A SPREADSHEET PROCESS MODEL FOR ANALYSIS OF COSTS AND LIFE-CYCLE INVENTORY PARAMETERS ASSOCIATED WITH COLLECTION OF MUNICIPAL SOLID WASTE

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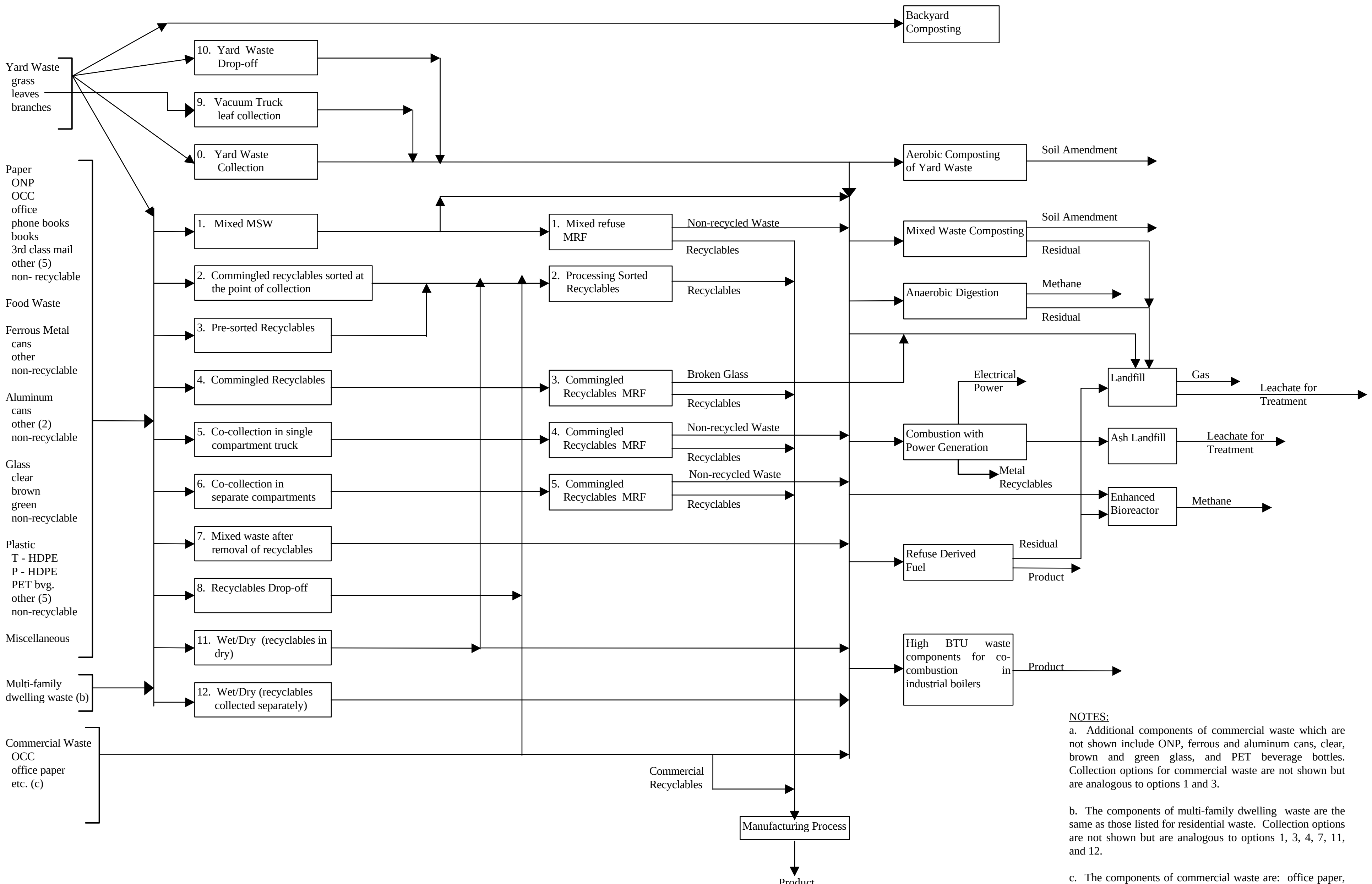
1. INTRODUCTION

A city or county has several options available when it comes to each step in the collection and disposal of solid waste. These range from simply collecting all municipal solid waste (MSW) with one fleet of collection vehicles which carry it to a landfill, to a more complex system where yard waste and recyclables are collected separately from other refuse with yard waste carried to a composting facility, recyclables to a materials recovery facility (MRF), and the residual refuse to a treatment facility such as a combustor. Different types of containers and trucks may be used to collect MSW from residential neighborhoods than those used to collect MSW from apartment complexes or commercial businesses. Likewise, different portions of these residential, multi-family and commercial sectors might be collected using different methods with the destination for unloading being different for each. For example, some sectors might be routed to a landfill while others might be routed to a material recovery facility. Additionally, there may be one or more locations in the city or county that residents can drive to and drop-off their own yard waste or recyclables.

For the municipal official, agency or outside consultant responsible for making recommendations on the “best” way to manage the city or county’s solid waste, one approach is to first determine the types and amounts of waste generated by households, apartment dwellers, and commercial businesses. The next step would be to collect as much information as possible about all the options at each step in the waste management process, including, collection of the waste, treatment, disposal, and, if applicable, transformation of waste into new products. Figure 1 is a network diagram showing alternative solid waste management options and how they can be “connected” to produce an overall solid waste management program.



North Carolina State University, 1995

Figure 1 - Alternatives for Solid Waste Management

NOTES:

a. Additional components of commercial waste which are not shown include ONP, ferrous and aluminum cans, clear, brown and green glass, and PET beverage bottles. Collection options for commercial waste are not shown but are analogous to options 1 and 3.

b. The components of multi-family dwelling waste are the same as those listed for residential waste. Collection options are not shown but are analogous to options 1, 3, 4, 7, 11, and 12.

c. The components of commercial waste are: office paper, old corrugated containers, Phone Books, Third Class Mail, ferrous cans, aluminum cans, clear glass, brown glass, green glass, PET beverage bottles, newspaper, other recyclable (3), non-recyclables (3).

d. Transfer stations (truck and rail) are not shown due to space limitations. They are included in the system of alternatives.

It would help to have a tool that would model as many of these options as possible, assemble various combinations of options into waste management strategies or scenarios, calculate the cost and life-cycle inventory (LCI) for each scenario that the recommendation will be based on, and then rank them from best to worst. Cost is the most obvious parameter on which to base such a recommendation, but there might be situations where another parameter is of overriding importance. For instance if reduction in CO_2 emissions were a priority, then the lowest cost waste management scenario may not be the optimal implementation.

The Decision Support Tool (DST) is a personal computer based decision making tool for analyzing solid waste management alternatives using the LCI approach. This document describes one component of the DST: the collection portion of an overall Excel spreadsheet that calculates costs and LCI parameters for MSW collection options. It is referred to throughout this document as the “Collection Process Model”. It was developed for use with other “process model” portions of the spreadsheet that calculate LCI parameters for other waste management process options such as landfilling, composting, and combustion. Another component of the DST is a user interface that allows a user to conveniently enter input data that enable the DST to closely model current or future characteristics of his or her city’s solid waste management program, including options that the city may be considering as alternatives. The other major component of the DST is a linear optimization module that analyzes the process model LCI parameters (coefficients) and selects the optimum set of options for the LCI parameter that the user has designated for optimization. If the parameter is cost, then the DST selects options that produce the lowest overall solid waste management cost. Likewise, if the parameter is methane emissions, the DST selects options that together emit the least amount of methane.

The Collection process model is also designed as a tool that can be used independently from the DST. In this so called “stand alone” mode of operation, the Collection process model serves as a means for comparing the costs, energy usage rates, pollutant emissions, and other factors for 21 different MSW collection options. This gives the user the opportunity to see how changing the value of one input variable such as the length of a collection vehicle’s workday affects the number of vehicles needed to collect all of the city’s waste and how, in turn, this affects the total annual cost of MSW collection. However, in this mode of operation, it must be understood that the resulting costs and LCI burdens are only representative of the case where all waste is collected by only a single collection option or valid combination of options and that recycling occurs at the maximum dictated by factors such as participation rate . For example, the C1 (mixed waste collection) costs and LCI burdens are only valid for collection of all waste and would not be directly applicable to the case where a C3 recycling program were implemented for some fraction of a given residential sector. As such, use of this model in as a stand alone tool should be attempted only by a knowledgeable user.

When operating in this stand alone mode, the Collection process model must access some of the information contained in several other process models: the Common process model, where solid waste composition data and demographic information such as the number of residential homes, multi-family dwellings (i.e., apartments), and commercial sites are stored; the Electrical Energy process model, which stores data on the water and air pollutant emissions associated with the consumption of electricity; the Collection Distances process model, which stores distances to the various unloading locations to which each of the collection options can be routed and the Collection by Sector process model which stores sector specific data for each of the 2 residential, 2 multi-family and 10 commercial sectors defined in the model. The Collection process model contains links to these sheets of the overall spreadsheet. Thus, if a new value for the number of residential households in a sector is input, all of the calculations in the Collection process model that use this particular variable are automatically updated.

The next chapter in this document, Methodology, describes what LCI parameters the Collection process model calculates and the approach and assumptions that these calculations are based on. Chapter 3, Collection Cost Equations, lists the equations and explains the methodology used in the spreadsheet to calculate a city or county's annual cost of collecting residential, multi-family, and commercial MSW as well as how inflation is accounted for. In addition, the Collection process model calculates three types of unit costs: annual cost per collection vehicle, annual cost per collection location, and cost per ton of MSW. Chapter 3 covers each of the 21 collection options. Chapter 4 describes calculation procedures for parameters such as daily collection vehicle mileage and fuel usage that are referenced in subsequent chapters. The equations used to calculate consumption rates of energy and water associated with MSW collection are listed and explained in Chapters 5 and 6, respectively. Chapters 7, 8, and 9 cover the calculation of airborne pollutant release rates, waterborne pollutant release rates, and solid waste generation rates.

The Collection process model and the other process model that it accesses in stand alone mode each include a set of default input variable values. These values are drawn from a variety of sources and are intended to represent national averages. The DST or the Collection process model user has the option to override these default values with other values that represent more closely the solid waste management program that he or she is trying to model. The default input variable values for all Collection process model collection options are listed in Appendix A. Appendices B and C include default input values for parameters that vary by sector and for those that vary by sector and "next node", respectively. Appendix D lists the output values for all parameters that are calculated by the Collection process model using the default input variable values.

Consumption and release rates for LCI parameters in the Collection process model are expressed in terms of units of the consumption or release parameter (Btu's of energy, pounds of pollutant, etc.) per ton of MSW. These rates and the unit costs of MSW collection vary depending on the weight and density of the waste generated by city or county residents and commercial waste generators, which in turn depend on which components of the MSW stream are being collected by each collection method. For instance, the cost per ton to collect recyclables will be different depending on whether or not old newsprint is included in the recyclables collection program. When used in stand alone mode, the user can specify which MSW components are collected by each method and their component weights and densities, or use the default input data values included in the Collection and Common process models. However, one of the functions of the Optimization Module is to select the most economical, most energy efficient, or least polluting combination of components at each stage of the MSW management process, including collection. The Collection process model therefore includes sets of coefficients for costs and selected LCI consumption and release parameters for each MSW component and collection option that are independent of the aggregate MSW weight and density. Appendix E lists the equations for these coefficients for collection costs and each of the LCI parameters.

Appendix F lists all variable names used in the Collection process model. Appendix G includes cost escalation data used to account for inflation.

2. METHODOLOGY

The methodology used in the Collection process model to calculate the number of collection vehicles needed to service all the collection locations in a city or county and the cost to collect the waste generated at those locations is modeled after the equations developed by Kaneko (1995). Kaneko's method starts by determining the number of collection locations that a collection vehicle can stop at along a collection route before it is filled to capacity. This number, multiplied by the amount of time that a vehicle spends stopped at each location and traveling between locations, yields the length of time that a collection vehicle takes to travel from the beginning to the end of its collection route. The length of time that a collection vehicle takes to make a complete collection trip includes the route travel time plus time spent traveling back and forth from the location where it unloads the material that it collects (landfill, Material Recovery Facility, composting facility, etc.) and the time spent unloading at that location. Many inputs that flow into these calculations will vary depending on the characteristics of the sector being collected (MSW composition, etc.) and the average distance from that sector to each of the several possible unloading facilities. The implications of different collection sectors and unloading locations are addressed in Sections 2.1 and 0, respectively.

At this point in the calculation procedure it is possible to iteratively determine the integer number of fully loaded trips that a collection vehicle can make during one workday, after time is deducted for travel to and from the vehicle garage at the end of each day and the beginning of the next day and for the lunch break and other break time. However, it is not feasible to express the iterative calculations in the form of a cost or LCI parameter coefficient cell formula, which is the format that is required for interface with the DST Optimization Module. For this reason, Kaneko developed an equation which calculates a non-integer number of daily collection vehicle trips. This equation closely approximates the integer value for daily collection trips. Given the other approximations which must be made to calculate collections costs and other LCI parameters such as rates of MSW generation and vehicle travel and loading/unloading times, the use of a non-integer value for daily collection vehicle trips does not significantly affect the accuracy of the Collection Preprocess output data.

The next step is to divide the total number of collection locations in the area served by a collection option by the number of collection locations that a vehicle stops at during one collection trip to determine the total number of trips needed to collect all the MSW generated in that area during on collection cycle. (A collection cycle may represent one or more visits to each collection site per week, with a default value of one visit per week). When used in stand alone mode, the Collection process model offers the user the option of dividing the city or county being modeled into areas that are served by different collection options. This is done by means of the *option_frac* input variable. If the user enters and *option_frac* value of 1.00 for a particular collection option, say for C1 (residential curbside mixed waste collection), then 100% of the households in the city or county would be served by option C1 collection vehicles. If, however, the user wished to model a situation where half of the neighborhoods in a city are served by mixed waste collection and the other half set out their recyclables in a bin for collection by a commingled recyclables collection vehicle (option C4), then he or she would specify *option_frac* values of 0.50 for option C1 and C4. The Collection Processor uses these values to calculate the required number of C1, C4, and C7 (collection of residual waste from locations served by option C4) collection trips. It should be noted that the *option_frac* values are relevant only in stand-alone mode. When the optimization model is used, the fraction of households collected be each collection option will be dictated be the model solution based on the user's optimization criteria (minimum cost, CO_2, etc.).

Once the numbers of daily collection vehicle trips and total collection trips are known, the number of trucks is determined by dividing total trips by daily trips and by the number of days per week that collection vehicles operate. (This also produces a non-integer value which is considered adequate for use with the Decision Support System.) Then annual MSW collection cost is found by multiplying the number of trucks by economic factors including a vehicle's annualized capital cost based on the purchase price amortized over service life, vehicle operating costs, labor costs, overhead costs, and costs for backup vehicles and collection crew personnel as well as factors to account for inflation from the base year for which the default cost data were collected.

Unit costs for MSW collection (annual cost per collection vehicle, annual cost per collection location, and cost per ton MSW collected) are independent of the number of collection vehicles. The annual collection cost per vehicle is determined for each collection option using the economic factors listed above. The annual cost per collection location is found by dividing the annual vehicle cost by the number of locations visited by each vehicle during one collection cycle. The cost per ton of MSW collected is found by dividing the annual cost per collection location by the number of tons of MSW generated per year by the residents or commercial businesses whose waste is collected at that collection.

The Collection process model spreadsheet includes a calculation section that breaks down the collection vehicle workday into the number of minutes that a vehicle is used for each task. Default or user override values for the speed that a vehicle travels while performing different tasks and its fuel consumption rate are used to determine how many miles it travels and how many gallons of fuel it consumes per day. (Similar calculations are performed for the two collection options that model residents' use of their own vehicles to drop off recyclables or yard waste at designated drop-off sites.) These in turn are multiplied by pollutant emission factors and energy content factors to arrive at values for the amounts of energy, and maintenance items consumed and the amount of air pollutants, water pollutants, and solid wastes generated per ton of waste collected. The LCI parameter calculations also include the consumption of electrical energy at the garage where the collection vehicles are stored and maintained when not in service. The water pollutant, air pollutant, and solid waste generation rates also include the pollutants and solid wastes associated with the generation of electrical energy consumed at the garage.

2.1 Collection Sectors

In order to allow for the likelihood that certain parameters such as MSW composition might vary between geographic subsections of the entity being modeled (city, county, etc.) and for similar variations between commercial business types, multiple sectors can be modeled simultaneously. The model provides for 2 residential sectors, 2 multi-family sectors and 10 commercial sectors. While the user can only examine one sector of each type (residential, multi-family and commercial) using the stand-alone method, the optimization model increments through all sectors and their related sector variable parameters to gather cost and LCI coefficients for each sector for optimization. This is yet another example of the previously stated caution that stand-alone use of the collection process model should be used only with great caution and by a user that is familiar with the applicability of the resulting values.

Variables which vary by collection sector include the following list of variables, all of which are defined in Appendix F:

HS, Fr, TL, Tbtw, Trf, Tgr, Tfg, Nw, Vt, Lt, Pt, c, Vbet, Vgr, Dbet, Dgr, res_pop, ph, gr, h_res, g_res, mf_pop, mf_gen, h_mf, g_mf, h_com, g_com, RES_WT_FRAC, MF_WT_FRAC, COM_WT_FRAC, option_frac

2.2 Collection "Next Node"

The distance to the unloading location (landfill, MRF, etc.) will affect the cost since a different number of vehicles will be required depending on this distance. Likewise, the LCI burden will vary depending on the amount of time that collection vehicles are traveling to these various locations. Since the destination to which MSW and recyclables are taken after collection will affect cost and LCI coefficients, the optimization model must have a set of coefficients for each unloading location or "next node". As such, the user must define the average distance (for each sector) from the collection sector to each possible facility to which the collected material can be routed. These inputs for these distances for all sectors are shown in Appendix C.

While the user can only examine one unloading location (or "next node") using the stand-alone method, the optimization model increments through all "next nodes" and their related distances for each sector to gather cost and LCI coefficients for optimization. This is yet another example of the previously stated caution that stand-alone use of the collection process model should be used only with great caution and by a user that is familiar with the applicability of the resulting values.

Variables which vary by collection sector and "next node" include the following list of variables, all of which are defined in Appendix F:
Trf, Tfg, Vrf, Vfg, Drf, Dfg

3. COLLECTION COST EQUATIONS

The Collection process model calculates the following four unit costs for 20 of the 21 waste collection options:

(a) collection cost per year
(b) collection cost per collection vehicle per year
(c) collection cost per collection location per year
(d) collection cost per ton of refuse collected

[Option C10, Yard Waste Drop-Off, does not incur any costs for purchase or operation of municipal collection vehicles. Therefore, no unit costs are calculated for this collection option.]

Unit cost (a), *collection cost per year*, is determined by calculating the number of municipal collection vehicles and containers that are used to collect the waste generated by community residents, then multiplying the totals by the annualized vehicle and container costs. As explained below, the user can specify whether the entire community is served by a particular collection option, or only a fraction of the community. *Collection cost per year* is a function of the number of residents served by that collection option.

Unit costs (b), (c), and (d) are independent of the number of residents served by a particular collection option. Unit cost (b), *collection cost per collection vehicle per year*, is the sum of the annualized capital and operating costs for one collection vehicle plus the annualized capital cost of any containers provided to the residents at collection locations serviced by that vehicle.

Unit cost (c), *collection cost per collection location per year*, is the sum of the annualized costs for one collection vehicle divided by number of collection locations serviced by that vehicle plus the annualized cost of any containers provided to the residents at those locations. “Collection location” refers to single family households for residential waste collection options. For multi-family waste collection options, “collection location” refers to groups of multi-family dwellings whose residents deposit their waste at a single collection container.

Unit cost (d), *collection cost per ton of refuse collected*, is found by dividing unit cost (c) by the weight (in tons) of waste generated during one year by the residents whose waste is collected at one collection location.

Only unit cost (d), *collection cost per ton of refuse collected*, is used by the Optimization Model when it is seeking a lowest cost waste management strategy. The other three unit costs are provided for the convenience of the user when using the Collection process model in a stand-alone mode to compare costs of different collection options.

3.1 Cost Escalation

All default costs for the collection model are based on 1993 data. In order to have these default values reflect inflation to the year in which the model is being run, all default costs are multiplied by a factor based on the Producer Price Index values for capital equipment (USBLS, 1996). This escalation factor is:

$$CI\_Factor = \frac{CI\_cur\_year}{CI\_1993} \ ,$$

where:

$CI\_Factor =$ Cost index factor used to inflate 1993 costs.
$CI\_cur\_year =$ Cost index factor for the year indicated by the computer 0perating system or the override year entered by the model user (see Appendix E)
$CI\_1993 =$ Cost index factor for 1993 (see Appendix E).

All costs referenced in this document are treated in this way.

3.2 Residential Waste Collection

Residents living in single family dwellings ("households") can be served by one or more of the 10 residential waste collection options included in the Collection process model. They are assumed to dispose of their refuse in their own containers. Some collection options allow for additional containers that are provided to each household at community expense, in which residents can dispose of recyclables separately from the rest of their refuse.

The general pattern for residential waste collection proceeds as follows: Collection vehicles leave from a vehicle garage at the beginning of each workday to begin collecting residential refuse along predetermined routes. The length of a collection route is determined by the number of households that a vehicle can service before it is filled to capacity. Fully loaded vehicles drive to a treatment or disposal facility, unload, and drive back to the starting point of another collection route. At the end of the workday the vehicles travel from the treatment or disposal facility back to the vehicle garage.

The default value for frequency of waste collection is once per week. (The user can specify more or less frequent collection frequencies based on fractions or multiples of weeks.) For that reason, many of the cost calculations in the Collection process model include a parameter for the amount of waste generated per week at each collection location. The Collection process model calculates this parameter from values specified by the user for the number of residents living in single family households (*res_pop*), the total number of single family households in the community (*H_res*), and the residential per capita waste generation rate (*GR*). The Collection process model calculates the average weekly waste generation rate per household (*G_res*) using the formula:

$$G\_res = \frac{GR \times res\_pop \times 7\ {}^{days}\!/_{week}}{H\_res} \ ,$$

where:

$G\_res =$ waste generated per residential household (pounds per household per week)

$GR =$ waste generated per resident per day (pounds per person per day)

$res\_pop =$ number of people living in residential households (persons)

$H\_res =$ number of residential households (households)

3.2.1 Mixed Waste (C1)

The Mixed Waste cost equations used in Collection Option C1 calculate the cost to collect residential mixed solid waste in single compartment collection vehicles. The waste is not separated into different components such as recyclables and non-recyclables at the point of collection. No special containers are provided to residents, so collection costs are only associated with purchase and operation of collection vehicles.

3.2.1.1 Generation Rate

One of the parameters used to calculate Mixed Waste collection costs is the weekly household mixed solid waste generation rate (*G_msw*). Since there is no waste separation at the point of collection, the value of *G_msw* for Collection Option C1 is the same as the weekly residential waste generation rate *G_res* calculated by the Collection process model:

$$G\_msw = G\_res$$

3.2.1.2 Waste Density

Default values for the compacted density of individual components of the waste stream are listed in the Collection process model (*D_cv*). The Collection process model uses these values and the default values of the individual component weight fractions for residential waste sector 1 listed in the Common process model (*RES_WT_FRAC_1*) to calculate an overall density for residential mixed waste:

$$D\_msw = \frac{1}{\sum_i \frac{RES\_WT\_FRAC\_1_i}{D\_cv_i}} \quad ,$$

where:

$D\_msw =$ overall density of mixed waste (pounds per cubic yard)
$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition
$D\_cv_i =$ compacted density of waste component *i*

This value represents the overall density of the waste after compaction in the collection vehicle.

D_msw can also be specified by the user. This is done by entering the desired value in cell *d_msw* in the Option C1 column of the Input Parameters section of the Collection process model. Entering a value in this cell overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_msw* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.2.1.3 Cost Equations

The steps used to calculate residential curbside collection costs are as follows:

1. Number of households that a collection vehicle can stop at to collect mixed waste refuse before it is filled to capacity. This represents the number of households that a vehicle can service along a collection route during one collection trip.

$$Ht = \frac{Ut \times Vt \times Fr}{\left(G\_msw / D\_msw\right)} ,$$

where:

$Ht =$ number of households serviced per collection trip (households per trip)
$Ut =$ collection vehicle utilization factor (useable cubic yards of vehicle capacity per total cubic yards of vehicle capacity)
$Vt =$ collection vehicle capacity (cubic yards per trip)
$D\_msw =$ overall density of mixed waste (pounds per cubic yard)
$Fr =$ collection frequency (collection cycles per week)
$G\_msw =$ mixed waste generation rate (pounds per week per household)

2. Travel time from the vehicle garage to the starting point of the first collection route (*Tgr*). (Collection vehicles are assumed to remain parked at a garage/maintenance facility overnight between the end of one workday and the beginning of the next workday.)

   Tgr can be specified by the user (default value: 20 minutes). If there is no value entered in the *Tgr* cell or if the value in the *Tgr* input cell is zero, the Collection process model calculates a value for *Tgr* using user-specified or default values for the distance from the garage to the collection route starting point (*Dgr*) and the average speed that the vehicle travels over this distance (*Vgr*). Default values for *Dgr* and *Vgr* are 11.67 miles and 35 miles per hour, respectively. The Collection process model then calculates *Tgr* as:

$$Tgr = \frac{Dgr}{Vgr} \times 60 \, {}^{min}\!/\!_{hr} ,$$

where:

$Tgr =$ travel time from garage to start of first collection route (minutes per day per vehicle)
$Dgr =$ distance from garage to start of first collection route (miles per day per vehicle)
$Vgr =$ average travel speed between garage and start of first collection route (miles per hour)

3. Length of time to travel between collection stops (*Tbet*).

   Tbet can be specified by the user (default value: 0.17 minutes). If there is no value entered for *Tbet* or if the value in the *Tbet* input cell is zero, the Collection process model calculates a value for *Tbet* using user-specified or default values for the average distance between collection stops (*Dbet*) and the average speed that the vehicle travels over this distance (*Vbet*). Default values for *Dbet* and *Vbet* are 0.0142 miles (75 feet) and 5 miles per hour, respectively. The Collection process model then calculates *Tbet* as:

$$Tbet = \frac{Dbet}{Vbet} \times 60 \ {}^{min}\!/_{hr} \ ,$$

where:

$Tbet =$ travel time between collection stops (minutes/stop)
$Dbet =$ distance between collection stop (miles)
$Vbet =$ average travel speed collection stops (miles per hour)

4. Travel time between the start/end of a collection route and the disposal facility (*Trf*). (The Collection process model calculations assume that a collection vehicle takes the same amount of time to travel from the end of a collection route to the disposal facility as it does to travel from the disposal facility to the start of its next collection route.)

   Trf can be specified by the user (default value: 20 minutes). If there is no value entered for *Trf* or if the value in the *Trf* input cell is zero, the Collection process model calculates a value for *Trf* using user-specified or default values for the distance from the end of the collection route to the facility (*Drf*) and the average speed that the vehicle travels over this distance (*Vrf*). Default values for *Drf* and *Vrf* are 10 miles and 30 miles per hour, respectively. The Collection process model then calculates *Trf* as:

$$Trf = \frac{Drf}{Vrf} \times 60 \ {}^{min}\!/_{hr} \ ,$$

where:

Trf = travel time between start/end of collection route and the disposal facility (minutes per trip)
Drf = distance between start/end of a collection route and the disposal facility (miles)
Vrf = average travel speed between start/end of collection route and the disposal facility (miles per hour)

5. Travel time from the disposal facility to the vehicle garage at the end of the workday (*Tfg*).

   Tfg can be specified by the user (default value: 20 minutes). If there is no value entered for *Tfg* or if the value in the *Tfg* input cell is zero, the Collection process model calculates a value for *Tfg* using the user-specified or default values for the distance from the disposal facility to the (*Dfg*) and the average speed that the vehicle travels over this distance (*Vfg*). Default values for *Dfg* and *Vfg* are 11.67 miles and 35 miles per hour, respectively. The Collection process model then calculates *Tfg* as:

$$Tfg = \frac{Dfg}{Vfg} \times 60 \, {}^{min}\!/\!_{hr} \ ,$$

where:

Tfg = travel time from disposal facility to garage at the end of the workday (minutes per day per vehicle)
Dfg = distance from disposal facility to the garage (miles per day per vehicle)
Vfg = average travel speed between disposal facility and garage (miles per hour)

6. Length of time that it takes a collection vehicle to make one collection trip (*Tc*), including time spent traveling from a disposal facility to the beginning of the collection route, loading waste at collection stops, traveling to the disposal facility at the end of the trip, and unloading the vehicle at the disposal facility.

$$Tc = \left[Tbet \times \left({}^{Ht}\!/\!_{HS} - 1 \right)\right] + \left[TL \times \left({}^{Ht}\!/\!_{HS} \right)\right] + \left(2 \times Trf\right) + S \ ,$$

where:

Tc = collection trip time (minutes per trip)
$Tbet$ = travel time between collection stops (minutes per stop)
Ht = number of households serviced per collection trip (households per trip)

HS = number of households from which refuse is collected at one collection stop (households per stop)
TL = loading time at a collection stop (minutes per stop)
Trf = travel time between beginning/end of collection route and disposal facility (minutes per trip)
S = time to unload collection vehicle at the disposal facility (minutes per trip)

7. Number of collection trips that a vehicle can make during one workday after time is deducted for a lunch period, other breaks, and travel to and from the vehicle garage.

$$RD = \frac{(WV \times 60) - (F1 + F2 + Tgr + Tfg) - [0.5 \times (Trf + S)]}{Tc} ,$$

where:

RD = collection trips per day per vehicle (trips per day per vehicle)
WV = work hours per workday (hours per day per vehicle)
$F1$ = lunch period (minutes per day per vehicle)
$F2$ = break period (minutes per day per vehicle)
Tgr = travel time between garage and beginning of collection route (minutes per day per vehicle)
Tfg = travel time between disposal facility and garage (minutes per day per vehicle)

8. Number of collection vehicle trips needed to service all of the households served by collection option C1.

$$RT = \frac{H\_res \times option\_frac}{Ht} ,$$

where:

RT = number of collection trips needed (trips)
H_res = number of households in the community (households)
$option\_frac$ = fraction of households served by collection option C1
Ht = number of households serviced per collection trip (households per trip)

9. Number of collection vehicles needed to visit all of the households served by collection option C1 during one collection cycle:

$$Nt = \frac{RT}{RD} \times \frac{Fr}{CD} ,$$

where:

$Nt =$ number of collection vehicles
$CD =$ number of workdays per week (days per week)

10. Annual capital (*C_cap_v*) and operating (*C_op*) costs associated with a single collection vehicle:

Capital Cost

$$C\_cap\_v = (1+e) \times Pt \times CRF \quad ,$$

where:

$C\_cap\_v =$ collection vehicle capital cost amortized over the economic life of the vehicle ($ per vehicle per year)
$e =$ administrative rate ($ of administrative expense per $ of capital or operating cost)
$Pt =$ unit price of a collection vehicle ($ per vehicle)
$CRF =$ capital recovery factor for a collection vehicle ($year^{-1}$)

The capital recovery factor is defined as:

$$CRF = \frac{i \times (1+i)^L}{(1+i)^L - 1} \quad ,$$

where:

$i =$ yearly discount rate ($year^{-1}$)
$L =$ economic life of a collection vehicle (years)

Operating Cost

$$C\_op = (1+e) \times \left\{ (1+a) \times \left[(1+bw) \times (Wa \times Nw + Wd) \times WP \times CD \times \frac{365 \, {}^{days}\!/\!_{year}}{7 \, {}^{days}\!/\!_{week}} \right] + c + \left[d \times (Nw+1) \right] \right\}$$

where:

$C\_op =$ collection vehicle operating cost per year ($ per vehicle per year)
$a =$ fringe benefit rate ($ of fringe benefits per $ of wages)
$bw =$ backup rate for collection workers (backup worker per collection worker)
$Wa =$ hourly wage rate for collection worker ($ per hour per worker)

$Nw =$ number of collection workers per vehicle (workers)
$Wd =$ hourly wage rate for a collection vehicle driver ($ per hour per driver)
$WP =$ work hours per day for wage (hours per worker per day)
$c =$ annual vehicle operation and maintenance cost ($ per year per vehicle)
$d =$ other expenses ($ per worker per year)

11. Annual collection cost per vehicle:

$$C\_vehicle = \left[(1 + bv) \times C\_cap\_v\right] + C\_op \ ,$$

where:

$vehicle$ ction cost per collection vehicle ($ per vehicle per year)
$bv =$ backup rate for collection vehicles (backup vehicle per collection vehicle)

12. Total annual collection cost for the community:

$$C\_ann = Nt \times C\_vehicle \ ,$$

where:

$C\_ann =$ total annual collection cost ($ per year)

13. Number of households that one collection vehicle can visit during a collection cycle:

$$H\_c = \frac{Ht \times RD \times CD}{Fr} \ ,$$

where:

$H\_c =$ households visited by one collection vehicle during one collection cycle (households per vehicle)

14. Collection cost per household per year:

$$C\_house = \frac{C\_vehicle}{H\_c \times HS} \ ,$$

where:

$C\_house =$ annual collection cost per household ($ per household per year)

15. Collection cost per ton of refuse:

$$C\_ton = \frac{C\_house \times 2000\ {}^{lb}\!/_{ton} \times 7\ {}^{days}\!/_{week}}{G\_msw \times 365\ {}^{days}\!/_{year}} \quad ,$$

where:

$C\_ton =$ collection cost per ton of refuse ($ per ton)

3.2.2 Recyclables (C2, C3, and C4)

Options C2, C3, and C4 model collection of recyclables which have been separated from the non-recyclable portion of residential refuse ("residuals") and set out by residents for collection. Each household can be supplied with one or more containers ("bins") to hold their recyclable refuse. The user can specify both the number of containers supplied per household and the unit price of any containers that are supplied at community expense. The annualized capital cost of the bins is treated as an additional capital collection cost. The default values for the number of recyclables containers included in the Input Parameter section of the Collection process model are discussed below. [Note: The Collection process model assumes that containers are supplied to all households in the section of the community served by a recyclables collection option regardless of whether they elect to participate in the recycling program or not.]

The cost equations for options C2, C3, and C4 are identical; differences in collection costs among the three options are due to differences in the values of input data such as the number of recycling bins supplied to each household, the time to load (and, in some cases separate) recyclables at collection stops, the number of workers in the vehicle crew, and the collection vehicle capital and operating costs. The recyclables collection options are described as follows:

- Option C2 models collection of commingled recyclables set out in a single bin. The recyclables in the bin are sorted by the collection vehicle crew at the time of collection and loaded into separate compartments of a multi-compartment collection vehicle.
- Option C3 covers collection of pre-sorted recyclables set out in multiple bins. The collection crew empties each bin into the appropriate compartment of a multi-compartment collection vehicle. The default value for the number of bins is five per household.
- Option C4 models collection of commingled recyclables set out in a single bin. The collection crew empties the bin into a single compartment collection vehicle. It is assumed that residents separate their old newspapers from their other recyclables and that these are loaded into a separate compartment of the collection vehicle.

