions. However, it is advisable to assess whether any such exemption would not affect the overall quality and functioning of the deposit and return system as such, or would lead to discriminatory application of its conditions."*

The next step to consider was how the containers would be collected by retailers. In Section 3.0 of the main report it was argued that automatic take back of containers, through placing of machines in stores, would be necessary to provide easily accessible take-back points for consumers in Scotland, and to enhance the efficiency of the logistics systems.

For the purposes of this modelling, we have assumed that the automated machines would be reverse vending machines (RVMs), though other methods of automated collection exist, including high-speed counting machines which may be chosen by some as a preferred collection option. Automated machines will be pragmatic for a large number of shops within Scotland, being already used in stores such as Tesco, but will not be pragmatic for bars and restaurants. Table A-24 shows the proportions of each retail category which we have assumed would have an RVM in their store and the average number of RVMs per store, with the remaining proportion of each retail category undertaking 'manual' container take-back. It should be noted that, for a small proportion of those retailers classed as 'manual' take-backs, particularly for bars and restaurants, the deposit may never be passed onto the consumer in the first place as it may be relatively easy for the retailer to retain the beverage container and serve the beverage in a glass, thereby reducing staff time required for the manual process. However, for the purposes of ensuring that the estimation of handling fees is not too low, all non-RVM retail outlets have been allocated the same amount of resource time as for manual collection.

[23] EC (2009), Communication from the Commission: Beverage Packaging, Deposit Systems and Free Movement of Goods, May 2009

Table A-24: Retail Outlets Requiring RVMs and Number per Store

Type of Retailer	% of Retailers Requiring an RVM	No. of RVMs per store
Hypermarkets	100%	4
Superstores	100%	3
Small Supermarkets	100%	2
Convenience Stores	40%	1
Pubs	0%	0
Restaurants	0%	0
Hotels/B&Bs	0%	0
Food Retailer	0%	0
Leisure	0%	0
Canteens/cafes in workplace	0%	0
Kiosks	0%	0

Source: Eunomia

From this analysis the total number of retail outlets requiring an RVM in Scotland is calculated as around 2,000. The total number of *RVM machines* is just over 2,700; a proportion of 1 for every 1,900 people. This figure is very similar to the density of RVMs in Denmark and Sweden, where the size of population and retail landscape is most similar to Scotland, thereby suggesting this density is appropriate to provide an adequate level of convenience to consumers.

In order to check the validity of these assumptions, the average take back rate per RVM was subsequently calculated. Assuming a 7 day opening week and two hour peak time frame, the return rate is around 15 containers per minute. This is eminently possible as the operating capacity of the machines is around 30 to 45 containers per minute.

The number of businesses opting to join the system but not requiring an RVM is estimated at around 11,000.

The combined analysis of retail outlets, market distribution, container material type and likely take back methods, culminates in the initial flow of containers shown in Table A-25.

Table A-25: Number of Containers Requiring Collection via RVMs or through Manual Take Back (High Return Rate Scenario), millions

Product	RVMs	Manual
Glass	181	233
Plastic	684	307
Metal	442	199
Cartons	155	70
Sub-Total	1,463	809
Total	2,272	

Source: Eunomia

A.3.1.2 Reverse Vending Machine (RVM) Costs

The key cost elements associated with RVMs are a) capital costs (including installation) and b) operating costs.

Capital Costs

In terms of capital costs, average figures of £30,000 for the machine, and £2,000 for the installation were provided by TOMRA. The installation fee includes fitting the machines in the store, and connecting to the back-office equipment (via ADSL cables etc.). The back-office IT equipment is then connected to the internet – this is to link the machine to the central system.

The annual cost to the retailer for the RVM is based upon the assumption that the retailer would purchase an RVM and repay the loan over a period of 7 years.[24] The interest rate is assumed to be 5%.

Operating Costs

Annual operating and maintenance costs are assumed to be 9% of the total capital cost of the machine.[25] Additional operating costs include the cost of paper roll for the receipt

[24] 7 years is also expected to be the lifetime of the machine.
[25] Personal communication with TOMRA, May 2010.

printer (an additional 1% of total annual costs), and the cost of replacing the compactors for compacting RVMs. This cost of replacing the compactors is £2,000. This has to be carried out on average after every 1.3 million containers have been compacted. The total cost of the RVMs was estimated to vary between **£28.5m** and **£29m** per annum for the low and high scenarios respectively.

Table A-26: Breakdown of RVM Costs, £million

Cost Element	Low Scenario	High Scenario
RVM Costs - Installation and Operation	24.7	25.0
RVM Costs - Labour	2.4	2.6
RVM Costs - Space	1.4	1.4
Total	**28.5**	**29.0**

A.3.1.3 Retail Space Infringement Costs

Shop space may be required for stores installing RVMs (some could be installed outside), and storage space will be required for all retailers who take back containers. This will be a cost to the retail industry, and as such is to be compensated for by the central system. The methodology for calculating the financial impact on retailers for loss of floor space is described below.

RVM Store Costs

The costs for retailers who install RVMs will be the actual cost to lease the floor space in the sales area, the additional storage area required for the containers, and the lost opportunity cost resulting from a reduction in floor space in the sales area. It also should be noted that many supermarkets will use outside space to house RVMs and therefore calculations are on the conservative side.

It is estimated that an average retailer will require an area of 5 m^2. The opportunity cost of retail floor space and operator margin (i.e. the profit the retailer would receive) are also estimated at £12,444 per m^2 per annum and 5%[26] respectively. The opportunity cost is calculated from the average turnover per square foot for four of the large supermarket chains[27].

[26] GLA (2005) *Retail in London: Working Paper C Grocery Retailing*, October 2005, http://www.london.gov.uk/mayor/economic_unit/docs/retail_in_london_wpc_grocery_retailing.pdf
[27] See 2011 annual financial reports for Morrison's, Sainsbury's, Tesco and Asda.

The average rateable value estimated by the Valuation Office Agency (VOA)[28] for retail floor space in England was £148 per m^2 in 2012. This value was steady over the preceding 3 years so is a reasonable benchmark for this study.

The Colliers International Great British Retail Survey[29] suggests a ***prime*** rental value of £882 per m^2 of retail space within Scotland. This is lower than most areas of England which would suggest that using England as a benchmark may cause an over valuation. The North East of England is estimated at £904 per $m^2$by Colliers and therefore is the closest substitute. According to the VOA the North East of England had an average rateable value of £128 per m^2 in 2012 which will be used as a proxy for Scotland in absence of Scotland specific data.

