Bulk density and apportionment of C&I waste

A user guide describing a methodology (and supporting spreadsheet tool) to apportion commercial wastes and recyclables co-collected with household waste at the kerbside

WRAP helps individuals, businesses and local authorities to reduce waste and recycle more, making better use of resources and helping to tackle climate change.

Written by: AMEC Environment and Infrastructure UK Limited

Contents

Acknowledgements

1. Introduction

1.1 Background and purpose of the guide

Co-collecting household and commercial waste or recycling on the same vehicle represents one way of efficiently providing services. Where this approach is implemented it is important that the local authority adopts a robust approach to accurately apportion the amount of material which is derived from households and from business, due to:

- The requirement for local authorities to report household and commercial, industrial or other non-household tonnages separately in WasteDataFlow;
- The benefits derived from being able to assess the relative costs of the household and commercial waste services. As well as top level budgeting, this information will be needed to determine charges and ensure that the commercial operation is covering its costs;
- The need to support transparent reporting and transfer of payments such as recycling credits and levies within two-tier authorities; and
- Councils in two-tier authorities being subject to Section 52(9) of the Environmental Protection Act 1990, which states that a Waste Disposal Authority (WDA) is entitled to receive from a Waste Collection Authority (WCA) "such sums as are needed to reimburse the waste disposal authority the reasonable cost of making arrangements for the disposal of commercial and industrial (C&I) waste collected in the area of the waste disposal authority".

Where local authorities have adopted co-collection strategies in the past, they have typically used estimates to apportion household and commercial fractions. The wide range of approaches adopted to do this introduces both uncertainty and inconsistency. The study initiated to develop this user guide and a tool for apportionment of co-collected household and business waste is intended to help address these issues. It provides a methodology, reviewed by a cross industry Steering Group (including key organisations such as NAWDO, LARAC, Defra and the Environment Agency), that should help to improve reporting consistency and reduce uncertainties on the amount of business waste collected.

This document explains how to use the apportionment tool covering commercial waste/recycling co-collected with that from households at the kerbside, and provides a summary of the underlying methodology and data used to support the tool. It is intended to be read and used alongside the spreadsheet tool containing bulk density data that can be used directly to estimate co-collected commercial waste/recycling tonnages.

The work has been undertaken based on consultation with a project Steering Group, engagement with a number of UK local authorities and a review of reported data. These activities identified a mix of recorded material bulk density and commercial weights data, composition data (some sector-specific) and apportionment factors already in use by local authorities or published by regulators. An assessment of the source and limitations of the identified data was undertaken followed by development of a draft set of apportionment factors and review via the Steering Group.

The final data used in the tools are derived from a range of sources including local authorities, waste management operators, WRAP and SEPA.

2. Apportionment method for kerbside collected commercial waste and recycling

This section of the guide summarises the methodology for local authorities seeking to apportion commercial waste/recycling co-collected with that from households at the kerbside

2.1 Tool development

Development of the kerbside apportionment tool took place in two phases. Phase 1 included a review of existing co-collection apportionment methods and literature on commercial waste arisings and composition. The purpose of phase 1 was to develop a methodology for apportioning co-collected waste/recycling which could be readily adopted by local authorities (and their contractors) that currently co-collect or are considering co-collection. After an apportionment method was selected a draft spreadsheet-based apportionment tool was produced and reviewed by members of the Steering Group.

The aim of phase 2 was to test and validate the draft apportionment tool through comparing tool estimates to the weight of commercial waste/recycling collected by existing dedicated or separate commercial waste collection services. Results from a validation exercise proved that the tool is capable of producing estimates which are **not** significantly different to the quantity of material which is actually collected, albeit the quality of the data (i.e. lifts) has an influence on the tools' accuracy. Phase 2 also included a 'user testing' exercise where a number of local authorities were recruited to evaluate the tool, feedback from which was incorporated into the final tool design and this user guide.

Future development

The proposed method does not seek to take account of the business type, acknowledging that average weights per bin size (particularly for residual waste and mixed recycling streams) will vary depending on the sector and the range of waste and recycling services applying to each business. It is possible to calculate commercial waste arisings based on an average weight per volume and by sector, however not all local authorities have sufficient data on their customers, or the resources required for fieldwork, to calculate commercial waste arisings in this way. In addition, there is currently a lack of sector-specific waste data publicly available. The availability of underpinning data is expected to improve over time as WRAP and others research the types and quantities of waste in, e.g. the hospitality and other business sectors.

