User guide for WasteCAT waste collection assessment tool

Model created by: T. W. Chu, A.C. Lock, S. Heaven

Software implementation: A.C. Lock

Manual prepared by: T.W. Chu

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Contents

Main contributors:

Tsz Wing Chu [a], Antony C. Lock [a], Sonia Heaven [a]

With information and assistance from VALORGAS partners:

Ludwig Gredmaier [a], Keith Riley [b], Cristina Cavinato [c], Rebecca Arnold [d], Filipa Vaz [e]

[a] University of Southampton, Faculty of Engineering and the Environment, Southampton SO17 1BJ, UK
[b] Veolia ES (UK) Ltd, Veolia House, Pentonville Road, London N1 9PE, UK
[c] Dipartimento di Scienze Ambientali, Università Ca' Foscari di Venezia, Calle Larga S. Marta 2137, 30123 Venezia, Italy
[d] Greenfinch Ltd, Business Park, Coder Road, Ludlow SY8 1XE, UK
[e] Valorsul SA – Valorização e Tratamento dos Resíduos Sólidos das Regiões de Lisboa e do Oeste, Plataforma Ribeirinha da CP, Estação de Mercadorias da Bobadela, S. Joao da Talha, 2696-801, Portugal

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0.0 Introduction

The Waste Collection Assessment Tool (WasteCAT) is a mechanistic model designed to determine some of the resource requirements associated with different types of collection system for source segregated wastes. The model inputs include waste generation rate, waste stream composition, materials to be collected and vehicle types, plus a range of information to characterise the collection area. Outputs include the total fuel consumption in collection, number of vehicles required, staff time, and some features of the service.

WasteCAT can be used to model alternative options for new collection schemes; or to benchmark the performance of an existing scheme against modelled output. Rather than identifying a single optimum solution, it provides a decision support tool for planners and operators to investigate the consequences of different choices: in reality a much wider range of parameters will influence the decisions made. It does, however, offer a robust basis for comparison of options and a powerful research tool for investigating the impacts of collection systems.

The WasteCAT model was primarily constructed for the purpose of evaluating energy consumption. Results from modelling have been used to deduce 'typical' energy costs per tonne of food waste collected, as a component in the overall energy balance for food waste valorisation to biogas. Outputs include energy (fuel) consumption and staff time (contributing to running costs, and to GHG emissions in the case of fuel), and vehicle numbers (an indicator of capital cost and embodied energy). The model already allows user-specified vehicles: in future it is hoped to include a wider choice of non-conventional vehicle and fuel types.

The current version of WasteCAT is available from www.valorgas.soton.ac.uk. Version 2, which includes a sensitivity analysis option, will be released after beta-testing.

1.0 System Requirements

The WasteCAT tool requires the following system configuration:

- Windows operation systems
- Microsoft.NET Framework 4.5
- At least 9 MB of hard disc space
- 1280 * 960 or more pixel screen resolution recommended

To see the Help file (accessed by clicking on "?"), Adobe Reader version X or above is required

1.1 Setup and start the program

WasteCAT setup is quick and easy. Unzip the WasteCAT.zip file; find the **Setup.exe** file from the Publish Directory. Double click Setup.exe file to install and launch the program. A cover page of the tool, shown in Figure 1, is splashed once the tool is ready. Click on it to enter the first page of the tool.

Figure 1. Cover page of WasteCAT

1.2 Using WasteCAT

This section provides a detailed description of system functions. The layout of the WasteCAT main page is shown in Figure 2. The layout can be divided into two parts: Main window (Green) and menu bar (Red).