Manual Take Back Store Costs

The only impingement on floor space when containers are taken back manually is the storage area. It is assumed that this storage will take place in the back of the store and not in the sales space so there will be no loss of turnover. The same rateable value for floor space presented above is also used for this calculation.

If it is assumed that a containment bag (see Appendix A.3.1.5) can store, on average, 200 beverage containers, then one retail outlet will amalgamate eight containment bags per week. In the collection modelling, a weekly pickup rate for each retail outlet is assumed (see Appendix A.3.1.6 below). The *average* collection frequency is just under twice per week. Therefore the average retailer will have to store 4 bags between pickups. An area of 2 m^2 has been given to each retailer for storing these bags.

Retail space costs are estimated at **£2.8m**.

A.3.1.4 Labour Costs

The additional handling and collection of containers from retail outlets will demand labour time, and therefore additional costs will be incurred by the retailer. The two main activities requiring additional labour are:

1) Take back of containers from customers and placing in storage locations; and
2) Facilitating pickup of containers from the contracted logistics company.

The calculation of these cost elements is described below.

[28] VOA (2012) Business Floorspace (Experimental Statistics), Valuable at: http://www.voa.gov.uk/corporate/statisticalReleases/120517_CRLFloorspace.html
[29] (2012) *Great Britain Retail*, Autumn 2012, http://www.colliers.com/~/media/Files/EMEA/UK/research/retail/201210-great-britain-retail-v2.pdf

Labour Costs for Customer Take Back via RVMs

The outline plan for the German deposit system estimated that the time required to process receipts from stores with RVMs was 0.3 hours per day.[30] Based on a seven day working week and a labour cost at the minimum wage (currently £6.50/hr), with on-costs of 25%, the hourly costs of labour used in the model is around £8.12.

This is based upon the following assumptions:

- Each customer returns an average of 15 containers in one go;
- It takes 10 seconds for the retailer to process the receipt and reimburse the customer with the monetary value of the accumulated deposits;
- Each 'average sized' RVM has a storage capacity of 500 glass, 800 plastic, 3,500 metal and 900 carton containers;
- The time taken to empty the RVM when it is full and store the containers at the back of the store is 5 minutes; and
- Staff are unskilled and paid the minimum wage.

Labour Costs for Manual Customer Take Back

For retail stores, the labour costs for manual take back will be associated with additional time to collect the containers from the customer, pay the deposit, and place the containers in the designated storage area. Operational experience from existing DRSs shows that most retailers will have an intermediate storage bag close to the cashier. When it is full, the bag will be sealed and taken to the storage area.

The time taken for the cashier/ waiter to accept an average of 15 containers and store them is estimated at 45 seconds.

Labour costs are valued at the basic wage plus 25% for on-costs.

Labour Costs for Customer Take Back from Retailers Outside of DRS

Some of the smaller retailers, such as corner shops, kiosks, and cafes, will not receive a high enough volume of containers to warrant paying the joining fee. This is, in one way, a valued side effect, enabling the efficiency of the overall collection logistics to be greatly improved by concentrating the volume of containers in a smaller number of locations. However, on the negative side, an additional cost will be incurred by these retailers in having to store a small number of containers and subsequently transfer the containers to local take-back points to redeem the deposits. Rather than being included in the running costs of the DRS, this cost is presented separately. It is discussed in this section of the report only because the methodology is closely linked to that used in the calculation of the labour costs presented above.

[30] TOMRA (2001), *Zentrale Organization Einweg Pfand Deutschland: Business Model Development Guide.*

In this calculation it is assumed that the small retailer will be able to store containers for around 14 days. This could be much less for some retailers, particularly if they were to take containers back to, for example, a cash and carry whilst purchasing new goods for sale. However, in order to take a conservative approach, we have assumed a storage period of 14 days for all small retailers. Furthermore, it will take half an hour of labour time to visit a local take back point and redeem the deposits. Again the cost of labour is valued as above.

It is assumed that 70% of the total number of retail outlets categorised at the start of this section stock beverages (even though some leisure outlets and canteens will just serve food).

Total labour costs related to RVMs or manual take-back were estimated to vary between **£4.8m** and **£5.3m** per annum for the low and high scenarios respectively

<u>Transport Labour Costs for Container Collection</u>

In implementing a DRS, there would potentially need to be three main avenues of collection services for the retailer: one for refuse, one for beverage containers, and one for other recyclable materials. Although it is assumed that the volume, and hence frequency of refuse and dry recycling collections, would be reduced following the introduction of a DRS, the overall labour cost is still assumed to be higher, given that staff would have to set out waste for collection on three separate occasions. Hence, an additional labour cost of 5 minutes per container pickup has been included in the calculations. Estimates for the number of pickups required per week for each of the main retail categories was also made (see Table A-27). Labour is valued at higher than an unskilled rate, as more senior staff may need to facilitate this process. A rate of £9 per hour has been used (plus 25% on-costs).

Table A-27: Retailers Requiring Collection and Pickups per Week

Type of Retailer	Number of Retailers Requiring a Collection	Pickups per Week
Hypermarkets	0	n/a
Superstores	0	n/a
Small Supermarkets	52	7
convenience stores	1,938	3
Pubs	1,903	3
Restaurants	625	1
Hotels/B&Bs	975	1
Fast Food	145	1
Leisure	238	0.5
Canteens/cafes in workplace	445	2

Source: Eunomia

Total pickup and unload labour costs related to transportation were estimated as **£1.0m**.

A.3.1.5 Logistics Container Costs

Many permutations of setup for the transportation of containers are possible. The nature of the containment system is dependent upon whether or not the deposit on the containers has been cleared or not. If the containers have already been cleared, through the RVM/ automated machine in-store, the shape of the containers does not need to be preserved for downstream recognition. Consequently, the items can be compacted and an applicable containment device used. Experience from other countries suggests that collapsible plastic bins are a useful mechanism for transportation of compacted containers received through RVMs (see Figure A-2). When backhauling, these bins could be stored folded up in the vehicle and given to the retailer to replace the full bin.