3.2.2.1 Generation Rate

The weekly household generation rate for recyclables (*G_recyc*) is found by multiplying the total weekly household waste generation rate (*G_res*) by the fraction of recyclables removed, or "captured", from the waste stream (*frac_cap_recyc*). When the Collection process model is used with the Optimization Model, the Optimization Model determines which components of the waste stream are collected by a particular collection option.

When the Collection process model is used in stand-alone mode, the user specifies which components are collected. This procedure is described below.

The weekly recyclable generation rate for recyclables collection option *j* is calculated as:

$$G\_recyc_j = G\_res \times frac\_cap\_recyc_j \ ,$$

where:

G_recyc_j = weekly recyclable generation rate for collection option *j* where *j* is option C2, C3, or C4 (pounds per week per household)

G_res = weekly residential MSW generation rate (pounds per week per household)

$frac\_cap\_recyc_j$ = captured recyclables fraction for collection option *j*

The captured recyclables fraction is found by summing the fraction of recyclable material removed by households from each component of the residential MSW stream. A table is provided in the Collection process model spreadsheet where the user can enter values to indicate what fraction of each recyclable component is removed by participating households from their mixed waste and transferred into their recycling bin(s). This fraction is referred to as the "capture rate" (*cr*). Entering a value of 0.75 as the capture rate for aluminum cans, for instance, indicates that participating households successfully remove 75% of their aluminum cans from refuse and put them in their recycling bins for collection by a recyclables collection vehicle. The other 25% of their cans are collected along with the household's non-recyclable refuse by another collection vehicle. Costs for collection of this "residual" waste are accounted for by one of the residual collection options (C7 or C12). Leaving a cell blank or entering a zero in the capture rate table indicates that the component represented by that cell is not included in the recyclables collection program.

Default capture rates are assigned to the following residential waste stream components:

- Old Newsprint
- Old Corrugated Cardboard
- Office Paper
- Phone Books
- Old Magazines
- Third Class Mail
- Paper - Other (5 classes)
- Ferrous Cans
- Ferrous Metal - Other
- Aluminum Cans

- Aluminum - Other (2 classes)
- Clear Glass
- Brown Glass
- Green Glass
- Translucent HDPE
- Pigmented HDPE
- PET
- Plastic - Other (5 classes)

The Common process model contains tables of waste component weight fractions for two different residential waste compositions representing different sectors of the community (*RES_WT_FRAC_1* and *RES_WT_FRAC_2*). To determine *frac_cap_recyc* the Collection process model worksheet multiplies the user-specified/default capture rate for each waste component by the corresponding weight fraction specified for that component in the *RES_WT_FRAC_1* table.

$$frac\_cap\_recyc_j = \sum_i cr_{ij} \times RES\_WT\_FRAC\_1_i \quad ,$$

where:

$frac\_cap\_recyc_j =$ captured recyclables fraction for collection option *j* where *j* is C2, C3, or C4

$cr_{ij} =$ capture rate for waste component *i* for collection option *j*

$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition

3.2.2.2 Waste Density

Default values for the as-collected density of recyclable components of the residential waste stream are listed in the Common process model (*D_rcv*). Default values for waste component compaction factors (*CF*) are listed in the Input Parameters section of the Collection process model. Compaction factors represent the increased density of any waste components that are compacted during collection. The default compaction factor values for all waste components are 1.0. The Collection process model uses these values and the default values of the individual component weight fractions for residential waste Sector 1 listed in the Common process model (*RES_WT_FRAC_1*) to calculate an overall density for residential recyclables in a recyclables collection vehicle.

$$D\_recyc_j = \frac{frac\_cap\_recyc_j}{\sum_i \frac{cr_{ij} \times RES\_WT\_FRAC\_1_i}{D\_rcv_i \times CF_{ij}}} \quad ,$$

where:

D_recyc_j = overall density of recyclables for collection option *j* where *j* is C2, C3, or C4 (pounds per cubic yard)
$frac\_cap\_recyc_j$ = captured recyclables fraction for collection option *j*
cr_{ij} = capture rate for waste component *i* for collection option *j*
$RES\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 residential waste composition
D_rcv_i = as-collected density of recyclables component *i*
CF_{ji} = compaction factor for waste component *i* (pound per cubic yard compacted density per pound per cubic yard as-collected density)

D_recyc can also be specified by the user. This is done by entering the desired value in cell *d_recyc* in the Option C2, C3, or C4 columns of the Input Parameters section of the Collection process model. Entering a value in one of these cells overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_recyc* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.2.2.3 Cost Equations

Recyclables collection costs are calculated using the same steps described for mixed waste collection. However, since the recyclables collection vehicle only stops at households where a bin is set out, a "participation factor" (*PF*) is introduced into the Step 2 cost equation to account for the longer average travel time between collection stops. The user can specify a participation factor to indicate the average percentage of households that set out recycling bins for each collection cycle. A participation factor of 0.50 indicates that, on average, 50% of households set out recyclables bins for collection. Default participation factors of 0.65, 0.50, and 0.65 are assigned to options C2, C3, and C4, respectively. The participation factor also appears in the Step 4 equation which calculates the number of collection trips needed to service the households participating in the recycling program.

The steps used to calculate recyclables curbside collection costs are as follows:

1. Number of participating households that a recyclables collection vehicle can stop at to collect recyclables before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(G\_recyc / D\_recyc\right)} \ ,$$

where:

$Ht =$ number of participating households serviced per collection trip (participating households per trip)
$Ut =$ collection vehicle utilization factor
$Vt =$ usable collection vehicle capacity (cubic yards per trip)
$Fr =$ collection frequency (collection cycles per week)
$D\_recyc =$ overall density of recyclables (pounds per cubic yard)
$G\_recyc =$ recyclables generation rate (pounds per week per participating household)

2. Length of time that it takes a collection vehicle to make one collection trip:

$$Tc = \left[Tbet/PF \times \left(Ht/HS - 1 \right) \right] + \left[TL \times \left(Ht/HS \right) \right] + \left(2 \times Trf \right) + S \quad ,$$

where:

$Tc =$ collection trip time (minutes per trip)
$Tbet =$ travel time between collection stops (minutes per stop)
$PF =$ participation factor (participating households per total households)
$Ht =$ number of participating households serviced per collection trip (participating households per trip)
$HS =$ number of households from which refuse is collected at one collection stop (households per stop)
$TL =$ loading time at a collection stop (minutes per stop)
$Trf =$ travel time between beginning/end of collection route and disposal facility (minutes per trip)
$S =$ time to unload collection vehicle at the disposal facility (minutes per trip)

3. Number of collection trips that a vehicle can make during one workday:

$$RD = \frac{(WV \times 60) + \left(F1 + F2 + Tgr + Tfg \right) + \left[0.5 \times \left(Trf + S \right) \right]}{Tc} \quad ,$$

where:

$RD =$ collection trips per day per vehicle (trips per day per vehicle)

4. Number of collection vehicle trips (*RT*) needed to visit all of the participating households in the community served by recyclables collection option *j*. Since the Collection process model includes three recyclables collection options, the user can

specify the fraction of households in the community that are served by each collection option ($option\_frac_j$).

$$RT = \frac{H\_res \times PF \times option\_frac_j}{Ht} ,$$

where:

RT = number of collection trips needed to visit all served by collection option *j* (trips)
H_res = number of households in the community (total households)
PF = participation factor (participating households per total households)
$option\_frac_j$ = fraction of households served by collection option *j* (households served/total households)
Ht = number of participating households serviced per collection trip (participating households per trip)

NOTE: The sum of the *option_frac* fractions specified for options C2, C3, and C4 must be less than or equal to 1.00. The default values in the Collection process model are 1.00 for option C2 and 0.00 for options C3 and C4.

5. Number of collection vehicles needed to visit all participating households served by collection option *j*:

$$Nt = \frac{RT}{RD} \times \frac{Fr}{CD} ,$$

where:

Nt = number of collection vehicles (vehicles)
CD = number of workdays per week (days per week)

6. Annual capital (C_cap) and operating (C_op) costs associated with a single collection vehicle.

Capital Cost

$$C\_cap\_v = (1+e) \times Pt \times CRF\_v$$

Operating Cost

$$C\_op\_v = (1+e) \times \left\{ (1+a) \times \left[(1+bw) \times (Wa \times Nw + Wd) \times WP \times CD \times \frac{365 \ ^{days}\!/\!_{year}}{7 \ ^{days}\!/\!_{week}} \right] + c + \left[d \times (Nw+1) \right] \right\}$$

7. Number of participating households that one collection vehicle can visit during a collection cycle:

$$H\_c = \frac{Ht \times RD \times CD}{Fr} \quad ,$$

where:

$H\_c =$ households visited by one collection vehicle during one collection cycle (participating households per vehicle)

8. Number of recycling bins located at households serviced by a collection vehicle during one collection cycle, including non-participating households:

$$Nb = \frac{Rb \times H\_c}{PF} \quad ,$$

where:

$Nb =$ number of recycling bins located at households visited by one collection vehicle (bins per vehicle)
$Rb =$ number of bins distributed to each household (bins per household)
$PF =$ participation factor (participating households per total households)

9. Annual capital costs associated with a single recycling bin:

$$Cb = (1+e) \times Pb \times CRF\_b \quad ,$$

where:

$Cb =$ recycling bin capital cost amortized over the economic life of the bin ($ per bin per year)
$e =$ administrative rate ($ of administrative expense per $ of capital cost)
$Pb =$ unit price of a recycling bin ($ per bin)
$CRF\_b =$ capital recovery factor for a recycling bin ($year^{-1}$)

The recycling bin capital recovery factor is defined as:

$$CRF\_b = \frac{i \times (1+i)^{Lb}}{(1+i)^{Lb} - 1} \quad ,$$

where:

$i =$ yearly discount rate ($year^{-1}$)
$Lb =$ economic life of a recycling bin (years)

10. Annualized capital cost of bins located at households serviced by one collection vehicle, including those at non-participating households:

$$C\_cap\_b = Cb \times Nb \quad ,$$

where:

$C\_cap\_b =$ annualized capital cost of recycling bins at households visited by one collection vehicle ($ per vehicle per year)

11. Collection cost per vehicle per year:

$$C\_vehicle = (1+bv) \times C\_cap\_v + C\_cap\_b + C\_op$$

12. Total annual collection cost for the community:

$$C\_ann = Nt \times C\_vehicle$$

13. Collection cost per household per year:

$$C\_house = \frac{C\_vehicle \times PF}{H\_c}$$

14. Collection cost per ton of recyclables:

$$C\_ton = \frac{C\_house \times 2000\ ^{lb}/_{ton} \times 7\ ^{days}/_{week}}{G\_recyc \times PF \times 365\ ^{days}/_{year}}$$

3.2.3 Yard Waste (C0 and C9)

The Collection process model includes two options for collection of residential yard waste. Option C0 models curbside collection of miscellaneous yard waste (leaves, grass clippings, branches) in a single compartment vehicle. Option C9 models curbside collection of leaves only using a leaf vacuum truck. Vehicles transport the collected yard waste to a composting, combustion, anaerobic digestion, or enhanced bioreactor facility or to a landfill, as determined by the Optimization Model.

The user can specify which components of residential MSW are collected, the capture rates that apply to these components, and the participation factor that applies to each yard waste collection option. These are used to calculate the fraction of the total yard waste generated by residential households that is set out for collection.

3.2.3.1 Generation Rate

The generation rate for yard waste (*G_yw*) is a function of two variables: the total weekly household waste generation rte (*G_res*) and the amount of yard waste removed from the waste stream (*frac_yw*). The user can specify these variables by entering values in the appropriate cells in the Collection process model worksheet to override the process model default values.

The captured yard waste fraction (*frac_yw*) is found by summing the fraction of material removed by households from the yard waste components of the residential MSW stream. A table is provided in the Collection process model worksheet where the user can enter a value to indicate what fraction on average of each yard waste component is removed by participating households from their mixed waste and set out for separate collection. This fraction is referred to as the "capture rate" (*cr*). Leaving a cell blank or entering a zero in the capture rate table indicates that the component represented by that cell is not included in the yard waste collection program.

For option C0, default capture rates are assigned to the following components:

- Leaves
- Grass clippings
- Branches

For option C9 a default capture rate is assigned to the Leaves component only.

The Common process model contains listings of waste component weight fractions for two residential waste compositions. To determine *frac_yw* the Collection process model spreadsheet multiplies the user-specified/default capture rate for each yard waste component by the corresponding Sector 1 weight fraction specified for that component in the Common process model (*RES_WT_FRAC_1)*.

$$frac\_cap\_yw_k = \sum_i cr_{ik} \times RES\_WT\_FRAC\_1_i \quad ,$$

where:

$frac\_cap\_yw_k$ = captured yard waste fraction for collection option *k* where *k* is option C0 or C9

cr_{ik} = capture rate for waste component *i* for collection option *k*

$RES\_WT\_FRAC\_n_i$ = weight fraction for waste component *i* of Sector 1 residential waste composition

The weekly recyclable generation rate for yard waste collection option *k* is calculated as:

$$G\_yw_k = G\_res \times frac\_cap\_yw_k \quad ,$$

where:

G_yw_k = weekly yard waste generation rate for collection option *k* where *k* is option C0 or C9 (pounds per week per participating household)

G_res = weekly residential MSW generation rate (pounds per week per participating household)

$frac\_cap\_yw_k$ = captured yard waste fraction for collection option *k*

3.2.3.2 Waste Density

Default values for the as-collected density of yard waste components of the residential waste stream are listed in the Common process model (*D_rcv*). The Collection process model uses these values and the default values of the individual component weight fractions for residential waste Sector 1 listed in the Common process model (*RES_WT_FRAC_1*) to calculate an overall density for residential yard waste in a collection vehicle:

$$D\_yw_k = \frac{frac\_cap\_yw_k}{\sum_i \frac{cr_{ik} \times RES\_WT\_FRAC\_1_i}{D\_rcv_i}} \quad ,$$

where:

D_yw_k = overall density of yard waste for collection option *k* where *k* is C0 or C9 (pounds per cubic yard)

$frac\_cap\_yw_k$ = captured yard waste fraction for collection option *k*

cr_{ik} = capture rate for yard waste component i for collection option k

$RES\_WT\_FRAC\_1_i$ = weight fraction for waste component i of the Sector 1 residential waste composition

D_rcv_i = as-collected density of yard waste component i

D_yw can also be specified by the user. This is done by entering the desired value in cell *d_yw* in the C0 or C9 column of the Input Parameters section of the Collection process model. Entering a value in one of these cells overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_yw* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.2.3.3 Cost Equations

Yard waste collection costs are calculated using the same steps described for mixed waste collection. However, since the yard waste collection vehicle only stops at households where a yard waste is set out, a "participation factor" (*PF*) is introduced into the Step 2 cost equation to account for the longer average travel time between collection stops. The user can specify a participation factor to indicate the average percentage of households that set out yard waste for each collection cycle. Default participation factors of 0.50 are assigned to options C0 and C9. The participation factor also appears in the Step 4 equation which calculates the number of collection trips needed to visit the participating households.

The following steps are used to calculate yard waste collection costs:

1. Number of participating households that a yard waste collection vehicle can stop at to collect yard waste before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{(G\_yw / D\_msw)}$$

2. Amount of time that it takes a collection vehicle to make one collection trip:

$$Tc = \left[Tbet/PF \times \left(Ht/HS - 1 \right) \right] + \left[TL \times \left(Ht/HS \right) \right] + (2 \times Trf) + S$$

3. Number of collection trips that a vehicle can make during one workday:

$$RD = \frac{(WV \times 60) + (F1 + F2 + Tgr + Tfg) + [0.5 \times (Trf + S)]}{Tc}$$

4. Number of collection vehicle trips needed to visit all of the participating households served by yard waste collection option *k*. Since the Collection process model includes two yard waste collection options, the user can specify the fraction of households in the community that are served by each option ($option\_frac_k$).

$$RT = \frac{H\_res \times PF \times option\_frac_k}{Ht} ,$$

where:

RT = number of collection vehicle trips (trips)
H_res = number of households in the community (households)
PF = participation factor (participating households/total households)
Ht = number of participating households visited per collection trip (participating households per trip)
$option\_frac_k$ = fraction of households served by yard waste collection option *k* (households served per total households)

NOTE: The sum of the *option_frac* fractions specified for options C0 and C9 must be less than or equal to 1.00. The default values in the spreadsheet are 1.00 for option C0 and 0.00 for option C9.

5. Number of collection vehicles:

$$Nt = \frac{RT}{RD} \times \frac{Fr}{CD}$$

6. Annual capital (C_cap) and operating (C_op) costs associated with a single collection vehicle:

Capital Cost

$$C\_cap\_v = (1+e) \times P\_v \times CRF\_v$$

Operating Cost

$$C\_op = (1+e) \times \left\{ (1+a) \times \left[(1+bw) \times (Wa \times Nw + Wd) \times WP \times CD \times \frac{365 \, {}^{days}/_{year}}{7 \, {}^{days}/_{week}} \right] + c + \left[d \times (Nw+1) \right] \right\}$$

7. Collection cost per vehicle per year:

$$C\_vehicle = (1+bv) \times C\_cap\_v + C\_op$$

8. Annual collection cost for the community:

$$C\_ann = Nt \times C\_vehicle$$

9. Number of participating households that one collection vehicle can visit during a collection cycle:

$$H\_c = \frac{Ht \times RD \times CD}{Fr}$$

10. Collection cost per household per year:

$$C\_house = \frac{C\_vehicle}{H\_c} \times PF$$

11. Collection cost per ton of yard waste:

$$C\_ton = \frac{C\_house \times 2000\ {}^{lb}\!/_{ton} \times 7\ {}^{days}\!/_{week}}{G\_yw \times 365\ {}^{days}\!/_{year} \times PF}$$

3.2.4 Residuals (C7)

Option C7 covers collection of the remaining refuse discarded by residential households after the removal and separate collection of recyclables (via options C2, C3, C4, and C8) and/or yard waste (via options C0, C9, and C10).

3.2.4.1 Generation Rate

The waste generation rate for residuals reflects the reduced weight of refuse set out weekly by households for collection due to the removal of recyclables and/or yard waste. *G_residual* is calculated as follows:

$$G\_residual = G\_res - \left(\frac{\sum_j G\_recyc_j \times PF_j \times option\_frac_j}{\sum_j option\_frac_j} \right) - \left(\frac{\sum_k G\_yw_k \times PF_k \times option\_frac_k}{\sum_k option\_frac_k} \right)$$

where:

$G\_residual$ = residual refuse generation rate (pounds per week per household)

G_recyc_j = recyclables generation rate for collection option *j*, where *j* is options C2, C3, C4, and C8 (pounds per week per household)

PF_j = participation factor for recyclables collection option *j*

$option\_frac_j$ = fraction households served by recyclables collection option *j*

G_yw_k = yard waste generation rate for collection option *k*, where *k* is options C0, C9, and C10 (pounds per week per household)

PF_k = participation factor for yard waste collection option *k*

$option\_frac_k$ = fraction households served by recyclables collection option *k*

3.2.4.2 Waste Density

The Collection process model calculates an overall density of residual waste collected by option C7 by averaging the density of the residuals set out by households served by each of the recyclables and yard waste collection options:

$$D\_residual_{C7} = \frac{\sum_j D\_residual_j \times option\_frac_j + \sum_k D\_residual_k \times option\_frac_k}{\sum_j option\_frac_j + \sum_k option\_frac_k} ,$$

where:

$D\_residual_{C7} =$ average density of residual waste collected by option C7 (pounds per cubic yard)

$D\_residual_j =$ overall density of residual waste set out by households served by recyclables collection option *j* where *j* is C2, C3, C4, or C8 (pounds per cubic yard)

$option\_frac_j =$ fraction of households served by recyclables collection option *j*

$D\_residual_k =$ overall density of residual waste set out households served by yard waste collection option *k* where *k* is C0, C9, or C10 (pounds per cubic yard)

$option\_frac_j =$ fraction of households served by yard waste collection option *k*

The overall density of residual waste set out by households served by a particular recyclables collection option is calculated as follows:

$$D\_residual_j = \left[\sum_i \frac{PF_j \times \left(1 - cr_{ij}\right) \times RES\_WT\_FRAC\_1_i}{\left(1 - frac\_cap\_recyc_j\right) \times D\_cv_i} + \sum_i \frac{\left(1 - PF_j\right) \times RES\_WT\_FRAC\_1_i}{D\_cv_i} \right]^{-1}$$

where:

$PF_j =$ participation factor for recyclables collection option *j* where *j* is C2, C3, C4, or C8 (participating households per total households)

$cr_{ij} =$ capture rate for waste component *i* for collection option *j*

$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition

$D\_cv_i =$ compacted density of waste component *i*

$frac\_cap\_recyc_j =$ captured recyclables fraction for collection option *j*

The overall density of residual waste set out by households served by a particular yard waste collection option is calculated as follows:

$$D\_residual_j = \left[\sum_i \frac{PF_k \times \left(1 - cr_{ik}\right) \times RES\_WT\_FRAC\_1_i}{\left(1 - frac\_cap\_yw_k\right) \times D\_cv_i} + \sum_i \frac{\left(1 - PF_k\right) \times RES\_WT\_FRAC\_1_i}{D\_cv_i} \right]^{-1}$$

where:

PF_k = participation factor for yard waste collection option *k* where *k* is C0, C9, or C10 (participating households per total households)
cr_{ik} = capture rate for waste component *i* for collection option *k*
$RES\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 residential waste composition
D_cv_i = compacted density of waste component *i*
$frac\_cap\_yw_k$ = captured yard waste fraction for collection option *j*

$D\_residual_{C7}$ can also be specified by the user. This is done by entering the desired value in cell *d_residual* in the Option C7 column of the Input Parameters section of the Collection process model. Entering a value in this cell overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_residual* cell is empty, the Collection process model calculates the average residual waste density as described above and uses the calculated value in subsequent calculations.

3.2.4.3 Cost Equations

The steps used to calculate residual collection costs are as follows:

1. Number of participating households that a collection vehicle can stop at to collect residual waste before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(G\_residual / D\_residual\right)}$$

The remaining cost equations for Residuals collection are identical to the Mixed Waste (option C1) cost equations except that the mixed waste generation rate (*G_msw*) is replaced by a residuals generation rate (*G_residual)*. See Section 3.1.1.3 for a description of the Mixed Waste cost equations.

3.2.5 Co-Collection

Co-collection options use a single vehicle to collect mixed waste and recyclables set out by households in different colored bags. The Collection process model includes two co-collection options. The procedures for calculating collection costs for each option are discussed separately below.

3.2.5.1 Co-Collection Using a Single Compartment Vehicle (C5)

Option C5 covers collection of mixed waste and recyclables bags in a single compartment vehicle for transport to a transfer station or commingled recyclables MRF. The bags are sorted after they are unloaded at the MRF. Since all of the refuse is collected in a single compartment vehicle just as it would be for Mixed Waste Collection (option C1), the cost equations for option C5 are identical to the cost equations listed in Section 3.2.1.3 for Mixed Waste Collection.

The Input Parameter section of the Collection process model includes a list of default capture rates for each component of the residential waste stream. Although capture rates are not used to calculate collection cost or life-cycle inventory parameter values, they are included in the Collection process model so that they can be accessed by process models that model solid waste treatment and disposal processes.

3.2.5.2 Co-Collection Using a Two Compartment Vehicle (C6)

Option C6 covers collection of bags containing mixed waste and recyclables in separate compartments of the same vehicle. The vehicle unloads the compartment containing recyclables bags at a transfer station or commingled recyclables MRF and transports the mixed waste bags to a combustion facility, composting facility, landfill, or other processing facility. **NOTE: The Collection process model C6 option only includes costs for transporting waste to the initial drop-off point (i.e., transfer station or commingled recyclables MRF). The cost of subsequent transportation of the remaining bags to another location is included in the cost associated with processing the refuse at the initial drop-off point.**

The Collection process model for option C6 assumes that the two compartments of the collection vehicle are sized such that they both fill at the same rate. In other words, when one compartment is filled to capacity and the vehicle stops collecting and travels to its unloading point, there is no empty space remaining in the other compartment.

3.2.5.2.1 Generation Rates

The value of *G_recyc* for option C6 is determined using the same procedure as is used to calculate *G_recyc* for the recyclables collection options. I.e., the user can specify capture rates (cr_i) for the desired recyclable components of the residential MSW stream in the capture rate table. The Collection process model multiplies the weight fraction specified for that component in the Common process model worksheet by the corresponding capture rate from the capture rate table. The results are summed to obtain the fraction of the MSW stream that is discarded in recyclables bins:

$$frac\_cap\_recyc = \sum_i cr_i \times RES\_WT\_FRAC\_1_i \quad ,$$

where:

$frac\_cap\_recyc =$ captured recyclables fraction
$cr_i =$ capture rate for waste component *i*
$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition *n*

The weekly recyclable generation rate is calculated as:

$$G\_recyc = G\_res \times frac\_recyc \quad ,$$

where:

$G\_recyc =$ weekly recyclable generation rate (pounds per week per household)
$G\_res =$ weekly residential MSW generation rate (pounds per week per household)
$frac\_recyc =$ captured recyclables fraction

The refuse remaining after recyclables are removed from the waste stream is collected in the mixed waste compartment of the co-collection vehicle. The weekly generation rate for this residual waste is calculated as:

$$G\_residual = G\_res - G\_recyc$$

3.2.5.2.2 Waste Densities

Default values for the as-collected density of recyclable components of the residential waste stream are listed in the Common process model (*D_rcv*). The Collection process model uses these values and the default values of the individual component weight fractions for residential waste Sector 1 listed in the Common process model (*RES_WT_FRAC_1*) to calculate the overall density of recyclables in the recyclables compartment of a two compartment co-collection vehicle. The user can specify a compaction factor (*CF*) for each component of the waste stream. The compaction factor represents the increased density of any components that are compacted during collection.

The compaction factor default values for all waste components are 1.0 . Compaction factors are listed in the Input Parameters section of the Collection process model.

The overall density of material collected in the recyclables compartment of a two compartment co-collection vehicle is calculated as:

$$D\_recyc = \frac{frac\_cap\_recyc}{\sum_i \frac{cr_i \times RES\_WT\_FRAC\_1_i}{D\_rcv_i \times CF_i}} \quad ,$$

where:

$D\_recyc =$ overall density of recyclables (pounds per cubic yard)
$frac\_cap\_recyc =$ captured recyclables fraction
$cr_i =$ capture rate for waste component *i*
$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition
$D\_rcv_i =$ as-collected density of recyclables component *i*
$CF_i =$ compaction factor for waste component *i* (pound per cubic yard compacted density per pound per cubic yard as-collected density)

The compacted density of the residual waste collected in the mixed waste compartment of the co-collection vehicle is calculated as:

$$D\_residual = \frac{1 - frac\_cap\_recyc}{\sum_i \frac{(1 - cr_i) \times RES\_WT\_FRAC\_1_i}{D\_cv_i}} \quad ,$$

where:

$D\_residual =$ overall density of residual waste (pounds per cubic yard)
$frac\_cap\_recyc =$ captured recyclables fraction
$cr_i =$ capture rate for waste component *i*
$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition
$D\_cv_i =$ compacted density of waste component *i*

D_recyc and *D_residual* can also be specified by the user. This is done by entering the desired values in cells *d_recyc* and *d_residual* in the Option C6 column of the Input Parameters section of the Collection process model. Entering values in these cells overrides the calculation procedures described above and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_recyc* and/or *d_residual* cells are empty, the Collection process model calculates the overall densities and uses the calculated values in subsequent calculations.

3.2.5.2.3 Waste Volume

The volume occupied in the collection vehicle by the weekly amount of refuse collected from each household (in cubic yards per household per week) is given by the expression:

$$\frac{G\_residual}{D\_residual} + \frac{G\_recyc}{D\_recyc} ,$$

where:

$G\_residual$ = residual waste generation rate (pounds per household per week)
$D\_residual$ = overall residual waste density (pounds per cubic yards)
G_recyc = recyclables generation rate (pounds per household per week)
D_recyc = as-collected recyclables density (pounds per cubic yard)

3.2.5.2.4 Cost Equations

The steps used to calculate two compartment vehicle co-collection costs are as follows:

1. Number of participating households that a two compartment co-collection vehicle can stop at before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(\frac{G\_residual}{D\_residual} + \frac{G\_recyc}{D\_recyc}\right)}$$

The remaining steps in the cost calculations for Option C6 are identical to those listed in Section 3.2.1 for Mixed Waste Collection (Option C1).

3.2.6 Wet/Dry Collection

Wet/dry collection refers to curbside collection of waste which has been separated by residents into wet, dry, and recyclable components. The wet and recyclable portions are set out in two separate containers provided by the municipality. Residents provide their own containers for the dry portion. Collection Option C11 models simultaneous collection of all three waste types by a three-compartment vehicle. Option C12 models collection of the wet and dry portions by a two-compartment vehicle; recyclables are collected by another vehicle (Option C2, C3, or C4) or taken by residents to a drop-off site (Option C8). The methods used to calculate waste generation rates, densities, and collection costs for each option are described below.

3.2.6.1 Wet/Dry/Recyclables (C11)

The user may specify what fraction of each component of MSW will be collected as wet refuse, dry refuse, and recyclables by making entries in the Wet/Dry/Recyclables Separation Factors table located in the Common process model. Component fractions are specified by entering separation factor values ($sf\_WDR\_wet_i$, $sf\_WDR\_dry_i$, or $sf\_WDR\_recyc_i$) between 0.00 and 1.00 in the appropriate cells to indicate the fraction of each component set out for collection in a wet, dry, or recyclables container. **Note: The wet, dry, and recyclables separation factors for each component of MSW must sum to 1.00.** Thus, C11 cannot be used in conjunction with other residential collection options. The components listed below as "Wet" have default $sf\_WDR\_wet_i$ values of 1.00; components listed as "Dry" have default $sf\_WDR\_dry_i$ values of 1.00. The components in the list of recyclables have a default $sf\_WDR\_recyc_i$ value of 0.75 and a default $sf\_WDR\_dry_i$ value of 0.25.

WET	DRY	RECYCLABLES
Leaves	Non-recyclable paper	Old Newsprint
Grass clippings	Non-recyclable ferrous metal	Old Corrugated Cardboard
Branches	Non-recyclable aluminum	Office Paper
Food waste	Non-recyclable glass	Paper - Other
	Non-recyclable plastic	Ferrous Cans
	Miscellaneous refuse	Ferrous Metal - Other
		Aluminum Cans
		Aluminum - Other
		Clear Glass
		Brown Glass
		Green Glass
		Translucent HDPE
		Pigmented HDPE
		PET
		Plastic - Other

3.2.6.1.1 Dry Waste Generation Rate

The dry waste generation rate is the product of dry waste fraction (*frac_dry*) and the weekly residential waste generation rate:

$$G\_dry = frac\_dry \times G\_res ,$$

where:

$G\_dry =$ weekly dry waste generation rate (pounds per week per household)

$G\_res =$ weekly residential waste generation rate (pounds per week per household)

The dry refuse fraction (*frac_dry*) is the sum of the weight fractions specified for each component in the Sector 1 residential waste composition list in the Common process model multiplied by the corresponding dry refuse separation factor:

$$frac\_dry = \sum_i RES\_WT\_FRAC\_1_i \times sf\_WDR\_dry_i ,$$

where:

$frac\_dry =$ dry refuse fraction

$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition

$sf\_WDR\_dry_i =$ dry refuse separation factor for waste component *i*

3.2.6.1.2 Wet Waste Generation Rate

The wet waste generation rate is the product of the wet waste fraction (*frac_wet*) and the total weekly refuse generation rate (*G_res*):

$$G\_wet = frac\_wet \times G\_res$$

where:

$G\_wet =$ weekly wet waste generation rate (pounds per week per household)

The wet refuse fraction (*frac_wet*) is the sum of the weight fractions specified for each components in the Sector 1 residential waste composition list in the Common process model multiplied by the corresponding wet refuse separation factor:

$$frac\_wet = \sum_i RES\_WT\_FRAC\_1_i \times sf\_WDR\_wet_i \quad ,$$

where:

$frac\_wet =$ wet refuse fraction

$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition

$sf\_WDR\_wet_i =$ wet refuse separation factor for waste component *i*

3.2.6.1.3 Recyclables Generation Rate

The recyclables generation rate is the product of the captured recyclables fraction (*frac_cap_recyc*) and the total weekly refuse generation rate (*G_res*):

$$G\_recyc = frac\_cap\_recyc \times G\_res \quad ,$$

where:

$G\_recyc =$ weekly recyclables waste generation rate (pounds per week per household)

The captured recyclables fraction (*frac_cap_recyc*) is the sum of the weight fractions specified for each component in the Sector 1 residential waste composition list in the Common process model (*RES_WT_FRAC_*1*)* multiplied by the recyclables separation factor specified for that component in the Common process model:

$$frac\_cap\_recyc = \sum_i RES\_WT\_FRAC\_1_i \times sf\_WDR\_recyc_i \quad ,$$

where:

$frac\_cap\_recyc$ = captured recyclables fraction
$RES\_WT\_FRAC\_1_i$ = weight fraction for recyclable waste components of the Sector 1 residential waste composition
$sf\_WDR\_recyc_i$ = recyclables separation factor for waste component *i*

3.2.6.1.4 Waste Densities

Unless the user enters override density values in the appropriate Input Parameter cells in the C11 column, the Collection process model uses the default mixed waste collection vehicle component densities (*D_cv*) listed in the Common process model to calculate overall densities for dry and wet refuse. Default recyclables collection densities (*D_rcv*) and compaction factors (*CF*) are used to calculate an overall density for recyclables. Compaction factors represent the increased density of recyclables that are compacted during collection. The default compaction factor values for all waste components listed in the Input Parameters section of the Collection process model are 1.0.