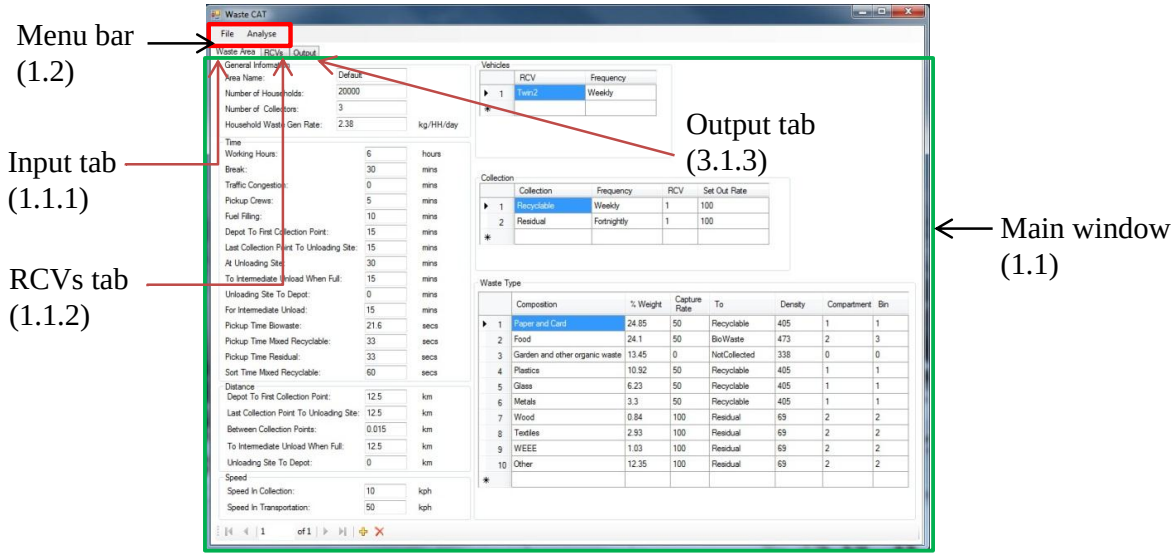


Figure 2. Layout of WasteCAT main page

1.3 Main Window

The main window has three tabs: Input, RCVs and output.

1.3.1 Input tab

The input tab is made up of 7 input tables containing general information on collection system, time, distance, speed, vehicles, collection and waste type. An explanation of inputs is given in Table 1.

Table 1. Description of terms in input tab

Term	Description
Area name:	Name of the area being analysed
Number of households:	Number of households in the area.
Number of collectors:	This represents the number of staff involved in picking up household waste. Decimal fractions are accepted.
Household waste gen rate:	This is the total waste generated per household per day (kg household^{-1} day^{-1}).
Working hours:	Total length of a working day including time for non-productive activities such as breaks (hours).
At unloading site:	Time at unloading site including time queuing and unloading (min).
To intermediate unload when full:	This is the time from the last collection point to the bulking point (e.g. transfer station), and only applies when a vehicle must deposit two or more loads in one day (min).
For intermediate unload:	Time at unloading site when more than one load is deposited per day (min); normally equal to time at unloading site.
Sort time mixed recyclables:	The average time required to sort each recyclable (min).
Speed in collection:	The average speed inside collection area – first dwelling or collection point to last dwelling or collection point (min).
Speed in transportation:	The average speed outside collection area (km hour^{-1}).

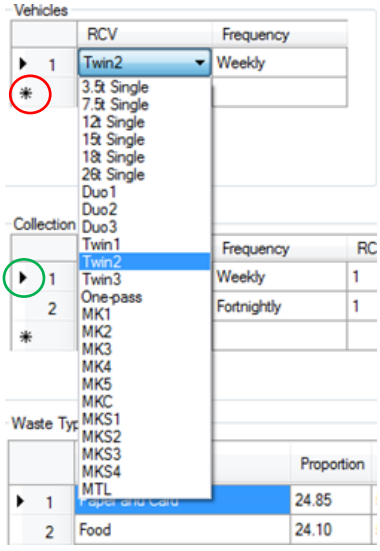
In this tool, when the input value of time is changed, the distance changes automatically, and vice versa. This is because the calculation of time and distance is based on speed. On the other hand distance depends on speed, thus when the speed in transportation is changed, the distance will be recalculated.

At the right hand side of the input tab there are three input tables: vehicles, collection and waste types.