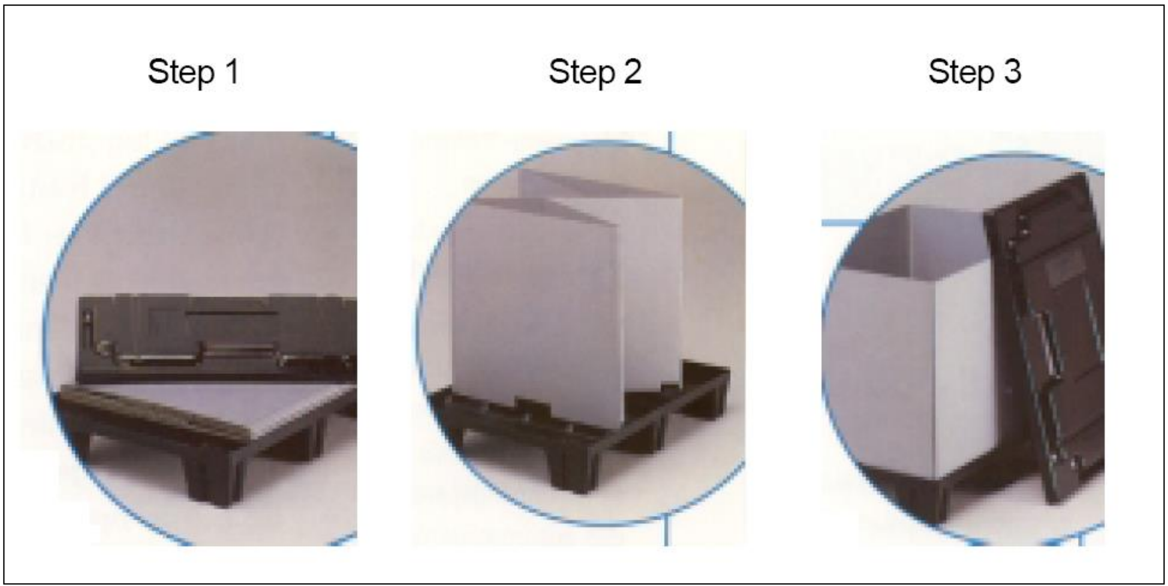
Alternatively, logistics companies could use existing delivery devices. Common practice is to use wheeled storage cages. However, placing the compacted containers in the cages may be time consuming. Furthermore, additional containment would be required to manage the loose items. Taking a conservative approach, it has been assumed that new

collapsible bins would be required by all retailers or logistics companies. The following assumptions have been made in the calculation of the resultant containment costs:

- An average capacity figure, for all container types, of 1,400 per bin;
- Each bin will be in use or storage for a period of 14 days before being refilled;
- The cost for one bin is £125;[31]
- A nominal charge or £5 per bin for cleaning has been included;
- The lifetime of the bin is three years; and
- The value of the bins has been annualised over a period of three years at an interest rate of 7%.

Subsequent calculation of an average of five bins per store was considered a reasonable number in providing a sense-check for this section of the modelling.

Figure A-2: Collapsible Bins for Transporting Compacted Containers



For containers which have not been cleared, the transport mechanism has to be able to maintain the fidelity of the attributes used by the automated counting centres, for example, the barcode, shape and weight of the container. Therefore, the transport process must retain these key attributes for each container. Plastics bottles and cans will sufficiently maintain their shape for recognition, as long as no direct pressure is exerted. Again, common experience from other countries, including Norway, Sweden and Germany, suggests that plastic bags are sufficient for containment of plastic bottles and cans. This is similar to many kerbside collections of plastic bottles already in place in the

[31] Personal communication with TOMRA, May 2010

UK.[32] Bags are stored either at the front of a shop, or in the backroom storage area in supporting frames. When full, they are sealed and tagged ready for collection (Figure A-3).

Figure A-3: Plastic Bags with Empty Beverage Containers for Transportation

The number of bags required per year is estimated from the total number of containers requiring collection and the number of containers that can be transported in each bag. Each bag is designed to take approximately 150 PET bottles or 250 cans.[33] The cost of a bag and a tag is modelled at 67p. In reality, this cost could go down if bags are reused, or the purchasing power of the central system comes into play, and all 2.5 million bags (per annum) are ordered in bulk and distributed to retailers accordingly.

For glass containers there is a much higher likelihood for breakages due to the nature of the material. Therefore, plastic crates are required to transport the containers to counting centres (see Figure A-4). The total number of crates required and the total cost was calculated using the following assumptions:

- Each crate can hold around 40 glass bottles. Crates will therefore need to be stackable in order to ensure that there is sufficient storage room in busy periods, particularly from retailers such as pubs;
- Each crate will be in use or storage for a period of 3 days before being refilled;
- The cost for one crate is £10;[34,35]
- A nominal charge or £1 per crate has been included for cleaning;

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[32] WRAP (2007), *Annual Local Authorities Plastics Collection Survey 2007*, June 2007, available at http://www.wrap.org.uk/downloads/Wrap_ReportDisclaimerSmaller.513fb4e1.3869.pdf

[33] TOMRA (2001), *Zentrale Organization Einweg Pfand Deutschland: Business Model Development Guide*

[34] Solent Plastics (2010) *Recycle Bins / Recycling Storage / Segregated Bins / Waste / Rubbish Bins*, Accessed 20th May 2010, http://www.solentplastics.co.uk/recycling-rubbish-waste-bins/

[35] PHS, Teacrate (2010) *Retail and Logistics*, Accessed 20th May 2010, http://www.teacrate.com/retail-and-logistics.aspx

- The lifetime of the crate is 3 years; and
- The value of the bins has been annualised over a period of 3 years at an interest rate of 7%.

Figure A-4: Plastic Crate for Transporting Glass Bottles

The cost of containers was estimated to vary between **£3.2m** and **£3.5m** per annum for the low and high scenarios respectively.

A.3.1.6 Transport Costs

The transport costs have been modelled with the Scottish situation in mind, not simply copied from existing systems in other countries – although these were used to understand some general principles. The main principles were:

- Backhauling using existing logistics networks is common practice for larger retailers (e.g. supermarkets);
- Containers from smaller outlets are collected by logistics contractors using curtain-side, or back lift, lorries, in the range 7.5 to 18 tonnes;
- Containers are transported directly to recyclers (if compacting RVMs are utilised), or to counting centres for clearing.