The dry refuse overall density is calculated as:

$$D\_dry = \frac{frac\_dry}{\sum_i \frac{sf\_WDR\_dry_i \times RES\_WT\_FRAC\_1_i}{D\_cv_i}} \quad ,$$

where:

D_dry = overall density of dry refuse (pounds per cubic yard)
$frac\_dry$ = dry refuse fraction
$sf\_WDR\_dry_i$ = dry refuse separation factor for waste component *i*
$RES\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 residential waste composition
D_cv_i = compacted density of component *i* (pounds per cubic yard)

The wet refuse overall density is calculated as:

$$D\_wet = \frac{frac\_wet}{\sum_i \frac{sf\_WDR\_wet_i \times RES\_WT\_FRAC\_1_i}{D\_cv_i}} \quad ,$$

where:

D_wet = overall density of wet refuse (pounds per cubic yard)

$frac\_wet =$ wet refuse fraction
$sf\_WDR\_wet_i =$ wet refuse separation factor for waste component *i*
$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition
$D\_cv_i =$ compacted density of component *i* (pounds per cubic yard)

The recyclables overall density is calculates as:

$$D\_recyc = \frac{frac\_cap\_recyc}{\sum_i \frac{sf\_WDR\_recyc_i \times RES\_WT\_FRAC\_1_i}{D\_rcv_i \times CF_i}} ,$$

where:
$D\_recyc =$ overall density of recyclables (pounds per cubic yard)
$frac\_cap\_recyc =$ captured recyclables fraction
$sf\_WDR\_recyc_i =$ recyclables separation factor for waste component *i*
$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition
$D\_rcv_i =$ as-collected density of recyclables component *i* (pounds per cubic yard)
$CF_i =$ compaction factor for recyclables component *i* (pound per cubic yard compacted density per pound per cubic yard as-collected density)

3.2.6.1.5 Waste Volume

The volume occupied in the collection vehicle by the weekly amount of refuse collected from each household (in cubic yards per household per week) is given by the expression:

$$\frac{G\_wet}{D\_wet} + \frac{G\_dry}{D\_dry} + \frac{G\_recyc}{D\_recyc}$$

3.2.6.1.6 Cost Equations

The steps used to calculate wet/dry/recyclables collection costs are as follows:

1. Number of participating households that a wet/dry/recyclables collection vehicle can stop at before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(\frac{G\_wet}{D\_wet} + \frac{G\_dry}{D\_dry} + \frac{G\_recyc}{D\_recyc} \right)}$$

The remaining steps in the cost calculations for Option C11 are identical to those listed in Section 3.2.1.3 for Mixed Waste Collection (Option C1).

3.2.6.2 Wet/Dry (C12)

Collection Option C12 models wet/dry collection of waste from households that are also served by a recyclables collection option. The waste collected by a C12 wet/dry collection vehicle is the residual waste remaining after residents have removed some portion of the recyclables for separate collection or drop-off. The cost to collect this residual waste must account for the recyclable material which was not separated from the rest of their refuse by residents, either because they chose not to participate in a recyclables collection program or because they did not successfully remove 100% of each recyclable component from the rest of their refuse. The collection cost must also account for how residents divide all of the residual waste between the wet and dry containers they set out for collection, including their remaining recyclable material.

The user may specify what fraction of each component of MSW will be collected as wet refuse and dry refuse by making entries in the Wet/Dry Separation Factors table located in the Common process model. Component fractions are specified by entering separation factor values ($sf\_WD\_wet_i$ or $sf\_WD\_dry_i$) between 0.00 and 1.00 in the appropriate cells to indicate the fraction of each component set out for collection in a wet, dry, or recyclables container. **Note: The wet and dry separation factors for each component of MSW must sum to 1.00.**

3.2.6.2.1 Dry Waste Generation Rate

The weekly dry refuse generation rate (G_dry) for Collection Option C12 is found by summing the residual dry waste fractions calculated for each of the recyclables collection and drop-off options and multiplying the result by the weekly residential waste generation rate:

$$G\_dry = G\_res \times \sum_j frac\_dry_j \times option\_frac_j \ ,$$

where:

$G\_dry =$ weekly dry waste generation rate (pounds per week per household)

$G\_res =$ weekly residential waste generation rate (pounds per week per household)

$frac\_dry_j =$ dry refuse fraction for recyclables collection option j where j is C2, C3, C4, or C8

$option\_frac_j =$ fraction of households served by recyclables collection option j

The dry residuals fraction for a particular recyclables collection option ($frac\_dry_j$) is the sum of the dry portion of the remaining recyclables components from participating and non-participating households plus the dry portion of the non-recyclables components. This can be calculated as:

$$frac\_dry_j = \sum_i RES\_WT\_FRAC\_1_i \times sf\_WDR\_dry_i \times \left[PF_j \times \left(1 - cr_{ij}\right) + \left(1 - PF_j\right)\right] ,$$

where:

$frac\_dry_j =$ dry refuse fraction for recyclables collection option j

$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component i of the Sector 1 residential waste composition

$sf\_WDR\_dry_i =$ dry refuse separation factor for waste component i

$PF_j =$ participation factor for recyclables collection option j

$cr_{ij} =$ capture rate for component i, recyclables collection option j

3.2.6.2.2 Wet Waste Generation Rate

The weekly wet refuse generation rate (G_wet) for Collection Option C12 is found by summing the residual wet waste fractions calculated for each of the recyclables collection and drop-off options and multiplying the result by the weekly residential waste generation rate:

$$G\_wet = G\_res \times \sum_j frac\_wet_j \times option\_frac_j ,$$

where:

$G\_wet =$ weekly wet waste generation rate (pounds per week per household)

$G\_res =$ weekly residential waste generation rate (pounds per week per household)

$frac\_wet_j =$ wet refuse fraction for recyclables collection option j where j is C2, C3, C4, or C8

$option\_frac_j =$ fraction of households served by recyclables collection option j

The wet residuals fraction for a particular recyclables collection option ($frac\_wet_j$) is the sum of the wet portion of the remaining recyclables components from participating and non-participating households plus the wet portion of the non-recyclables components. This can be calculated as:

$$frac\_wet_j = \sum_i RES\_WT\_FRAC\_1_i \times sf\_WDR\_wet_i \times \left[PF_j \times \left(1 - cr_{ij}\right) + \left(1 - PF_j\right)\right],$$

where:

$frac\_wet_j =$	wet refuse fraction for recyclables collection option *j*
$RES\_WT\_FRAC\_1_i =$	weight fraction for waste component *i* of the Sector 1 residential waste composition
$sf\_WDR\_wet_i =$	wet refuse separation factor for waste component *i*
$PF_j =$	participation factor for recyclables collection option *j*
$cr_{ij} =$	capture rate for component *i*, recyclables collection option *j*

3.2.6.2.3 Wet Waste Density

Unless the user enters an override wet waste density in the *d_wet* cell in the C12 column, the Collection process model calculates the overall wet waste density by averaging the overall wet densities of residual waste collected from households served by different recyclables collection options:

$$D\_wet_{C12} = \sum_j D\_wet_j \times option\_frac_j \quad ,$$

where:

$D\_wet_{C12} =$	overall density of wet refuse collected by a C12 wet/dry collection vehicle (pounds per cubic yard)
$D\_wet_j =$	overall density of wet refuse from households served by recyclables collection option *j*, where *j* is C2, C3, C4, or C8
$option\_frac_j =$	fraction of households served by collection option *j*

The overall wet density of waste collected from households that are served by a particular recyclables collection option (D_wet_j) must account for both the wet portions of the non-recyclable components of the waste stream and the wet portions of the recyclable components which were not collected from participating and non-participating households. D_wet_j is calculated as:

$$D\_wet_j = \frac{frac\_wet_j}{\sum_i \frac{sf\_WDR\_wet_i \times RES\_WT\_FRAC\_1_i \times \left[PF_j \times \left(1 - cr_{ij}\right) + \left(1 - PF_j\right)\right]}{D\_cv_i}}$$

where:

D_wet_j = overall density of wet waste from households served by recyclables collection option *j* (pounds per cubic yard)

$frac\_wet_j$ = wet refuse fraction for recyclables collection option *j*

$sf\_WDR\_wet_i$ = wet refuse separation factor for waste component *i*

$RES\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 residential waste composition

PF_j = participation factor for recyclables collection option *j*

cr_{ij} = capture rate for component *i*, recyclables collection option *j*

D_cv_i = compacted density of component *i* (pounds per cubic yard)

3.2.6.2.4 Dry Waste Density

Unless the user enters an override dry waste density in the *d_dry* cell in the C12 column, the Collection process model calculates the overall dry waste density by averaging the overall dry densities of residual waste collected from households served by different recyclables collection options:

$$D\_dry_{C12} = \sum_j D\_dry_j \times option\_frac_j$$

where:

D_dry_{C12} = overall density of dry refuse collected by a C12 wet/dry collection vehicle (pounds per cubic yard)

D_dry_j = overall density of dry refuse from households served by recyclables collection option *j*, where *j* is C2, C3, C4, or C8

$option\_frac_j$ = fraction of households served by collection option *j*

The overall dry density of waste collected from households that are served by a particular recyclables collection option (D_dry_j) must account for both the dry portions of the non-recyclable components of the waste stream and the dry portions of the recyclable components which were not collected from participating and non-participating households. D_dry_j is calculated as:

$$D\_dry_j = \frac{frac\_dry_j}{\sum_i \frac{sf\_WDR\_dry_i \times RES\_WT\_FRAC\_1_i \times \left[PF_j \times \left(1-cr_{ij}\right) + \left(1-PF_j\right)\right]}{D\_cv_i}}$$

where:

D_dry_j = overall density of dry waste from households served by recyclables collection option *j* (pounds per cubic yard)

$frac\_dry_j$ = dry refuse fraction for recyclables collection option *j*

$sf\_WDR\_dry_i$ = dry refuse separation factor for waste component *i*

$RES\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 residential waste composition

PF_j = participation factor for recyclables collection option *j*

cr_{ij} = capture rate for component *i*, recyclables collection option *j*

D_cv_i = compacted density of component *i* (pounds per cubic yard)

3.2.6.2.5 Waste Volume

The volume occupied in the collection vehicle by the weekly amount of refuse collected from each household (in cubic yards per household per week) is given by the expression:

$$\frac{G\_wet}{D\_wet} + \frac{G\_dry}{D\_dry}$$, where:

G_wet = residential wet refuse generation rate (pounds per household per week)

D_wet = overall density of wet refuse (pounds per cubic yard)

G_dry = residential dry refuse generation rate (pounds per household per week)

D_dry = overall density of dry refuse (pounds per cubic yard)

3.2.6.2.6 Cost Equations

The steps used to calculate wet/dry collection costs are as follows:

1. Number of participating households that a wet/dry collection vehicle can stop at before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(\frac{G\_wet}{D\_wet} + \frac{G\_dry}{D\_dry}\right)}$$

The remaining steps in the cost calculations for Option C12 are identical to those listed in Section 3.2.1.3 for Mixed Waste Collection (Option C1).

3.3 Residential Waste Drop-Off

The Collection process model includes two collection options that model drop-off of selected components of residential MSW at a drop-off site by residents using their own vehicles. For Option C8 (Recyclables Drop-Off) the drop-off site consists of roll-on/roll-off containers at a central location in the community. Municipal collection vehicles periodically transport full containers to a disposal facility. For Option C10 (Yard Waste Drop-Off) participating households transport their yard waste directly to a disposal facility for composting or some other waste disposal process.

3.3.1 Recyclables (C8)

Option C8 models transport of recyclables by residents using their own vehicles to a centrally located drop-off site. Residents deposit recyclables in roll-on/roll-off containers at the drop-off site. Municipal collection vehicles are dispatched from a garage at the beginning of a workday to off-load empty containers at the drop-off site and on-load full containers. Full containers are taken to a recycling facility (a MRF, for example) and emptied. Collection vehicles then return to the drop-off site and repeat the process until the end of the workday when they return to the vehicle garage. Only the capital and operating costs associated with the municipal collection vehicles are included in the Option C8 cost calculations; costs associated with the drop-off vehicles used by residents are excluded. However, life-cycles parameters for both collection vehicles and drop-off vehicles are accounted for as described in Sections 5-8.

3.3.1.1 Generation Rate

The weekly generation rate for recyclables (*G_recyc*) is a function of the weekly MSW generation rate (*G_res*) and the amount of recyclables removed from the waste stream. The user can specify values for these variables by entering values in the appropriate cells in the Collection process model worksheet to override the process model default values.

The captured recyclables fraction (*frac_cap_recyc*) is found by summing the fraction of recyclable material removed by households from each component of the residential MSW stream. A table is provided in the Collection process model worksheet where the user can enter values to identify what fraction on average of each recyclable component is removed by participating households from their mixed waste for transport and disposal at the drop-off site. This fraction is referred to as the “capture rate” (*cr*). Entering a value of 0.75 as the capture rate for aluminum cans, for instance, indicates that on average households successfully remove 75% of their aluminum cans from their refuse. The other 25% is collected along with other non-captured recyclables and the household’s non-recyclable refuse by another collection vehicle. Costs for collection of this “residual” waste are accounted for by one of the residuals collection options (C7 or C12). Leaving a cell blank or entering a zero in the capture rate table indicates that the component represented by that cell is not included in the recyclables drop-off program.

Default capture rates are assigned to the following residential waste stream components:

- Old Newsprint
- Old Corrugated Cardboard
- Office Paper
- Paper Other (5 classes)
- Ferrous Cans

- Ferrous Metal - Other
- Aluminum Cans
- Aluminum - Other (2 classes)
- Clear Glass
- Brown Glass
- Green Glass
- Translucent HDPE
- Pigmented HDPE
- PET
- Plastic - Other (5 classes)

The Common process model contains listings of waste component weight fractions for two different residential waste compositions (*RES_WT_FRAC*_1 and *RES_WT_FRAC*_2). To determine *frac_cap_recyc* the Collection process model worksheet multiplies the user-specified/default capture rate for each waste component by the corresponding weight fraction specified for that component in the *RES_WT_FRAC*_1 table:

$$frac\_cap\_recyc = \sum_i cr_i \times RES\_WT\_FRAC\_1_i \quad ,$$

where:

$frac\_cap\_recyc =$ captured recyclables fraction for collection option C8
$cr_i =$ capture rate for waste component *i*
$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition *n*

The weekly recyclable generation rate for recyclables collection option *j* is calculated as:

$$G\_recyc = G\_res \times frac\_cap\_recyc \quad ,$$

where:

$G\_recyc =$ weekly recyclable generation rate for collection option C8 (pounds per week per household)
$G\_res =$ weekly residential MSW generation rate (pounds per week per household)
$frac\_cap\_recyc =$ captured recyclables fraction for collection option C8

3.3.1.2 Density

Default values for the as-collected density of recyclable components of the residential waste stream are listed in the Common process model (*D_rcv*). Default values for waste component compaction factors (*CF*) are listed in the Input Parameters section of the Collection process model. Compaction factors represent the increased density of any waste components that are compacted during collection from the drop-off site. The default compaction factor values for all waste components are 1.0 . The Collection process model uses these values and the default values of the individual component weight fractions for residential waste Sector 1 listed in the Common process model (*RES_WT_FRAC_*1) to calculate an overall density for residential recyclables in a recyclables collection vehicle.

$$D\_recyc = \frac{frac\_cap\_recyc}{\sum_i \frac{cr_i \times RES\_WT\_FRAC\_1_i}{D\_rcv_i \times CF_i}} \quad ,$$

where:

D_recyc = overall density of recyclables (pounds per cubic yard)
$frac\_cap\_recyc$ = captured recyclables fraction
cr_i = capture rate for waste component *i*
$RES\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 residential waste composition
D_rcv_i = as-collected density of recyclables component *i*
CF_i = compaction factor for waste component *i* (pound per cubic yard compacted density per pound per cubic yard as-collected density)

D_recyc can also be specified by the user. This is done by entering the desired value in cell *d_recyc* in the Option C8 column of the Input Parameters section of the Collection process model. Entering a value in this cell overrides the calculation procedure described above. The Collection process model uses the user-specified density value in all subsequent calculations. If the *d_recyc* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.3.1.3 Cost Equations

Option C8 costs are calculated using the following steps:

1. Volume of recyclables that accumulate at the drop-off site per week:

$$vol\_recyc = \frac{H\_res \times PF \times G\_recyc}{D\_recyc} \quad ,$$

where:

vol_recyc = weekly volume of recyclables deposited at drop-off site (cubic yards per week)
H_res = number of households in the community (households)

PF = participation factor (participating households/total households)
G_recyc = recyclable material generation rate (pounds per week per participating household)
D_recyc = overall density of recyclables (pounds per cubic yard)

2. Length of time that it takes a collection vehicle to make one collection trip (*Tc*), including time spent off-loading an empty container at the collection location, loading on a full container, traveling between the drop-off site and the disposal site, and unloading the full container at the disposal site:

$$Tc = TL + (2 \times Trf) + S \quad ,$$

where:

Tc = collection trip time (minutes per trip)
TL = off-loading/on-loading time at the drop-off site (minutes per trip)
Trf = travel time between drop-off site and MRF (minutes per trip)
S = time to empty container at the MRF (minutes per trip)

3. Number of collection trips (*RD*) that a collection vehicle can make during one workday after time is deducted for a lunch period and other breaks and for travel to and from the vehicle garage:

$$RD = \frac{(WV \times 60) - (F1 + F2 + Tgr + Tfg) + Trf}{Tc} \quad ,$$

where:

RD = collection trips per day per vehicle (trips per day per vehicle)
WV = work hours per day (hours per day per vehicle)
$F1$ = lunch period (minutes per day per vehicle)
$F2$ = break period (minutes per day per vehicle)
Tgr = travel time between garage and beginning of collection route (minutes per day per vehicle)
Tfg = travel time between facility and garage (minutes per day per vehicle)

4. Number of collection vehicle trips (*RT*) needed to collect all of the recyclable material that accumulates during one week:

$$RT = \frac{vol\_recyc}{Vc \times Uc} \quad ,$$

where:

$RT =$ number of collection vehicle trips per week (trips per week)
$Vc =$ roll-on/roll-off container capacity (cubic yards per trip)
$Uc =$ roll-on/roll-off container utilization factor (%)

5. Number of collection vehicles needed collect all of the accumulated recyclable material:

$$Nt = \frac{RT}{RD \times CD} \quad ,$$

where:

$Nt =$ number of collection vehicles (vehicles)
$CD =$ number of workdays per week (days per week)

6. Annual capital (*C_cap*) and operating (*C_op*) costs associated with a single collection vehicle:

Capital Cost

$$C\_cap\_v = (1+e) \times Pt \times CRF$$

Operating Cost

$$C\_op = (1+e) \times \left\{ (1+a) \times \left[(1+bw) \times (Wa \times Nw + Wd) \times WP \times CD \times \frac{365 \, {}^{days}\!/\!_{year}}{7 \, {}^{days}\!/\!_{week}} \right] + c + \left[d \times (Nw+1) \right] \right\}$$

7. Collection cost per vehicle per year:

$$C\_vehicle = (1+bv) \times C\_cap\_v + C\_cap\_b + C\_op$$

8. Total annual collection cost (*C_ann*) for the community:

$$C\_ann = Nt \times C\_vehicle$$

9. Collection cost per household per year:

$$C\_house = \frac{C\_vehicle \times PF}{RD \times CD \times Ut \times Vt \times \left(D\_recyc / G\_recyc \right)}$$

10. Collection cost per ton of recyclables:

$$C\_ton = \frac{C\_house \times 2000\ {}^{lb}\!/\!_{ton} \times 7\ {}^{days}\!/\!_{week}}{G\_recyc \times PF \times 365\ {}^{days}\!/\!_{year}}$$

3.3.2 Yard Waste (C10)

Residents participating in yard waste drop-off transport their yard waste directly to a disposal facility (a composting facility, for example). No municipal collection vehicles are used to collect this waste, so no collection costs are calculated for option C10. However, the generation rate and density parameters associated with yard waste are used to calculate life-cycle parameters associated with this option, so calculation of those parameters is described below.

3.3.2.1 Generation Rate

The generation rate for yard waste (*G_yw*) is a function of two variables: the total weekly household waste generation rte (*G_res*) and the amount of yard waste removed from the waste stream (*frac_yw*). The user can specify these variables by entering values in the appropriate cells in the Collection process model worksheet to override the process model default values.

The captured yard waste fraction (*frac_yw*) is found by summing the fraction of material removed by households from the yard waste components of the residential MSW stream. The user can enter values in the capture rate table to indicate what fraction on average of each yard waste component is removed by participating households from their mixed waste and set out for separate collection. Leaving a cell blank or entering a zero indicates that the component represented by that cell is not included in the yard waste collection program. Default capture rates are assigned to the following components:

- Leaves
- Grass clippings
- Branches

The Common process model contains listings of waste component weight fractions for two residential waste compositions (*RES_WT_FRAC_1* and *RES_WT_FRAC_2*). To determine *frac_yw* the Collection process model worksheet multiplies the user-specified/default capture rate for each yard waste component (cr_i) by the corresponding weight fraction specified for that component in the *RES_WT_FRAC_1* table.

$$frac\_cap\_yw = \sum_i cr_i \times RES\_WT\_FRAC\_1_i \quad ,$$

where:

$frac\_cap\_yw =$ captured yard waste fraction

$cr_i =$ capture rate for waste component *i*

$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition

The weekly recyclable generation rate for yard waste is calculated as:

$$G\_yw = G\_res \times frac\_cap\_yw \quad ,$$

where:

$G\_yw =$ weekly yard waste generation rate (pounds per week per participating household)
$G\_res =$ weekly residential MSW generation rate (pounds per week per participating household)
$frac\_cap\_yw =$ captured yard waste fraction

3.3.2.2 Density

Default values for the as-collected density of yard waste components of the residential waste stream are listed in the Common process model (*D_rcv*). The Collection process model uses these values and the default values of the individual component weight fractions for residential waste Sector 1 listed in the Common process model (*RES_WT_FRAC_1*) to calculate an overall density for residential yard waste in a collection vehicle:

$$D\_yw = \frac{frac\_cap\_yw}{\sum_i \frac{cr_i \times RES\_WT\_FRAC\_1_i}{D\_rcv_i}} \quad ,$$

where:

$D\_yw =$ overall density of yard waste (pounds per cubic yard)
$frac\_cap\_yw =$ captured yard waste fraction
$cr_i =$ capture rate for yard waste component *i*
$RES\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 residential waste composition
$D\_rcv_i =$ as-collected density of yard waste component *i*

D_yw can also be specified by the user. This is done by entering the desired value in cell *d_yw* in the C10 column of the Input Parameters section of the Collection process model. Entering a value in this cell overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_yw* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.4 Multi-Family Dwelling Waste Collection

Residents of multi-family dwellings (e.g. apartment complexes) are assumed to dispose of their refuse in containers placed at one or more locations within each group of dwellings. Some collection options include multiple containers at each location so that residents can dispose of recyclables separately from the rest of their refuse. Collection vehicles are dispatched from a vehicle garage at the beginning of each workday to make the rounds of these refuse container locations. Vehicles collect waste or recyclables until they reach capacity. Fully loaded vehicles drive to a landfill or another disposal facility, unload, and begin another collection trip. At the end of the workday the vehicles return to the vehicle garage.

The user specifies the number of residents living in multi-family dwellings (*mf_pop*), the total number of multi-family collection locations (*H_mf*), and the per capita waste generation rate for multi-family dwelling residents (*GR*) in the appropriate data entry cells of the Common process model worksheet. Another cell in the Common process model calculates the average weekly waste generation rate per multi-family collection location (*G_mf*):

$$G\_mf = \frac{GR \times mf\_pop \times 7\ {}^{days}\!/_{week}}{H\_mf} ,$$

where

G_mf = waste generated per multi-family collection location (pounds per location per week)
GR = waste generated per multifamily dwelling resident per day (pounds per person per day)
mf_pop = number of people living in multifamily dwellings (persons)
H_mf = number of collection locations (locations)

3.4.1 Mixed Waste (C13)

Collection option C13 models collection of multi-family waste using single compartment collection vehicles. There is no separation of the waste at the point of collection, either by residents or the collection vehicle crews. The collection vehicles transport the waste to a treatment or disposal facility such as a landfill, MRF, of transfer station.

3.4.1.1 Generation Rate

Since there is no waste separation at the point of collection for this collection option, the weekly mixed waste generation rate (*G_msw*) at multi-family collection locations is the same as the weekly multi-family waste generation rate calculated by the Common process model:

$$G\_msw = G\_mf$$

3.4.1.2 Waste Density

Default values for the compacted density of individual components of the waste stream are listed in the Collection process model (*D_cv*). The Collection process model uses these values and the default values of the individual component weight fractions for multi-family waste sector 1 listed in the Common process model (*RES_WT_FRAC_1*) to calculate an overall density for multi-family mixed waste:

$$D\_msw = \frac{1}{\sum_i \frac{MF\_WT\_FRAC\_1_i}{D\_cv_i}} \quad ,$$

where:

$D\_msw =$ overall density of mixed waste (pounds per cubic yard)
$MF\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 multi-family waste composition
$D\_cv_i =$ compacted density of waste component *I* (pounds per cubic yard)

This value represents the overall density of the waste after compaction in the collection vehicle.

D_msw can also be specified by the user. This is done by entering the desired value in cell *d_msw* in the Option C13 column of the Input Parameters section of the Collection process model. Entering a value in this cell overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_msw* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.4.1.3 Cost Equations

Option C13 collection costs are calculated using the same equations and many of the same input variables as those used in the Residential Mixed Waste Collection (Option C1) collection equations. Of course, these input variables can take on different values between Option C1 and Option C13. The Multi-Family Mixed Waste Collection equations and input variables are listed below. See Section 3.2.1.3 for a more detailed description of the equations.

1. Number of collection locations (*Ht*) that a collection vehicle can stop at to collect mixed waste during one collection trip before it its filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(G\_mf / D\_msw\right)} \quad ,$$

where:

$Ht =$	locations per collection trip (locations per trip)
$Ut =$	collection vehicle utilization factor
$Vt =$	collection vehicle capacity (cubic yards per trip)
$D\_msw =$	overall density of mixed waste (pounds per cubic yard)
$Fr =$	collection frequency (collection cycles per week)
$G\_mf =$	mixed waste generation rate (pounds per week per household)

NOTE: If the value of *Ht* calculated by the Collection process model is less than 1, the user should increase the collection frequency (*Fr*) until *Ht* is greater than or equal to 1. *Ht* will be less than 1 if the volume of mixed waste generated at individual collection locations is greater than the usable capacity of the collection vehicle. This may result in the calculation of negative values for some of the parameters calculated below. Alternatively, the capacity of the collection vehicle could be increased where possible based on conditions.

2. Length of time that it takes a collection vehicle to make one collection trip (*Tc*):

$$Tc = \left[Tbtw \times (Ht - 1)\right] + \left[TL \times Ht\right] + \left(2 \times Trf\right) + S \quad ,$$

where:

$Tc =$	collection trip time (minutes per trip)
$Tbtw =$	travel time between collection stops (minutes per stop)

$TL =$ loading time at a collection stop (minutes per stop)
$Trf =$ travel time between beginning/end of collection route and disposal facility (minutes)
$S =$ time to unload collection vehicle at the disposal facility (minutes)

3. Number of collection trips that a vehicle can make during one workday after time is deducted for a lunch period and other breaks and for travel to and from the vehicle garage:

$$RD = \frac{(WV \times 60) + (F1 + F2 + Tgr + Tfg) + [0.5 \times (Trf + S)]}{Tc} \quad ,$$

where:

$RD =$ collection trips per day per vehicle (trips per day per vehicle)
$WV =$ work hours per day (hours per day per vehicle)
$F1 =$ lunch period (minutes per day per vehicle)
$F2 =$ break period (minutes per day per vehicle)
$Tgr =$ travel time between garage and beginning of collection route (minutes)
$Tfg =$ travel time between facility and garage (minutes)

4. Number of collection vehicle trips (RT) needed to visit all of the multi-family collection locations in the community served by collection option C13:

$$RT = \frac{H\_mf \times option\_frac}{Ht} \quad ,$$

where:

$RT =$ number of collection trips (trips)
$option\_frac =$ fraction of collection locations served by collection option C13

5. Number of collection vehicles (Nt) needed to visit all of the multi-family collection locations in the community served by collection option C13 during one collection cycle:

$$Nt = \frac{RT}{RD} \times \frac{Fr}{CD} \quad ,$$

where:

$Nt =$ number of collection vehicles (vehicles)
$CD =$ number of workdays per week (days per week)

6. Annual capital (*C_cap*) and operating (*C_op*) costs associated with a single collection vehicle:

Capital Cost

$$C\_cap = (1+e) \times Pt \times CRF \quad ,$$

where:

$C\_cap =$ collection vehicle capital cost amortized over the economic life of the vehicle ($ per vehicle per year)
$e =$ administrative rate ($ of administrative expense per $ of capital cost or operating expense)
$Pt =$ unit price of a collection vehicle ($ per vehicle)
$CRF =$ capital recovery factor for a vehicle (year^{-1})

The capital recovery factor is defined as:

$$CRF = \frac{i \times (1+i)^L}{(1+i)^L - 1} \quad ,$$

where:

$i =$ yearly discount rate (year^{-1})
$L =$ economic life of a collection vehicle (years)

Operating Cost

$$C\_op = (1+e) \times \left\{ (1+a) \times \left[(1+bw) \times (Wa \times Nw + Wd) \times WP \times CD \times \frac{365 \, {}^{days}\!/_{year}}{7 \, {}^{days}\!/_{week}} \right] + c + \left[d \times (Nw+1) \right] \right\}$$

where:

$C\_op =$ collection vehicle operating cost per year ($ per year)
$e =$ administrative rate (($ of administrative expense per $ of capital cost or operating expense)
$a =$ fringe benefit rate ($ of fringe benefit per $ of wages)
$bw =$ backup rate for collection workers (%)
$Wa =$ hourly wage rate for collection worker ($ per hour per worker)
$Nw =$ number of collection workers per vehicle (workers)
$Wd =$ hourly wage rate for a collection vehicle driver ($ per hour per driver)

$WP =$ work hours per day for wage (hours per worker per day)
$c =$ annual vehicle operation and maintenance cost ($ per year per vehicle)
$d =$ other expenses ($ per worker per year)

7. Annual cost per vehicle (*C_vehicle*):

$$C\_vehicle = (1 + bv) \times C\_cap\_v + C\_op$$

8. Annual collection cost (*C_ann*) for the community:

$$C\_ann = Nt \times C\_vehicle$$

9. Number of collection locations that one vehicle can visit during a collection cycle (*H_c*):

$$H\_c = \frac{Ht \times RD \times CD}{Fr}$$

10. Annual collection cost per location (*C_location*):

$$C\_location = \frac{C\_vehicle}{H\_c}$$

11. Collection cost per ton of refuse (*C_ton*):

$$C\_ton = \frac{C\_location \times 2000\ {}^{lb}/_{ton} \times 7\ {}^{days}/_{week}}{G\_msw \times 365\ {}^{days}/_{year}}$$

3.4.2 Recyclables (C14 and C15)

Collection options C14 and C15 model collection of recyclables from multi-family dwellings that have been separated from the non-recyclable portion of multi-family refuse ("residuals"). Each collection location is supplied with one or more containers to hold recyclable refuse. Option C14 covers pre-sorted recyclables deposited by residents into multiple containers; option C15 is for commingled recyclables deposited in a single container. The annualized cost of the containers is treated as an additional capital cost.

The cost equations for options C14 and C15 are very similar in form to the cost equations for options C2, C3, and C4 for collection of residential recyclables. See Section 3.2.2.3 for descriptions of the calculation methodology.

3.4.2.1 Generation Rate

The generation rate for recyclables (*G_recyc*) is found my multiplying the weekly collection location waste generation rate (*G_mf*) by the fraction of recyclables removed or "captured" from the waste stream by residents (*frac_cap_recyc*). When the Collection process model is used with the Optimization Model, the Optimization Model determines which components of the waste stream are collected by a particular collection option. When the Collection process model is used in stand-alone mode, the user specifies which components are collected. The method used to do this is described below.

The weekly recyclable generation rate for recyclables collection option *j* is calculated as:

$$G\_recyc_j = G\_mf \times frac\_cap\_recyc_j \quad ,$$

where:

G_recyc_j = weekly recyclables generation rate for collection option *j* where *j* is option C14 or C15 (pounds per week per location)

G_mf = weekly multi-family MSW generation rate (pounds per location per week)

$frac\_cap\_recyc_j$ = captured recyclables fraction for collection option *j*

The captured recyclables fraction is found by summing the fraction of recyclable material removed by multi-family dwelling residents from each component of the multi-family MSW stream. A table is provided in the Collection process model worksheet where the user can enter values to indicate what fraction of each recyclable component is removed by participating residents from their mixed waste and deposited into recyclables containers. This fraction is referred to as the "capture rate" (*cr*). Entering a value of 0.75 as the capture rate for aluminum cans, for instance, indicates that on average residents successfully remove 75% of their aluminum cans from refuse and deposit them in a recyclables container. The other 25% is collected along with other non-captured recyclables and the residents' non-recyclable refuse by another collection vehicle. Costs for collection of this "residual" waste are accounted for in the Multi-Family Residual Waste collection option (C16). Leaving a cell blank or entering a zero in the capture rate table indicates that the component represented by that cell is not included in the recyclables collection program.

Default capture rates are assigned to the following multi-family waste stream components:

- Old Newsprint
- Old Corrugated Cardboard
- Office Paper
- Phone Books
- Old Magazines
- Third Class Mail
- Paper - Other (5 classes)
- Ferrous Cans
- Ferrous Metal - Other
- Aluminum Cans
- Aluminum - Other (2 classes)
- Clear Glass
- Brown Glass
- Green Glass
- Translucent HDPE
- Pigmented HDPE
- PET
- Plastic - Other (5 classes)

The Common process model contains listings of waste component weight fractions for two different multi-family waste compositions (*MF_WT_FRAC_1* and *MF_WT_FRAC_2*). To determine the amount of recyclables removed from the waste stream (*frac_cap_recyc*), the Collection process model cell formulas multiply the user-specified/default capture rate for each waste component *i* (cr_i) by the corresponding weight fraction specified for that component in the *MF_WT_FRAC_1* table.

$$frac\_recyc_j = \sum_i cr_i \times MF\_WT\_FRAC\_1$$

where:

$frac\_cap\_recyc_j$ = captured recyclables fraction for collection option *j* where *j* is C14 or C15

cr_i = capture rate for waste component *i*

$MF\_WT\_FRAC\_1$ = weight fraction for waste component *i* of the Sector 1 multi-family waste composition

3.4.2.2 Waste Density

Default values for the as-collected density of recyclable components of the multi-family waste stream are listed in the Common process model (*D_rcv*). Default values for waste component compaction factors (*CF*) are listed in the Input Parameters section of the Collection process model. Compaction factors represent the increased density of any waste components that are compacted during collection. The default compaction factor values for all waste components are 1.0. The Collection process model uses these values and the default values of the individual component weight fractions for multi-family waste Sector 1 listed in the Common process model (*MF_WT_FRAC_1*) to calculate an overall density for multi-family recyclables in a recyclables collection vehicle:

$$D\_recyc_j = \frac{frac\_cap\_recyc_j}{\sum_i \frac{cr_{ij} \times MF\_WT\_FRAC\_1_i}{D\_rcv_i \times CF_i}} \quad ,$$

where:

D_recyc_j = overall density of recyclables for collection option *j* where *j* is C4 or C15 (pounds per cubic yard)

$frac\_cap\_recyc_j$ = captured recyclables fraction for collection option *j*

cr_{ij} = capture rate for waste component *i* for collection option *j*

$MF\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 multi-family waste composition

D_rcv_i = as-collected density of recyclables component *i*

CF_i = compaction factor for waste component *i* (pound per cubic yard compacted density per pound per cubic yard as-collected density)

D_recyc can also be specified by the user. This is done by entering the desired value in cell *d_recyc* in the Option C14 or C15 columns of the Input Parameters section of the Collection process model. Entering a value in one of these cells overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_recyc* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.4.2.3 Cost Equations

Multi-family recyclables collection costs are calculated using the same steps described in Section 3.2.2 for residential recyclables collection. However, the participation factor used in the residential recycling cost equations to adjust for fewer households visited by collection vehicles is omitted from the multi-family collection equations. A recyclables collection vehicle stops at all multi-family collection location regardless of how many individual residents elected to participate in the recycling program. Thus, the participation factor value is 1 and is not listed as a variable.