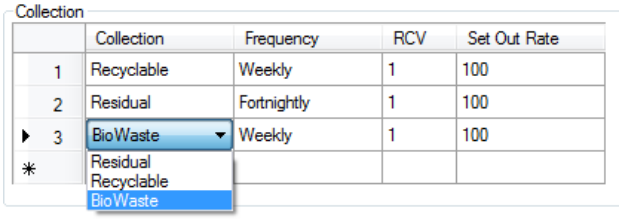
Vehicle table:

The first column of the table contains the vehicle number, which is used to identify the vehicle in the collection and waste type tables. User can select the vehicle type from the drop down list by double clicking the text field in the RCV column. More information about the vehicle type can be found on the RCVs tab. Adjacent to the RCV column is the frequency with which this particular vehicle visits each household on its route: note that this may not be the same as the frequency of collection (see Scenario 3 in examples below). Double click on this to select the option weekly or fortnightly from the drop down list.

When setting up a scenario, the user can select more than one collection vehicle by clicking "*" (red circle). To delete, click the number in the first column (green circle) so that the whole row is highlighted in blue and then press the delete key.



Collection table:


Collection

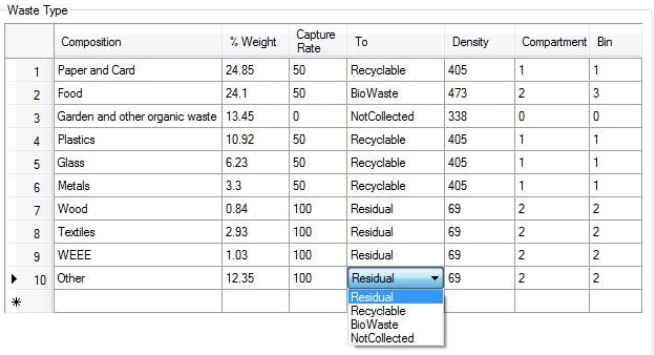
	Collection	Frequency	RCV	Set Out Rate
1	Recyclable	Weekly	1	100
2	Residual	Fortnightly	1	100
3	BioWaste	Weekly	1	100
*				

Residual
Recyclable
BioWaste

Waste type can be selected from the drop down list in the collection column: the categories are residual waste, recyclable and biowaste. Frequency here is different from the frequency shown in vehicle table. It represents the period of time for which waste is stored by the householder or waste generator, i.e. weekly means waste is accumulated for 7 days before the next collection day. In the RCV column, the number in text field refers to the vehicle number shown in the first column of vehicle table. It indicates which vehicle is used to collect the waste selected in the associated collection column.

Set out rate means the proportion of households that set out this bin on the collection day.

Waste type table:


Waste Type

	Composition	% Weight	Capture Rate	To	Density	Compartment	Bin
1	Paper and Card	24.85	50	Recyclable	405	1	1
2	Food	24.1	50	BioWaste	473	2	3
3	Garden and other organic waste	13.45	0	NotCollected	338	0	0
4	Plastics	10.92	50	Recyclable	405	1	1
5	Glass	6.23	50	Recyclable	405	1	1
6	Metals	3.3	50	Recyclable	405	1	1
7	Wood	0.84	100	Residual	69	2	2
8	Textiles	2.93	100	Residual	69	2	2
9	WEEE	1.03	100	Residual	69	2	2
10	Other	12.35	100	Residual	69	2	2
*							

Residual
Recyclable
BioWaste
NotCollected

The composition and % weight of kerbside household waste can be modified. Waste types can be added or deleted by clicking '*' or pressing the delete key. The user can double click the input field to enter or alter the text. Capture rate refers to amount of a particular waste that is put out for separate collection in the bin, as a percentage of the total quantity of that waste in the kerbside-collected household waste stream. The minimum and maximum values of capture rate are 0 and 100 respectively. If the capture rate is set to zero, this means none of the selected waste is diverted to the selected recycling or biowaste bin and it all goes into the residual waste stream. The set out rate is fixed at 100 for waste going to the residual waste stream.

"To" column: The user can allocate the waste type to residual waste, recyclable, biowaste and not collected by selecting the waste category from the drop down list located in the "To" column. For example, if mixed recyclables (i.e. paper, card, plastics, grass and metals) are collected, then the category "Recyclable" should be chosen.