The area which will provide the greatest potential for financial savings is backhauling. This is where delivery vehicles that distribute products to shops, bars etc. will fill the empty space with returned deposit containers, rather than the current practice which is to return to the depot empty (or at least with no containers, it is common practice to backhaul cardboard boxes). Therefore, we have modelled the collection logistics using both backhauling and collection rounds direct to the retail outlet. The system is summarised in Figure A-5 and described under each of the subsequent headings.

Backhauling – From Retail to Depots

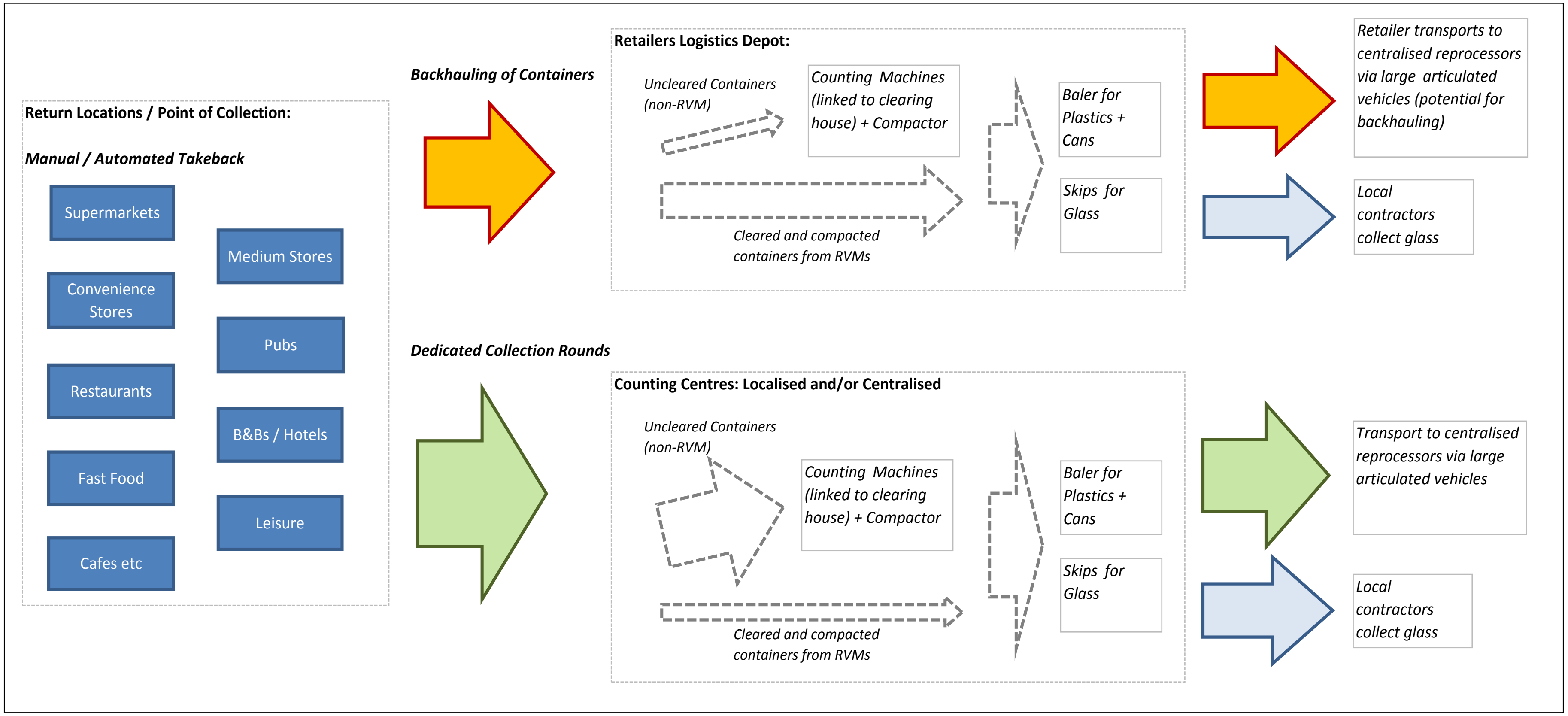
Where possible, it is recommended to backhaul containers using existing logistics infrastructure. This would be a simpler task where a large retailer is in control of its own logistics, or a large distribution company delivers the majority of the products to a store.

For smaller shops, which are supplied by a larger number of independent traders, backhauling would be less beneficial for the supplier, as transporting the smaller volume of containers to a recycler or counting centre would be less efficient. What the balance of cost to benefit would be is unclear from this high level analysis. However, what can be assumed is that retailers and suppliers will seek to optimise their arrangements in the most appropriate manner, and that back-hauling would reduce the overall logistical costs of collecting and transporting the empty containers.

Estimates regarding the proportion of each retail category able to backhaul are shown in Table A-28. The key assumptions in the setting of these conditions were:

- All supermarkets are of a large enough size to warrant backhauling;
- Fewer small supermarkets would be large enough to warrant backhauling;
- 50% of convenience stores will be serviced by large-scale distribution companies which will backhaul;
- Half of pubs (whose main trade is beverages) will be supplied by a distribution company large enough to backhaul. In practice many pubs are supplied by a small number of large suppliers or breweries, so in reality the potential for backhauling using existing collection logistics could be more substantial than estimated; and
- The potential for backhauling is considered a possibility for half of the businesses in the remaining categories.

Figure A-5: Transport Requirements for Container Collection



Source: Eunomia

Table A-28: Backhauling from Retailers

Type of Retailer	% of Retailers able to Backhaul
Superstores	100%
Medium Stores	100%
Convenience Stores	75%
Pubs	50%
Restaurants	50%
Hotels/B&Bs	50%
Food Retailer	50%
Leisure	50%
Canteens/cafes in workplace	50%

Source: Eunomia

The marginal cost to the distribution company for backhauling to their centralised depot would be a minor increase in fuel usage, due to the increased weight of the returning vehicles. Labour time is assumed to remain constant as vehicles need loading with returned logistics cages regardless. In fact some of the capacity in the cages will already being used to backhaul card and plastic packaging to central depots for recycling.