The steps used to calculate multi-family recyclables collection costs are as follows:

1. Number of locations that a recyclables collection vehicle can stop at to collect recyclables before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(G\_recyc / D\_recyc\right)} \ ,$$

where:

D_recyc = density of recyclables (pounds per cubic yard)
G_recyc = recyclables generation rate (pounds per week per location)

NOTE: If the value of *Ht* calculated by the Collection process model is less than 1, the user should increase the collection frequency (*Fr*) until *Ht* is greater than or equal to 1. *Ht* will be less than 1 if the volume of mixed waste generated at individual collection locations is greater than the usable capacity of the collection vehicle. This may result in the calculation of negative values for some of the parameters calculated below. Alternatively, the capacity of the collection vehicle could be increased where possible based on local conditions.

2. Length of time that it takes a collection vehicle to make one collection trip:

$$Tc = \left[Tbet \times (Ht - 1)\right] + \left[TL \times Ht\right] + \left(2 \times Trf\right) + S$$

3. Number of collection trips that a vehicle can make during one workday:

$$RD = \frac{(WV \times 60) + \left(F1 + F2 + Tgr + Tfg\right) + \left[0.5 \times \left(Trf + S\right)\right]}{Tc}$$

4. Number of collection vehicle trips (*RT*) needed to visit all of the multi-family recyclables collection locations in the community served by the collection option. Since the Collection process model includes two multi-family recyclables collection options, the user can specify the percentage of collection locations in the community that are served by each collection option (*option_frac*).

$$RT = \frac{H\_mf \times option\_frac_j}{Ht} \quad ,$$

where:

$RT =$ number of collection trips (trips)
$H\_mf =$ number of multi-family collection locations (locations)
$option\_frac_j =$ fraction of locations served by collection option j

NOTE: The sum of the *option_frac* fractions specified by the for options C14 and C15 should not exceed 1.00. The default values in the spreadsheet are 1.00 for option C14 and 0.00 for option C15.

5. Number of collection vehicles:

$$Nt = \frac{RT}{RD} \times \frac{Fr}{CD}$$

6. Annual capital (*C_cap*) and operating (*C_op*) costs associated with a single collection vehicle:

Capital Cost

$$C\_cap\_v = (1+e) \times P\_v \times CRF\_v$$

Operating Cost

$$C\_op\_v = (1+e) \times \left\{ (1+a) \times \left[(1+bw) \times (Wa \times Nw + Wd) \times WP \times CD \times \frac{365 \; {}^{days}\!/\!_{year}}{7 \; {}^{days}\!/\!_{week}} \right] + c + \left[d \times (Nw+1) \right] \right\}$$

7. Number of collection locations that one collection vehicle can visit during a collection cycle:

$$H\_c = \frac{Ht \times RD \times CD}{Fr}$$

8. Number of recyclables containers placed at locations visited by a collection vehicle during one collection cycle (*Nb*):

$$Nb = Rb \times H\_c$$

where:

$Nb =$ number of recyclables containers (containers)
$Rb =$ number of containers distributed to each location (containers per location)

9. Annual capital costs associated with a single recyclables container (*Cb*):

$$Cb = (1+e) \times P\_b \times CRF\_b \quad ,$$

where:

$Cb =$ recyclables container capital cost amortized over the economic life of the bin ($ per container per year)
$e =$ administrative rate ($ of administrative expense per $ of capital cost)
$P\_b =$ unit price of a recyclables container ($ per container)
$CRF\_b =$ capital recovery factor for a recyclables container ($year^{-1}$)

The recyclables container capital recovery factor is defined as:

$$CRF\_b = \frac{i \times (1+i)^{L\_b}}{(1+i)^{L\_b} - 1} \quad ,$$

where:

$i =$ yearly discount rate ($year^{-1}$)
$L\_b =$ economic life of a recyclables container (years)

10. Annualized capital cost of recyclables containers placed at locations visited by one collection vehicle (*C_cap_b*):

$$C\_cap\_b = Cb \times Nb \quad ,$$

where:

$C\_cap\_b =$ annualized capital cost of recycling containers ($ per vehicle per year)

11. Annual collection cost per vehicle (*C_vehicle*).

$$C\_vehicle = (1+bv) \times C\_cap\_v + C\_cap\_b + C\_op$$

12. Total annual collection cost (*C_ann*) for the community:

$$C\_ann = Nt \times C\_vehicle$$

13. Annual collection cost per collection location (*C_location*):

$$C\_location = \frac{C\_vehicle}{H\_c}$$

14. Collection cost per ton of recyclables (*C_ton*):

$$C\_ton = \frac{C\_location \times 2000\ {}^{lb}\!/\!_{ton} \times 7\ {}^{days}\!/\!_{week}}{G\_recyc \times 365\ {}^{days}\!/\!_{year}}$$

3.4.3 Residuals (C16)

Option C16 covers collection of the refuse discarded by residents of multi-family dwellings after the removal and separate collection of recyclables. The cost associated with recyclables collection is accounted for by options C14 and/or C15. There is no provision in the Collection process model for separate collection of yard waste generated by residents of multi-family dwellings.

3.4.3.1 Generation Rate

The waste generated for multi-family residual waste reflects the reduced weight of refuse set out for collection due to the removal of recyclables. *G_residual* is calculated as follows:

$$G\_residual = G\_mf - \frac{\sum_j G\_recyc_j \times PF_j \times option\_frac_j}{\sum_j option\_frac_j} ,$$

where:

$G\_residual$ = residual refuse generation rate (pounds per week per collection location)

G_recyc_j = recyclables generation rate for collection option *j*, where *j* is options C14 and C15 (pounds per week per collection location)

PF_j = participation factor for recyclables collection option *j*

$option\_frac_j$ = fraction of collection locations served by collection option *j*

3.4.3.2 Waste Density

The Collection process model calculates an overall density of residual refuse collected by option C16 by averaging the density of the residuals at locations served by each of the multi-family recyclables collection options:

$$D\_residual_{C16} = \frac{\sum_j D\_residual_j \times option\_frac_j}{\sum_j option\_frac_j} ,$$

where:

$D\_residual_{C16}$ = average density of residuals collected by option C16 pounds per cubic yard)

$D\_residual_j$ = overall density of residuals set out by households served by recyclables collection option *j* where *j* is C14 or C15 (pounds per cubic yard)

$option\_frac_j$ = fraction of households served by recyclables collection option *j*

The overall density of residuals set out by households served by a particular recyclables collection option is calculated as follows:

$$D\_residual_j = \left[\sum_i \frac{PF_j \times (1 - cr_{ij}) \times MF\_WT\_FRAC\_1_i}{(1 - frac\_cap\_recyc_j) \times D\_cv_i} + \sum_i \frac{(1 - PF_j) \times MF\_WT\_FRAC\_1_i}{D\_cv_i} \right]^{-1}$$

where:

PF_j = participation factor for recyclables collection option *j* where *j* is C14 or C15 (participating households per total households)

cr_{ij} = capture rate for recyclables component *i* for collection option *j*

$MF\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 multi-family waste composition

D_cv_i = compacted density of recyclables component

$frac\_cap\_recyc_j$ = captured recyclables fraction for collection option *j*

$D\_residual_{C16}$ can also be specified by the user. This is done by entering the desired value in cell *d_residual* in the Option C16 column of the Input Parameters section of the Collection process model. Entering a value in this cell overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_residual* cell is empty, the Collection process model calculates the average residual waste density as described above and uses the calculated value in subsequent calculations.

3.4.3.3 Cost Equations

The steps used to calculate residual collection costs are as follows:

1. Number of locations that a collection vehicle can stop at to collect residual waste before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{(G\_residual / D\_residual)}$$

The remaining cost equations for Residuals collection are identical to the Mixed Waste (option C13) cost equations except that the mixed waste generation rate (*G_msw*) is replaced by a residuals generation rate (*G_residual)*. See Section 3.4.1.3 for a description of the Mixed Waste cost equations.

3.4.4 Wet/Dry Collection

Collection options C17 and C18 model collection of multi-family dwelling waste which has been separated into wet, dry, and recyclable components by residents. Option C17 models simultaneous collection of all three waste types by a three-compartment vehicle. Option C18 models collection of the wet and dry portions only using a two-compartment vehicle; recyclables are collected by another vehicle. (The cost of recyclables collection is accounted for using collection option C14 or C15.) The Collection process model calculates multi-family wet/dry collection costs using the methodology described in Section 3.2.6 for residential wet/dry collection. The reader should refer to that section for a more complete description of the calculation methodology.

3.4.4.1 Wet/Dry/Recyclables (C17)

The user may specify what fraction of each component of MSW will be collected as wet refuse, dry refuse, and recyclables by making entries in the Wet/Dry/Recyclables Separation Factors table located in the Common process model. Component fractions are specified by entering separation factor values ($sf\_WDR\_wet_i$, $sf\_WDR\_dry_i$, or $sf\_WDR\_recyc_i$) between 0.00 and 1.00 in the appropriate cells to indicate the fraction of each component disposed of in a wet, dry, or recyclables container. **Note: The wet, dry, and recyclables separation factors for each component of MSW must sum to 1.00.** Thus, C17 cannot be used in conjunction with other multi-family collection options. The components listed below as “Wet” have default $sf\_WDR\_wet_i$ values of 1.0; components listed as “Dry” have default $sf\_WDR\_dry_i$ values of 1.0. The components in the list of recyclables have a default $sf\_WDR\_recyc_i$ value of 0.75 and a default $sf\_WDR\_dry_i$ value of 0.25.

WET	DRY	RECYCLABLES
Leaves	Non-recyclable paper	Old Newsprint
Grass clippings	Non-recyclable ferrous metal	Old Corrugated Cardboard
Branches	Non-recyclable aluminum	Office Paper
Food waste	Non-recyclable glass	Paper - Other
	Non-recyclable plastic	Ferrous Cans
	Miscellaneous refuse	Ferrous Metal - Other
		Aluminum Cans
		Aluminum - Other
		Clear Glass
		Brown Glass
		Green Glass
		Translucent HDPE
		Pigmented HDPE
		PET
		Plastic - Other

3.4.4.1.1 Dry Waste Generation Rate

The dry waste generation rate is the product of dry waste fraction (*frac_dry*) and the weekly multi-family waste generation rate:

$$G\_dry = frac\_dry \times G\_mf \quad ,$$

where:

$G\_dry =$ weekly dry waste generation rate (pounds per week per collection location)

$G\_mf =$ weekly multi-family waste generation rate (pounds per week per collection location)

The dry refuse fraction (*frac_dry*) is the sum of the weight fractions specified for each component in the Sector 1 multi-family waste composition list in the Common process model multiplied by the corresponding dry refuse separation factor:

$$frac\_dry = \sum_i MF\_WT\_FRAC\_1_i \times sf\_WDR\_dry_i$$

where:

$frac\_dry =$ dry refuse fraction

$MF\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 multi-family waste composition

$sf\_WDR\_dry_i =$ dry refuse separation factor for waste component *i*

3.4.4.1.2 Wet Waste Generation Rate

The wet waste generation rate is the product of the wet waste fraction (*frac_wet*) and the total weekly multi-family waste generation rate (*G_mf*):

$$G\_wet = frac\_wet \times G\_mf \quad ,$$

where:

$G\_wet =$ weekly wet waste generation rate (pounds per week per collection location)

The wet refuse fraction (*frac_wet*) is the sum of the weight fractions specified for each components in the Sector 1 multi-family waste composition list in the Common process model multiplied by the corresponding wet refuse separation factor:

$$frac\_wet = \sum_i MF\_WT\_FRAC\_1_i \times sf\_WDR\_wet_i \quad ,$$

where:

$frac\_wet =$ wet refuse fraction

$MF\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 multi-family waste composition

$sf\_WDR\_wet_i =$ wet refuse separation factor for waste component *i*

3.4.4.1.3 Recyclables Generation Rate

The recyclables generation rate is the product of the captured recyclables fraction (*frac_cap_recyc*) and the total weekly multi-family waste generation rate (*G_mf*):

$$G\_recyc = frac\_cap\_recyc \times G\_mf \quad ,$$

where:

$G\_recyc =$ weekly recyclables waste generation rate (pounds per week per collection location)

The captured recyclables fraction (*frac_cap_recyc*) is the sum of the weight fractions specified for each component in the Sector 1 multi-family waste composition list in the Common process model (*MF_WT_FRAC_*1*)* multiplied by the recyclables separation factor specified for that component in the Common process model:

$$frac\_cap\_recyc = \sum_i MF\_WT\_FRAC\_1_i \times sf\_WDR\_recyc_i \quad ,$$

where:

$frac\_cap\_recyc =$ captured recyclables fraction
$MF\_WT\_FRAC\_1_i =$ weight fraction for recyclable waste components of the Sector 1 multi-family waste composition
$sf\_WDR\_recyc_i =$ recyclables separation factor for waste component *i*

3.4.4.1.4 Waste Densities

Unless the user enters override density values in the appropriate Input Parameter cells in the C17 column, the Collection process model uses the default mixed waste collection vehicle component densities (*D_cv*) listed in the Common process model to calculate overall densities for dry and wet refuse. Default recyclables collection densities (*D_rcv*) and compaction factors (*CF*) are used to calculate an overall density for recyclables. Compaction factors represent the increased density of any recyclables components that are compacted during collection. The default values for all waste components listed in the Input Parameters section of the Collection process model are 1.0.

The dry refuse overall density is calculated as:

$$D\_dry = \frac{frac\_dry}{\sum_i \frac{sf\_WDR\_dry_i \times MF\_WT\_FRAC\_1_i}{D\_cv_i}} \quad ,$$

where:

$D\_dry =$ overall density of dry refuse (pounds per cubic yard)
$frac\_dry =$ dry refuse fraction
$sf\_WDR\_dry_i =$ dry refuse separation factor for waste component *i*
$MF\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 multi-family waste composition
$D\_cv_i =$ compacted density of component *i* (pounds per cubic yard)

The wet refuse overall density is calculated as:

$$D\_wet = \frac{frac\_wet}{\sum_i \frac{sf\_WDR\_wet_i \times MF\_WT\_FRAC\_1_i}{D\_cv_i}} \quad ,$$

where:

$D\_wet =$ overall density of wet refuse (pounds per cubic yard)

$frac\_wet =$ wet refuse fraction
$sf\_WDR\_wet_i =$ wet refuse separation factor for waste component *i*
$MF\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 multi-family waste composition
$D\_cv_i =$ compacted density of component *i* (pounds per cubic yard)

The recyclables overall density is calculated as:

$$D\_recyc = \frac{frac\_cap\_recyc}{\sum_i \frac{sf\_WDR\_recyc_i \times MF\_WT\_FRAC\_1_i}{D\_rcv_i \times CF_i}} \quad ,$$

where:
$D\_recyc =$ overall density of recyclables (pounds per cubic yard)
$frac\_cap\_recyc =$ captured recyclables fraction
$sf\_WDR\_recyc_i =$ recyclables separation factor for waste component *i*
$MF\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 multi-family waste composition
$D\_rcv_i =$ as-collected density of recyclables component *i* (pounds per cubic yard)
$CF_i =$ compaction factor for recyclables component *i* (pound per cubic yard compacted density per pound per cubic yard as-collected density)

3.4.4.1.5 Waste Volumes

The volume occupied in the collection vehicle by the weekly amount of refuse collected at each location (in cubic yards per location per week) is given by the expression:

$$\frac{G\_wet}{D\_wet} + \frac{G\_dry}{D\_dry} + \frac{G\_recyc}{D\_recyc} \ ,$$

where:
$G\_wet =$ multi-family wet refuse generation rate (pounds per location per week)
$D\_wet =$ overall wet refuse density (pounds per cubic yard)
$G\_dry =$ multi-family dry refuse generation rate (pounds per location per week)
$D\_dry =$ overall dry refuse density (pounds per cubic yard)
$G\_recyc =$ multi-family recyclables generation rate (pounds per location per week)
$D\_recyc =$ overall recyclables density (pounds per cubic yard)

3.4.4.1.6 Cost Equations

The steps used to calculate wet/dry/recyclables collection costs are as follows:

1. Number of collection locations that a wet/dry/recyclables collection vehicle can stop at before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(\frac{G\_wet}{D\_wet} + \frac{G\_dry}{D\_dry} + \frac{G\_recyc}{D\_recyc} \right)}$$

The remaining steps in the cost calculations for Option C17 are identical to those listed in Section 3.4.1.3 for Mixed Waste Collection (Option C13).

3.4.4.2 Wet/Dry (C18)

Collection Option C18 models wet/dry collection of waste from multi-family dwellings that are also served by a recyclables collection option. The waste collected by a C18 wet/dry collection vehicle is the residual waste remaining after residents have removed some portion of the recyclables for separate collection. The cost to collect this residual waste must account for the recyclable material which residents did not separate from the rest of their refuse, either because they chose not to participate in a recyclables collection program or because they did not successfully remove 100% of each recyclable component from the rest of their refuse. The collection cost must also account for how residents divide all of the residual waste between the wet and dry waste.

The user may specify what fraction of each component of MSW will be collected as wet refuse and dry refuse by making entries in the Wet/Dry Separation Factors table located in the Common process model. Component fractions are specified by entering separation factor values ($sf\_WD\_wet_i$ or $sf\_WD\_dry_i$) between 0.00 and 1.00 in the appropriate cells to indicate the fraction of each component disposed of in a wet, dry, or recyclables container. **Note: The wet and dry separation factors for each component of MSW must sum to 1.00.**

3.4.4.2.1 Dry Waste Generation Rate

The weekly dry refuse generation rate (*G_dry*) for Collection Option C18 is found by summing the residual dry waste fractions calculated for each of the recyclables collection options and multiplying the result by the weekly multi-family waste generation rate:

$$G\_dry = G\_mf \times \sum_j frac\_dry_j \times option\_frac_j \quad ,$$

where:

G_dry = weekly dry waste generation rate (pounds per week per collection location)
G_mf = weekly multi-family waste generation rate (pounds per week per collection location)
$frac\_dry_j$ = dry refuse fraction for recyclables collection option *j* where *j* is C14 or C15
$option\_frac_j$ = fraction of multi-family dwellings served by recyclables collection option *j*

The dry residuals fraction for a particular recyclables collection option ($frac\_dry_j$) is the sum of the dry portion of the remaining recyclables components from participating and non-participating residents plus the dry portion of the non-recyclables components. This can be calculated as:

$$frac\_dry_j = \sum_i MF\_WT\_FRAC\_1_i \times sf\_WDR\_dry_i \times \left[PF_j \times \left(1 - cr_{ij}\right) + \left(1 - PF_j\right)\right]$$

where:

$frac\_dry_j$ = dry refuse fraction for recyclables collection option *j*
$MF\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 multi-family waste composition
$sf\_WDR\_dry_i$ = dry refuse separation factor for waste component *i*
PF_j = participation factor for recyclables collection option *j*
cr_{ij} = capture rate for component *i*, recyclables collection option *j*

3.4.4.2.2 Wet Waste Generation Rate

The weekly wet refuse generation rate (G_wet) for Collection Option C18 is found by summing the residual wet waste fractions calculated for each of the recyclables collection options and multiplying the result by the weekly multi-family waste generation rate:

$$G\_wet = G\_mf \times \sum_j frac\_wet_j \times option\_frac_j \ ,$$

where:

G_wet = weekly wet waste generation rate (pounds per week per collection location)
G_mf = weekly multi-family waste generation rate (pounds per week per collection location)
$frac\_wet_j$ = wet refuse fraction for recyclables collection option *j* where *j* is C14 or C15

$option\_frac_j =$ fraction of multi-family dwellings served by recyclables collection option *j*

The wet residuals fraction for a particular recyclables collection option ($frac\_wet_j$) is the sum of the wet portion of the remaining recyclables components from participating and non-participating residents plus the wet portion of the non-recyclables components. This can be calculated as:

$$frac\_wet_j = \sum_i MF\_WT\_FRAC\_1_i \times sf\_WDR\_wet_i \times \left[PF_j \times \left(1 - cr_{ij}\right) + \left(1 - PF_j\right)\right] ,$$

where:

$frac\_wet_j =$ wet refuse fraction for recyclables collection option *j*
$MF\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 multi-family waste composition
$sf\_WDR\_wet_i =$ wet refuse separation factor for waste component *i*
$PF_j =$ participation factor for recyclables collection option *j*
$cr_{ij} =$ capture rate for component *i*, recyclables collection option *j*

3.4.4.2.3 Wet Waste Density

Unless the user enters override wet waste density in the *d_wet* Input Parameter cell in the C18 column, the Collection process model calculates the overall wet waste density by averaging the overall wet densities of residual waste collected from multi-family dwellings served by different recyclables collection options:

$$D\_wet_{C18} = \sum_j D\_wet_j \times option\_frac_j$$

where:

$D\_wet_{C18} =$ overall density of wet refuse collected by a C18 wet/dry collection vehicle (pounds per cubic yard)
$D\_wet_j =$ overall density of wet refuse from multi-family dwellings served by recyclables collection option *j*, where *j* is C14 or C15
$option\_frac_j =$ fraction of multi-family dwellings served by recyclables collection option *j*

The overall wet density of waste collected from locations that are served by a particular recyclables collection option (D_wet_j) must account for both the wet portions of the non-recyclable components of the waste stream and the wet portions of the recyclable components which were not collected from participating and non-participating residents. D_wet_j is calculated as:

$$D\_wet_j = \frac{frac\_wet_j}{\sum_i \frac{sf\_WDR\_wet_i \times RES\_WT\_FRAC\_1_i \times \left[PF_j \times \left(1-cr_{ij}\right) + \left(1-PF_j\right)\right]}{D\_cv_i}}$$

where:

D_wet_j = overall density of wet waste from households served by recyclables collection option *j* (pounds per cubic yard)

$frac\_wet_j$ = wet refuse fraction for recyclables collection option *j*

$sf\_WDR\_wet_i$ = wet refuse separation factor for waste component *i*

$RES\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 residential waste composition

PF_j = participation factor for recyclables collection option *j*

cr_{ij} = capture rate for component *i*, recyclables collection option *j*

D_cv_i = compacted density of component *i* (pounds per cubic yard)

3.4.4.2.4 Dry Waste Density

Unless the user enters override dry waste density in the *d_dry* Input Parameter cell in the C18 column, the Collection process model calculates the overall dry waste density by averaging the overall dry densities of residual waste collected from multi-family dwellings served by different recyclables collection options:

$$D\_dry_{C18} = \sum_j D\_dry_j \times option\_frac_j \ ,$$

where:

D_dry_{C18} = overall density of dry refuse collected by a C18 wet/dry collection vehicle (pounds per cubic yard)

D_dry_j = overall density of dry refuse from multi-family dwellings served by recyclables collection option *j*, where *j* is C14 or C15

$option\_frac_j$ = fraction of multi-family dwellings served by collection option *j*

The overall dry density of waste collected from locations that are served by a particular recyclables collection option (D_dry_j) must account for both the dry portions of the non-recyclable components of the waste stream and the dry portions of the recyclable components which were not collected from participating and non-participating residents. D_dry_j is calculated as:

$$D\_dry_j = \frac{frac\_dry_j}{\sum_i \frac{sf\_WDR\_dry_i \times MF\_WT\_FRAC\_1_i \times \left[PF_j \times \left(1 - cr_{ij}\right) + \left(1 - PF_j\right)\right]}{D\_cv_i}}$$

where:

D_dry_j = overall density of dry waste from multi-family dwellings served by recyclables collection option *j* (pounds per cubic yard)

$frac\_dry_j$ = dry refuse fraction for recyclables collection option *j*

$sf\_WDR\_dry_i$ = dry refuse separation factor for waste component *i*

$MF\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 multi-family waste composition

PF_j = participation factor for recyclables collection option *j*

cr_{ij} = capture rate for component *i*, recyclables collection option *j*

D_cv_i = compacted density of component *i* (pounds per cubic yard)

3.4.4.2.5 Waste Volume

The volume occupied in the collection vehicle by the weekly amount of refuse collected at each location (in cubic yards per location per week) is given by the expression:

$$\frac{G\_wet}{D\_wet} + \frac{G\_dry}{D\_dry}$$

3.4.4.2.6 Cost Equations

The steps used to calculate wet/dry collection costs are as follows:

1. Number of collection locations that a wet/dry collection vehicle can stop at before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(\frac{G\_wet}{D\_wet} + \frac{G\_dry}{D\_dry}\right)}$$

The remaining steps in the cost calculations for Option C18 are identical to those listed in Section 3.4.1.3 for Mixed Waste Collection (Option C13).

3.5 Commercial Waste Collection

Factories, stores, office buildings, etc. may use their own vehicles to transport waste generated on their sites to a disposal site. Or, they may contract with a privately owned collection service to provide vehicles for this purpose. However, the Collection process model calculates costs to collect commercial waste as though these costs are borne by the public sector, as they are assumed to be for residential and multi-family dwelling waste collection.

The Collection process model models the collection of commercial waste the same way that it models multi-family waste collection. Commercial businesses are assumed to dispose of their waste in containers located at their places of business. Collection vehicles are dispatched from a vehicle garage at the beginning of each workday to make the rounds of these refuse container locations. Vehicles collect waste or recyclables until they reach capacity. Fully loaded vehicles drive to a treatment or disposal facility, unload, and begin another collection trip. At the end of the workday the vehicles return to the vehicle garage.

The user can specify the total number of commercial waste collection locations (H_com) and the per capita generation rate for commercial waste (GR) in the appropriate data entry cells of the Common process model. Another cell in the Common process model calculates the average weekly waste generation rate per commercial waste collection location (G_com):

$$G\_com = \frac{GR \times (res\_pop + mf\_pop) \times 7 \ {}^{days}\!/\!_{week}}{H\_com} ,$$

where:

$G\_com =$ weekly commercial waste generation rate (pounds per location per week)
$GR =$ daily commercial waste generation rate (pounds per person per day)
$res\_pop =$ number of people living in residential households (persons)
$mf\_pop =$ number of people living in multi-family dwellings (persons)
$H\_com =$ number of commercial collection locations (locations)

There are two collection options provided in the Collection process model to describe commercial waste collection. Option C20 models collection of mixed refuse while Option C19 models collection of commercial recyclables. If the user specifies that the participation factor for Option C19 is zero (i.e., no recycling), then Option C20 models collection of the entire waste stream. If the user specifies a non-zero recycling participation factor for Option C19, then Option C20 models collection of the residual waste.

3.5.1 Recyclables (C19)

Collection option C19 models collection of recyclables that have been separated from the non-recyclable portion of commercial waste. The cost equations for options C19 are very similar in form to the cost equations for options C2, C3, and C4 for collection of residential recyclables. See Section 3.2.2.3 for a more detailed description of the calculation methodology.

3.5.1.1 Generation Rate

The generation rate for recyclables (*G_recyc*) is found my multiplying the weekly collection location waste generation rate (*G_com*) by the fraction of recyclables removed or "captured" from the waste stream by residents (*frac_cap_recyc*). When the Collection process model is used with the Optimization Model, the Optimization Model determines which components of the waste stream are collected by a particular collection option. When the Collection process model is used in stand-alone mode, the user specifies which components are collected. The method used to do this is described below.

The weekly recyclable generation rate for recyclables collection option *j* is calculated as:

$$G\_recyc = G\_com \times frac\_cap\_recyc \quad ,$$

where:

$G\_recyc =$ weekly commercial recyclables generation rate (pounds per week per location)

$G\_com =$ weekly commercial MSW generation rate (pounds per location per week)

$frac\_cap\_recyc =$ captured recyclables fraction

The captured recyclables fraction is found by summing the fraction of recyclable material removed by commercial businesses from each component of the commercial MSW stream. A table is provided in the Collection process model worksheet where the user can enter values to indicate what fraction of each recyclable component is removed by participating businesses from their mixed waste and deposited into recyclables containers. This fraction is referred to as the "capture rate" (*cr*). Entering a value of 0.75 as the capture rate for aluminum cans, for instance, indicates that on average businesses successfully remove 75% of their aluminum cans from refuse and deposit them in a recyclables container. The other 25% is collected along with other non-captured recyclables and the business' non-recyclable refuse by another collection vehicle. Costs for collection of this "residual" waste are accounted for in the Commercial Mixed Waste collection option (C20). Leaving a cell blank or entering a zero in the capture rate table indicates that the component represented by that cell is not included in the recyclables collection program.

Default capture rates are assigned to the following commercial waste stream components:

- Old Newsprint
- Old Corrugated Cardboard
- Office Paper
- Phone Books
- Third Class Mail
- Paper - Other (3 classes)
- Ferrous Cans
- Ferrous Metal - Other
- Aluminum Cans
- Clear Glass
- Brown Glass
- Green Glass
- PET
- Other combustible/compostable/recyclable material
- Other combustible/non-compostable/recyclable material

The Common process model contains listings of waste component weight fractions for ten different commercial waste compositions. To determine the amount of recyclables removed from the waste stream (*frac_cap_recyc*), the Collection process model cell formulas multiply the user-specified/default capture rate for each waste component *i* (cr_i) by the corresponding weight fraction specified for that component in the Sector 1 commercial waste composition table (*COM_WT_FRAC_1*).

$$frac\_recyc = \sum_i cr_i \times COM\_WT\_FRAC\_1 \ ,$$

where:

$frac\_cap\_recyc =$ captured recyclables fraction for collection option *j* where *j* is C14 or C15
$cr_i =$ capture rate for waste component *i*
$COM\_WT\_FRAC\_1 =$ weight fraction for waste component *i* of the Sector 1 commercial waste composition

3.5.1.2 Waste Density

Default values for the as-collected density of recyclable components of the commercial waste stream are listed in the Common process model (*D_rcv*). Default values for waste component compaction factors (*CF*) are listed in the Input Parameters section of the

Collection Processor. Compaction factors represent the increased density of waste components that are compacted during collection. The default compaction factor value for all commercial waste components is 1.0. The Collection process model uses these values and the default values of the individual component weight fractions for commercial waste Sector 1 listed in the Common process model (*COM_WT_FRAC_1*) to calculate an overall density for commercial recyclables in a recyclables collection vehicle:

$$D\_recyc = \frac{frac\_cap\_recyc}{\sum_i \frac{cr_i \times COM\_WT\_FRAC\_1_i}{D\_rcv_i \times CF_i}} \quad ,$$

where:

$D\_recyc =$ overall density of (pounds per cubic yard)
$frac\_cap\_recyc =$ captured recyclables fraction
$cr_i =$ capture rate for waste component *i*
$MF\_WT\_FRAC\_1_i =$ weight fraction for waste component *i* of the Sector 1 commercial waste composition
$D\_rcv_i =$ as-collected density of recyclables component *i* (pounds per cubic yard)
$CF_i =$ compaction factor for waste component *i* (pound per cubic yard compacted density per pound per cubic yard as-collected density)

D_recyc can also be specified by the user. This is done by entering the desired value in cell *d_recyc* in the Option C19 column of the Input Parameters section of the Collection process model. Entering a value in this cell overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_recyc* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.5.1.3 Cost Equations

Commercial recyclables collection costs are calculated using the same steps described in Section 3.2.2.3 for residential recyclables collection. However, the participation factor used in the residential recycling cost equations to adjust for fewer households visited by collection vehicles is omitted from the commercial collection cost equations. A recyclables collection vehicle stops at all commercial collection location regardless of how many individual businesses elected to participate in the recycling program. Thus, the participation factor value is 1 and is not listed as a variable.

The steps used to calculate commercial recyclables collection costs are as follows:

1. Number of locations that a recyclables collection vehicle can stop at to collect recyclables before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{\left(G\_recyc / D\_recyc\right)} \ ,$$

where:

$D\_recyc =$ density of recyclables (pounds per cubic yard)
$G\_recyc =$ recyclables generation rate (pounds per week per location)

NOTE: If the value of *Ht* calculated by the Collection process model is less than 1, the user should increase the collection frequency (*Fr*) until *Ht* is greater than or equal to 1. *Ht* will be less than 1 if the volume of recyclables generated at individual collection locations is greater than the usable capacity of the collection vehicle. This may result in the calculation of negative values for some of the parameters calculated below. Alternatively, the capacity of the collection vehicle could be increased where possible based on local conditions.

2. Length of time that it takes a collection vehicle to make one collection trip:

$$Tc = \left[Tbet \times (Ht - 1)\right] + \left[TL \times Ht\right] + \left(2 \times Trf\right) + S$$

3. Number of collection trips that a vehicle can make during one workday:

$$RD = \frac{(WV \times 60) + \left(F1 + F2 + Tgr + Tfg\right) + \left[0.5 \times \left(Trf + S\right)\right]}{Tc}$$

4. Number of collection vehicle trips (*RT*) needed to visit all of the commercial recyclables collection locations in the community served by the collection option:

$$RT = \frac{H\_com}{Ht} \ ,$$

where:

$RT =$ number of collection trips (trips)
$H\_com =$ number of commercial collection locations (locations)

5. Number of collection vehicles:

$$Nt = \frac{RT}{RD} \times \frac{Fr}{CD}$$

6. Annual capital (*C_cap*) and operating (*C_op*) costs associated with a single collection vehicle:

Capital Cost

$$C\_cap\_v = (1+e) \times P\_v \times CRF\_v$$

Operating Cost

$$C\_op\_v = (1+e) \times \left\{ (1+a) \times \left[(1+bw) \times (Wa \times Nw + Wd) \times WP \times CD \times \frac{365 \, {}^{days}\!/_{year}}{7 \, {}^{days}\!/_{week}} \right] + c + \left[d \times (Nw+1) \right] \right\}$$

7. Number of collection locations that one collection vehicle can visit during a collection cycle:

$$H\_c = \frac{Ht \times RD \times CD}{Fr}$$

8. Number of recyclables containers placed at locations visited by a collection vehicle during one collection cycle (*Nb*):

$$Nb = Rb \times H\_c \quad ,$$

where:

$Nb =$ number of recyclables containers (containers)
$Rb =$ number of containers distributed to each location (containers per location)

9. Annual capital costs associated with a single recyclables container (*Cb*):

$$Cb = (1+e) \times P\_b \times CRF\_b$$

where:

$Cb =$ recyclables container capital cost amortized over the economic life of the bin ($ per container per year)
$e =$ administrative rate ($ of administrative expense per $ of capital cost)
$P\_b =$ unit price of a recyclables container ($ per container)
$CRF\_b =$ capital recovery factor for a recyclables container ($year^{-1}$)

The recyclables container capital recovery factor is defined as:

$$CRF\_b = \frac{i \times (1+i)^{L\_b}}{(1+i)^{L\_b} - 1}$$

where:

$i =$ yearly discount rate ($year^{-1}$)
$L\_b =$ economic life of a recyclables container (years)

10. Annualized capital cost of recyclables containers placed at locations visited by one collection vehicle (*C_cap_b*):

$$C\_cap\_b = Cb \times Nb \ ,$$

where:

$C\_cap\_b =$ annualized capital cost of recycling containers ($ per vehicle pr year)

11. Annual collection cost per vehicle (*C_vehicle*).

$$C\_vehicle = (1 + bv) \times C\_cap\_v + C\_cap\_b + C\_op$$

12. Total annual collection cost (*C_ann*) for the community:

$$C\_ann = Nt \times C\_vehicle$$

13. Annual collection cost per collection location (*C_location*):

$$C\_location = \frac{C\_vehicle}{H\_c}$$

14. Collection cost per ton of recyclables (*C_ton*):

$$C\_ton = \frac{C\_location \times 2000\ {}^{lb}\!/_{ton} \times 7\ {}^{days}\!/_{week}}{G\_recyc \times 365\ {}^{days}\!/_{year}}$$

3.5.2 Mixed Waste (C20)

Collection option C20 models collection of commercial mixed waste. If recyclables are collected separately using option C19, then option C20 models collection of the residual commercial waste.