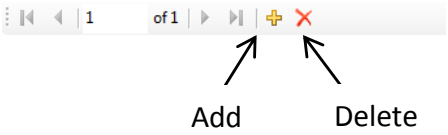
Density column: This gives the bulk density of each waste, and is associated with the waste type and the type of vehicle to be used for the collection. Default values for bulk density are based on WRAP (2008, 2009 and 2010).

Compartment column: The number in the compartment column identifies which wastes go to which compartment(s). As default, compartment 1 refers to the small compartment while compartment 2 is the larger compartment if two-compartment vehicle is selected. Details of compartment sizes are given on the RCVs tab. When a waste is not collected, "0" should be entered in the text field.

Bin column: This is used to assign which waste types go into the bins. The number is used to identify the bin, and to count the number of sorts required in a kerbside-sorted system. For example, if glass and metals are collected in the same bin but emptied separately into two compartments, this means one sorting of recyclables is required. Another example is given in section 2.

Tool bar:

The user can duplicate the scenario or create a new scenario by clicking on "✚"or delete the scenario by clicking on "✕"at the bottom of the input tab.



1.3.2 RCVs tab

Figure 3 shows the database of refuse collection vehicles, which contains information on each vehicle including the gross weight, payload, volume capacity of vehicle, number of compartments, volume capacity of each compartment and the factor for the hydraulic system. Details of terms are explained in Table 2.

Table 2. Description of terms in RCVs tab

Term	Description
Code:	This is the code for each vehicle which displayed in the drop down list in the vehicle table.
Refuse collection vehicle:	This provides the brief description of vehicle, e.g. the manufacturer, data source, type of vehicle, etc.
GVW:	Gross weight of the collection vehicle.
Payload:	Maximum load capacity of vehicle.
Number of compartments:	Total number of vehicle compartments.
Total volume:	Maximum volume capacity of vehicle.
Compartment:	Volume capacity of each compartment: click the up arrow button to show the volume capacity of other compartments.
Factor for using hydraulic system during collection:	This represents the extra fuel required to operate the hydraulic system and in the 'stop and go' pattern in the collection area. 35% extra fuel is assumed, thus the default value for this factor is 1.35

In addition to choosing from the 24 collection vehicles in the database, the user can create new vehicles or remove a vehicle by clicking the "✚" or "✕" buttons. After clicking on the "✚" button, a new vehicle form appears, as shown in Figure 4. If the new created vehicle is a compartmentalised vehicle, the volume of each individual compartment must be entered in the "compartment" text field by clicking the up and down arrow buttons. The sum of the volume of each compartment should be equal to the total volume for the vehicle.