Summary

The methodology and tool is based on an average weight per container as it remains the most practical way for local authorities to estimate commercial waste/recycling arisings without undertaking extensive waste sampling activities. Furthermore an apportionment method based on average weight calculations will be able to incorporate differences between business sectors as further research on co-collection and commercial waste is undertaken and more reliable data become available. Hence apportionment based on average weight assumptions represents a sensible starting point that can be developed and further refined over time.

2.2 How does the tool work?

The kerbside apportionment tool is based on a database of bulk density estimates that have been researched as part of this study. It works by inputting the number of lifts by material stream and container type to estimate first the volume and then the weight (based on the relevant (bulk density) conversion factor) of co-collected commercial waste.

To demonstrate how the tool works, consider the example below which may look complicated, but remember using the tool avoids the need to handle all these numbers.

Worked Example

If you collect fifty 240 litre bins of commercial refuse twice a week for three months the total volume lifted can be calculated as follows:

Total volume of waste (litres)	=	50 (no. of bins)	x	240 (volume of bin)	x	2 (twice weekly collection)	x	13 (no. of weeks)	=	312,000 litres

To convert litres to cubic metres divide by 1,000

312,000 litres	÷	1000	=	312 m^3

Commercial refuse in a 240l wheeled bin has an effective bulk density or conversion factor of 0.083 t/m^3, therefore the total estimated weight collected is:.

312 m^3	x	0.083	=	25.9 tonnes

The apportionment tool calculates all this for you! All that is required is **the total number of lifts per waste stream and the container type** (see Section 2.3 for further detail on data requirements).

Advantages

The primary advantage of this method is that it makes use of information most local authorities are likely to hold or should readily be able to access, namely: the number and type of bins / containers serving each business and the frequency of collection. Calculations based on average weight per bin size allow estimates to be tailored to individual authority customer bases, and also allows for adjustment of containment and frequency of lift figures as customer requirements change.

Results from a validation exercise have proven that the tool is capable of producing estimates which are **not** significantly different to the quantity of material which is actually collected. However users should note that the quality of data an authority holds on their customers has an effect on the tool's accuracy. The ramifications this may have for a given local authority is likely to be a function of **scale**. Where co-collection of commercial waste/recycling is limited to a small number of customers, the accuracy of the estimate for this relatively small amount of waste is less important than for an authority which co-collects waste from hundreds or thousands of customers. Scale is also relevant when selecting the time period for which you want to apportion co-collected kerbside commercial waste, with **longer timeframes tending to be more accurate than shorter ones.**

Limitations

There remains a risk that by only using data on the waste stream, container volume and frequency of waste collections servicing businesses the estimated arisings of co-collected commercial waste may be inaccurate[1]. Central records held by local authorities may not fully

---

[1] *The extent to which using data on the customer base will over or underestimate commercial waste arisings will depend upon the quality of the customer data and extent to which businesses act rationally. It is reasonable to assume that a profit maximising business will aim to minimise costs by identifying the most appropriate waste services, receptacles and frequencies and hence tend to use the service fully and as described in the customer records. This may not always be the case and is more likely to become an issue in authorities where accurate record keeping and/or monitoring does not occur.*

reflect the services provided to customers. Not every business will necessarily present waste for collection at every opportunity and/or present every receptacle. In addition, there may be circumstances where it is possible for a business to present their waste more often than their contract allows (for example, in areas with daily collections). Hence it is important that local authorities ensure crews accurately record the actual number and detail of lifts made to enable accurate apportionment.

Tests on the tool outputs have shown that where contract records are used instead of monitored collection data the kerbside apportionment tool was overestimating the amount of waste generated by between 10 – 20%[2]. As many local authorities do not monitor actual number and detail of lifts (instead, relying on central databases), this has been accounted for in the 'volume adjustment'. If a local authority does monitor actual number of lifts e.g. via GIS or by crews, then the volume adjustment factor needs to be changed to 0%.

An approach based on conversion factors assumes that all containers will be filled to the same level which might not always be the case. Some businesses may not completely fill their containers prior to collection whereas others may overfill. The apportionment tool includes default average fill levels by waste stream and container type such as residual waste, paper or glass. To achieve a greater level of accuracy, a local authority may wish to undertake monitoring exercises to calculate average fill levels for their customer base. Fill levels can be adjusted in the 'Data' worksheet.