3.5.2.1 Waste Generation Rate

The waste generation rate for commercial mixed waste (*G_msw*) reflects the reduced amount of refuse disposed of for collection due to the removal of recyclables. *G_msw* is calculated as follows:

$$G\_msw = G\_com - \left(G\_recyc \times PF\right)$$

where:

G_msw = mixed waste generation rate (pounds per week per collection location)
G_com = weekly commercial waste generation rate (pounds per location per week)
G_recyc = weekly commercial recyclables generation rate (pounds per week per location)
PF = recycling program participation factor (participating businesses per total businesses)

3.5.2.2 Waste Density

The Collection process model calculates the overall density of commercial mixed waste collected by option C20 as follows:

$$D\_msw = \left[\sum_i \frac{PF \times \left(1 - cr_i\right) \times COM\_WT\_FRAC\_1_i}{\left(1 - frac\_cap\_recyc\right) \times D\_cv_i} + \sum_i \frac{\left(1 - PF\right) \times COM\_WT\_FRAC\_1_i}{D\_cv_i}\right]^{-1}$$

where:

D_msw = overall density of mixed waste (pounds per cubic yard)
PF = recycling program participation factor (number of participating businesses per total number of businesses)
cr_i = capture rate for recyclables component *i*
$COM\_WT\_FRAC\_1_i$ = weight fraction for waste component *i* of the Sector 1 commercial waste composition

$D\_cv_i =$ compacted density of waste component *i* (pounds per cubic yard)
$frac\_cap\_recyc =$ captured recyclables fraction for collection option C19

D_msw can also be specified by the user. This is done by entering the desired value in cell *d_msw* in the Option C20 column of the Input Parameters section of the Collection process model. Entering a value in this cell overrides the calculation procedure described above, and the Collection process model uses the user-specified density value in all subsequent calculations. If the *d_msw* cell is empty, the Collection process model calculates the overall density and uses the calculated value in subsequent calculations.

3.5.2.3 Cost Equations

The steps used to calculate commercial mixed waste collection costs are as follows:

1. Number of locations that a collection vehicle can stop at to collect residual waste before it is filled to capacity:

$$Ht = \frac{Ut \times Vt \times Fr}{(G\_msw / D\_msw)}$$

NOTE: If the value of *Ht* calculated by the Collection process model is less than 1, the user should increase the collection frequency (*Fr*) until *Ht* is greater than or equal to 1. *Ht* will be less than 1 if the volume of mixed waste generated at individual collection locations is greater than the usable capacity of the collection vehicle. This may result in the calculation of negative values for some of the parameters calculated below. Alternatively, the capacity of the collection vehicle could be increased where possible based on local conditions.

The remaining cost equations for commercial mixed waste collection are identical to the Mixed Waste (option C13) cost equations. See Section 3.4.1.3 for a description of the Mixed Waste cost equations.

4. COLLECTION VEHICLE CALCULATION PARAMETERS

The calculations performed in the Collection process model to determine LCI parameter consumption and release rates are based in part on a common set of collection vehicle parameters. Once calculated from user input or default values, they are used repeatedly in subsequent calculations. To avoid repetition in this document, the equations used to calculate these parameters are described in Chapter 4. References to the appropriate section of this chapter are provided when these parameters are used in the calculations described in later chapters.

4.1 Daily Activity Durations

The following equations are used to calculate the length of time that an individual collection vehicle spends performing various activities during one workday. Some of these times are specified directly by the user or are provided as default values. The others are derived from values of collection cost parameters previously described in Chapter 3. These times are used to calculate fuel consumption associated with stop and go driving on the collection route and fuel consumption associated with other driving activities.

4.1.1 Residential Curbside, Multi-Family, and Commercial Waste Collection

Collection options that describe residential curbside collection, multi-family waste collection, and commercial waste collection involve collection vehicles traveling from one collection location to the next location where they stop, load refuse or recyclables deposited for collection, and drive on to the next location. The following equations calculate time durations for collection vehicle activities.

1. Travel time from the vehicle garage to the first collection site it visited by a collection vehicle during its workday (*Tgr*).

    See Equation 2 in Section 3.2.1.3

2. Number of collection stops that a collection vehicle makes during one workday (*SD*):

$$SD = \frac{Ht \times RD}{HS} ,$$

where:

- SD = number of collection stops per day (stops per day per vehicle)
- Ht = number of households/collection locations that a collection vehicle can collect refuse from during one collection trip (households/locations per trip)
- RD = number of collection trips that a collection vehicle can make in one day (trips per day per vehicle)
- HS = number of households that a collection vehicle collects refuse from at each stop (households per stop) **NOTE: This parameter is only used for residential collection options.**

3. Cumulative time spent loading refuse into the vehicle at collection stops (*LD*):

$$LD = TL \times SD ,$$

where:

- LD = cumulative daily loading time at collection stops (minutes per day per vehicle)
- TL = loading time at a collection stop (minutes per stop)
- SD = number of collection stops per day (stops per day per vehicle)

4. Travel time between collection stops (*Tbtw*):

   See Equation 3 in Section 3.2.1.3

5. Cumulative daily travel time between collection stops (*Tb*):

$$Tb = \left[SD - \left(1 \,{}^{stop}\!/_{day} \times RD\right)\right] \times Tbtw \ ,$$

where:

- $Tb =$ cumulative daily travel time between collection stops (minutes per day per vehicle)
- $SD =$ number of collection stops per day (stops per day per vehicle)
- $RD =$ number of collection trips that a collection vehicle can make in one day (trips per day per vehicle)
- $Tbtw =$ average travel time between adjacent collection stops (minutes)

6. Travel time between start/end of a collection route and the disposal facility (*Trf*):

   See Equation 4 in Section 3.2.1.3

7. Cumulative daily time spent traveling between starting or ending points of collection routes and the disposal facility (*F_R*):

$$F\_R = \left[\left(2 \times RD\right) + 0.5\right] \times Trf \ ,$$

where:

- $F\_R =$ cumulative daily travel time between collection route and disposal facility (minutes per day per vehicle)
- $RD =$ number of collection trips that a collection vehicle can make in one day (trips per day per vehicle)
- $Trf =$ travel time between start/end of collection route and the disposal facility (minutes per trip)

8. Cumulative daily time spent unloading refuse at the disposal facility (*UD*):

$$UD = \left(RD + 0.5\right) \times S \ ,$$

where:

- $UD =$ cumulative daily unloading time at disposal site (minutes per day per vehicle)

RD = number of collection trips that a collection vehicle can make in one day (trips per day per vehicle)
S = unloading time at disposal site (minutes per trip)

9. Travel time from the disposal facility to the vehicle garage at the end of the workday (Tfg):

   See Equation 5 in Section 3.2.1.3

4.1.2 Recyclables Drop-Off

Residential waste collection option C8 covers collection of recyclable material that residents have deposited in roll-on/roll-off containers at a centrally located drop-off site. Collection vehicles are dispatched from a garage to collect the accumulated material and transport it to a treatment or disposal facility. Instead of making a sequence of stops to collect refuse, the collection vehicles make round trips between the waste sites and the recyclables treatment or disposal facility. The following equations calculate collection vehicle travel times between the vehicle garage, the collection site, and the treatment/disposal facility, and the time spent loading and unloading recyclables.

1. Travel time from the vehicle garage to the collection site (*Tgr*):

   See Equation 2 in Section 3.2.1.3.

2. Cumulative daily time spent loading recyclables into the vehicle at the collection site (*LD*):

$$LD = TL \times RD$$

where:

LD = cumulative daily loading time at the collection site (minutes per day per vehicle)
TL = loading time at the collection site (minutes per stop)
RD = collection trips per day (trips per day per vehicle)

3. Travel time between collection site and the treatment/disposal facility (*Trf*):

   See Equation 3 in Section 3.2.1.3.

4. Cumulative daily time spent traveling between the collection site and the treatment or disposal facility (*F_S*):

$$F\_S = [(2 \times RD) - 1] \times Trf$$

5. Cumulative daily time spent unloading recyclables at the treatment/disposal facility (*UD*):

$$UD = RD \times S$$

6. Travel time from the treatment/disposal facility to the vehicle garage at the end of the workday (*Tfg*). See Equation 5 in Section 3.2.1.3

4.2 Daily Service Hours

Service hours are the length of time that a vehicle is used for collection activities, excluding lunch and other breaks. The parameter "service hours per day" is used to calculate the frequency of maintenance activities that result in LCI parameter consumption and/or release rates such as vehicle washdowns and motor fluid replacement.

4.2.1 Residential Curbside, Multi-Family, and Commercial Waste Collection

Daily service hours for residential curbside, multi-family, and commercial waste collection vehicles are calculated as follows:

$$ShD = \frac{Tgr + LD + Tb + F\_R + UD + Tfg}{60\ ^{min}/_{hr}},$$

where:

$ShD =$ collection vehicle service hours per day (hours per day per vehicle)
$Tgr =$ travel time from vehicle garage to first collection location (minutes per day per vehicle)
$LD =$ cumulative daily loading time at collection locations (minutes per day per vehicle)
$Tb =$ cumulative daily travel time between collection stops (minutes per day per vehicle
$F\_R =$ cumulative daily travel time between collection routes and disposal facility (minutes per day per vehicle)
$UD =$ cumulative daily unloading time at disposal facility (minutes per day per vehicle)
$Tfg =$ travel time from disposal facility to vehicle garage (minutes per day per vehicle)

4.2.2 Recyclables Drop-Off

Daily service hours for a collection vehicle that services a recyclables drop-off collection site are calculated as follows:

$$ShD = \frac{Tgr + LD + F\_R + UD + Tfg}{60 \, {}^{min}\!/_{hr}} \ ,$$

where:

$ShD =$ collection vehicle service hours per day (hours per day per vehicle)
$Tgr =$ travel time from vehicle garage to the collection site (minutes per day per vehicle)
$LD =$ cumulative daily loading time at the collection site (minutes per day per vehicle)
$F\_R =$ cumulative daily travel time between the collection site and te treatment/disposal facility (minutes per day per vehicle)
$UD =$ cumulative daily unloading time at the treatment/disposal facility (minutes per day per vehicle)
$Tfg =$ travel time from treatment/disposal facility to vehicle garage (minutes per day per vehicle)

4.3 Daily Miles Traveled

The number of miles traveled per day by a collection vehicle is used to calculate mileage-based LCI parameters including air emissions and consumption of vehicle maintenance items such as engine oil.

4.3.1 Residential Curbside, Multi-Family, and Commercial Waste Collection

The following equations are used to calculate the total distance that a residential curbside, multi-family, or commercial waste collection vehicle travels during one workday.

1. Distance vehicle travels from vehicle garage to the starting point of the first collection route (*Dgr*):

$$Dgr = \frac{Vgr \times Tgr}{60 \, {}^{min}\!/_{hr}} \, ,$$

where:

$Dgr =$ distance from garage to start of first collection route (miles per day per vehicle)
$Vgr =$ average travel speed between garage and start of first collection route (miles per hour)
$Tgr =$ travel time from garage to start of first collection route (minutes per day per vehicle)

2. Cumulative daily distance traveled between collection stops (*Db*):

$$Db = \frac{Vbet \times Tb}{60 \, {}^{min}\!/_{hr}} \, ,$$

where:

$Db =$ cumulative daily distance traveled between collection stops (miles per day per vehicle)
$Vbet =$ average travel speed between collection stops (miles per hour)
$Tb =$ cumulative daily travel time between collection stops (minutes per day)

3. Cumulative daily distance traveled between start/end points of collection routes and the treatment or disposal facility (*DF_R*):

$$DF\_R = \frac{Vfr \times F\_R}{60 \, {}^{\text{min}}\!/_{hr}} \, ,$$

where:

$DF\_R =$ cumulative daily distance between start/end of collection routes and the treatment/disposal facility (miles per day per vehicle)
$Vrf =$ average travel speed between start/end of collection route and the disposal facility (miles per hour)

$F\_R =$ cumulative travel time between start/end of collection routes and the disposal facility (minutes per day per vehicle)

4. Distance from the treatment or disposal facility to the vehicle garage (*Dfg*):

$$Dfg = \frac{Vfg \times Tfg}{60 \text{ min}/_{hr}} ,$$

where:

$Dfg =$ distance from treatment/disposal facility to the garage (miles per day per vehicle)

$Vfg =$ average travel speed between disposal facility and garage (miles per hour)

$Tfg =$ travel time from disposal facility to garage at the end of the workday (minutes per day per vehicle)

5. Total distance traveled by a collection vehicle during one workday (*MiD*):

$$MiD = Dgr + Db + DF\_R + Dfg ,$$

where:

$MiD =$ total miles traveled per day (miles per day per vehicle)

4.3.2 Recyclables Drop-Off

The following equations are used to calculate the distance that a recyclables drop-off collection vehicle travels during one workday.

1. Distance vehicle travels from vehicle garage to the collection site at the beginning of its workday (*Dgr*):

$$Dgr = \frac{Vgr \times Tgr}{60\ {}^{min}\!/_{hr}}$$

2. Cumulative daily distance traveled between the collection site and the recyclables treatment/disposal facility (*DF_S*):

$$DF\_S = \frac{Vrf \times F\_S}{60\ {}^{min}\!/_{hr}},$$

where:

DF_S	=	cumulative daily distance traveled between the collection site and the treatment/disposal facility (miles per day per vehicle)
Vrf	=	average travel speed between the collection site and the treatment/disposal facility (miles per hour)
F_S	=	cumulative travel time between the collection site and the treatment/disposal facility (minutes per day per vehicle)

3. Distance from the treatment/disposal facility to the vehicle garage (*Dfg*):

$$Dfg = \frac{Vfg \times Tfg}{60\ {}^{\min}\!/_{hr}}$$

4. Total distance traveled by a collection vehicle during one workday (*MiD*):

$$MiD = Dgr + DF\_R + Dfg$$

4.4 Daily Fuel Usage

The parameter "gallons of fuel per day per vehicle" (*Fuel_D*) is used to calculate energy consumption rates, airborne pollutant release rates, and waterborne pollutant release rates.

4.4.1 Residential Curbside, Multi-Family, and Commercial Waste Collection

The following equations are used to calculate the amount of fuel used by a residential curbside, multi-family, or commercial waste collection vehicle during one day's activities. Total daily fuel usage is the sum of the fuel burned while the vehicle is traveling (garage to first collection route; between collection stops; between collection route and disposal facility; disposal facility to garage) and the fuel burned while the vehicle is stopped with its engine idling (loading at collection stops; unloading at disposal site).

1. Daily fuel usage while traveling (*fuel_trav*):

$$fuel\_trav = \frac{(Tgr \times Vgr) + (F\_R \times Vrf) + (Tfg \times Vfg)}{MPG\_trav\_cv \times 60\ {}^{min}\!/\!_{hr}} + \frac{(Tb \times Vbet)}{MPG\_btwn\_cv \times 60\ {}^{min}\!/\!_{hr}}\ ,$$

where:

$fuel\_trav =$ daily collection vehicle fuel usage while traveling (gallons per day per vehicle)

$MPG\_trav\_cv =$ collection vehicle fuel consumption rate while traveling (miles per gallon)

$MPG\_btwn\_cv =$ collection vehicle fuel consumption rate while traveling between collection stops (miles per gallon)

2. Daily fuel usage while idling (*fuel_idle*):

$$fuel\_idle = \frac{(LD + UD) \times GPH\_idle\_cv}{60\ {}^{min}\!/\!_{hr}},$$

where:

$fuel\_idle =$ daily collection vehicle fuel usage while traveling (gallons per day per vehicle)

$GPH\_idle\_cv =$ collection rate fuel consumption rate while idling (gallons per hour)

3. Total daily fuel usage (*FuelD*):

$$FuelD = fuel\_trav + fuel\_idle\ ,$$

where:

$FuelD$ = daily collection vehicle fuel usage (gallons per day per vehicle)

4.4.2 Recyclables Drop-Off

The following equations are used to calculate the amount of fuel used by a recyclables drop-off collection vehicle during one day's activities. Total daily fuel usage is the sum of the fuel burned while the vehicle is traveling (garage to collection site; between collection site and treatment/disposal facility; treatment/disposal facility to garage) and the fuel burned while the vehicle is stopped with its engine idling (loading at collection site; unloading at treatment/disposal facility).

1. Daily fuel usage while traveling (*fuel_trav*).

$$fuel\_trav = \frac{(Tgr \times Vgr) + (F\_S \times Vrf) + (Tfg \times Vfg)}{MPG\_trav\_cv \times 60 \ {}^{min}\!/\!_{hr}}$$

2. Daily fuel usage while idling (*fuel_idle*).

$$fuel\_idle = \frac{(LD + UD) \times GPH\_idle\_cv}{60 \ {}^{min}\!/\!_{hr}}$$

3. Total daily fuel usage (*FuelD*).

$$FuelD = fuel\_trav + fuel\_idle$$

4.5 Daily Waste Collection Rate

The parameter "daily weight of refuse collected per vehicle" (*RefD*) is used to compute LCI parameter consumption and release rates on a "per ton of waste collected" basis. For instance, energy consumption is initially calculated in units of kilowatt hours per collection vehicle per day. Dividing this quantity by the tons of waste collected per day per collection vehicle yields an energy consumption rate in terms of kilowatt hours per ton of waste collected.

The formula used to calculate *Ref_D* is:

$$RefD = \frac{Vt \times Ut \times D\_avg \times RD}{2000\ {}^{lb}\!/_{ton}}\ ,$$

where:

$RefD =$ daily weight of refuse collected per collection vehicle (tons per day per vehicle)

$Vt =$ collection vehicle capacity (cubic yards per trip)

$Ut =$ collection vehicle utilization factor

$D\_avg =$ overall density of refuse (pounds per cubic yard)

$RD =$ number of collection trips per day per vehicle (trips per day per vehicle)

5. ENERGY CONSUMPTION EQUATIONS

The Collection process model uses default or user-supplied data on fuel consumed by collection vehicles, drop-off vehicles (options C8 and C10 only), and electricity consumed at the vehicle garage to calculate the total amount of energy consumed per ton of material collected. Energy consumption is expressed in terms of British Thermal Units per ton of waste collected (Btu per ton).

The Collection process model accounts for two types of energy associated with both fuel and electricity. The fuel energy calculations include (1) the energy released when fuel is combusted in a collection vehicle or a resident's drop-off vehicle and (2) the energy expended to manufacture the fuel from petroleum feed stock. This second form of energy is called "pre-combustion energy". Likewise for electricity usage, the calculations include (1) the Btu value of the electricity consumed at the vehicle garage and (2) the pre-combustion energy associated with the production of the fuels used to generate the electricity consumed at the vehicle garage. Default data relating fuel combustion and pre-combustion energy to air, water, and solid waste emissions are found in the Common process model. Default data on the Btu value of electricity, including its pre-combustion energy, are located in the Electrical Energy process model.

For all collection options except C8 and C10, the total energy consumption rate per ton of refuse collected is expressed by:

$$E\_ton = E\_cv\_ton + E\_gar\_ton \;,$$

where:

$E\_ton =$ total energy consumption rate (Btu per ton)

$E\_cv\_ton =$ collection vehicle energy consumption rate (Btu per ton)

$E\_gar\_ton =$ garage energy consumption rate (Btu per ton)

For collection option C8 (recyclables drop-off by residents using their own vehicles; transfer of recyclables from the drop-off site to a treatment/disposal site using collection vehicles), the total energy consumption rate is given by:

$$E\_ton = E\_cv\_ton + E\_gar\_ton + E\_dov\_ton \;,$$

where:

$E\_dov\_ton =$ drop-off vehicle energy consumption rate (Btu per ton)

For collection option C10 (yard waste drop-off at a treatment/disposal site by residents using their own vehicles), the total energy consumption rate is given by:

$$E\_ton = E\_dov\_ton$$

5.1 Collection Vehicles

Energy consumption by collection vehicles is the sum of the energy consumed by the combustion of diesel fuel plus the pre-combustion energy associated with production of diesel fuel from petroleum feedstock.

1. Fuel usage per ton of refuse (*FuelTon*).

$$FuelTon = \frac{FuelD}{RefD} ,$$

where:

$FuelTon =$ fuel usage per ton of refuse (gallons per ton)
$FuelD =$ daily collection vehicle fuel usage (gallons per day per vehicle)
$RefD =$ daily weight of refuse collected per vehicle (tons per day per vhicle)

2. Fuel combustion energy per ton of refuse (*E_fuel_ton*).

$$E\_fuel\_ton = FuelTon \times dsl\_enrg ,$$

where:

$E\_fuel\_ton =$ fuel combustion energy consumption rate (Btu per ton)
$dsl\_enrg =$ energy content of diesel fuel (Btu per gallon)

3. Pre-combustion energy per ton of refuse (*E_pc_ton*).

$$E\_pc\_ton = FuelTon \times dsl\_pc\_enrg ,$$

where:

$E\_pc\_ton =$ fuel pre-combustion energy consumption rate (Btu per ton)
$dsl\_pc\_enrg =$ pre-combustion energy content of diesel fuel (Btu per gallon)

4. Total collection vehicle energy consumption per ton of refuse (*E_cv_ton*).

$$E\_cv\_ton = E\_fuel\_ton + E\_pc\_ton$$

5.2 Drop-Off Vehicles

The fuel energy consumed by drop-off vehicles is a function of the round trip distance they travel between a residence and the drop-off site, their fuel consumption rate while traveling (expressed in miles per gallon), the fraction of trips they make that are dedicated solely to recyclables or yard waste drop-off (versus trips made for other purposes that include refuse drop-off as a secondary objective), the weight of refuse carried per trip, and the Btu value of the fuel they consume (including both combustion and pre-combustion energy).

5.2.1 Recyclables (C8)

1. Fuel usage per trip to the recyclables drop-off site (*FuelT*).

$$FuelT = \frac{RTDdos \times DED}{MPG\_dov} \ ,$$

where:

$FuelT =$ fuel usage per trip (gallons per trip)
$RTDdos =$ round trip distance to drop-off site (mile per trip)
$DED =$ fraction of trips that are dedicated trips (dedicated trips per total trips)
$MPG\_dov =$ drop-off vehicle fuel consumption rate (miles per gallon)

2. Weight of recyclables delivered to drop-off site per trip (*RefT*).

$$RefT = \frac{G\_recyc \times 365 \ {}^{days}\!/_{year}}{7 \ {}^{days}\!/_{week} \times FREQdos \times 12 \ {}^{months}\!/_{year}} \ ,$$

where:

$RefT =$ weight of recyclables dropped off per trip (pounds per trip)
$G\_recyc =$ weekly recyclables generation rate (pounds per week per household)
$FREQdos =$ frequency of trips to the drop-off site (trips per month)

3. Fuel usage per ton of recyclables delivered to the drop-off site (*FuelTon_dov*).

$$FuelTon\_dov = \frac{FuelT}{RefT} \times 2000 \ {}^{lb}\!/_{ton} \ ,$$

where:

$FuelTon\_dov =$ fuel usage per ton of recyclables (gallons per ton)

4. Fuel combustion energy per ton of recyclables (*E_fuel_ton*).

$$E\_fuel\_ton = FuelTon\_dov \times gas\_enrg \ ,$$

where:

$E\_fuel\_ton =$ fuel combustion energy consumption rate (Btu per ton)

$gas\_enrg =$ energy content of gasoline (Btu per gallon)

5. Pre-combustion energy per ton of recyclables (*E_pc_ton*).

$$E\_pc\_ton = FuelTon\_dov \times gas\_pc\_enrg\ ,$$

where:

$E\_pc\_ton =$ fuel pre-combustion energy consumption rate (Btu per ton)
$gas\_pc\_enrg =$ pre-combustion energy content of gasoline (Btu per gallon)

6. Total drop-off vehicle energy consumption per ton of recyclables (*E_dov_ton*).

$$E\_dov\_ton = E\_fuel\_ton + E\_pc\_ton\ ,$$

where:

$E\_dov\_ton =$ drop-off vehicle energy consumption rate (Btu per ton)

5.2.2 Yard Waste (C10)

1. Fuel usage per trip to the yard waste drop-off site (*FuelT*).

$$FuelT = \frac{RTDdos \times DED}{MPG\_dov} ,$$

where:

$FuelT =$ fuel usage per trip (gallons per trip)
$RTDdos =$ round trip distance to drop-off site (mile per trip)
$DED =$ fraction of trips that are dedicated trips (dedicated trips per total trips)
$MPG\_dov =$ drop-off vehicle fuel consumption rate (miles per gallon)

2. Weight of yard waste delivered to drop-off site per trip (*RefT*).

$$RefT = \frac{G\_yw \times 365 \, {}^{days}\!/_{year}}{7 \, {}^{days}\!/_{week} \times FREQdos \times 12 \, {}^{months}\!/_{year}} ,$$

where:

$RefT =$ weight of yard waste dropped off per trip (pounds per trip)
$G\_yw =$ weekly yard waste generation rate (pounds per week per household)
$FREQdos =$ frequency of trips to the drop-off site (trips per month)

3. Fuel usage per ton of yard waste delivered to the drop-off site (*FuelTon_dov*).

$$FuelTon\_dov = \frac{FuelT}{RefT} \times 2000 \, {}^{lb}\!/_{ton} ,$$

where:

$FuelTon\_dov =$ fuel usage per ton of yard waste (gallons per ton)

4. Fuel combustion energy per ton of yard waste (*E_fuel_ton*).

$$E\_fuel\_ton = FuelTon\_dov \times gas\_enrg ,$$

where:

$E\_fuel\_ton =$ fuel combustion energy consumption rate (Btu per ton)

$gas\_enrg =$ energy content of gasoline (Btu per gallon)

5. Pre-combustion energy per ton of yard waste (*E_pc_ton*).

$$E\_pc\_ton = FuelTon\_dov \times gas\_pc\_enrg \ ,$$

where:

$E\_pc\_ton =$ fuel pre-combustion energy consumption rate (Btu per ton)
$gas\_pc\_enrg =$ pre-combustion energy content of gasoline (Btu per gallon)

6. Total drop-off vehicle energy consumption per ton of yard waste (*E_dov_ton*).

$$E\_dov\_ton = E\_fuel\_ton + E\_pc\_ton \ ,$$

where:

$E\_dov\_ton =$ drop-off vehicle energy consumption rate (Btu per ton)

5.3 Garage

The collection vehicle garage includes both a covered maintenance area and an office. The energy consumed at the collection vehicle garage per ton of refuse is a function of the garage area per collection vehicle, the electricity consumed per unit of garage area, the weight of refuse collected per vehicle, and the Btu value of the electricity (including the pre-combustion energy associated with generation of the electricity). The Btu value of electricity used in the Collection process model is the regional Btu value per aggregate kilowatt hour of electricity. This value is obtained from the Electric Energy process model.

1. Electricity consumed per collection vehicle (*ElecD*).

$$ElecD = (maint\_area \times maint\_elec) + (off\_area \times off\_elec) ,$$

where:

$ElecD =$ electricity consumed per collection vehicle (kWh per vehicle)
$maint\_area =$ garage maintenance area per collection vehicle (ft^2 per vehicle)
$maint\_elec =$ garage maintenance area electricity consumption rate (kWh per ft^2)
$off\_area =$ garage office area per collection vehicle (ft^2 per vehicle)
$off\_elec =$ garage office area electricity consumption rate (kWh per ft^2)

2. Electricity consumed per ton of refuse (*ElecTon*).

$$ElecTon = \frac{ElecD}{RefD} ,$$

where:

$ElecTon =$ electricity consumed per ton of refuse (kWh per ton)

3. Energy consumed at garage per ton of refuse (*E_gar_ton*).

$$E\_gar\_ton = ElecTon \times region\_btu\_per\_elec\_kwh ,$$

where:

$region\_btu\_per\_elec\_kwh =$ regional Btu value per aggregate kilowatt hour of electricity (Btu per kWh)

6. WATER CONSUMPTION EQUATIONS

When calculating the volume of water consumption associated with waste collection, the Collection process model accounts for water used to wash down collection vehicles and to wash down the garage maintenance area. This water volume is used in Chapter 9 to calculate the amounts of waterborne pollutants emitted per ton of material collected. The Chapter 9 calculations also account for waterborne pollutants released in the water used to generate the energy consumed in the collection vehicle garage and in the water used to produce the fuel consumed in collection vehicles and drop-off vehicles.

For each type of water usage, the Collection process model calculates the daily amount of water required for an individual collection vehicle, then divides the result by the daily weight of refuse collected by a vehicle to obtain the volume of water used per ton of refuse collected. This can be expressed as:

$$WaterTon = \frac{W\_cv + W\_gar}{RefD} ,$$

where:

$WaterTon =$ total water consumption rate (gallons per ton)
$W\_cv =$ collection vehicle water consumption (gallons per vehicle per day)
$W\_gar =$ garage water consumption (gallons per vehicle per day)
$RefD =$ daily weight of refuse collected by a collection vehicle (tons per vehicle per day)

6.1 Collection Vehicles

Collection vehicle water consumption is a function of the volume of water used to wash down a vehicle and the frequency of vehicle washdowns. The user can specify vehicle washdown frequency based on cumulative vehicle miles traveled (*WdMi*) or cumulative service hours (*WdSh*). The Collection Preprocess first checks the value for *WdMi*. If the value in the *WdMi* cell is non-zero, the collection vehicle water consumption rate is calculated as:

$$W\_cv = \frac{WdVol \times MiD}{WdMi} ,$$

where:

$WdVol =$ volume of water per vehicle washdown (gallons per washdown per vehicle)
$MiD =$ daily miles traveled by a collection vehicle (miles per day)
$WdMi =$ washdown frequency (miles per washdown)

If there is no value entered for *WdMi* or if the value in the *WdMi* cell is zero, the Collection process model uses the value for *WdSh* to calculate collection vehicle water consumption as follows:

$$W\_cv = \frac{WdVol \times ShD}{WdSh} ,$$

where:

$ShD =$ daily number of hours that a collection vehicle is in service (hours per day)
$WdSh =$ washdown frequency (hours per washdown)

If vehicles are never washed, or if the user wishes to neglect this water use, *WdVol* should be assigned a value of zero.

6.2 Garage

Daily water consumption associated with the garage is found by calculating the volume of water used to wash down the maintenance area of the garage. It is calculated on a per vehicle basis to keep its units consistent with those for vehicle washdowns.

$$W\_gar = maint\_wd\_vol \times maint\_area \times WdD \ ,$$

where:

$maint\_wd\_vol =$ volume of washdown water per unit area (gallons per ft^2 per washdown)
$maint\_area =$ garage maintenance area per collection vehicle (ft^2 per vehicle)
$WdD =$ garage washdown frequency (washdowns per day)

7. AIRBORNE RELEASE EQUATIONS

The Collection process model calculates the amounts (by weight) of airborne pollutants emitted per ton of material collected using the miles traveled and fuel consumed by collection vehicles and electricity consumed at the vehicle garage. These calculations are made for all collection options except for option C10 (yard waste drop-off) which does not use collection vehicles. The equations for options C8 (recyclables drop-off) and C10 include the emissions associated with fuel consumed in the vehicles residents use to drop off their refuse at collection sites. Airborne release rates are expressed in terms of pounds of pollutant per ton of waste collected.

Release rates are calculated for the following airborne pollutants:

- Carbon monoxide
- Nitrogen oxides
- Total Particulates (particulate matter greater than 10 microns)
- PM_{10} (particulate matter smaller than 10 microns)
- Carbon dioxide emissions from fossil fuel sources
- Carbon dioxide emissions from biomass fuel sources
- Sulfur oxides
- Hydrocarbons, excluding methane
- Methane
- Lead
- Ammonia
- Hydrochloric acid

The Collection process model also calculates values for the Greenhouse Gas Equivalence of the emissions associated with each collection option. This calculation is described in Section 7.4.

The Collection process model accounts for two forms of airborne pollutant emissions associated with the fuel combusted in vehicles. The fuel emission calculations include (1) the pollutants released when fuel is combusted in a collection vehicle or a resident's drop-off vehicle and (2) the pollutants emitted when the fuel was refined from petroleum feed stock. This second form of release is called "pre-combustion emissions". Similarly, the emissions calculations for electricity consumed at the vehicle garage include (1) the pollutants released when the electricity was generated and (2) the pre-combustion emissions associated with the production of the fuels used to generate the electricity. Default values for fuel combustion emission factors (EF_p, where p is a particular pollutant) are listed in the Input Parameter section of the Collection process model. Default values for pre-combustion emission factors for diesel fuel (d_em_p) and gasoline (g_em_p) are found in the Common process model. Default values for electricity generation emission factors (r_tot_p) are located in the Electrical Energy process model. These factors include pre-combustion emissions.

For all collection options except C8 and C10, the total airborne release rate per ton of refuse collected for pollutant p is expressed by:

$$A\_ton_p = A\_cv\_ton_p + A\_gar\_ton_p \ ,$$

where:

$A\_ton_p =$ total airborne release rate of pollutant p (pounds per ton)
$A\_cv\_ton_p =$ collection vehicle emission rate of pollutant p (pounds per ton)
$A\_gar\_ton_p =$ garage emission rate of pollutant p (pounds per ton)

For collection option C8 (recyclables drop-off with collection vehicles used to transfer recyclables from the drop-off site to a disposal site), the total airborne release rate is given by:

$$A\_ton_p = A\_cv\_ton_p + A\_gar\_ton_p + A\_dov\_ton_p \ ,$$

where:

$A\_dov\_ton_p =$ drop-off vehicle emission rate of pollutant p (pounds per ton)

For collection option C10 (yard waste drop-off at a disposal site), the total airborne release rate is given by:

$$A\_ton_p = A\_dov\_ton_p$$

7.1 Collection Vehicles

The mass of airborne pollutant *p* released per ton of refuse collected is found by summing the emissions associated with collection vehicle fuel combustion and the pre-combustion emissions associated with production of fuel from petroleum feedstock.