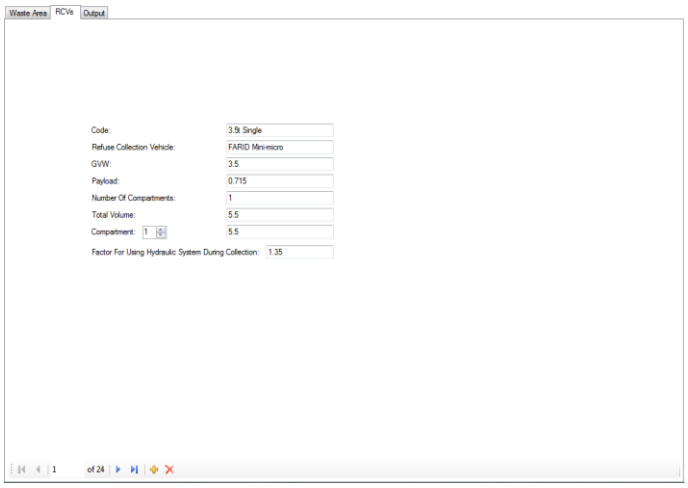


Figure 3. Layout of RCVs tab

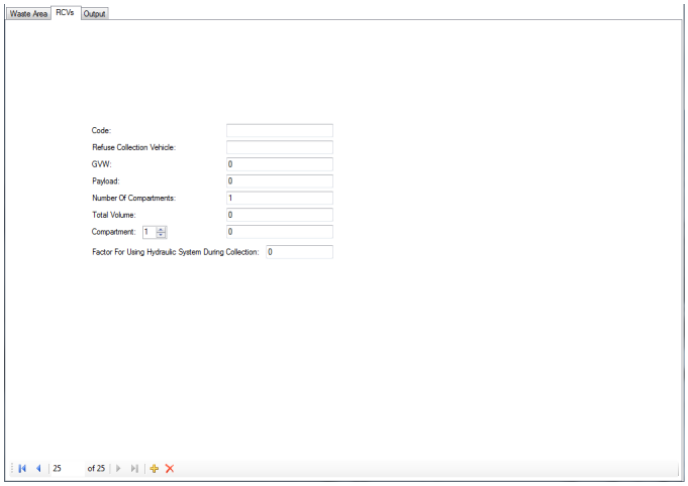


Figure 4. Form for new RCVs

1.3.3 Output tab

The output tab lists the results of the scenario modelling. The key outputs of WasteCAT include: limiting factors, number of vehicles required, average laden percentage, total fuel consumption, energy consumption, travelled distance, total time, number of routes and litre diesel per tonne waste collected. An explanation of these terms is given in Table 3.

Table 3. Description of terms in output tab

Term	Description
Limiting collection:	This shows which compartment is filled up by the waste first.
Limited by:	This shows whether the collection round is limited by service time, payload or volume capacity of the vehicle.
Number of loads per day:	This equals the number of loads taken for transfer or disposal per day. For example if it shows 2 rounds per day, this means waste must be unloaded once before the whole round is finished.
Laden percent:	Average laden percentage in weight per vehicle.
Number of routes per collection:	This shows the total number of routes required to collect waste for the whole collection, and is equal to the number of collection vehicles times the number of collection days.
Total time spent in collection:	Time spent inside the collection area only.
Total time:	Time spent inside and outside the collection area, including non-productive time.

Figure 5 shows the layout of the output tab. There are two tool bars: one at the top and another at the bottom. On the top tool bar, the user can click the left and right arrow buttons to switch page and view the performance of vehicles in each scenario. To view the result of different scenarios, the tool bar at the bottom can be used to switch pages.

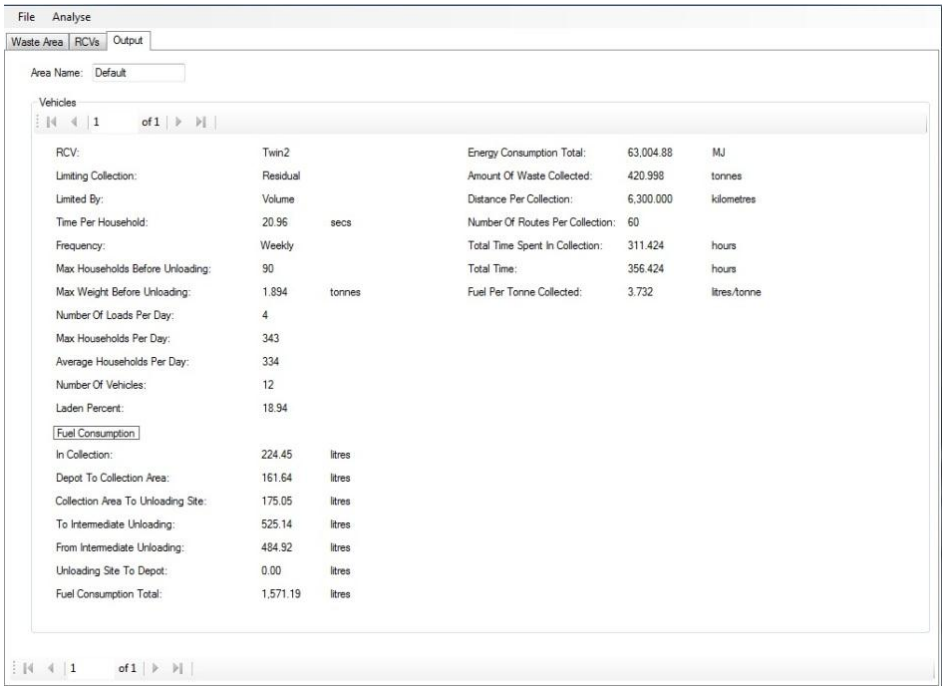
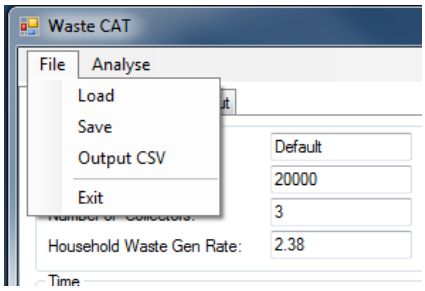