Updating or amending the tool
Estimate parameters
The tool has been designed so that local authorities can update or amend certain values to include the results from monitoring exercises or to better reflect their circumstances. The primary tool for adjustments is the 'volume adjustment factor' on the 'Apportionment Tool' worksheet. This parameter is used to correct for the tendency of the tool to overestimate commercial waste arisings when *customer records* are used to estimate lifts rather than *monitored collection round data*. Local authorities with a high confidence in their customer records may believe this factor to be too high and choose to reduce it. Other authorities with low confidence in their customer records may choose to increase this value. 12.5% was the average difference between the actual and estimated weights data from authorities which provided lift data derived from customer records during the phase 2 validation exercise.

Another option for updating the tool is to amend the default average fill level values assumed for different waste streams, perhaps after a monitoring exercise. This can be done in the 'Data' tab. Bulk density values should not be altered.

Any adjustments that Local Authorities make to the tool should be recorded and include the rationale for the changes for transparency.

Container options
A wide range of standard container sizes have been included in the tool. Users can alter the name of the containers if they wish as well as amending the sizes of them. It needs to be understood however that there are different bulk densities for sacks, two wheeled bins and four wheeled bins. If you adjust the bin sizes, ensure that you do so in the correct column so that the tool applies the correct bulk density figure (there is one sack size option, three 2 wheeled bins and three 4 wheeled bins). Container name can be changed by altering the

---

[2] *A 'volume adjustment factor' has been included in the tool to account for the tendency to overestimate commercial waste arisings where customer records are used.*

text in cells I2:O2. The associated volume of the container in litres can be input in cells I3:O3.

2.3   Data requirements
Minimum data requirements
The tool requires the user to input the number of lifts (by waste stream and bin size) for a given time period to estimate the quantity of co-collected commercial waste.

Regularly monitoring collection rounds[3] to record the lifts actually performed will produce the most accurate estimates. If monitoring rounds is impractical, customer/contract data could be used to estimate lifts. Please note tests on the accuracy of the tool estimates have shown that where lifts are estimated from customer/contract data the tool will tend to overestimate the amount of waste generated. Therefore a 'volume adjustment factor' has been included in the tool to correct for this. **Where an authority has monitored collection round data the 'volume adjustment factor' value should be changed to 0%.**

What to do if a Local Authority does not have the minimum information
Should an authority not have the information on number and type of bin / containers and frequency of collection, an exercise to update customer records will be required, paying particular attention to what actually happens on the rounds rather than relying on contract data.

How to enhance data quality
As well as collecting data on streams collected, containers used and the frequency of lifts for different customers, information on the type of business could also be collected. Information on business type will facilitate the calculation of waste arisings by sector, and more accurate apportionment, if sector-specific waste data becomes available and is incorporated in the tool.

Customer/contract records should be regularly reviewed to ensure they are up to date and reflect what actually happens on the collection rounds. Where lifts are monitored by crews you should occasionally visit your collection rounds and periodically review how operations are recorded by the crews to ensure that lifts are accurately documented.

Collection monitoring options
The more often crews can record data, the better the picture of the collection service. Where continuous monitoring is not practical, authorities should look to design a robust monitoring schedule to accurately estimate the number of lifts per business per stream. Monitoring of business waste lifts should broadly follow the requirements of monitoring participation of households in waste services[4]. Business waste lifts should be monitored on a minimum of 3 consecutive collection opportunities for each stream (recycling and general waste). Ideally all businesses should be monitored as the factors affecting the number of lifts *actually* performed as a proportion of the number of lifts *contracted* to perform will tend to be specific to individual businesses and circumstances with the exception of seasonal variation which will particularly affect seasonal businesses. Where businesses are seasonal or a town's economy has a large seasonal element it is recommended business waste lifts are monitored both in season and out of season to understand effects of seasonality. Bar-coding bins and sacks is another method to monitor business waste lifts which has been

---

[3] *Manually or through Radio Frequency Identification (RFID) technology.*

[4] *Monitoring household recycling scheme usage, participation and uptake*

used successfully by at least one authority[5]. Fill level monitoring (recording the approximate volume used in each container per collection) could be undertaken in conjunction with business waste lift monitoring. However, please note that any authority that may plan to undertake fill level monitoring they should be aware of anecdotal evidence that, in general, people tend to overestimate waste volumes and associated risks of requesting operational staff to collect this information on top of their usual jobs.

Where collections monitoring is not feasible, the number of lifts per stream will have to be estimated from information held by the local authority on business waste services such as contracts or service agreements. Where the number of lifts is estimated in this way annual bin surveys should be performed to check the accuracy of local authority records, in particular, the number and type of receptacles provided to businesses.