1. Airborne releases from fuel combustion:

$$A\_fuel\_ton_p = \frac{EF_p \times 0.002205\, {}^{lb}\!/_{g} \times MiD}{RefD},$$

where:

$A\_fuel\_ton_p$ = collection vehicle airborne release rate for pollutant *p* due to combustion of diesel fuel (pounds per ton)
EF_p = collection vehicle combustion emission factor for pollutant *p* (rams per mile)
MiD = collection vehicle miles traveled per day (miles per day)
$RefD$ = daily weight of refuse collected per vehicle (pounds per vehicle per day)

2. Airborne releases from fuel pre-combustion:

$$A\_pc\_ton_p = \frac{FuelTon \times d\_em_p}{1000\, {}^{gal}\!/_{1,000\,gal}},$$

where:

$A\_pc\_ton_p$ = collection vehicle airborne release rate for pollutant *p* due to diesel fuel pre-combustion (pounds per ton)
$FuelTon$ = collection vehicle fuel usage per ton of refuse collected (gallons per ton)
d_em_p = diesel fuel pre-combustion emission factor for pollutant *p* (pounds per 1000 gallons)

3. Total collection vehicle airborne release rate:

$$A\_cv\_ton_p = A\_fuel\_ton_p + A\_pc\_ton_p$$

7.2 Drop-Off Vehicles

The mass of airborne pollutant *p* released per ton of recyclables or yard waste dropped off at a collection or disposal site is found by summing the emissions associated with drop-off vehicle fuel combustion and the pre-combustion emissions associated with production of fuel from petroleum feedstock.

1. The fuel combustion air pollutant emission rate for drop-off vehicles is a function of the round trip distance they travel between a residence and the drop-off site, the fraction of trips they make that are dedicated solely to recyclables or yard waste drop-off (versus trips made for other purposes that include refuse drop-off as a secondary objective), the weight of material carried per trip, and the emission factor for a particular pollutant:

$$A\_fuel\_ton_p = \frac{RTDdos \times DED \times EF_p \times 0.002205\ {}^{lb}\!/_{g} \times 2000\ {}^{lb}\!/_{ton}}{RefT} \ ,$$

where:

$RTDdos =$ round trip distance to drop-off site (mile per trip)
$DED =$ fraction of trips that are dedicated trips (dedicated trips per total trips)
$RefT =$ weight of material dropped off per trip (pounds per trip)

2. The pre-combustion air pollutant emission rate for drop-off vehicles is a function of the volume of fuel (assumed to be gasoline) consumed per ton of refuse and the pre-combustion emission factor for a particular pollutant:

$$A\_pc\_ton_p = \frac{FuelTon\_dov \times g\_em_p}{1000\ {}^{gal}\!/_{1{,}000\,gal}} \ ,$$

where:

$A\_pc\_ton_p =$ drop-off vehicle airborne release rate for pollutant *p* due to gasoline pre-combustion (pounds per ton)
$FuelTon\_dov =$ drop-off vehicle fuel usage per ton of recyclables (gallons per ton)
$g\_em_p =$ gasoline pre-combustion emission factor for pollutant *p* (pounds per 1000 gallons)

3. Total drop-off vehicle airborne release rate:

$$A\_cv\_ton_p = A\_fuel\_ton_p + A\_pc\_ton_p$$

7.3 Garage

The airborne emission rates associated with the electricity consumed at the collection vehicle garage are a function of the garage area per collection vehicle, the electricity consumed per unit of garage area, the weight of refuse collected per vehicle, and the pollutant emission rate per kilowatt hour of electricity (including the pre-combustion energy associated with generation of the electricity). The pollutant emission rates used in the Collection process model are the regional total emissions per aggregate kilowatt hour of electricity. These values are obtained from the Electric Energy process model in units of pounds per kilowatt hour.

1. Electricity consumed per collection vehicle (*ElecD*):

$$ElecD = (maint\_area \times maint\_elec) + (off\_area \times off\_elec)$$

2. Electricity consumed per ton of refuse (*ElecTon*):

$$ElecTon = \frac{ElecD}{RefD}$$

3. Airborne emission rate of pollutant *p* per ton of refuse ($A\_gar\_ton_p$):

$$A\_gar\_ton_p = ElecTon \times r\_tot_p$$

where:

r_tot_p = regional total emission rate of pollutant *p* per aggregate kilowatt hour of electricity (pound per kWh)

7.4 Greenhouse Gas Equivalence

The Collection process model calculates Greenhouse Gas Equivalence per ton of refuse (*GGE*) collected for four atmospheric releases: carbon dioxide (CO_2), methane (CH_4), nitrogen oxides (NO_x), and other hydrocarbons (HC). It is calculated as:

$$GGE_p = A\_ton_p \times GWP_p \ ,$$

where:

GGE_p = Greenhouse Gas Equivalence per ton for pollutant *p* where *p* is CO_2, CH_4, NO_x, or HC (equivalents per ton)

A_ton_p = total airborne release rate of pollutant *p* (pounds per ton)

GWP_p = Relative 20-year Global Warming Potential for pollutant *p* (equivalents per pound)

The Greenhouse Gas Equivalence per ton of refuse from all four components is summed and reported as Total Greenhouse Gas Equivalence per ton of refuse:

$$GGE_{total} = \sum_p GGE_p$$

8. WATERBORNE RELEASE EQUATIONS

The Collection process model uses the previously described consumption parameters *WaterTon* (gallons of water consumed per ton of refuse collected), *FuelTon* (gallons of fuel consumed per ton of refuse), and *ElecTon* (kilowatts of electricity consumed per ton of refuse) to calculate the amounts of waterborne pollutants emitted per ton of material collected. Waterborne release rates are expressed in terms of pounds of pollutant per ton of material collected.

Release rates are calculated for the following waterborne pollutants:

- Dissolved Solids
- Suspended Solids
- Biochemical Oxygen Demand
- Chemical Oxygen Demand
- Oil
- Sulfuric Acid
- Iron
- Ammonia
- Copper
- Cadmium
- Arsenic
- Mercury
- Phosphate
- Selenium
- Chromium
- Lead
- Zinc

The Collection process model accounts for two types of waterborne pollutant emissions associated with generation of the electricity consumed at the vehicle garage. The waterborne release calculations include (1) the pollutants released when the electricity consumed at the garage was generated and (2) the pre-combustion emissions associated with the production of the fuels used to generate electricity. Waterborne releases associated with fuel combustion are assumed to be nil, so the fuel emission calculations only include pre-combustion waterborne pollutants. Default values for electricity generation waterborne pollutant emission factors (r_tot_p , where p is particular pollutant) are located in the Electrical Energy process model. Default values for pre-combustion waterborne pollutant emission factors for diesel fuel (d_em_p) and gasoline (g_em_p) are found in the Common process model.

For all collection options except C8 and C10, the total waterborne release rate per ton of refuse collected for pollutant *p* is expressed by:

$$W\_ton_p = W\_cv\_ton_p + W\_gar\_ton_p \ ,$$

where:

W_ton_p = total waterborne emission rate of pollutant *p* (pounds per ton)

$W\_cv\_ton_p$ = collection vehicle emission rate of pollutant *p* (pounds per ton)

$W\_gar\_ton_p$ = garage emission rate of pollutant *p* (pounds per ton)

For collection option C8 (recyclables drop-off with collection vehicles used to transfer recyclables from the drop-off site to a disposal site), the total waterborne release rate is given by:

$$W\_ton_p = W\_cv\_ton_p + W\_gar\_ton_p + W\_dov\_ton_p \ ,$$

where:

$W\_dov\_ton_p$ = drop-off vehicle emission rate of pollutant *p* (pounds per ton)

For collection option C10 (yard waste drop-off at a disposal site), the total waterborne release rate is given by:

$$W\_ton_p = W\_dov\_ton_p$$

8.1 Collection Vehicles

The mass of waterborne pollutant *p* released per ton of refuse collected is found by summing the emissions associated with water usage and the pre-combustion emissions associated with production of fuel from petroleum feedstock.

1. Waterborne releases from water usage (vehicle and garage washdown water):

$$W\_water\_ton_p = WaterTon \times EF_p \ ,$$

where:

$W\_water\_ton_p =$ collection vehicle waterborne release rate for pollutant *p* due to water consumption (pounds per ton)
$WaterTon =$ collection vehicle water consumption rate (gallons per ton)
$EF_p =$ washdown water emission factor for pollutant *p* (pounds per gallon)

2. Waterborne releases from fuel pre-combustion:

$$W\_pc\_ton_p = \frac{FuelTon \times d\_em_p}{1000 \ {}^{gal}\!/\!_{1{,}000\,gal}} \ ,$$

where:

$W\_pc\_ton_p =$ collection vehicle waterborne release rate for pollutant *p* due to diesel fuel pre-combustion (pounds per ton)
$FuelTon =$ collection vehicle fuel usage per ton of refuse collected (gallons per ton)
$d\_em_p =$ diesel fuel pre-combustion emission factor for pollutant *p* (pounds per 1000 gallons)

3. Total collection vehicle waterborne release rate:

$$W\_cv\_ton_p = W\_water\_ton_p + W\_pc\_ton_p$$

8.2 Drop-Off Vehicles

The drop-off vehicle water pollutant emission rate is due solely to pre-combustion of gasoline which is a function of the volume of fuel (assumed to be gasoline) consumed per ton of refuse and the pre-combustion emission factor for a particular pollutant:

$$W\_dov\_ton_p = \frac{FuelTon\_dov \times g\_em_p}{1000\ {}^{gal}\!/_{1,000\,gal}} \ ,$$

where:

$W\_dov\_ton_p$ = total drop-off vehicle waterborne release rate for pollutant *s* (pounds per ton)

$FuelTon\_dov$ = drop-off vehicle fuel usage rate (gallons per ton)

g_em_p = gasoline pre-combustion emission factor for pollutant *p* (pounds per 1000 gallons)

8.3 Garage

The waterborne emission rates associated with the electricity consumed at the collection vehicle garage are a function of the electricity consumed per ton of refuse collected and the pollutant emission rate per kilowatt hour of electricity (including the pre-combustion emissions associated with production of the fuel used to generate the electricity). The pollutant emission rates used in the Collection process model are the regional total emissions per aggregate kilowatt hour of electricity. These values are obtained from the Electric Energy process model in units of pounds of pollutant per kilowatt hour.

$$W\_gar\_ton_p = ElecTon \times r\_tot_p$$

where:

$ElecTon =$ electricity consumed per ton of refuse (kWh per ton)
$r\_tot_p =$ regional total emission rate of pollutant p per aggregate kilowatt hour of electricity (pounds per kWh)

9. SOLID WASTE GENERATION EQUATIONS

The Collection process model uses previously described consumption parameters to calculate the amount of solid waste generated by collection vehicles, drop-off vehicles, and the collection vehicle garage. The generation rates of the solid waste by-products of fuel and energy consumption are expressed in terms of pounds of solid waste per ton of refuse collected. Generation rates for miscellaneous waste items such as tires and engine fluids are expressed in terms appropriate for the particular item.

Solid wastes associated with fuel combustion are negligible, so the fuel emission calculations only include pre-combustion solid wastes (i.e., wastes created when the fuel was refined from petroleum feedstock). The Collection process model accounts for two types of solid waste associated with generation of the electricity consumed at the vehicle garage: (1) the solid waste produced by the combustion of fuel to generate electricity and (2) the pre-combustion solid waste associated with the production of the fuels used to generate electricity. Default values for five categories of electricity solid waste generation factors are located in the Electrical Energy process model (r_tot_s, where s is a solid waste category). Default values for fuel pre-combustion solid waste generation factors for diesel fuel (d_em_s) and gasoline (g_em_s) are found in the Common process model.

For all collection options except C8 and C10, the total generation rate per ton of refuse collected for solid waste s is expressed by:

$$SW\_ton_s = SW\_cv\_ton_s + SW\_gar\_ton_s \ ,$$

where:

$SW\_ton_s =$ total generation rate for solid waste s (pounds per ton)

$SW\_cv\_ton_s =$ collection vehicle generation rate for solid waste s (pounds per ton)

$SW\_gar\_ton_s =$ garage generation rate for solid waste s (pounds per ton)

For collection option C8 (recyclables drop-off with collection vehicles used to transfer recyclables from the drop-off site to a disposal site), the total solid waste generation rate is given by:

$$SW\_ton_s = SW\_cv\_ton_s + SW\_gar\_ton_s + SW\_dov\_ton_s \ ,$$

where:

$SW\_dov\_ton_s$ = drop-off vehicle generation rate for solid waste *s* (pound per ton)

For collection option C10 (yard waste drop-off at a disposal site), the total solid waste generation rate is given by:

$$SW\_ton_s = SW\_dov\_ton_s$$

9.1 Collection Vehicles

The mass of solid waste *s* released per ton of refuse collected is found by calculating the pre-combustion emissions associated with production of fuel from petroleum feedstock.

$$SW\_pc\_ton_p = \frac{FuelTon \times d\_em_s}{1000\ {}^{gal}\!/_{1,000\,gal}} ,$$

where:

$SW\_pc\_ton_s$ = collection vehicle generation rate for solid waste *s* due to diesel fuel pre-combustion (pounds per ton)
$FuelTon$ = collection vehicle fuel usage per ton of refuse collected (gallons per ton)
d_em_s = diesel fuel pre-combustion emission factor for solid waste *s* (pounds per 1000 gallons)

9.2 Drop-Off Vehicles

The drop-off solid waste rate is a function of the volume of fuel (assumed to be gasoline) consumed per ton of recyclables or yard waste dropped off at a collection site and the pre-combustion emission factor for a particular category of solid waste:

$$SW\_dov\_ton_s = \frac{FuelTon\_dov \times g\_em_s}{1000 \; {}^{gal}\!/_{1,000\,gal}} ,$$

where:

$SW\_dov\_ton_s$ = total drop-off vehicle generation rate for solid waste *s* (pounds per ton)
$FuelTon\_dov$ = drop-off vehicle fuel usage rate (gallon per ton)
g_em_s = gasoline pre-combustion emission factor for solid waste *s* (pounds per 1000 gallons)

9.3 Garage

The solid waste generation rates associated with the electricity consumed at the collection vehicle garage are a function of the electricity consumed per ton of refuse collected and the waste generation rates per kilowatt hour of electricity (including the pre-combustion waste associated with production of fuel used to generate the electricity). The solid waste generation rates used in the Collection process model are the regional total emissions per aggregate kilowatt hour of electricity. These values are obtained from the Electric Energy process model in units of pounds per kilowatt hour.

$$SW\_gar\_ton_s = ElecTon \times r\_tot_s$$

where:

$SW\_gar\_ton_s =$ garage generation rate for solid waste *s* (pounds per ton)
$ElecTon =$ electricity consumed per ton of refuse (kWh per ton)
$r\_tot_s =$ regional total emission rate of solid waste *s* per aggregate kilowatt hour of electricity (pounds per kWh)

10. REFERENCES

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USEPA, 1993. "Life Cycle Design Guidance Manual - Environmental Requirements and The Product System." EPA/600/R-92/226.

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Appendices

APPENDIX A

DEFAULT INPUT VALUES (FOR VARIABLES WITHOUT SECTOR OR NEXT NODE VARIABILITY)

The following pages show a printout of default values for Collection Preprocessor input values.

Solid vertical lines are used in the printout to separate collection options into sets of options that are similar to each other. Lightly shaded cells represent input variables which might be expected to have a unique value for the option in which the shaded cell appears. Darkly shaded cells represent input variables that are used in the area of the spreadsheet shown, but which are entered in some other location. An example of this type of input would be the distance to unloading. These distances are entered for each possible unloading destination in the "Collection Distances" sheet of the process model. Cells that are not shaded represent input variables that are expected to have the same value for some or all collection options. Non-shaded cells are linked to the value of a shaded cell in the same row. If the user overrides the value of a shaded cell by entering an new value, then the values of all the non-shaded cells in the same row that are linked to the shaded cell will take on the override value. For instance, the default value for HS (the number of households whose waste is collected at one collection vehicle stop) for Collection Option C1 (Residential Mixed Waste Collection) is one household per stop. The HS cell in column C1 is a shaded cell. All of the other HS cells for residential collection options are non-shaded and hence they all have default values of one household per stop. If the HS value in the C1 column is changed to 2 households per stop, then the HS values for Collection Options C0, C2, C3, C4, C5, C6, C7, C9, C11, and C12 will automatically change to 2 households per stop.

Table A - 1 Residential Collection Inputs

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
collection schedule												
no. of households at one stop (households/stop)	HS	1	1	1	1	1	1	1	1	1	1	1
collection frequency (1 / week)	Fr	1	1	1	1	1	1	1	1	1	1	1
number of working days a week (days/week)	CD	5	5	5	5	5	5	5	5	5	5	5
actual working hours a day (hours/vehicle-day)	WV	7	7	7	7	7	7	7	7	7	7	7
working hours a day for wage (hours/person-day)	WP	8	8	8	8	8	8	8	8	8	8	8
collection operation times												
loading time at one service stop (min/stop)	TL	0.15	0.15	0.15	0.17	0.17	0.15	0.45	0.45	0.15	0.15	0.15
travel time between service stops (min/stop)	Tbtw	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
travel time btwn route and disposal fac. (min/trip)	Trf	20	20	20	20	20	20	20	20	20	20	20
time to unload at disposal facility (min/trip)	S	15	15	15	20	20	15	20	20	15	15	15
lunch time (min/day-vehicle)	F1	30	30	30	30	30	30	30	30.00	30.00	30	30
break time (min/day-vehicle)	F2	30	30	30	30	30	30	30	30.00	30.00	30	30
time from grg to 1st collection route (min/day-vhcl)	Tgr	20	20	20	20	20	20	20	20	20	20	20
time from disposal fac. to garage (min/day-vhcl)	Tfg	20.00	20	20	20	20.00	20	20.00	20	20	20.00	20.00
labor												
does a driver work as a collector? (y/n)		n	n	n	n	n	n	y	y	n	y	y
number of collectors per vehicle (person/vehicle)	Nw	1	1	1	1	1	1	0	0	1	0	0
worker backup rate (backup workers/coll. workers)	bw	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
economic data												
fringe benefit rate (fringe benefit $/wage$)	a	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
other expenses rate ($/worker-year)	d	8,083	8083	8083	8083	8083	8083	8083	8083	8083	8083	8083
administrative rate (admin. $/capital & op.cost $)	e	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
hourly wage for a collector ($/hr-person)	Wa	8.65	8.65	8.65	8.65	8.65	8.65	8.65	8.65	8.65	8.65	8.65
hourly wage for a driver ($/hr-person)	Wd	12	12	12	12	12	12	12	12	12	12	12

Table A - 2 Residential Collection Inputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
collection vehicle												
backup rate for vehicles (backup vhcl/coll. vhcl)	bv	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
utilization factor (occupied yd3 / usable yd3)	Ut	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
usable vehicle capacity (yd3)	Vt	20	20	20	20	20	20	23	23	23	20	20
economic life of a vehicle (year)	Lt	7	7	7	7	7	7	8	8	8	7	7
unit price of a vehicle ($/vehicle)	Pt	133525.11	133525.1142	133525.1142	144652.207	144652.207	133525.1142	55635.46423	55635.46423	133525.1142	133525.1142	166906.3927
vehicle operation and maint. cost ($/vehicle)	c	29375.53	29375.52511	29375.52511	33381.27854	33381.27854	29375.52511	30822.04718	30822.04718	29375.52511	29375.52511	29375.52511
msw compartment compaction density (lb / yd3)	d_msw	0	N/A	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
recyclables compartment density (lb / yd3)	d_recyc	N/A	N/A	N/A	0	0	N/A	0	0	0	N/A	N/A
residual waste compaction density (lb / yd3)	d_residual	N/A	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
wet waste compaction density (lb/yd3)	d_wet	N/A	N/A	N/A	N/A	0	0	N/A	N/A	N/A	N/A	N/A
dry waste compaction density (lb/yd3)	d_dry	N/A	N/A	N/A	N/A	0	0	N/A	N/A	N/A	N/A	N/A
yard waste compaction density (lb / yd3)	d_yw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0
travel speeds												
between collection stops (miles/hour)	Vbet	5	5	5	5	5	5	5	5	5	5	5
from collection route to facility (miles/hour)	Vrf	30.00	30	30	30	30	30	30	30	30	30	30
from garage to route in the morning (mile/hour)	Vgr	35	35	35	35	35	35	35	35	35	35	35
from facility to garage (miles/hour)	Vfg	35	35	35	35	35	35	35	35	35	35	35
distances												
distance between collection stops (miles)	Dbet	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142
distance btwn collection route and facility (miles)	Drf	11.00	11.00	11.00	11.00	15.00	15.00	11.00	11.00	11.00	10.00	10.00
distance btwn garage and collection route (miles)	Dgr	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667
distance between facility and garage (miles)	Dfg	13.00	13.00	13.00	13.00	14.00	14.00	13.00	13.00	13.00	11.67	11.67
fuel usage rates												
while traveling (miles/gallon)	MPG_trav_cv	5	5	5	5	5	5	5	5	5	5	5
between collection stops (miles/gallon)	MPG_btwn_cv	2	2	2	2	2	2	2	2	2	2	2
while idling (gallons/hour)	GPH_idle_cv	1	1	1	1	1	1	1	1	1	1	1

Table A - 3 Residential Collection Inputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
airborne emission release rates												
HC release rate (gram/mile)	HC_mile_cv	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
CO release rate (gram/mile)	CO_mile_cv	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03	5.03
NOx release rate (gram/mile)	NOx_mile_cv	34.02	34.02	34.02	34.02	34.02	34.02	34.02	34.02	34.02	34.02	34.02
Total particulates release rate (gram/mile)	PM_mile_cv	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
PM10 release rate (grams/mile)	PM10_mile_cv	0	0	0	0	0	0	0	0	0	0	0
CO2 release rate - fossil (gram/mile)	CO2f_mile_cv	0	0	0	0	0	0	0	0	0	0	0
CO2-biomass release rate (gram/mile)	CO2bm_mile_cv	0	0	0	0	0	0	0	0	0	0	0
SOx release rate (gram/mile)	SOx_mile_cv	0	0	0	0	0	0	0	0	0	0	0
CH4 release rate (gram/mile)	CH4_mile_cv	0	0	0	0	0	0	0	0	0	0	0
Lead release rate (gram/mile)	Pb_mile_cv	0	0	0	0	0	0	0	0	0	0	0
Ammonia release rate (gram/mile)	NH3_mile_cv	0	0	0	0	0	0	0	0	0	0	0
Hydrochloric acid release rate (gram/mile)	HCl_mile_cv	0	0	0	0	0	0	0	0	0	0	0
waterborne release rates												
Dissolved solids (lb/gal)	DS	0	0	0	0	0	0	0	0	0	0	0
Suspended solids (lb/gal)	SS	0	0	0	0	0	0	0	0	0	0	0
BOD of washdown water (lb/gal)	BOD	0	0	0	0	0	0	0	0	0	0	0
COD of washdown water (lb/gal)	COD	0	0	0	0	0	0	0	0	0	0	0
Oil (lb/gal)	OIL	0	0	0	0	0	0	0	0	0	0	0
Sulfuric acid (lb/gal)	H2SO4	0	0	0	0	0	0	0	0	0	0	0
Iron (lb/gal)	Fe	0	0	0	0	0	0	0	0	0	0	0
Ammonia (lb/gal)	W_NH3	0	0	0	0	0	0	0	0	0	0	0
Copper (lb/gal)	Cu	0	0	0	0	0	0	0	0	0	0	0
Cadmium (lb/gal)	Cad	0	0	0	0	0	0	0	0	0	0	0
Arsenic (lb/gal)	As	0	0	0	0	0	0	0	0	0	0	0
Mercury (lb/gal)	Hg	0	0	0	0	0	0	0	0	0	0	0
Phosphate (lb/gal)	P_x	0	0	0	0	0	0	0	0	0	0	0
Selenium (lb/gal)	Se	0	0	0	0	0	0	0	0	0	0	0
Chromium (lb/gal)	Cr	0	0	0	0	0	0	0	0	0	0	0
Lead (lb/gal)	W_Pb	0	0	0	0	0	0	0	0	0	0	0
Zinc (lb/gal)	Zn	0	0	0	0	0	0	0	0	0	0	0
garage/office												
maint. area per collection vehicle (sf/vehicle)	maint_area	400	400	400	400	400	400	400	400	400	400	400
office area per collection vehicle (sf/vehicle)	off_area	20	20	20	20	20	20	20	20	20	20	20
maint. area elec. consumption rate (kWh/day/sf)	maint_elec	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
office area elec. consumption rate (kWh/day/sf)	off_elec	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
water volume per washdown (gallons/day-sf)	maint_wd_vol	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
bins												
unit price of a bin ($/bin)	Pb	N/A	N/A	N/A	N/A	6.00	6.00	6.00	6.00	6.00	N/A	N/A
number of bins for each house (bins/house)	Rb	N/A	N/A	N/A	N/A	2	1	1	5	1	N/A	N/A
economic life of a bin (year)	Lb	N/A	N/A	N/A	N/A	8	8	8	8	8	N/A	N/A

Table A - 4 Residential Drop Off Inputs

Residential Drop-off Options		**Recyc-labels C_8**	**Yard Waste C_10**
number of houses at one service stop (houses/stop)	0	N/A	N/A
collection frequency (1/week)	0	N/A	N/A
number of working days a week (days/week)	CD	5	N/A
actual working hours a day (hours/vehicle-day)	WV	7	N/A
working hours a day for wage (hours/person-day)	WP	8	N/A
loading time at one service stop (min/stop)	TL	20	N/A
travel time between service stops (min/stop)	0	N/A	N/A
travel time btwn route and disposal fac. (min/trip)	Thf	20	N/A
time to unload at disposal facility (min/trip)	S	15	N/A
lunch time (min/day-vehicle)	F1	30	N/A
break time (min/day-vehicle)	F2	30	N/A
time from grg to 1st collection route (min/day-vhcl)	Tgr	20	N/A
time from disposal fac. to garage (min/day-vhcl)	Tfg	20.00	N/A
does a driver work as a collector? (y/n)	0	y	N/A
number of collectors per vehicle (person/vehicle)	Nw	0	N/A
worker backup rate (backup workers/coll. workers)	bw	0.10	N/A
economic data	0	0	0
fringe benefit rate (fringe benefit $/wage$)	a	0.46	N/A
other expenses rate ($/worker-year)	d	8083	N/A
administrative rate (admin. $/capital & op.cost $)	e	0.12	N/A
hourly wage for a collector ($/hr-person)	Wa	0.00	N/A
hourly wage for a driver ($/hr-person)	Wd	12	N/A

Table A - 5 Residential Drop Off Inputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
collection vehicle			
backup rate for vehicles (backup vhcl/coll. vhcl)	bv	0.10	N/A
utilization factor (occupied yd3 / usable yd3)	Ut	0.80	N/A
usable vehicle capacity (yd3)	Vt	23	N/A
economic life of a vehicle (year)	Lt	8	N/A
unit price of a vehicle ($/vehicle)	Pt	55635.46423	N/A
vehicle operation and maint. cost ($/vehicle)	c	30822.04718	N/A
msw compartment compaction density (lb / yd3)	d_msw	N/A	N/A
recyclables compartment density (lb / yd3)	d_recyc	0	N/A
residual waste compaction density (lb / yd3)	d_residual	N/A	N/A
wet waste compaction density (lb/yd3)	d_wet	N/A	N/A
dry waste compaction density (lb/yd3)	d_dry	N/A	N/A
yard waste compaction density (lb / yd3)	d_yw	N/A	0
travel speeds			
between collection stops (miles/hour)	Vbet	N/A	N/A
from collection route to facility (miles/hour)	Vrf	30.00	N/A
from garage to route in the morning (mile/hour)	Vgr	35.00	N/A
from facility to garage (miles/hour)	Vfg	35.00	N/A
distances			
distance between collection stops (miles)	Dbet	N/A	N/A
distance btwn collection route and facility (miles)	Drf	15.00	N/A
distance btwn garage and collection route (miles)	Dgr	11.67	N/A
distance between facility and garage (miles)	Dfg	11.67	N/A
fuel usage rates			
while traveling (miles/gallon)	MPG_trav_cv	5	N/A
between collection stops (miles/gallon)	MPG_btwn_cv	2	N/A
while idling (gallons/hour)	GPH_idle_cv	1	N/A

Table A - 6 Residential Drop Off Inputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
airborne emission release rates			
HC release rate (gram/mile)	HC_mile_cv	0.61	N/A
CO release rate (gram/mile)	CO_mile_cv	5.03	N/A
NOx release rate (gram/mile)	NOx_mile_cv	34.02	N/A
Total particulates release rate (gram/mile)	PM_mile_cv	0.25	N/A
PM10 release rate (grams/mile)	PM10_mile_cv	0	N/A
CO2 release rate - fossil (gram/mile)	CO2f_mile_cv	0	N/A
CO2-biomass release rate (gram/mile)	CO2bm_mile_cv	0	N/A
SOx release rate (gram/mile)	SOx_mile_cv	0	N/A
CH4 release rate (gram/mile)	CH4_mile_cv	0	N/A
Lead release rate (gram/mile)	Pb_mile_cv	0	N/A
Ammonia release rate (gram/mile)	NH3_mile_cv	0	N/A
Hydrochloric acid release rate (gram/mile)	HCl_mile_cv	0	N/A
waterborne release rates			
Dissolved solids (lb/gal)	DS	0	N/A
Suspended solids (lb/gal)	SS	0	N/A
BOD of washdown water (lb/gal)	BOD	0	N/A
COD of washdown water (lb/gal)	COD	0	N/A
Oil (lb/gal)	OIL	0	N/A
Sulfuric acid (lb/gal)	H2SO4	0	N/A
Iron (lb/gal)	Fe	0	N/A
Ammonia (lb/gal)	W_NH3	0	N/A
Copper (lb/gal)	Cu	0	N/A
Cadmium (lb/gal)	Cad	0	N/A
Arsenic (lb/gal)	As	0	N/A
Mercury (lb/gal)	Hg	0	N/A
Phosphate (lb/gal)	P_x	0	N/A
Selenium (lb/gal)	Se	0	N/A
Chromium (lb/gal)	Cr	0	N/A
Lead (lb/gal)	W_Pb	0	N/A
Zinc (lb/gal)	Zn	0	N/A
garage/office			
maint. area per collection vehicle (sf/vehicle)	maint_area	400	N/A
office area per collection vehicle (sf/vehicle)	off_area	20	N/A
maint. area elec. consumption rate (kWh/day/sf)	maint_elec	0.001	N/A
office area elec. consumption rate (kWh/day/sf)	off_elec	0.002	N/A
water volume per washdown (gallons/day-sf)	maint_wd_vol	0.2	N/A
bins			
	Pb	N/A	N/A
number of bins for each house (bins/house)	Rb	N/A	N/A
economic life of a bin (year)	Lb	N/A	N/A

Table A - 7 Residential Drop Off Inputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
drop off vehicle			
roundtrip distance to drop-off site (miles)	RTDdos	10	10
frequency of trips to drop-off site (trips/month)	FREQdos	2	2
fraction of trips to drop-off site that are dedicated trips	DED	0.50	0.50
drop-off vehicle fuel efficiency (miles/gallon)	MPG_dov	20	20
HC release rate (gram/mile)	HC_mile_dov	0.41	0.41
CO release rate (gram/mile)	CO_mile_dov	3.4	3.4
NOx release rate (gram/mile)	NOX_mile_dov	1	1
Particulates release rate (gram/mile)	PM_mile_dov	0	0
PM 10 release rate (gram/mile)	PM10_mile_dov	0.2	0.2
Fossil CO2 release rate (gram/mile)	CO2f_mile_dov	0	0
Biomass CO2 release rate (gram/mile)	CO2bm_mile_dov	0	0
SOx release rate (gram/mile)	SOX_mile_dov	0	0
CH4 release rate (gram/mile)	CH4_mile_dov	0	0
Lead release rate (lb/Btu)	Pb_mile_dov	0	0
Ammonia release rate (lb/Btu)	NH3_mile_dov	0	0
Hydrochloric acid release rate (lb/Btu)	HCL_mile_dov	0	0

Table A - 8 Multi-Family Collection Inputs

Multi-Family Collection Options		Mixed Waste	Resi-duals	Wet/Dry		Recyclables	
		C_13	C_16	C_17	C_18	C_14	C_15
collection schedule							
collection frequency (1 / week)	Fr	1	1	1	1	1	1
number of working days a week (days/week)	CD	5	5	5	5	5	5
actual working hours a day (hours/vehicle-day)	WV	7	7	7	7	7	7
working hours a day for wage (hours/person-day)	WP	8	8	8	8	8	8
loading time at one service stop (min/stop)	TL	5	5	5	5	10	10
travel time between service stops (min/stop)	Tbet	1.5	1.5	1.5	1.5	1.5	1.5
travel time btwn route and disposal fac. (min/trip)	Thf	20	20	20.00	20	20	20
time to unload at disposal facility (min/trip)	S	15	15	20	15	20	15
lunch time (min/day-vehicle)	F1	30	30	30	30	30	30
break time (min/day-vehicle)	F2	30	30	30	30	30	30
time from grg to 1st collection route (min/day-vhcl)	Tgr	20	20	20	20	20	20
time from disposal fac. to garage (min/day-vhcl)	Tfg	20.00	20	20.00	20	20	20
does a driver work as a collector? (y/n)	0	n	n	n	n	y	n
number of collectors per vehicle (person/vehicle)	Nw	1	1	1	1	0	1
worker backup rate (backup workers/coll. workers)	bw	0.10	0.10	0.10	0.10	0.10	0.10
economic data							
fringe benefit rate (fringe benefit $/wage$)	a	0.46	0.46	0.46	0.46	0.46	0.46
other expenses rate ($/worker-year)	d	8083	8083	8083	8083	8083	8083
administrative rate (admin. $/capital & op.cost $)	e	0.12	0.12	0.12	0.12	0.12	0.12
hourly wage for a collector ($/hr-person)	Wa	8.65	8.65	8.65	8.65	8.65	8.65
hourly wage for a driver ($/hr-person)	Wd	12	12	12	12	12	12

Table A - 9 Multi-Family Collection Inputs (Continued)