Figure 5. Layout of output tab

1.4 Menu bar

There are two buttons in the menu bar: File and Analysis. The user can save the scenarios by clicking "Save". The scenario is saved in .wmd format. To load the file, the user can click "Load", and a new window appears. All the results can also be exported in.csv format by clicking "Output CSV".



"Analyse" function: This is the command to run the tool. Once the user has set up all the required scenarios, press "Analyse" to run the model before viewing the results on the output tab.

2.0 Demonstration

Four examples are used to explain how to set up the scenario in the input tab.

Scenario 1: Weekly separate collections of recyclables, residual and food waste by a 26t single compartment vehicle.

Scenario 2: Weekly co-collection of recyclables and food waste by equal split-bodied vehicle (Twin1), fortnightly collection of residual waste by a 26t single vehicle.

Scenario 3: Weekly food waste collection with alternate weekly collection (AWC) of recyclables and residual waste by equal split-bodied vehicle (Twin1).

Scenario 4: Recyclables are kerbside sorted and food waste is collected weekly by the three-compartment vehicle (One-pass).

Figure 6 shows the setup of Scenario 1. Firstly, three 26-tonne vehicles are selected for the collection. Vehicles 1, 2 and 3 are used to collect recyclables, residual waste and biowaste respectively. The waste stream in the collection table links up to the "To" column in the waste type table and allows the user to trace which vehicle is being used to collect what kind of waste stream. In the waste type table, all wastes go to compartment 1, simply because single compartment vehicles are used.
In this scenario, three bins are used to collect wastes. It is assumed all recyclables are collected co-mingled in Bin 1. Food waste and residual waste go to Bin 2 and Bin 3 respectively.