Change in fuel costs were estimated by taking Defra's conversion factors for lorry emissions for both empty and fully laden vehicles (3.9 and 2.3 km/l respectively).[36] It was assumed the lorry would be 10% laden, by weight, from the empty containers (transporting empty beverage containers is more likely to be constrained by volume than weight, and it is not expected the vehicles will be full of empty containers). The total number of trips per annum is estimated based upon the number of containers requiring collection from each retail outlet and the volume of the containers. The model estimates that 800 thousand trips for backhauling are required per annum. Assuming that each trip

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[36] 2009 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting, http://www.defra.gov.uk/environment/business/reporting/pdf/20090928-guidelines-ghg-conversion-factors.xls

is 100km and the fuel price (exc. VAT) is around £1.10[37], the change in the total cost of fuel can be calculated.

The additional fuel cost from backhauling containers from retail outlets is estimated at **£0.94m**.

Dedicated Collection Rounds

For many smaller businesses the possibility of backhauling will be limited due to the multiple suppliers servicing the outlet. Organising the loads of vehicles delivering mixed products (including non-beverages) to a large number of different locations would be challenging. Without further dedicated research into supply logistics, it is difficult to ascertain whether any additional backhauling might be possible via some of the suppliers. As the scope of this study does not cover such research, we have assumed a conservative level of backhauling. Table A-29 shows the proportion of each retail category which would require a dedicated collection of containers.

Table A-29: Dedicated Collection from Retailers

Type of Retailer	% of Retailers Requiring a Dedicated Collection
Superstores	0%
Medium Stores	0%
Convenience Stores	25%
Pubs	50%
Restaurants	50%
Hotels/B&Bs	50%
Food Retailer	50%
Leisure	50%
Canteens/cafes in workplace	50%

Source: Eunomia

37 http://www.fta.co.uk/policy_and_compliance/fuel_prices_and_economy/fuel_prices/forecourt_fuelprices.html

Under these assumptions, around 0.8 billion containers would require collecting from around 6,000 locations throughout Scotland every year. Figure A-5 shows that the collected containers would be transported to dedicated counting and processing centres (see Appendix A.3.1.7). The setup would be similar to that described above at the centralised collection depots of retailers – requiring counting of un-cleared containers, baling of plastics and cans, and storage of glass cullet in skips. The down-stream transport arrangements will also be the same – baled plastic and cans taken to a central reprocessor and glass collected by local contractors. The main elements in the cost calculations, therefore, are a) transport to counting centres and b) subsequent transport to reprocessing (the latter already being accounted for in the sub-section below).

The majority of containers collected on dedicated collection rounds will be uncleared and uncompacted. Plastic bottles and cans will be comingled in heavy-duty bags, potentially including glass where the quantities are small. Where volumes of glass are significant, reusable plastics crates will be employed (see Appendix A.3.1.5). In Germany, for example, containers collected on dedicated rounds are transported in plastics boxes of Europallet size, and on vehicles with tail-lift, or the like.[38] However, the nature of the collections will be different in a UK system.

Taking the existing type of waste collection vehicles in Scotland into consideration and the requirement to collect mostly bagged low density containers, the following vehicle setup has been assumed for this study:

- Vehicles will be 12 to 18 tonne curtain-siders, or back lifts;
- Sealed boxes for glass will be stacked on the floor of the vehicle; and
- Cages will be used to store bags of comingled plastic bottles and cans above the glass.

In reality, the design of the collection vehicles will vary according to service provider and will depend on the detailed logistics that are required for the collection systems in different areas. Nonetheless, the basic vehicle set-up described above should provide a logical starting point on which to model the required collection logistics at a Scotland-wide level.

A simple collection model was developed to estimate the number of vehicle days required per annum to collect the containers, and the cost of operation per vehicle. The key assumptions are listed below:

- Number of pickups per week (see Table A-27);
- Bulk densities of the containers, estimated based upon likely number per Europallet, and knowledge of wastes collected in the UK for recycling:[39]

[38] TOMRA (2001), *Zentrale Organization Einweg Pfand Deutschland: Business Model Development Guide.*
[39] Personal communications with TOMRA and Andy Grant, Eunomia

  - Glass bottles – 111 kg/m^3 compacted and 93 kg/m^3 un-compacted;
  - Plastic bottles – 27 kg/m^3 compacted and 17 kg/m^3 un-compacted;
  - Cans – 455 kg/m^3 compacted and 83 kg/m^3 un-compacted;
- 80% of retail outlets requiring a collection will be urban, 20% will be rural;
- There are 18 cages (2 m^3 each) on a larger urban vehicle, and 9 on a smaller rural vehicle;
- Drivers work a 9.5 hour day;
- Time is required to drive to and from the round and tip when the vehicle is full;
- It takes an average of five minutes to pick up containers from each store;
- It takes eight minutes to travel between stores in urban areas and 15 minutes in rural areas;
- The cost to operate a vehicle per day (including capital costs, driver wage, fuel cost, maintenance etc., and a large overhead) is estimated at around £500.

The following 'sense-checks' were made to make sure the model was not generating spurious results:

- The average volume of containers picked up per store is 2 m^3. This seems reasonable, being at around 2/3 of a large bag load;
- Individual vehicles collect between 2 and 4 tonnes when full, depending on size. Again, this low weight is reasonable considering the low bulk density of un-compacted plastics and cans;
- The cost of collecting the containers is around £100 per tonne. This is not inconsiderable, but the nature of the collections– small quantities, from a large number of locations, and requiring frequent collections – suggests that this would not be unexpected.

Haulage from Depots to Counting Centres

As can be seen from Figure A-5, the backhauled containers from the retail outlets are transported back to a central collection depot.[40] A large number of the backhauled containers will already be 'cleared' in the central system and compacted ready for transport, as they will have been delivered from stores with RVMs.[41] However, some backhauling of containers from uncompacting RVMs or from manual collection will occur, meaning clearing and compacting of containers will be required. This will either take place at the centralised depots, using automated high-speed counting devices on-

[40] It is recognised that some optimisation, or expansion, of depots may be required.
[41] 'Cleared' means that the container has been processed and recorded as returned in the central system, and the subsequent handling fee and deposit can be paid out to the retailer.

site, or via transportation to one of the two centrally operated counting centres (the costs of which are discussed in Section A.3.1.7). In either case, containers will require further transportation, so this cost is also included the modelling.

If clearing has already taken place (through shop based RVMs) plastic bottles and cans will be baled ready for transportation to reprocessing centres in the UK, or to nearby docks for export abroad. This will happen using the retailers own existing fleet of large scale transporters, or through whichever logistics company this service has been outsourced to (articulated lorries etc.). Bales will simply be fork-lifted on and off the vehicle. Under this approach the potential for backhauling is also high. However, we have included this as a real cost to either the retailer or distributor.