Multi-Family Collection Options		Mixed Waste	Resi-duals	Wet/Dry		Recyclables	
		C_13	C_16	C_17	C_18	C_14	C_15
collection vehicle							
backup rate for vehicles (backup vhcl/coll. vhcl)	bv	0.10	0.10	0.10	0.10	0.10	0.10
utilization factor (occupied yd3 / usable yd3)	Ut	0.80	0.80	0.80	0.80	0.80	0.80
usable vehicle capacity (yd3)	Vt	20	20	20	20	23	23
economic life of a vehicle (year)	Lt	7	7	7	7	8	8
unit price of a vehicle ($/vehicle)	Pt	133525.1142	133525.1142	144652.207	133525.1142	55635.46423	133525.1142
vehicle operation and maint. cost ($/vehicle)	c	29375.52511	29375.52511	33381.27854	29375.52511	30822.04718	29375.52511
msw compartment compaction density (lb / yd3)	d_msw	0	N/A	N/A	N/A	N/A	N/A
recyclables compartment density (lb / yd3)	d_recyc	N/A	N/A	0	N/A	0	0
residual waste compaction density (lb / yd3)	d_residual	N/A	0	N/A	N/A	N/A	N/A
wet waste compaction density (lb/yd3)	d_wet	N/A	N/A	0	0	N/A	N/A
dry waste compaction density (lb/yd3)	d_dry	N/A	N/A	0	0	N/A	N/A
0		0	0	N/A	N/A	N/A	N/A
travel speeds							
between collection stops (miles/hour)	Vbet	10	10	10	10	10	10
from collection route to facility (miles/hour)	Vrf	30.00	30	30.00	30	30	30
from garage to route in the morning (mile/hour)	Vgr	35	35	35	35	35	35
from facility to garage (miles/hour)	Vfg	35.00	35	35.00	35	35	35
distances							
between collection stops (miles)	Dbet	0.25	0.25	0.25	0.25	0.25	0.25
between collection route and facility (miles)	Drf	10.00	10	15.00	15	10	10
between garage and collection route (miles)	Dgr	11.667	11.667	11.667	11.667	11.667	11.667
between facility and garage (miles)	Dfg	11.67	11.667	14.00	14	11.667	11.667
fuel usage rates							
while traveling (miles/gallon)	MPG_trav_cv	5	5	5	5	5	5
between collection stops (miles/gallon)	MPG_btwn_cv	2	2	2	2	2	2
while idling (gallons/hour)	GPH_idle_cv	1	1	1	1	1	1

Table A - 10 Multi-Family Collection Inputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	C_18	Recyclables C_14	C_15
airborne emission release rates							
HC release rate (gram/mile)	HC_mile_cv	0.61	0.61	0.61	0.61	0.61	0.61
CO release rate (gram/mile)	CO_mile_cv	5.03	5.03	5.03	5.03	5.03	5.03
NOx release rate (gram/mile)	NOx_mile_cv	34.02	34.02	34.02	34.02	34.02	34.02
Total particulates release rate (gram/mile)	PM_mile_cv	0.25	0.25	0.25	0.25	0.25	0.25
PM10 release rate (grams/mile)	PM10_mile_cv	0	0	0	0	0	0
CO2 release rate - fossil (gram/mile)	CO2f_mile_cv	0	0	0	0	0	0
CO2-biomass release rate (gram/mile)	CO2bm_mile_cv	0	0	0	0	0	0
SOx release rate (gram/mile)	SOx_mile_cv	0	0	0	0	0	0
CH4 release rate (gram/mile)	CH4_mile_cv	0	0	0	0	0	0
Lead release rate (gram/mile)	Pb_mile_cv	0	0	0	0	0	0
Ammonia release rate (gram/mile)	NH3_mile_cv	0	0	0	0	0	0
Hydrochloric acid release rate (gram/mile)	HCl_mile_cv	0	0	0	0	0	0
waterborne release rates							
Dissolved solids (lb/gal)	DS	0	0	0	0	0	0
Suspended solids (lb/gal)	SS	0	0	0	0	0	0
BOD of washdown water (lb/gal)	BOD	0	0	0	0	0	0
COD of washdown water (lb/gal)	COD	0	0	0	0	0	0
Oil (lb/gal)	OIL	0	0	0	0	0	0
Sulfuric acid (lb/gal)	H2SO4	0	0	0	0	0	0
Iron (lb/gal)	Fe	0	0	0	0	0	0
Ammonia (lb/gal)	W_NH3	0	0	0	0	0	0
Copper (lb/gal)	Cu	0	0	0	0	0	0
Cadmium (lb/gal)	Cad	0	0	0	0	0	0
Arsenic (lb/gal)	As	0	0	0	0	0	0
Mercury (lb/gal)	Hg	0	0	0	0	0	0
Phosphate (lb/gal)	P_x	0	0	0	0	0	0
Selenium (lb/gal)	Se	0	0	0	0	0	0
Chromium (lb/gal)	Cr	0	0	0	0	0	0
Lead (lb/gal)	W_Pb	0	0	0	0	0	0
Zinc (lb/gal)	Zn	0	0	0	0	0	0
garage/office							
maint. area per collection vehicle (sf/vehicle)	maint_area	400	400	400	400	400	400
office area per collection vehicle (sf/vehicle)	off_area	20	20	20	20	20	20
maint. area elec. consumption rate (kWh/day/sf)	maint_elec	0.001	0.001	0.001	0.001	0.001	0.001
office area elec. consumption rate (kWh/day/sf)	off_elec	0.002	0.002	0.002	0.002	0.002	0.002
water volume per washdown (gallons/day-sf)	maint_wd_vol	0.2	0.2	0.2	0.2	0.2	0.2
containers							
unit price of a container ($/container)	Pb	N/A	N/A	100	100	100	100
# of containers per location (containers/location)	Rb	N/A	N/A	3	2	5	1
economic life of a container (year)	Lb	N/A	N/A	8	8	8	8

Table A - 11 Commercial Collection Inputs

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
collection schedule			
collection frequency (1 / week)	Fr	3	2
number of working days a week (days/week)	CD	5	5
actual working hours a day (hours/vehicle-day)	WV	7	7
working hours a day for wage (hours/person-day)	WP	8	8
loading time at one service stop (min/stop)	TL	10	5
travel time between service stops (min/stop)	Tbet	1.5	1.5
travel time from collection route to a facility - fully loaded (min/trip)	Thf	20	20
time to unload at a facility (min/trip)	S	20	15
lunch time (min/day-vehicle)	F1	30	30
break time (min/day-vehicle)	F2	30	30
travel time from garage to route in the morning (min/day-vehicle)	Tgr	20	20
time from a facility to garage at the end (min/day-vehicle)	Tfg	20.00	20.00
does a driver work as a collector? (y/n)		y	n
number of collectors per vehicle (person/vehicle)	Nw	0	1
backup rate for worker (backup workers/collection workers)	bw	0.10	0.10
economic data			
fringe benefit rate (fringe benefit $/wage$)	a	0.46	0.46
other expenses rate ($/worker-year)	d	8083	8083
administrative rate (administrative expense $/capital & operating cost $)	e	0.12	0.12
hourly wage for a collector ($/hr-person)	Wa	8.65	8.65
hourly wage for a driver ($/hr-person)	Wd	12	12

Table A - 12 Commercial Collection Inputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
collection vehicle			
backup rate for collection vehicles (backup vehicles/collection vehicles)	bv	0.10	0.10
vehicle utilization factor (occupied yd3 / usable yd3)	Ut	0.80	0.80
usable vehicle capacity (yd3)	Vt	23	20
economic life of a vehicle (year)	Lt	8	7
unit price of a vehicle ($/vehicle)	Pt	55635.46423	133525.1142
vehicle operation and maintenance cost ($/vehicle)	c	30822.04718	29375.52511
msw compartment compaction density (lb / yd3)	d_msw	N/A	0
recyclables compartment density (lb / yd3)	d_recyc	0	N/A
travel speeds			
travel speed between collection stops (miles/hour)	Vbet	10	10
travel speed from collection route to facility (miles/hour)	Vrf	30.00	30.00
travel speed from garage to route in the morning (mile/hour)	Vgr	35	35
travel speed from facility to garage (miles/hour)	Vfg	35.00	35.00
distances			
distance between collection stops (miles)	Dbet	0.25	0.25
distance between collection route and facility (miles)	Drf	10.00	10.00
distance between garage and collection route (miles)	Dgr	11.667	11.667
distance between facility and garage (miles)	Dfg	11.67	11.67
fuel usage rates			
miles per gallon while traveling (miles/gallon)	MPG_trav_cv	5	5
miles per gallon between collection stops (mile/gallon)	MPG_btwn_cv	2	2
gallons/hour while idling (gallons/hour)	GPH_idle_cv	1	1

Table A - 13 Commercial Collection Inputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
airborne emission release rates			
HC release rate (gram/mile)	HC_mile_cv	0.61	0.61
CO release rate (gram/mile)	CO_mile_cv	5.03	5.03
NOx release rate (gram/mile)	NOx_mile_cv	34.02	34.02
Total particulates release rate (gram/mile)	PM_mile_cv	0.25	0.25
PM10 release rate (grams/mile)	PM10_mile_cv	0	0
CO2 release rate - fossil (gram/mile)	CO2f_mile_cv	0	0
CO2-biomass release rate (gram/mile)	CO2bm_mile_cv	0	0
SOx release rate (gram/mile)	SOx_mile_cv	0	0
CH4 release rate (gram/mile)	CH4_mile_cv	0	0
Lead release rate (gram/mile)	Pb_mile_cv	0	0
Ammonia release rate (gram/mile)	NH3_mile_cv	0	0
Hydrochloric acid release rate (gram/mile)	HCl_mile_cv	0	0
waterborne release rates			
Dissolved solids (lb/gal)	DS	0	0
Suspended solids (lb/gal)	SS	0	0
BOD of washdown water (lb/gal)	BOD	0	0
COD of washdown water (lb/gal)	COD	0	0
Oil (lb/gal)	OIL	0	0
Sulfuric acid (lb/gal)	H2SO4	0	0
Iron (lb/gal)	Fe	0	0
Ammonia (lb/gal)	W_NH3	0	0
Copper (lb/gal)	Cu	0	0
Cadmium (lb/gal)	Cad	0	0
Arsenic (lb/gal)	As	0	0
Mercury (lb/gal)	Hg	0	0
Phosphate (lb/gal)	P_x	0	0
Selenium (lb/gal)	Se	0	0
Chromium (lb/gal)	Cr	0	0
Lead (lb/gal)	W_Pb	0	0
Zinc (lb/gal)	Zn	0	0
garage/office			
maintenance area per collection vehicle (sf/vehicle)	maint_area	400	400
office area per collection vehicle (sf/vehicle)	off_area	20	20
maintenance area daily electricity consumption rate (kWh/day/sf)	maint_elec	0.001	0.001
office area daily electricity consumption rate (kWh/day/sf)	off_elec	0.002	0.002
water volume per washdown (gallons/day-sf)	maint_wd_vol	0.2	0.2
containers			
unit price of a container ($/container)	Pb	N/A	N/A
number of containers at each location (containers/location)	Rb	5	N/A
economic life of a container (year)	Lb	N/A	N/A

Table A - 14 Residential Capture Rates

DESCRIPTION	VARIABLE NAME	RESIDENTIAL COLLECTION OPTIONS											
		Mixed Waste			Residuals			Co-Collection					
		C 1			C 7			C 5			C 6		
		Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector
	R_CR_TABLE	C_1_CR_1	C_1_CR_2	C_1_CR	C_7_CR_1	C_7_CR_2	C_7_CR	C_5_CR_1	C_5_CR_2	C_5_CR	C_6_CR_1	C_6_CR_2	C_6_CR
Yard Trimmings, Leaves	R_YTL	1.00	1.00	1.00	1.00	1.00	1.00						
Yard Trimmings, Grass	R_YTG	1.00	1.00	1.00	1.00	1.00	1.00						
Yard Trimmings, Branches	R_YTB	1.00	1.00	1.00	1.00	1.00	1.00						
Old News Print	R_ONP	1.00	1.00	1.00	1.00	1.00	1.00	0.68	0.67	0.68	0.68	0.67	0.68
Old Corr. Cardboard	R_OCC	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
Office Paper	R_OFF	1.00	1.00	1.00	1.00	1.00	1.00	0.49	0.48	0.49	0.49	0.48	0.49
Phone Books	R_PBK	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
Books	R_BOOK	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
Old Magazines	R_OMG	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
3rd Class Mail	R_MAIL	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
Paper Other #1	R_PAOT1	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
Paper Other #2	R_PAOT2	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
Paper Other #3	R_PAOT3	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
Paper Other #4	R_PAOT4	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
Paper Other #5	R_PAOT5	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
CCCR Other	R_CCR_O	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
Mixed Paper	R_PMIX	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.60	0.59	0.60
HDPE - Translucent	R_HDT	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
HDPE - Pigmented	R_HDP	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
PET	R_PPET	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
Plastic - Other #1	R_PLOT1	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
Plastic - Other #2	R_PLOT2	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
Plastic - Other #3	R_PLOT3	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
Plastic - Other #4	R_PLOT4	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
Plastic - Other #5	R_PLOT5	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
Mixed Plastic	R_PLMIX	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.56	0.55	0.56
CCNR Other	R_CNR_O	1.00	1.00	1.00	1.00	1.00	1.00						
Ferrous Cans	R_FCAN	1.00	1.00	1.00	1.00	1.00	1.00	0.58	0.57	0.58	0.58	0.57	0.58
Ferrous Metal - Other	R_FMOT	1.00	1.00	1.00	1.00	1.00	1.00	0.58	0.57	0.58	0.58	0.57	0.58
Aluminum Cans	R_ACAN	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.64	0.63	0.64
Aluminum - Other #1	R_ALOT1	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.64	0.63	0.64
Aluminum - Other #2	R_ALOT2	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.64	0.63	0.64
Glass - Clear	R_GCLR	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.64	0.63	0.64
Glass - Brown	R_GBRN	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.64	0.63	0.64
Glass - Green	R_GGRN	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.64	0.63	0.64
Mixed Glass	R_GMIX	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.64	0.63	0.64
CNNR Other	R_NNR_O	1.00	1.00	1.00	1.00	1.00	1.00						
Paper - Non-recyclable	R_PANR	1.00	1.00	1.00	1.00	1.00	1.00						
Food Waste	R_FW	1.00	1.00	1.00	1.00	1.00	1.00						
CCCN Other	R_CCN_O	1.00	1.00	1.00	1.00	1.00	1.00						
Plastic - Non-Recyclable	R_PLNR	1.00	1.00	1.00	1.00	1.00	1.00						
Misc.	R_MIS_CNN	1.00	1.00	1.00	1.00	1.00	1.00						
CCNN Other	R_CNN_O	1.00	1.00	1.00	1.00	1.00	1.00						
Ferrous - Non-recyclable	R_FNR	1.00	1.00	1.00	1.00	1.00	1.00						
Al - Non-recyclable	R_ANR	1.00	1.00	1.00	1.00	1.00	1.00						
Glass - Non-recyclable	R_GNR	1.00	1.00	1.00	1.00	1.00	1.00						
Misc.	R_MIS_NNN	1.00	1.00	1.00	1.00	1.00	1.00						
CNNN Other	R_NNN_O	1.00	1.00	1.00	1.00	1.00	1.00						
Participation Factor	R_PF	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table A - 15 Residential Capture Rates (Continued)

DESCRIPTION	VARIABLE NAME	RESIDENTIAL COLLECTION OPTIONS														
		Wet/Dry						Recyclables								
		C 11			C 12			C 2			C 3			C 4		
		Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector
	R_CR_TABLE	C_11_CR_1	C_11_CR_2	C_11_CR	C_12_CR_1	C_12_CR_2	C_12_CR	C_2_CR_1	C_2_CR_2	C_2_CR	C_3_CR_1	C_3_CR_2	C_3_CR	C_4_CR_1	C_4_CR_2	C_4_CR
Yard Trimmings, Leaves	R_YTL	1.00	1.00	1.00	1.00	1.00	1.00									
Yard Trimmings, Grass	R_YTG	1.00	1.00	1.00	1.00	1.00	1.00									
Yard Trimmings, Branches	R_YTB	1.00	1.00	1.00	1.00	1.00	1.00									
Old News Print	R_ONP	1.00	1.00	1.00	1.00	1.00	1.00	0.68	0.67	0.68	0.63	0.62	0.63	0.68	0.67	0.68
Old Corr. Cardboard	R_OCC	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
Office Paper	R_OFF	1.00	1.00	1.00	1.00	1.00	1.00	0.49	0.48	0.49	0.46	0.46	0.46	0.49	0.48	0.49
Phone Books	R_PBK	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.45	0.56	0.60	0.59	0.60
Books	R_BOOK	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
Old Magazines	R_OMG	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
3rd Class Mail	R_MAIL	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
Paper Other #1	R_PAOT1	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
Paper Other #2	R_PAOT2	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
Paper Other #3	R_PAOT3	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
Paper Other #4	R_PAOT4	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
Paper Other #5	R_PAOT5	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
CCCR Other	R_CCR_O	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
Mixed Paper	R_PMIX	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.59	0.60	0.56	0.55	0.56	0.60	0.59	0.60
HDPE - Translucent	R_HDT	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
HDPE - Pigmented	R_HDP	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
PET	R_PPET	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
Plastic - Other #1	R_PLOT1	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
Plastic - Other #2	R_PLOT2	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
Plastic - Other #3	R_PLOT3	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
Plastic - Other #4	R_PLOT4	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
Plastic - Other #5	R_PLOT5	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
Mixed Plastic	R_PLMIX	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.55	0.56	0.53	0.52	0.53	0.56	0.55	0.56
CCNR Other	R_CNR_O	1.00	1.00	1.00	1.00	1.00	1.00									
Ferrous Cans	R_FCAN	1.00	1.00	1.00	1.00	1.00	1.00	0.58	0.57	0.58	0.53	0.52	0.53	0.58	0.57	0.58
Ferrous Metal - Other	R_FMOT	1.00	1.00	1.00	1.00	1.00	1.00	0.58	0.57	0.58	0.53	0.52	0.53	0.58	0.57	0.58
Aluminum Cans	R_ACAN	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.60	0.59	0.60	0.64	0.63	0.64
Aluminum - Other #1	R_ALOT1	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.60	0.59	0.60	0.64	0.63	0.64
Aluminum - Other #2	R_ALOT2	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.60	0.59	0.60	0.64	0.63	0.64
Glass - Clear	R_GCLR	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.60	0.59	0.60	0.64	0.63	0.64
Glass - Brown	R_GBRN	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.60	0.59	0.60	0.64	0.63	0.64
Glass - Green	R_GGRN	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.60	0.59	0.60	0.64	0.63	0.64
Mixed Glass	R_GMIX	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.63	0.64	0.60	0.59	0.60	0.64	0.63	0.64
CNNR Other	R_NNR_O	1.00	1.00	1.00	1.00	1.00	1.00									
Paper - Non-recyclable	R_PANR	1.00	1.00	1.00	1.00	1.00	1.00									
Food Waste	R_FW	1.00	1.00	1.00	1.00	1.00	1.00									
CCCN Other	R_CCN_O	1.00	1.00	1.00	1.00	1.00	1.00									
Plastic - Non-Recyclable	R_PLNR	1.00	1.00	1.00	1.00	1.00	1.00									
Misc.	R_MIS_CNN	1.00	1.00	1.00	1.00	1.00	1.00									
CCNN Other	R_CNN_O	1.00	1.00	1.00	1.00	1.00	1.00									
Ferrous - Non-recyclable	R_FNR	1.00	1.00	1.00	1.00	1.00	1.00									
Al - Non-recyclable	R_ANR	1.00	1.00	1.00	1.00	1.00	1.00									
Glass - Non-recyclable	R_GNR	1.00	1.00	1.00	1.00	1.00	1.00									
Misc.	R_MIS_NNN	1.00	1.00	1.00	1.00	1.00	1.00									
CNNN Other	R_NNN_O	1.00	1.00	1.00	1.00	1.00	1.00									
Participation Factor	R_PF	1.0	1.0	1.0	1.0	1.0	1.0	0.65	0.65	0.65	0.50	0.50	0.50	0.65	0.65	0.65

Table A - 16 Residential Capture Rates (Continued)

DESCRIPTION	VARIABLE NAME	RESIDENTIAL COLLECTION OPTIONS											
		Yard Waste						Recyclables			Yard Waste		
		C 0			C 9			C 8			C 10		
		Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector
	R_CR_TABLE	C_0_CR_1	C_0_CR_2	C_0_CR	C_9_CR_1	C_9_CR_2	C_9_CR	C_8_CR_1	C_8_CR_2	C_8_CR	C_10_CR_1	C_10_CR_2	C_10_CR
Yard Trimmings, Leaves	R_YTL	0.90	0.89	0.90	0.90	0.89	0.90				0.90	0.89	0.90
Yard Trimmings, Grass	R_YTG	0.90	0.89	0.90							0.90	0.89	0.90
Yard Trimmings, Branches	R_YTB	0.90	0.89	0.90							0.90	0.89	0.90
Old News Print	R_ONP							0.60	0.59	0.60			
Old Corr. Cardboard	R_OCC							0.60	0.59	0.60			
Office Paper	R_OFF							0.60	0.59	0.60			
Phone Books	R_PBK							0.60	0.59	0.60			
Books	R_BOOK							0.60	0.59	0.60			
Old Magazines	R_OMG							0.60	0.59	0.60			
3rd Class Mail	R_MAIL							0.60	0.59	0.60			
Paper Other #1	R_PAOT1							0.60	0.59	0.60			
Paper Other #2	R_PAOT2							0.60	0.59	0.60			
Paper Other #3	R_PAOT3							0.60	0.59	0.60			
Paper Other #4	R_PAOT4							0.60	0.59	0.60			
Paper Other #5	R_PAOT5							0.60	0.59	0.60			
CCCR Other	R_CCR_O							0.60	0.59	0.60			
Mixed Paper	R_PMIX							0.60	0.59	0.60			
HDPE - Translucent	R_HDT							0.60	0.59	0.60			
HDPE - Pigmented	R_HDP							0.60	0.59	0.60			
PET	R_PPET							0.60	0.59	0.60			
Plastic - Other #1	R_PLOT1							0.60	0.59	0.60			
Plastic - Other #2	R_PLOT2							0.60	0.59	0.60			
Plastic - Other #3	R_PLOT3							0.60	0.59	0.60			
Plastic - Other #4	R_PLOT4							0.60	0.59	0.60			
Plastic - Other #5	R_PLOT5							0.60	0.59	0.60			
Mixed Plastic	R_PLMIX							0.60	0.59	0.60			
CCNR Other	R_CNR_O												
Ferrous Cans	R_FCAN							0.60	0.59	0.60			
Ferrous Metal - Other	R_FMOT							0.60	0.59	0.60			
Aluminum Cans	R_ACAN							0.60	0.59	0.60			
Aluminum - Other #1	R_ALOT1							0.60	0.59	0.60			
Aluminum - Other #2	R_ALOT2							0.60	0.59	0.60			
Glass - Clear	R_GCLR							0.60	0.59	0.60			
Glass - Brown	R_GBRN							0.60	0.59	0.60			
Glass - Green	R_GGRN							0.60	0.59	0.60			
Mixed Glass	R_GMIX							0.60	0.59	0.60			
CNNR Other	R_NNR_O												
Paper - Non-recyclable	R_PANR												
Food Waste	R_FW												
CCCN Other	R_CCN_O												
Plastic - Non-Recyclable	R_PLNR												
Misc.	R_MIS_CNN												
CCNN Other	R_CNN_O												
Ferrous - Non-recyclable	R_FNR												
Al - Non-recyclable	R_ANR												
Glass - Non-recyclable	R_GNR												
Misc.	R_MIS_NNN												
CNNN Other	R_NNN_O												
Participation Factor	R_PF	0.50	0.50	0.50	0.50	0.50	0.50	0.40	0.40	0.40	0.40	0.40	0.40

Table A - 17 Multi-Family Capture Rates

DESCRIPTION	VARIABLE NAME	MULTI-FAMILY COLLECTION OPTIONS											
		Mixed Waste			Residuals			Wet/Dry					
		C 13			C 16			C 17			C 18		
		Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector
	MF CR TABLE	C_13_CR_1	C_13_CR_2	C_13_CR	C_16_CR_1	C_16_CR_2	C_16_CR	C_17_CR_1	C_17_CR_2	C_17_CR	C_18_CR_1	C_18_CR_2	C_18_CR
Yard Trimmings, Leaves	MF_YTL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yard Trimmings, Grass	MF_YTG	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yard Trimmings, Branches	MF_YTB	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Old News Print	MF_ONP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Old Corr. Cardboard	MF_OCC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Office Paper	MF_OFF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Phone Books	MF_PBK	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Books	MF_BOOK	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Old Magazines	MF_OMG	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3rd Class Mail	MF_MAIL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Paper Other #1	MF_PAOT1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Paper Other #2	MF_PAOT2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Paper Other #3	MF_PAOT3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Paper Other #4	MF_PAOT4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Paper Other #5	MF_PAOT5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CCCR Other	MF_CCMF_O	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mixed Paper	MF_PMIX	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
HDPE - Translucent	MF_HDT	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
HDPE - Pigmented	MF_HDP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PET	MF_PPET	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Plastic - Other #1	MF_PLOT1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Plastic - Other #2	MF_PLOT2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Plastic - Other #3	MF_PLOT3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Plastic - Other #4	MF_PLOT4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Plastic - Other #5	MF_PLOT5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mixed Plastic	MF_PLMIX	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CCNR Other	MF_CNMF_O	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ferrous Cans	MF_FCAN	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ferrous Metal - Other	MF_FMOT	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Aluminum Cans	MF_ACAN	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Aluminum - Other #1	MF_ALOT1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Aluminum - Other #2	MF_ALOT2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Glass - Clear	MF_GCLR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Glass - Brown	MF_GBRN	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Glass - Green	MF_GGRN	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mixed Glass	MF_GMIX	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CNNR Other	MF_NNMF_O	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Paper - Non-recyclable	MF_PANR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Food Waste	MF_FW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CCCN Other	MF_CCN_O	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Plastic - Non-Recyclable	MF_PLNR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Misc.	MF_MIS_CNN	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CCNN Other	MF_CNN_O	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ferrous - Non-recyclable	MF_FNR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Al - Non-recyclable	MF_ANR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Glass - Non-recyclable	MF_GNR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Misc.	MF_MIS_NNN	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CNNN Other	MF_NNN_O	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Participation Factor	MF_PF	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table A - 18 Multi-Family Capture Rates (Continued)

DESCRIPTION	VARIABLE NAME	MULTI-FAMILY COLLECTION OPTIONS								
		Recyclables								
		C 14			C 15			C 8		
		Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector	Sector 1	Sector 2	Selected Sector
	MF_CR_TABLE	C_14_CR_1	C_14_CR_2	C_14_CR	C_15_CR_1	C_15_CR_2	C_15_CR	C_8_mf_CR_1	C_8_mf_CR_2	C_8_mf_CR
Yard Trimmings, Leaves	MF_YTL									
Yard Trimmings, Grass	MF_YTG									
Yard Trimmings, Branches	MF_YTB									
Old News Print	MF_ONP	0.63	0.63	0.63	0.68	0.68	0.68	0.6	0.59	0.60
Old Corr. Cardboard	MF_OCC	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
Office Paper	MF_OFF	0.46	0.46	0.46	0.49	0.49	0.49	0.6	0.59	0.60
Phone Books	MF_PBK	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
Books	MF_BOOK	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
Old Magazines	MF_OMG	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
3rd Class Mail	MF_MAIL	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
Paper Other #1	MF_PAOT1	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
Paper Other #2	MF_PAOT2	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
Paper Other #3	MF_PAOT3	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
Paper Other #4	MF_PAOT4	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
Paper Other #5	MF_PAOT5	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
CCCR Other	MF_CCMF_O	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
Mixed Paper	MF_PMIX	0.56	0.56	0.56	0.6	0.6	0.60	0.6	0.59	0.60
HDPE - Translucent	MF_HDT	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
HDPE - Pigmented	MF_HDP	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
PET	MF_PPET	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
Plastic - Other #1	MF_PLOT1	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
Plastic - Other #2	MF_PLOT2	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
Plastic - Other #3	MF_PLOT3	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
Plastic - Other #4	MF_PLOT4	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
Plastic - Other #5	MF_PLOT5	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
Mixed Plastic	MF_PLMIX	0.53	0.53	0.53	0.56	0.56	0.56	0.6	0.59	0.60
CCNR Other	MF_CNMF_O									
Ferrous Cans	MF_FCAN	0.53	0.53	0.53	0.58	0.58	0.58	0.6	0.59	0.60
Ferrous Metal - Other	MF_FMOT	0.53	0.53	0.53	0.58	0.58	0.58	0.6	0.59	0.60
Aluminum Cans	MF_ACAN	0.6	0.6	0.60	0.64	0.64	0.64	0.6	0.59	0.60
Aluminum - Other #1	MF_ALOT1	0.6	0.6	0.60	0.64	0.64	0.64	0.6	0.59	0.60
Aluminum - Other #2	MF_ALOT2	0.6	0.6	0.60	0.64	0.64	0.64	0.6	0.59	0.60
Glass - Clear	MF_GCLR	0.6	0.6	0.60	0.64	0.64	0.64	0.6	0.59	0.60
Glass - Brown	MF_GBRN	0.6	0.6	0.60	0.64	0.64	0.64	0.6	0.59	0.60
Glass - Green	MF_GGRN	0.6	0.6	0.60	0.64	0.64	0.64	0.6	0.59	0.60
Mixed Glass	MF_GMIX	0.6	0.6	0.60	0.64	0.64	0.64	0.6	0.59	0.60
CNNR Other	MF_NNMF_O									
Paper - Non-recyclable	MF_PANR									
Food Waste	MF_FW									
CCCN Other	MF_CCN_O									
Plastic - Non-Recyclable	MF_PLNR									
Misc.	MF_MIS_CNN									
CCNN Other	MF_CNN_O									
Ferrous - Non-recyclable	MF_FNR									
Al - Non-recyclable	MF_ANR									
Glass - Non-recyclable	MF_GNR									
Misc.	MF_MIS_NNN									
CNNN Other	MF_NNN_O									
Participation Factor	MF_PF	0.80	0.80	0.80	0.80	0.80	0.80	0.40	0.40	0.40

Table A - 19 Commercial Capture Rates

DESCRIPTION	VARIABLE NAME	COMMERCIAL COLLECTION OPTIONS											
		Recyclables C 19											MSW/ Residuals C 20
		Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10	Selected Sector	Selected Sector
	C_CR_TABLE	C_19_CR_1	C_19_CR_2	C_19_CR_3	C_19_CR_4	C_19_CR_5	C_19_CR_6	C_19_CR_7	C_19_CR_8	C_19_CR_9	C_19_CR_10	C_19_CR	C_20_CR
Yard Trimmings, Leaves	C_YTL												
Yard Trimmings, Grass	C_YTG												
Yard Trimmings, Branches	C_YTB												
Old News Print	C_ONP	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	
Old Corr. Cardboard	C_OCC	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	
Office Paper	C_OFF	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	
Phone Books	C_PBK	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Books	C_BOOK												
Old Magazines	C_OMG												
3rd Class Mail	C_MAIL	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Paper Other #1	C_PAOT1	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Paper Other #2	C_PAOT2	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Paper Other #3	C_PAOT3	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Paper Other #4	C_PAOT4												
Paper Other #5	C_PAOT5												
CCCR Other	C_CCR_O	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Mixed Paper	C_PMIX	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
HDPE - Translucent	C_HDT												
HDPE - Pigmented	C_HDP												
PET	C_PPET	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	
Plastic - Other #1	C_PLOT1												
Plastic - Other #2	C_PLOT2												
Plastic - Other #3	C_PLOT3												
Plastic - Other #4	C_PLOT4												
Plastic - Other #5	C_PLOT5												
Mixed Plastic	C_PLMIX	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	
CCNR Other	C_CNR_O	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	
Ferrous Cans	C_FCAN	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	
Ferrous Metal - Other	C_FMOT	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
Aluminum Cans	C_ACAN	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Aluminum - Other #1	C_ALOT1												
Aluminum - Other #2	C_ALOT2												
Glass - Clear	C_GCLR	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Glass - Brown	C_GBRN	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Glass - Green	C_GGRN	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Mixed Glass	C_GMIX	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
CNNR Other	C_NNR_O	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Paper - Non-recyclable	C_PANR												
Food Waste	C_FW												
CCCN Other	C_CCN_O												
Plastic - Non-Recyclable	C_PLNR												
Misc.	C_MIS_CNN												
CCNN Other	C_CNN_O												
Ferrous - Non-recyclable	C_FNR												
Al - Non-recyclable	C_ANR												
Glass - Non-recyclable	C_GNR												
Misc.	C_MIS_NNN												
CNNN Other	C_NNN_O												
Participation Factor	C_PF	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.0

Table A - 20 Residential Wet/Dry Separation Factors

DESCRIPTION	Wet/Dry/Recyclables Separation Factors Collection Options C11 & C17			Wet/Dry Separation Factors Collection Options C12 & C18	
	sf_WDR_wet	sf_WDR_dry	sf_WDR_recyc	sf_WD_wet	sf_WD_dry
Yard Trimmings, Leaves	1.00	0.00	0.00	1.00	0.00
Yard Trimmings, Grass	1.00	0.00	0.00	1.00	0.00
Yard Trimmings, Branches	1.00	0.00	0.00	1.00	0.00
Old News Print	0.00	0.25	0.75	0.20	0.80
Old Corr. Cardboard	0.00	0.25	0.75	0.20	0.80
Office Paper	0.00	0.25	0.75	0.20	0.80
Phone Books	0.00	0.25	0.75	0.20	0.80
Books	0.00	0.25	0.75	0.20	0.80
Old Magazines	0.00	0.25	0.75	0.20	0.80
3rd Class Mail	0.00	0.25	0.75	0.20	0.80
Paper Other #1	0.00	0.25	0.75	0.20	0.80
Paper Other #2	0.00	0.25	0.75	0.20	0.80
Paper Other #3	0.00	0.25	0.75	0.20	0.80
Paper Other #4	0.00	0.25	0.75	0.20	0.80
Paper Other #5	0.00	0.25	0.75	0.20	0.80
CCCR Other					
Mixed Paper	0.00	0.25	0.75	0.20	0.80
HDPE - Translucent	0.00	0.25	0.75	0.10	0.90
HDPE - Pigmented	0.00	0.25	0.75	0.10	0.90
PET	0.00	0.25	0.75	0.10	0.90
Plastic - Other #1	0.00	0.25	0.75	0.10	0.90
Plastic - Other #2	0.00	0.25	0.75	0.10	0.90
Plastic - Other #3	0.00	0.25	0.75	0.10	0.90
Plastic - Other #4	0.00	0.25	0.75	0.10	0.90
Plastic - Other #5	0.00	0.25	0.75	0.10	0.90
Mixed Plastic	0.00	0.25	0.75	0.10	0.90
CCNR Other					
Ferrous Cans	0.00	0.25	0.75	0.10	0.90
Ferrous Metal - Other	0.00	0.25	0.75	0.10	0.90
Aluminum Cans	0.00	0.25	0.75	0.10	0.90
Aluminum - Other #1	0.00	0.25	0.75	0.10	0.90
Aluminum - Other #2	0.00	0.25	0.75	0.10	0.90
Glass - Clear	0.00	0.25	0.75	0.10	0.90
Glass - Brown	0.00	0.25	0.75	0.10	0.90
Glass - Green	0.00	0.25	0.75	0.10	0.90
Mixed Glass	0.00	0.25	0.75	0.10	0.90
CNNR Other					
Paper - Non-recyclable	0.00	1.00	0.00	0.25	0.75
Food Waste	1.00	0.00	0.00	1.00	0.00
CCCN Other					
Plastic - Non-Recyclable	0.00	1.00	0.00	0.10	0.90
Misc.	0.00	1.00	0.00	0.10	0.90
CCNN Other					
Ferrous - Non-recyclable	0.00	1.00	0.00	0.10	0.90
Al - Non-recyclable	0.00	1.00	0.00	0.10	0.90
Glass - Non-recyclable	0.00	1.00	0.00	0.10	0.90
Misc.	0.00	1.00	0.00	0.10	0.90
CNNN Other					