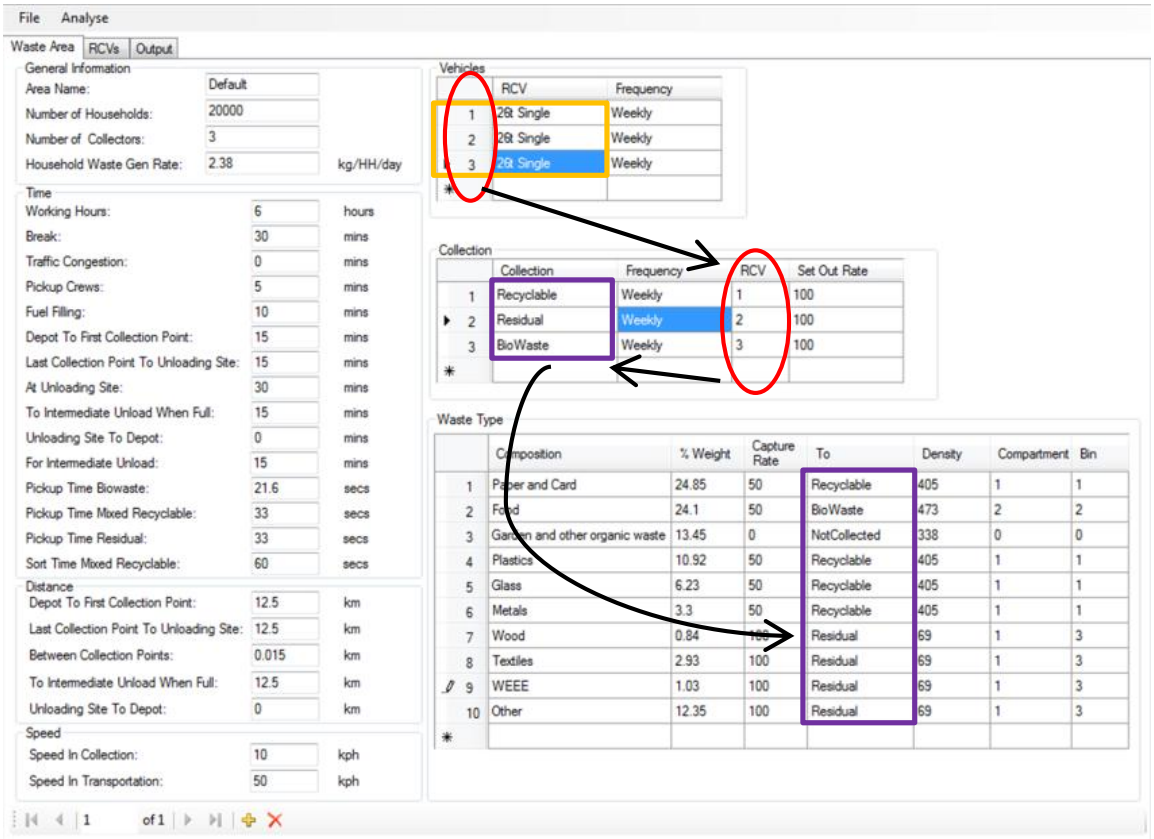


Figure 6. Input tab for Scenario 1

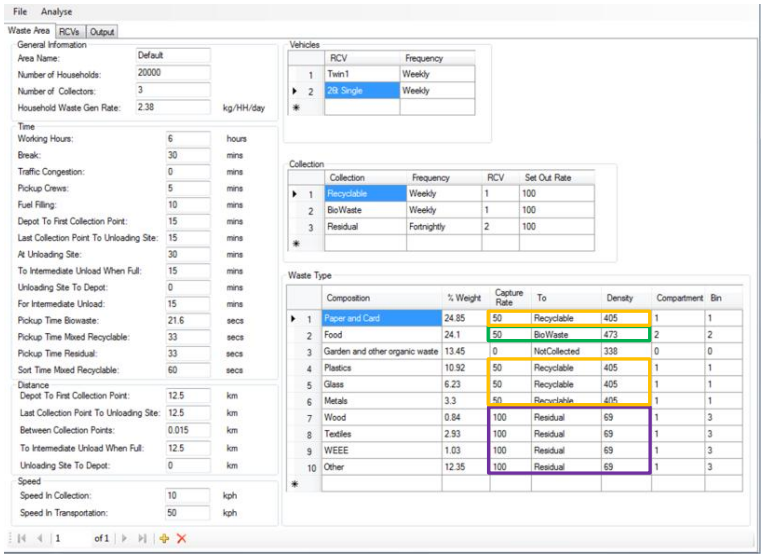


Figure 7. Input tab for Scenario 2

Figure 7 shows the input tab for Scenario 2. A Twin1 (Vehicle 1) collects the recyclable and biowaste weekly, recyclables are loaded into compartment 1 and food waste goes to compartment 2. A 26t Single (Vehicle 2) collects residual waste every fortnight, therefore the text field shows "Fortnightly" in both Frequency columns. As in scenario 1, three bins are used to collect waste. In this case, however, Bin 1 is used to collect recyclables, Bin 2 and 3 are for the collection of food waste and residual waste.