Glass, however, would be treated differently. When compacted, the density and nature of the material means that a containment device is required for transportation. Existing systems use skips (which could be of any size) to store the cullet, either colour segregated or mixed. It is not thought that there would be much appetite for the retailers to expand their vehicle fleet to facilitate the transportation of skips. Therefore, we have modelled the collection of colour separated glass being contracted to local waste management companies. These companies may then transport the material to the North East for re-melting, local docks for export, or to other reprocessing activities.

Empty, uncompacted containers transported to central counting centres would also utilise the existing fleet of large scale transporters (articulated lorries etc.).

For the purposes of calculating the costs the following average assumptions were made to cover both types of collection described above:

- The average maximum volume of the transporting vehicle is 64 m^3;
- The average distance from depot to reprocessor is 100 km; and
- The average haulage cost, per km, is 1.10p.

The cost of hauling empty containers from depots to counting centres or reprocessors was estimated to vary between **£1.9m** and **£2.2m** per annum for the low and high scenarios respectively.

A.3.1.7 Counting Centre Costs

A counting machine is an automated machine which, put simply, counts and registers used beverage containers that have been collected manually by an individual retailer, or through non-compacting RVMs (the latter is required to minimise fraud, which could occur if the containers were not counted again before they were destructed, as operators could take the containers – assumed cleared – and redeem the deposit twice). They are high-speed devices which accept a commingled stream of beverage containers as their input. Any container included in the system, be it plastic, glass or metal can be recognised by the machines. The bar code on each container is scanned, and the information is uploaded onto a database in order for the central system to determine what deposits and handling fees need to be paid to which retailers.

A small number of counting machines will probably be required at some retailer and supplier logistics depots, in order to clear any containers not received via RVMs or other automated systems. However, the majority of counting machines required would be those used by the central system. It is not within the scope of the study to consider spatial distribution of counting centres. However, it could perhaps be assumed that counting centres would follow the distribution of population across Scotland.

The system design and costs have been constructed by Anker-Andersen – a supplier of high-speed counting machines (HLZ) - which is based in Denmark.[42] The specification of the system was simply to be able to process the 1.1 billion containers returned manually to stores around Scotland or via non-compacting RVMs. The collection and transportation costs from the retailer to the counting centres are calculated in Section A.3.1.6. The key assumptions involved in the setup of the counting centres system are described as follows:

- There will be up to 24 high-speed machines located around Scotland, most likely in two or three main locations. Most of the machines would be in one or two locations close to Edinburgh and Glasgow to serve the majority of the population, and one further north to serve the rest of the country;
- This setup will ensure collection vehicles do not have to travel a significant distance from the end of a round to a counting centre, whilst maximising economies of scale by locating the facilities close to the main population centres;
- Labour costs for operating the centres are equivalent to the UK minimum wage (£6.31 in 2014, plus 25% on-costs);[43]
- Centralised counting centres are operated on a two shift basis.;[44]
- Industrial floorspace costs have been estimated at £80 per m^2 per annum;[45]
- Installation and service costs are included in the calculations;
- Each counting centre includes a separate compactor and baler for clear PET, coloured PET, ferrous cans and aluminium cans; and
- An additional factor to account for the counting centres required to process un-cleared containers collected via backhauling is also included. An additional 20% increase in the number of machines is required to manage these containers.

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[42] http://www.anker-andersen.com/

[43] https://www.gov.uk/national-minimum-wage-rates

[44] This allows a greater capacity at the introduction of the system, as centres will be able to operate on a higher shift pattern. The experience from Germany was that many stores initially operated manual take back whilst RVMs were being installed.

[45] King Sturge (2010) Industrial / Distribution Floorspace Today, March 2010, Accessed 18th May 2010, http://www.kingsturge.co.uk/research/industrial-distribution-floorspace-today-IDFT-march-2010.aspx

The cost of counting centres was estimated to vary between **£2.8m** and **£3.0m** per annum for the low and high scenarios respectively.

A.3.2 Administration Fee

The administration fee payable by the producer/importer to the central system alongside the deposit has been calculated as follows:

Collection, Transport and Processing Cost + Central Admin System Cost + Handling Fees − Material Revenues − Unclaimed Deposits = Admin Fee

Calculating the administration fee in this way ensures that the balance of costs and benefits for the retailer and the central system is zero. The overall administration fee is subsequently divided by the number of containers that are placed on the market in order to obtain a unit cost to the producer/importer for each container that might potentially end up being returned and subsequently recycled as part of the deposit refund system.

The revenue from producer fees was estimated to vary between **£6m** and **£17m** per annum for the low and high scenarios respectively.

A.4.0 Kerbside Collection Modelling

A.4.1 Local Authority Collection Modelling (using the Hermes model)

Eunomia's proprietary waste collection model, Hermes, has been used to investigate the effect on kerbside collection schemes of implementing a DRS in Scotland. Hermes is a sophisticated spreadsheet-based tool that allows a wide range of authority specific and collection scheme specific variables to be modelled. The optimisation of these variables allows the building of scenarios to accurately reflect local circumstances. The outputs of interest from the modelling conducted here are the collection system resources (staff and vehicles etc.), shown alongside the material revenues and disposal costs.

Eunomia is confident that Hermes is as reliable a tool as any of its kind. It has been used to model systems for authorities that collectively manage over 25% of the UK's total municipal waste. It is used to support contract procurement advice and contract dispute resolution by building 'shadow' bids against which contractors' tender submissions can be tested. Hermes has also been used in the context of studies of relevance to national policy, and in cost benefit analysis work such as for the kerbside collection of food waste across the UK.[46]

The first step in building up a model of national kerbside collection schemes was to understand the mix of dry recycling collection systems currently employed across Scotland, and the nature of the terrain they are operated in (i.e. urban or rural settings). A classification already exists in Scotland, specifically for the purpose of waste, and is summarised in the Supporting Information section of the SEPA Waste Data Digest.[47] This classifies authorities into urban, mixed, and rural groups.