Approach to estimating use of sacks
Most sack customers tend to purchase rolls of between 20 – 50 sacks for commercial waste and/or recyclables from their local authority. Where continuous monitoring is taking place collection operatives should record the number of sacks collected (from each business where possible) in the same way as they record bins lifted. Barcoding of sacks has proved for one authority to be a useful method of monitoring usage[6]. Alternatively, sales records for the period of interest could be used. Although some sacks which are sold may not be used for some time, and some may never be used, sales information provides an approximation of the number of sacks which require replacing and hence an indication of the number of sacks used.

---

[5] *See Ceredigion Case Study: WRAP, Co-collection of household and commercial waste and recycling, August 2011, http://www.wrap.org.uk/sites/files/wrap/Co-Collections_guidance.pdf*

[6] *See Ceredigion Case Study: WRAP, Co-collection of household and commercial waste and recycling, August 2011, http://www.wrap.org.uk/sites/files/wrap/Co-Collections_guidance.pdf*

Using the tool

The following steps outline how to use the kerbside collected commercial waste/recycling apportionment tool:

1. **Define the time period of interest (month/quarter/year).** It is expected most authorities will need to apportion commercial waste quarterly in line with WasteDataFlow reporting requirements. Where possible, authorities should consider apportioning co-collected waste every month in order to begin to build a database which will help to identify any seasonal or temporal trends in commercial lifts and estimated waste arisings. The time period entered does not influence the calculations. It is there to provide context to the outputs i.e. it shows if the estimates represent a week, month, quarter or a year's worth of commercial waste/recycling.

2. **Calculate the total number of lifts per waste stream and container type during the defined time period**. Ideally this will be operational data (such as manual monitoring, PDAs, RFID, barcodes or GIS data) on lifts performed as recorded by the collection crews. Where operational data does not exist, estimate the number of lifts per business from central records.

Total no. of lifts per waste stream and container type	=	No. of bins of certain size	x	Frequency of collection	x	No. of weeks in time period of interest

   If lifts are calculated from operational data (e.g. manual monitoring, GIS etc) please change the 'volume adjustment factor' to 0%.

   If lifts are estimated from central records please **do not** change the 'volume adjustment factor'.

3. **Input the total number of lifts by waste stream and container type** for the defined time period into the apportionment input sheet/cells.

INPUTS

	A	B	Sack (80	140 litre	240 litre	360 litre	660 litre	1100 litre	1280 litre
1		INPUTS							
3	**Time Period**								
5						**Number of Lifts**			
6	**Kerbside Streams**	**Volume Adjustment Fa**							
7	Commercial refuse	12.5%							
8	Commingled – plastic bottles and mixed cans	15.0%							
9	Commingled – paper, card, plastic bottles and mixed cans	15.0%							
10	Commingled – paper, card, plastic bottles, mixed cans and glas	15.0%							
11	Paper	15.0%							
12	Card	15.0%							
13	Paper & Card	15.0%							
14	Plastic Bottles	15.0%							
15	Mixed Plastic	15.0%							
16	Glass	15.0%							
17	Food	0.0%							

Input number of lifts here

21 **Instructions**	Input time period of interest
22	Alter 'Volume Adjustment Factor' if using monitored lift data (see User Guide)
23	Input number of lifts per container per time period in yellow cells
24	Results are presented in grey (refuse), green (recyclables) and blue (grand total) cells to the right

Instructions | **Apportionment Tool** | Data | Sources | Containers

---

The tool estimates commercial arisings for each relevant material stream. These figures can be used to update WasteDataFlow and other internal/external reports.

OUTPUTS

Number of Lifts

	360 litre	660 litre	1100 litre	1280 litre
7	62	30	24	32
8				
9				
10		5		
11	23	24	12	12
12	50	32	20	14
13				
14				
15			2	
16				
17				

Kerbside Streams	**Total (t)**	**%**
Commercial refuse	10.8	49%
Commingled – plastic bottles and mixed cans	0.0	0%
Commingled – paper, card, plastic bottles and mixed cans	0.3	1%
Commingled – paper, card, plastic bottles, mixed cans and glas	0.1	1%
Paper	8.3	37%
Card	2.4	11%
Paper & Card	0.0	0%
Plastic Bottles	0.0	0%
Mixed Plastic	0.1	0%
Glass	0.1	0%
Food	0.0	0%
Commercial Total	22.1	100%
Refuse Total	10.8	49%
Recyclables Total	11.3	51%

Estimated weight by material stream presented here

Estimated total weight presented here

Instructions | **Apportionment Tool** | Data | Sources | Containers

www.wrap.org.uk/content/local-authority-business-waste-recycling-guidance-documents

Printed on xx% recycled
content paper