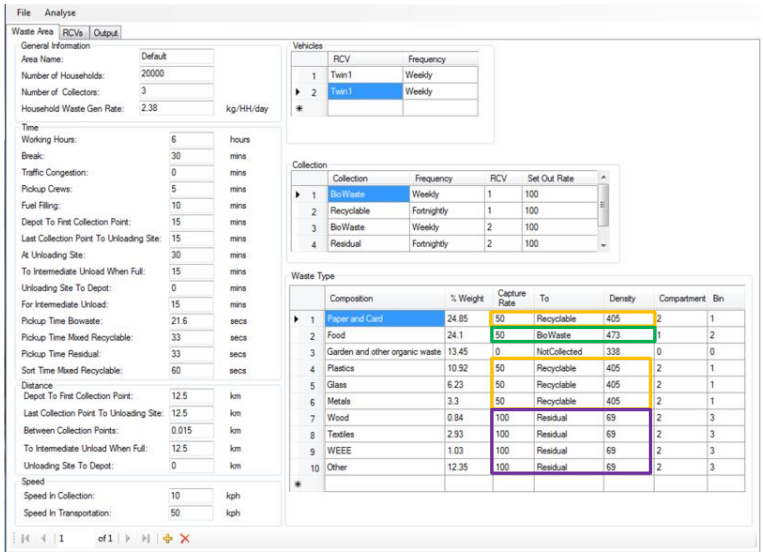


Figure 8. Input tab for Scenario 3

Figure 8 shows the input tab for AWC of household waste (Scenario 3). In this scenario, weekly is selected for all Twin1 in the vehicle table because it visits dwellings every week, but puts different waste in compartment 2 every two weeks. Fortnightly is chosen in the collection table for the recyclable and residual waste as they are stored at the household for two weeks before the next collection day. Food waste goes to compartment 1 every week, while recyclables and residual waste go into compartment 2 on alternate weeks. The arrangement of bins is the same as in Scenario 2.

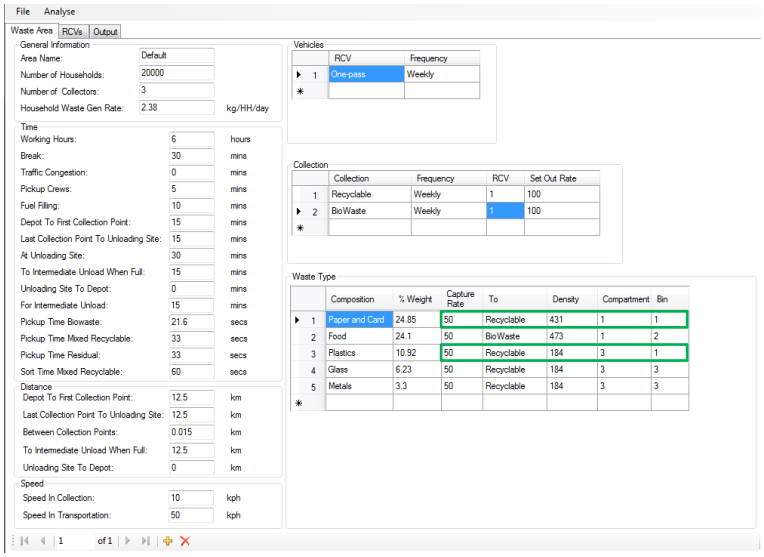


Figure 9. Input tab for Scenario 4

Figure 9 shows the connection between compartment and bin in Scenario 4. Recyclables and food waste are collected by the One-pass vehicle. Paper and card go to compartment 1; food waste goes to compartment 2 while plastics, glass and metals go to compartment 3. The bulk density of waste is adjusted according to the vehicle and combination of waste types. Bin 1 is used to collect paper, card and plastics; Bin 2 is assigned to collect food waste only and Bin 3 is for glass and metals collection. This arrangement implies a degree of kerbside sorting of Bin 1 as recyclables are loaded in different compartments (highlighted in green square boxes).

References

WRAP (2008). Kerbside Recycling: Indicative Costs and Performance. Technical Annex. Retrieved 23 June, 2011, from www.wrap.org.uk/sites/files/wrap/KerbsideReportAnnexFinal_1.pdf.

WRAP (2009). Evaluation of the WRAP Separate Food Waste Collection Trials. Retrieved 19 July, 2011, from http://www.wrap.org.uk/local_authorities/research_guidance/food_waste/.

WRAP (2010). Material bulk densities. Banbury.

The WasteCAT model is available from

www.valorgas.soton.ac.uk

and from **www.bioenergy.soton.ac.uk** on the Resources page