In addition to the urban/rural classification for each authority, information on the number of households and the recycling collection scheme were collated. Scotland's existing dry recycling kerbside collection schemes were categorised into five types, as follows. The local authority collection system information was taken from individual local authority websites, backed by information from the WRAP 'Local Authority Waste and Recycling Information Portal' and WasteDataFlow reports.[48] The five collection system categories are as follows:

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[46] Eunomia (2007) *Dealing with Food Waste in the UK,* report for WRAP, March 2007

[47] SEPA, and Natural Scotland (2012) *Waste Data Digest 12: Key Facts and Trends*, 2012

[48] http://www.wrap.org.uk/content/local-authority-waste-and-recycling-information

- Kerbside sort;
- Two stream (containers and fibres);
- Co-mingled without glass, but with a separate glass collection;
- Co-mingled without glass; and
- Co-mingled with glass.

Since no change to food and garden waste tonnages or collection systems are expected between the scenarios under consideration, we do not focus on these systems here.

The three rural/urban classifications were combined with the five recycling collection approaches to create fifteen unique baseline categories of recycling system. For each system, the most common approach to other aspects of the local authority collection systems (such as weekly or fortnightly residual waste) were selected. A summary of the options modelled is shown in Table A-30.

A summary of the number of authorities and the average number of households in each of the categories under consideration are provided Table A-31 and Table A-32 respectively. Three authorities operate services which were not possible to categorise into the five common types listed above, and are considered outside of the collection modelling.

The number of households and population were used to distinguish between the basic configurations of the three “districts” to be modelled, named Urban, Mixed, and Rural. For each of these three districts, the three collection systems were then modelled separately.

Table A-30: Modelled Options[49]

	Rural	Mixed	Urban	Communal Bins
Kerbside sort	Fortnightly RRV Fortnightly Residual	Weekly RRV (including food) Fortnightly Residual	Fortnightly RCV/ Fortnightly Kerbsider Weekly Residual	*
Two stream	Fortnightly split-back Weekly Residual	Monthly 2xRCV Fortnightly Residual	Fortnightly split-back Weekly Residual	-
Co-mingled, separate glass collection	Monthly RCV/Monthly Kerbsider Fortnightly Residual	Fortnightly RCV/Monthly Kerbsider Fortnightly Residual	Fortnightly RCV/Monthly Kerbsider Fortnightly Residual	Fortnightly RCV/Monthly Kerbsider Weekly Residual
Co-mingled without glass	Fortnightly RCV Fortnightly Residual	Fortnightly RCV Fortnightly Residual	Fortnightly RCV Fortnightly Residual	-
Co-mingled with glass	Fortnightly RCV Fortnightly Residual	Fortnightly RCV Fortnightly Residual	Fortnightly RCV Fortnightly Residual	Fortnightly RCV W Residual
Notes:	* Communal bin properties in Edinburgh are assumed to be collected on the same rounds as low-rise households.			

[49] RRV – resource recovery vehicle / RCV – refuse collection vehicle

Table A-31: Number of Authorities with Each Type of Collection System

	Urban	Mixed	Rural	Total
Kerbside sort	1	2	1	3
Two stream	2	2	1	5
Co-mingled, separate glass collection	3	5	1	9
Co-mingled without glass	1	2	4	8
Co-mingled with glass	2	2	0	4
Other	0	1	2	3
Total	**9**	**14**	**9**	**32**

Table A-32: Average Number of Households in Each Authority for Each Category, Rounded for Use in Modelling (thousands)

	Urban	Mixed	Rural	Overall Average
Kerbside sort	230	93	73	395
Two stream	116	214	46	376
Co-mingled, separate glass collection	514	297	14	824
Co-mingled without glass	44	114	346	503
Co-mingled with glass	191	120	0	311
Other	0	42	21	63
Overall Average	**1,094**	**880**	**499**	**2,473**

The tonnages of waste and recycling were linked to the mass flow modelling, described in Appendix A.2.0. The scenarios were run and evaluated first for the existing Scotland mass flows. They were then run a second time with the mass flows as modified for where the deposits system is in operation.

Comparing one set of results to the other allows the impact on the collection systems, as well as the avoided disposal benefits and local authority lost material revenues, to be calculated. Results are as presented in the main report in Section 5.2.1.

It should be noted that all assumptions in the collections modelling other than the mass flows and sorting costs (described in Section A.3.0) were kept constant across the two sets of modelling. This includes the kerbside recycling participation rate and the set-out rates (the percentage of households that put their containers out for collection in any given collection week). In practice, although it cannot be predicted what a DRS might do to kerbside recycling participation rates, there may be a small effect on set-out rates. It is conceivable that households may set-out their waste or recycling containers slightly less frequently where these fill up more slowly in the case that beverage containers are collected through DRSs. The impact of this could be a slight time saving for collection operatives and consequent slight reduction in collection costs. Nevertheless, this potential effect is not applied to the collections modelling, so the results may be considered on the conservative side (i.e. greater savings may be achievable in practice).

A.4.2 Material Revenue Assumptions

As discussed and agreed with Zero Waste Scotland during the course of the project, material revenue and MRF cost assumptions are as shown in Table A-33 and Table A-34. The MRF fees were adjusted for the deposits scenarios on the basis of the change in mix of materials, taking into account the impact on the cost of co-mingled sorting[50] as well as the altered material revenues[51].

[50] Calculated from adjustment of the co-mingled costs under the baseline situations proportionate to the loss of (the more easily sorted) mixed containers taken out of the recycling stream.
[51] Calculated from the loss of income derivable by MRF operators resulting from the reduction in containers through the kerbside collection systems.

Table A-33: Material Revenue Assumptions

	Source segregated
Paper and card	£80
Plastic bottles	£120
Ferrous cans	£107
Aluminium cans	£768
Glass bottles	£23

Table A-34: MRF Cost Assumptions (+ve = income, -ve = cost)

	Mixed containers	Co-mingled excluding glass	Co-mingled including glass
Basic MRF gate fee	£15	-£10	-£25
Approximate sorting cost accounting for derived material revenues* – baseline situations	-£60	-£106	-£102
Approximate sorting cost accounting for derived material revenues – under deposit situations	-£60	-£109	-£112

- **The difference between the gate fee and the sorting cost represents the derived material revenues on the basket of sorted recyclables.*

A.5.0 Additional Cost Modelling

Appendix A.4.0 describes the methodology for calculating the change in collection tonnages and hence the associated costs from a reduction in household kerbside arisings. Appendix A.3.0 explains the determination of the costs of operating the deposit system under both scenarios.

In examining the complete waste management system for dealing with beverage container waste, additional cost assumptions are also required in order to estimate indicative financial costs from introducing a DRS of the following waste management routes:

- Collection of containers through Household Waste Recycling Centres (HWRCs) – both recycling and disposal; and
- Commercial waste recycling / refuse collection.

A.5.1 Household Waste Recycling Centres (HWRCs)

The costs of operating an HWRC vary considerably depending upon the setup of the centre. Again we aim to estimate a single conservative figure for use in the cost benefit analysis.

The incremental cost of recycling waste at HWRCs has been estimated at £70 per tonne.[52] This figure includes staff costs, handling costs and additional capital costs to handle the waste. However, we have assumed that there will only be minimal changes in the HWRC infrastructure as a result of a decrease in beverage container tonnages in comparison to the baseline situation. Therefore, there will be no savings resulting from reduced capital expenditure; hence the avoided costs of recycling would be lower than the figure given, and we have therefore used a lower figure of £15 per tonne to represent savings in handling and staff time for a reduction in containers deposited at HWRCs.

Handling costs for refuse at HWRCs will be low. We estimate these at £15 per tonne of waste delivered to the centre. On the other hand, the cost of disposal of the refuse (landfill gate fees and landfill tax) will comprise a significant proportion of the total costs.

Regarding disposal, we have assumed an avoided disposal cost of £100 per tonne in this modelling. The justification is as follows:

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[52] Eunomia (2010) *Economics of Waste Management in London*, Appendices to Final Report for GLA

1) From WRAP's latest survey of gate fees, the median pre-tax gate fee for landfilling reported by local authorities is around £23 per tonne. The landfill tax will be at £80 per tonne in the period which we are modelling (from 2014). The tax rate is set in nominal terms and will be eroded somewhat by the effects of inflation. The level of tax in real terms is expected to be of the order £72.50 per tonne (we have assumed a 2.5% deflator). Hence, the costs of landfilling are likely to be around £95.50 per tonne if the pre-tax gate fees remain constant in real terms (and this has proven a relatively robust assumption over the last 15 years).
2) At the same time, an increasing amount of residual waste will be sent to treatments other than landfill. The gate fee for such treatments, at a scale of around 200,000 tonnes, is currently of the order £90-£120 per tonne. These figures have risen much faster than inflation, and are affected by a range of factors, including (for equipment sourced from overseas) the exchange rate.
3) The figure of £100 per tonne thus represents an estimate of the real costs of disposal in 2014 and beyond, effectively 'blending' landfill and other residual waste treatment costs. It should be noted that for some authorities with treatment facilities built in the 1990s, the avoided costs of disposal will be much lower than this. However, many of these will need to be retrofitted / replaced over the coming decade, and the costs seem likely to increase significantly as a result.

Hence the saving associated with a reduction of beverage containers deposited in the refuse skip at HWRCs is estimated to be £115 per tonne.

A.5.2 Commercial Collection

Costs per lift were used to estimate the savings from commercial collection services, then converted to a cost per tonne and multiplied by the reduction in material requiring collection. The full cost is not usually obtained as the bins are not 100% full and there may be some glass collections still taking place. Therefore we assume only 75% of the cost saving accrues.

Table A-35: Commercial Waste Collection Model Parameters

Type	Bulk Density, kg / m^3	Typical Bin Size, Litres
Glass Bottles	400	240
Plastics Bottles	20	1,100
Cans	30	1,100
Bev Cartons	20	1,100
Refuse	82	1,100

Table A-36: Commercial Waste Savings

		Per lift	Per tonne	Total (Low Return Rate Scenario), £million	Total (High Return Rate Scenario), £million
Metals / Plastics/ Cartons	Collection and sorting	£6.60	£267	£0.4	£0.4
Glass	Collection	£5.60	£58	£1.3	£1.3
Refuse	Collection	£13.80	£153	£1.6	£2.4
	Disposal		£100	£4.6	£5.4
			Total	**£7.9**	**£9.5**

The savings from a reduction in the use of commercial waste collection services was estimated to vary between **£7.9m** and **£9.5m** per annum for the low and high scenarios respectively.

A.5.3 Direct Costs of Litter

Until recently there has been very little research undertaken to quantify the direct litter costs specific to Scotland. However, a 2013 Eunomia study[53] for Zero Waste Scotland estimated that 27,000 tonnes of litter is collected very year in Scotland; of this amount it is estimated that 5,230 tonnes could be part of the DRS system. The calculation for this estimate is summarised in Appendix A.2.1.5. It is also estimated that 4,620 tonnes of this material will be captured within the DRS; a 90% reduction the DRS material littered. This is equivalent to a 17% reduction in overall litter by weight. The Eunomia study also estimated a cost associated with dealing with all litter by local authorities and duty bodies of £42.6 million per annum.

It is difficult to estimate the cost savings from litter picking or a reduction in the use of litter bins. By assuming that there is a linear relationship between tonnage of material recovered from litter picking and the costs involved, the financial savings generated by the overall reduction in DRS material becoming litter were estimated. The savings for the direct cost of litter under the DRS is estimated to be £7.28 million. A breakdown of these costs is seen in Table A-37.

It is recognised that collection costs are not perfectly scalable by weight, and therefore potentially overestimated, however, the figure is still considered appropriate as it also assumed to take into account savings from a reduction in the collection and disposal of empty beverage containers from on-street litter bins; a cost that was not accounted for in the ZWS report, and one that could be relatively significant.

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[53] Zero Waste Scotland (2013) *Scotland's Litter Problem: Quantifying the scale and cost of litter and flytipping*, 2013

Table A-37: Direct Costs of Litter, £ million

Activity	Litter Costs	Litter Costs under DRS	Savings
Local Authority			
Personnel	£28	£23	£4.8
Equipment	£2.3	£1.9	£0.4
Fleet	£4.3	£3.6	£0.7
Facilities	£0.6	£0.5	£0.1
Other	£1	£0.9	£0.2
Education	£0.8	£0.7	£0.14
Enforcement	£4.5	£3.7	£0.8
Duty Bodies			
Clearance	£0.6	£0.5	£0.1
Education	£0.35	£0.3	£0.61
Total	**£42.6**	**£35.2**	**£7.3**

Source: Eunomia