Table A - 21 Residential Collection Compaction Factors

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Leaves	YTL				1.0	1.0		1.0	1.0	1.0		
Grass	YTG				1.0	1.0		1.0	1.0	1.0		
Branches	YTB				1.0	1.0		1.0	1.0	1.0		
Old News Print	ONP				1.0	1.0		1.0	1.0	1.0		
Old Corr. Cardboard	OCC				1.0	1.0		1.0	1.0	1.0		
Office Paper	OFF				1.0	1.0		1.0	1.0	1.0		
Phone Books	PBK				1.0	1.0		1.0	1.0	1.0		
Books	BOOK				1.0	1.0		1.0	1.0	1.0		
Old Magazines	OMG				1.0	1.0		1.0	1.0	1.0		
3rd Class Mail	MAIL				1.0	1.0		1.0	1.0	1.0		
Paper Other #1	PAOT1				1.0	1.0		1.0	1.0	1.0		
Paper Other #2	PAOT2				1.0	1.0		1.0	1.0	1.0		
Paper Other #3	PAOT3				1.0	1.0		1.0	1.0	1.0		
Paper Other #4	PAOT4				1.0	1.0		1.0	1.0	1.0		
Paper Other #5	PAOT5				1.0	1.0		1.0	1.0	1.0		
CCCR Other	CCR_O				1.0	1.0		1.0	1.0	1.0		
Mixed Paper	PMIX				1.0	1.0		1.0	1.0	1.0		
HDPE - Translucent	HDT				1.0	1.0		1.0	1.0	1.0		
HDPE - Pigmented	HDP				1.0	1.0		1.0	1.0	1.0		
PET	PPET				1.0	1.0		1.0	1.0	1.0		
Plastic - Other #1	PLOT1				1.0	1.0		1.0	1.0	1.0		
Plastic - Other #2	PLOT2				1.0	1.0		1.0	1.0	1.0		
Plastic - Other #3	PLOT3				1.0	1.0		1.0	1.0	1.0		
Plastic - Other #4	PLOT4				1.0	1.0		1.0	1.0	1.0		
Plastic - Other #5	PLOT5				1.0	1.0		1.0	1.0	1.0		
Mixed Plastic	PLMIX				1.0	1.0		1.0	1.0	1.0		
CCNR Other	CNR_O				1.0	1.0		1.0	1.0	1.0		
Ferrous Cans	FCAN				1.0	1.0		1.0	1.0	1.0		
Ferrous Metal - Other	FMOT				1.0	1.0		1.0	1.0	1.0		
Aluminum Cans	ACAN				1.0	1.0		1.0	1.0	1.0		
Aluminum - Other #1	ALOT1				1.0	1.0		1.0	1.0	1.0		
Aluminum - Other #2	ALOT2				1.0	1.0		1.0	1.0	1.0		
Glass - Clear	GCLR				1.0	1.0		1.0	1.0	1.0		
Glass - Brown	GBRN				1.0	1.0		1.0	1.0	1.0		
Glass - Green	GGRN				1.0	1.0		1.0	1.0	1.0		
Mixed Glass	GMIX				1.0	1.0		1.0	1.0	1.0		
CNNR Other	NNR_O				1.0	1.0		1.0	1.0	1.0		
Paper - Non-recyclable	PANR				1.0	1.0		1.0	1.0	1.0		
Food Waste	FW				1.0	1.0		1.0	1.0	1.0		
CCCN Other	CCN_O				1.0	1.0		1.0	1.0	1.0		
Plastic - Non-Recyclable	PLNR				1.0	1.0		1.0	1.0	1.0		
Misc.	MIS_CNN				1.0	1.0		1.0	1.0	1.0		
CCNN Other	CNN_O				1.0	1.0		1.0	1.0	1.0		
Ferrous - Non-recyclable	FNR				1.0	1.0		1.0	1.0	1.0		
Al - Non-recyclable	ANR				1.0	1.0		1.0	1.0	1.0		
Glass - Non-recyclable	GNR				1.0	1.0		1.0	1.0	1.0		
Misc.	MIS_NNN				1.0	1.0		1.0	1.0	1.0		
CNNN Other	NNN_O				1.0	1.0		1.0	1.0	1.0		

Table A - 22 Residential Drop Off Compaction Factors

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Leaves	YTL	1.0	
Grass	YTG	1.0	
Branches	YTB	1.0	
Old News Print	ONP	1.0	
Old Corr. Cardboard	OCC	1.0	
Office Paper	OFF	1.0	
Phone Books	PBK	1.0	
Books	BOOK	1.0	
Old Magazines	OMG	1.0	
3rd Class Mail	MAIL	1.0	
Paper Other #1	PAOT1	1.0	
Paper Other #2	PAOT2	1.0	
Paper Other #3	PAOT3	1.0	
Paper Other #4	PAOT4	1.0	
Paper Other #5	PAOT5	1.0	
CCCR Other	CCR_O	1.0	
Mixed Paper	PMIX	1.0	
HDPE - Translucent	HDT	1.0	
HDPE - Pigmented	HDP	1.0	
PET	PPET	1.0	
Plastic - Other #1	PLOT1	1.0	
Plastic - Other #2	PLOT2	1.0	
Plastic - Other #3	PLOT3	1.0	
Plastic - Other #4	PLOT4	1.0	
Plastic - Other #5	PLOT5	1.0	
Mixed Plastic	PLMIX	1.0	
CCNR Other	CNR_O	1.0	
Ferrous Cans	FCAN	1.0	
Ferrous Metal - Other	FMOT	1.0	
Aluminum Cans	ACAN	1.0	
Aluminum - Other #1	ALOT1	1.0	
Aluminum - Other #2	ALOT2	1.0	
Glass - Clear	GCLR	1.0	
Glass - Brown	GBRN	1.0	
Glass - Green	GGRN	1.0	
Mixed Glass	GMIX	1.0	
CNNR Other	NNR_O	1.0	
Paper - Non-recyclable	PANR	1.0	
Food Waste	FW	1.0	
CCCN Other	CCN_O	1.0	
Plastic - Non-Recyclable	PLNR	1.0	
Misc.	MIS_CNN	1.0	
CCNN Other	CNN_O	1.0	
Ferrous - Non-recyclable	FNR	1.0	
Al - Non-recyclable	ANR	1.0	
Glass - Non-recyclable	GNR	1.0	
Misc.	MIS_NNN	1.0	
CNNN Other	NNN_O	1.0	

Table A - 23 Multi-Family Collection Compaction Factors

Multi-Family Collection Options		Mixed Waste	Resi-duals	Wet/Dry		Recyclables	
		C_13	C_16	C_17	C_18	C_14	C_15
Leaves	YTL			1.0		1.0	1.0
Grass	YTG			1.0		1.0	1.0
Branches	YTB			1.0		1.0	1.0
Old News Print	ONP			1.0		1.0	1.0
Old Corr. Cardboard	OCC			1.0		1.0	1.0
Office Paper	OFF			1.0		1.0	1.0
Phone Books	PBK			1.0		1.0	1.0
Books	BOOK			1.0		1.0	1.0
Old Magazines	OMG			1.0		1.0	1.0
3rd Class Mail	MAIL			1.0		1.0	1.0
Paper Other #1	PAOT1			1.0		1.0	1.0
Paper Other #2	PAOT2			1.0		1.0	1.0
Paper Other #3	PAOT3			1.0		1.0	1.0
Paper Other #4	PAOT4			1.0		1.0	1.0
Paper Other #5	PAOT5			1.0		1.0	1.0
CCCR Other	CCR_O			1.0		1.0	1.0
Mixed Paper	PMIX			1.0		1.0	1.0
HDPE - Translucent	HDT			1.0		1.0	1.0
HDPE - Pigmented	HDP			1.0		1.0	1.0
PET	PPET			1.0		1.0	1.0
Plastic - Other #1	PLOT1			1.0		1.0	1.0
Plastic - Other #2	PLOT2			1.0		1.0	1.0
Plastic - Other #3	PLOT3			1.0		1.0	1.0
Plastic - Other #4	PLOT4			1.0		1.0	1.0
Plastic - Other #5	PLOT5			1.0		1.0	1.0
Mixed Plastic	PLMIX			1.0		1.0	1.0
CCNR Other	CNR_O			1.0		1.0	1.0
Ferrous Cans	FCAN			1.0		1.0	1.0
Ferrous Metal - Other	FMOT			1.0		1.0	1.0
Aluminum Cans	ACAN			1.0		1.0	1.0
Aluminum - Other #1	ALOT1			1.0		1.0	1.0
Aluminum - Other #2	ALOT2			1.0		1.0	1.0
Glass - Clear	GCLR			1.0		1.0	1.0
Glass - Brown	GBRN			1.0		1.0	1.0
Glass - Green	GGRN			1.0		1.0	1.0
Mixed Glass	GMIX			1.0		1.0	1.0
CNNR Other	NNR_O			1.0		1.0	1.0
Paper - Non-recyclable	PANR			1.0		1.0	1.0
Food Waste	FW			1.0		1.0	1.0
CCCN Other	CCN_O			1.0		1.0	1.0
Plastic - Non-Recyclable	PLNR			1.0		1.0	1.0
Misc.	MIS_CNN			1.0		1.0	1.0
CCNN Other	CNN_O			1.0		1.0	1.0
Ferrous - Non-recyclable	FNR			1.0		1.0	1.0
Al - Non-recyclable	ANR			1.0		1.0	1.0
Glass - Non-recyclable	GNR			1.0		1.0	1.0
Misc.	MIS_NNN			1.0		1.0	1.0
CNNN Other	NNN_O			1.0		1.0	1.0

Table A - 24 Commercial Collection Compaction Factors

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Leaves	YTL	1.0	
Grass	YTG	1.0	
Branches	YTB	1.0	
Old News Print	ONP	1.0	
Old Corr. Cardboard	OCC	1.0	
Office Paper	OFF	1.0	
Phone Books	PBK	1.0	
Books	BOOK	1.0	
Old Magazines	OMG	1.0	
3rd Class Mail	MAIL	1.0	
Paper Other #1	PAOT1	1.0	
Paper Other #2	PAOT2	1.0	
Paper Other #3	PAOT3	1.0	
Paper Other #4	PAOT4	1.0	
Paper Other #5	PAOT5	1.0	
CCCR Other	CCR_O	1.0	
Mixed Paper	PMIX	1.0	
HDPE - Translucent	HDT	1.0	
HDPE - Pigmented	HDP	1.0	
PET	PPET	1.0	
Plastic - Other #1	PLOT1	1.0	
Plastic - Other #2	PLOT2	1.0	
Plastic - Other #3	PLOT3	1.0	
Plastic - Other #4	PLOT4	1.0	
Plastic - Other #5	PLOT5	1.0	
Mixed Plastic	PLMIX	1.0	
CCNR Other	CNR_O	1.0	
Ferrous Cans	FCAN	1.0	
Ferrous Metal - Other	FMOT	1.0	
Aluminum Cans	ACAN	1.0	
Aluminum - Other #1	ALOT1	1.0	
Aluminum - Other #2	ALOT2	1.0	
Glass - Clear	GCLR	1.0	
Glass - Brown	GBRN	1.0	
Glass - Green	GGRN	1.0	
Mixed Glass	GMIX	1.0	
CNNR Other	NNR_O	1.0	
Paper - Non-recyclable	PANR	1.0	
Food Waste	FW	1.0	
CCCN Other	CCN_O	1.0	
Plastic - Non-Recyclable	PLNR	1.0	
Misc.	MIS_CNN	1.0	
CCNN Other	CNN_O	1.0	
Ferrous - Non-recyclable	FNR	1.0	
Al - Non-recyclable	ANR	1.0	
Glass - Non-recyclable	GNR	1.0	
Misc.	MIS_NNN	1.0	
CNNN Other	NNN_O	1.0	

Table A - 25 Process Model Interest Rates

DESCRIPTION	VARIABLE NAME	VALUE	UNITS
MRF interest Rate	MRF_I	5%	%
Transfer Station interest rate	TR_I	10%	%
Landfill Interest Rate	LF_I	5%	%
Collection Interest Rate	COL_I	5%	%
Combustor Interest Rate	CF_I	5%	%
MSW Compost Interest Rate	MSW_C_I	5%	%
RDF Interest Rate	RDF_I	5%	%
Anerobic Digestion Interest Rate	DIG_I	5%	%
Yard Waste Compost Interest Rate	YW_I	5%	%

Table A - 26 Generation Rate Data

DESCRIPTION	VARIABLE NAME	VALUE	UNITS
Community Name	**comm_name**	**Wake County**	**N/A**
Residential Population 1	res_pop_1	200,000	people
Residents per house 1	res_per_dwel_1	2.63	people/house
Generation rate 1	res_gen_1	2.88	lb/person-day
Residential Population 2	res_pop_2	2,000	people
Residents per house 2	res_per_dwel_2	2.63	people/house
Generation rate 2	res_gen_2	2.88	lb/person-day
Currently Selected Residential Population	res_pop	200,000	people
Currently Selected Residents per House	ph	2.63	people/house
Currently Selected Residential Generation Rate	gr	2.88	lb/person-day
Currently Selected Houses in Sector	h_res	76,046	houses
Currently Selected Residential Waste Generation Rate	g_res	53.02	lb/house-week
Multi-Family Population 1	mf_pop_1	20,000	people
Generation rate 1	mf_gen_1	2.88	lb/person-day
Number of Multi-family collection locations 1	mf_loc_1	100	locations
Multi-Family Population 2	mf_pop_2	1,000	people
Generation rate 2	mf_gen_2	2.88	lb/person-day
Number of Multi-family collection locations 2	mf_loc_2	10	locations
Currently Selected MF Population	mf_pop	20,000	people
Currently Selected MF Generation Rate	mf_gen	2.88	lb/person-day
Currently Selected Number of Multi family collection locations	h_mf	100	locations
Multi-family Waste Generation Rate (lb/location-week)	g_mf	4,032.00	lb/location-week
Number of Commercial Collection locations 1	com_loc_1	100	locations
Number of Commercial Collection locations 2	com_loc_2	100	locations
Number of Commercial Collection locations 3	com_loc_3	100	locations
Number of Commercial Collection locations 4	com_loC_9	100	locations
Number of Commercial Collection locations 5	com_loc_5	100	locations
Number of Commercial Collection locations 6	com_loc_6	100	locations
Number of Commercial Collection locations 7	com_loc_7	100	locations
Number of Commercial Collection locations 8	com_loc_8	100	locations
Number of Commercial Collection locations 9	com_loc_9	100	locations
Number of Commercial Collection locations 10	com_loc_10	100	locations
Commercial Waste Generation Rate 1	com_gen_1	2,300	lb/location-week
Commercial Waste Generation Rate 2	com_gen_2	2,300	lb/location-week
Commercial Waste Generation Rate 3	com_gen_3	2,300	lb/location-week
Commercial Waste Generation Rate 4	com_gen_4	2,300	lb/location-week
Commercial Waste Generation Rate 5	com_gen_5	2,300	lb/location-week
Commercial Waste Generation Rate 6	com_gen_6	2,300	lb/location-week
Commercial Waste Generation Rate 7	com_gen_7	2,300	lb/location-week
Commercial Waste Generation Rate 8	com_gen_8	2,300	lb/location-week
Commercial Waste Generation Rate 9	com_gen_9	2,300	lb/location-week
Commercial Waste Generation Rate 10	com_gen_10	2,300	lb/location-week
Currently Selected Commercial Collection locations	h_com	100	locations
Currently Selected Commercial Waste Generation Rate	g_com	2,300	lb/location-week

Table A - 27 Residential Composition

DESCRIPTION	VARIABLE NAME	Densities (All Sectors)		Residential Composition							
		Density in Refuse Collection Vehicle (lb/yd3)	Density in Recycling Collection Vehicle (lb/yd3)	Default Residential Composition (wt. fraction)	Sector #1 User Override (wt. fraction)	Sector #1 Non-Override Fraction (wt. fraction)	Sector #1 Model Value (wt. fraction)	Sector #2 User Override (wt. fraction)	Sector #2 Non-Override Fraction (wt. fraction)	Sector #2 Model Value (wt. fraction)	Currently Selected Residential Values
	MSW_COMP_TABLE	D_cv	D_rcv				RES_WT_FRAC_1			RES_WT_FRAC_2	RES_WT_FRAC
Yard Trimmings, Leaves	YTL	550	350	0.056	0.142	0.000	0.142	0.000	0.056	0.056	0.142
Yard Trimmings, Grass	YTG	550	350	0.093	0.043	0.000	0.043	0.000	0.093	0.093	0.043
Yard Trimmings, Branches	YTB	550	350	0.037	0.041	0.000	0.041	0.000	0.037	0.037	0.041
Old News Print	ONP	550	500	0.067	0.075	0.000	0.075	0.000	0.067	0.067	0.075
Old Corr. Cardboard	OCC	550	150	0.021	0.018	0.000	0.018	0.000	0.021	0.021	0.018
Office Paper	OFF	550	500	0.013	0.012	0.000	0.012	0.000	0.013	0.013	0.012
Phone Books	PBK	550	500	0.002	0.003	0.000	0.000	0.000	0.002	0.000	0.000
Books	BOOK	550	500	0.009	0.005	0.000	0.005	0.000	0.009	0.009	0.005
Old Magazines	OMG	550	500	0.017	0.011	0.000	0.011	0.000	0.017	0.017	0.011
3rd Class Mail	MAIL	550	500	0.022	0.018	0.000	0.000	0.000	0.022	0.000	0.000
Paper Other #1	PAOT1	550	500	0.000	0.024	0.000	0.024	0.000	0.000	0.000	0.024
Paper Other #2	PAOT2	550	500	0.000	0.020	0.000	0.020	0.000	0.000	0.000	0.020
Paper Other #3	PAOT3	550	500	0.000	0.014	0.000	0.014	0.000	0.000	0.000	0.014
Paper Other #4	PAOT4	550	500	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001
Paper Other #5	PAOT5	550	500	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001
CCCR Other	CCR_O	550	500								
Mixed Paper	PMIX	550	500	0.000			0.021			0.024	0.021
HDPE - Translucent	HDT	550	24	0.004	0.014	0.000	0.014	0.000	0.004	0.004	0.014
HDPE - Pigmented	HDP	550	24	0.005	0.006	0.000	0.006	0.000	0.005	0.005	0.006
PET	PPET	550	40	0.004	0.005	0.000	0.005	0.000	0.004	0.004	0.005
Plastic - Other #1	PLOT1	550	50	0.000	0.043	0.000	0.000	0.000	0.000	0.000	0.000
Plastic - Other #2	PLOT2	550	50	0.000	0.032	0.000	0.000	0.000	0.000	0.000	0.000
Plastic - Other #3	PLOT3	550	50	0.000	0.021	0.000	0.000	0.000	0.000	0.000	0.000
Plastic - Other #4	PLOT4	550	50	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.003
Plastic - Other #5	PLOT5	550	50	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001
Mixed Plastic	PLMIX	550	50	0.000			0.096			0.000	0.096
CCNR Other	CNR_O	550	50								
Ferrous Cans	FCAN	550	150	0.015	0.016	0.000	0.016	0.000	0.015	0.015	0.016
Ferrous Metal - Other	FMOT	550	750	0.000	0.070	0.000	0.070	0.000	0.000	0.000	0.070
Aluminum Cans	ACAN	550	75	0.009	0.009	0.000	0.009	0.000	0.009	0.009	0.009
Aluminum - Other #1	ALOT1	550	400	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.002
Aluminum - Other #2	ALOT2	550	400	0.000	0.006	0.000	0.006	0.000	0.000	0.000	0.006
Glass - Clear	GCLR	550	400	0.039	0.029	0.000	0.029	0.000	0.039	0.039	0.029
Glass - Brown	GBRN	550	400	0.016	0.030	0.000	0.030	0.000	0.016	0.016	0.030
Glass - Green	GGRN	550	400	0.010	0.010	0.000	0.010	0.000	0.010	0.010	0.010
Mixed Glass	GMIX	550	400	0.000			0.000			0.000	0.000
CNNR Other	NNR_O	550	150								
Paper - Non-recyclable	PANR	550	500	0.171	0.055	0.000	0.055	0.000	0.171	0.171	0.055
Food Waste	FW	550	800	0.049	0.095	0.000	0.095	0.000	0.049	0.049	0.095
CCCN Other	CCN_O	550	700								
Plastic - Non-Recyclable	PLNR	550	50	0.099	0.008	0.000	0.008	0.000	0.099	0.099	0.008
Misc.	MIS_CNN	550	110	0.075	0.106	0.000	0.106	0.000	0.075	0.075	0.106
CCNN Other	CNN_O	550	110								
Ferrous - Non-recyclable	FNR	550	750	0.032	0.003	0.000	0.003	0.000	0.032	0.032	0.003
Al - Non-recyclable	ANR	550	400	0.005	0.001	0.000	0.001	0.000	0.005	0.005	0.001
Glass - Non-recyclable	GNR	550	400	0.007	0.010	0.000	0.010	0.000	0.007	0.007	0.010
Misc.	MIS_NNN	550	300	0.123	0.000	0.000	0.000	0.000	0.123	0.123	0.000
CNNN Other	NNN_O	550	400								

Table A - 28 Multi-Family Composition

DESCRIPTION	VARIABLE NAME	Default Mult. Family Composition (wt. fraction)	Sector #1 User Override (wt. fraction)	Sector #1 Non-Override Fraction (wt. fraction)	Sector #1 Model Value (wt. fraction)	Sector #2 User Override (wt. fraction)	Sector #2 Non-Override Fraction (wt. fraction)	Sector #2 Model Value (wt. fraction)	Currently Selected Multi-family Values
	MSW_COMP_TABLE				MF_WT_FRAC_1			MF_WT_FRAC_2	MF_WT_FRAC
Yard Trimmings, Leaves	YTL	0.056	0.142	0.000	0.142	0.000	0.056	0.056	0.142
Yard Trimmings, Grass	YTG	0.093	0.043	0.000	0.043	0.000	0.093	0.093	0.043
Yard Trimmings, Branches	YTB	0.037	0.041	0.000	0.041	0.000	0.037	0.037	0.041
Old News Print	ONP	0.067	0.075	0.000	0.075	0.000	0.067	0.067	0.075
Old Corr. Cardboard	OCC	0.021	0.018	0.000	0.018	0.000	0.021	0.021	0.018
Office Paper	OFF	0.013	0.012	0.000	0.012	0.000	0.013	0.013	0.012
Phone Books	PBK	0.002	0.003	0.000	0.000	0.000	0.002	0.000	0.000
Books	BOOK	0.009	0.005	0.000	0.005	0.000	0.009	0.009	0.005
Old Magazines	OMG	0.017	0.011	0.000	0.011	0.000	0.017	0.017	0.011
3rd Class Mail	MAIL	0.022	0.018	0.000	0.000	0.000	0.022	0.000	0.000
Paper Other #1	PAOT1	0.000	0.024	0.000	0.024	0.000	0.000	0.000	0.024
Paper Other #2	PAOT2	0.000	0.020	0.000	0.020	0.000	0.000	0.000	0.020
Paper Other #3	PAOT3	0.000	0.014	0.000	0.014	0.000	0.000	0.000	0.014
Paper Other #4	PAOT4	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001
Paper Other #5	PAOT5	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001
CCCR Other	CCR_O								
Mixed Paper	PMIX	0.000			0.021			0.024	0.021
HDPE - Translucent	HDT	0.004	0.014	0.000	0.014	0.000	0.004	0.004	0.014
HDPE - Pigmented	HDP	0.005	0.006	0.000	0.006	0.000	0.005	0.005	0.006
PET	PPET	0.004	0.005	0.000	0.005	0.000	0.004	0.004	0.005
Plastic - Other #1	PLOT1	0.000	0.043	0.000	0.000	0.000	0.000	0.000	0.000
Plastic - Other #2	PLOT2	0.000	0.032	0.000	0.000	0.000	0.000	0.000	0.000
Plastic - Other #3	PLOT3	0.000	0.021	0.000	0.000	0.000	0.000	0.000	0.000
Plastic - Other #4	PLOT4	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.003
Plastic - Other #5	PLOT5	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001
Mixed Plastic	PLMIX	0.000			0.096			0.000	0.096
CCNR Other	CNR_O								
Ferrous Cans	FCAN	0.015	0.016	0.000	0.016	0.000	0.015	0.015	0.016
Ferrous Metal - Other	FMOT	0.000	0.070	0.000	0.070	0.000	0.000	0.000	0.070
Aluminum Cans	ACAN	0.009	0.009	0.000	0.009	0.000	0.009	0.009	0.009
Aluminum - Other #1	ALOT1	0.000	0.002	0.000	0.002	0.000	0.000	0.000	0.002
Aluminum - Other #2	ALOT2	0.000	0.006	0.000	0.006	0.000	0.000	0.000	0.006
Glass - Clear	GCLR	0.039	0.029	0.000	0.029	0.000	0.039	0.039	0.029
Glass - Brown	GBRN	0.016	0.030	0.000	0.030	0.000	0.016	0.016	0.030
Glass - Green	GGRN	0.010	0.010	0.000	0.010	0.000	0.010	0.010	0.010
Mixed Glass	GMIX	0.000			0.000			0.000	0.000
CNNR Other	NNR_O								
Paper - Non-recyclable	PANR	0.171	0.055	0.000	0.055	0.000	0.171	0.171	0.055
Food Waste	FW	0.049	0.095	0.000	0.095	0.000	0.049	0.049	0.095
CCCN Other	CCN_O								
Plastic - Non-Recyclable	PLNR	0.099	0.008	0.000	0.008	0.000	0.099	0.099	0.008
Misc.	MIS_CNN	0.075	0.106	0.000	0.106	0.000	0.075	0.075	0.106
CCNN Other	CNN_O								
Ferrous - Non-recyclable	FNR	0.032	0.003	0.000	0.003	0.000	0.032	0.032	0.003
Al - Non-recyclable	ANR	0.005	0.001	0.000	0.001	0.000	0.005	0.005	0.001
Glass - Non-recyclable	GNR	0.007	0.010	0.000	0.010	0.000	0.007	0.007	0.010
Misc.	MIS_NNN	0.123	0.000	0.000	0.000	0.000	0.123	0.123	0.000
CNNN Other	NNN_O								

Table A - 29 Commercial Composition

DESCRIPTION	VARIABLE NAME	Default Commercial Composition (wt. fraction)	Sector #1 User Override (wt. fraction)	Sector #1 Non-Override Fraction (wt. fraction)	Sector #1 Model Value (wt. fraction)	. . . . .	Sector #10 User Override (wt. fraction)	Sector #10 Non-Override Fraction (wt. fraction)	Sector #10 Model Value (wt. fraction)	Currently Selected Commercial Values
	MSW_COMP_TABLE				COM_WT_FRAC_1				COM_WT_FRAC_10	COM_WT_FRAC
Yard Trimmings, Leaves	YTL					. . . . .				
Yard Trimmings, Grass	YTG									
Yard Trimmings, Branches	YTB									
Old News Print	ONP	0.022	0.000	0.022	0.022		0.000	0.022	0.022	0.0220
Old Corr. Cardboard	OCC	0.360	0.000	0.360	0.360	. . . . .	0.000	0.360	0.360	0.3600
Office Paper	OFF	0.072	0.000	0.072	0.072		0.000	0.072	0.072	0.0720
Phone Books	PBK	0.003	0.000	0.003	0.000		0.000	0.003	0.000	0.0000
Books	BOOK									
Old Magazines	OMG									
3rd Class Mail	MAIL	0.023	0.000	0.023	0.000	. . . . .	0.000	0.023	0.000	0.0000
Paper Other #1	PAOT1	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.0000
Paper Other #2	PAOT2	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.0000
Paper Other #3	PAOT3	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.0000
Paper Other #4	PAOT4									
Paper Other #5	PAOT5					. . . . .				
CCCR Other	CCR_O	0.019	0.000	0.019	0.019		0.000	0.019	0.019	0.0190
Mixed Paper	PMIX				0.026				0.026	0.0260
HDPE - Translucent	HDT									
HDPE - Pigmented	HDP									
PET	PPET	0.002	0.000	0.002	0.002	. . . . .	0.000	0.002	0.002	0.0020
Plastic - Other #1	PLOT1									
Plastic - Other #2	PLOT2									
Plastic - Other #3	PLOT3									
Plastic - Other #4	PLOT4									
Plastic - Other #5	PLOT5					. . . . .				
Mixed Plastic	PLMIX				0.000				0.000	0.0000
CCNR Other	CNR_O	0.041	0.000	0.041	0.041		0.000	0.041	0.041	0.0410
Ferrous Cans	FCAN	0.007	0.000	0.007	0.007		0.000	0.007	0.007	0.0070
Ferrous Metal - Other	FMOT									
Aluminum Cans	ACAN	0.004	0.000	0.004	0.004	. . . . .	0.000	0.004	0.004	0.0040
Aluminum - Other #1	ALOT1									
Aluminum - Other #2	ALOT2									
Glass - Clear	GCLR	0.019	0.000	0.019	0.019		0.000	0.019	0.019	0.0190
Glass - Brown	GBRN	0.008	0.000	0.008	0.008		0.000	0.008	0.008	0.0080
Glass - Green	GGRN	0.005	0.000	0.005	0.005		0.000	0.005	0.005	0.0050
Mixed Glass	GMIX				0.000	. . . . .			0.000	0.0000
CNNR Other	NNR_O	0.024	0.000	0.024	0.024		0.000	0.024	0.024	0.0240
Paper - Non-recyclable	PANR									
Food Waste	FW									
CCCN Other	CCN_O	0.171	0.000	0.171	0.171		0.000	0.171	0.171	0.1710
Plastic - Non-Recyclable	PLNR					. . . . .				
Misc.	MIS_CNN									
CCNN Other	CNN_O	0.113	0.000	0.113	0.113		0.000	0.113	0.113	0.1130
Ferrous - Non-recyclable	FNR									
Al - Non-recyclable	ANR					. . . . .				
Glass - Non-recyclable	GNR									
Misc.	MIS_NNN									
CNNN Other	NNN_O	0.107	0.000	0.107	0.107		0.000	0.107	0.107	0.1070

Table A - 30 Transportation Fuel Pre-Combustion Emissions

DESCRIPTION	VARIABLE NAME	DIESEL pre comb. (lbs emission per 1000 gal. combusted)	GASOLINE pre comb. (lbs emission per 1000 gal. combusted)
	Trans_fuel_pre_comb_table	d_pc_em	g_pc_em
Atmospheric Emissions			
Particulates (PM10)	T_F_PC_A_PART_10	0	0
Particulates (Total)	T_F_PC_A_PART	1.82	1.54
Nitrogen Oxides	T_F_PC_A_NO	7.19	6.06
Hydrocarbons (non CH4)	T_F_PC_A_HC	67.49014	57.29012
Sulfur Oxides	T_F_PC_A_SO	8.8	7.44
Carbon Monoxide	T_F_PC_A_CO	5.01	4.2
CO2 (biomass)	T_F_PC_A_CO2_BM	0	0
CO2 (non biomass)	T_F_PC_A_CO2	3594	3034
Ammonia	T_F_PC_A_NH3	0.039	0.033
Lead	T_F_PC_A_PB	1.10E-05	0.0000091
Methane	T_F_PC_A_CH4	0.05	0.043
Hydrochloric acid	T_F_PC_A_HCL	0.0012	0.00098
Solid Waste			
Solid Waste #1	T_F_PC_SW_1	82.4	69.7
Solid Waste #2	T_F_PC_SW_2	0	0
Solid Waste #3	T_F_PC_SW_3	0	0
Solid Waste #4	T_F_PC_SW_4	0	0
Solid Waste #5	T_F_PC_SW_5	0	0
Waterborne Emissions			
Dissolved Solids	T_F_PC_W_DS	102	86.9
Suspended Solids	T_F_PC_W_SS	0.095	0.081
BOD	T_F_PC_W_BOD	0.1	0.089
COD	T_F_PC_W_COD	0.49058	0.4205
Oil	T_F_PC_W_OIL	1.23	1.05
Sulfuric Acid	T_F_PC_W_H2SO4	0.31	0.26
Iron	T_F_PC_W_FE	0.081	0.068
Ammonia	T_F_PC_W_NH3	0.014	0.012
Copper	T_F_PC_W_Cu	0	0
Cadmium	T_F_PC_W_Cd	0	0
Arsenic	T_F_PC_W_As	0	0
Mercury	T_F_PC_W_Hg	0	0
Phosphate	T_F_PC_W_P_x	0	0
Selenium	T_F_PC_W_Se	0	0
Chromium	T_F_PC_W_CR	3.40E-05	0
Lead	T_F_PC_W_PB	1.50E-05	1.30E-05
Zinc	T_F_PC_W_ZN	2.20E-04	1.90E-04

Table A - 31 Transportation Fuel Pre-Combustion Energy

DESCRIPTION	VARIABLE NAME	pre comb. energy (btu/gal.)
Gasoline - mobil source	gas_pc_enrg	2.19E+04
Diesel - mobil source	dsl_pc_enrg	2.59E+04

Table A - 32 Transportation Fuel Combustion Energy

DESCRIPTION	VARIABLE NAME	comb. energy (btu/gal.)
Gasoline - mobil source	gas_enrg	1.51E+05
Diesel - mobil source	dsl_enrg	1.37E+05

Table A - 33 Greenhouse Gas Equivalents

GREENHOUSE GAS	variable name	20 Year Global Warming Potential
Carbon dioxide (fossil fuel)	CO2_f_GWP	1
Carbon dioxide (biomass)	CO2_bm_GWP	0
Methane	CH4_GWP	63
Nitrous Oxide	NO_GWP	270
Other hydrocarbons	HC_GWP	0

Table A - 34 Electric Energy Emissions

FUEL RELATED EMISSIONS BY USAGE	variable name	TOTAL Emissions (lb/kwh elect.)
		Regional Grid
		100.00%
	emissions table	r_tot
Atmospheric Emissions		
Particulates (PM10)	a_pm_10	0.00E+00
Particulates (Total)	a_pm	2.60E-03
Nitrogen Oxides	a_no	6.46E-03
Hydrocarbons (non CH4)	a_hc	1.02E-03
Sulfur Oxides	a_so	1.37E-02
Carbon Monoxide	a_co	2.14E-03
CO2 (biomass)	a_co2_bm	0.00E+00
CO2 (non biomass)	a_co2	1.49E+00
Ammonia	a_nh4	1.76E-07
Lead	a_pb	4.91E-11
Methane	a_ch4	9.85E-06
Hydrochloric acid	a_hcl	5.31E-09
Solid Waste		
Solid Waste #1	sw_1	1.91E-01
Solid Waste #2	sw_2	0.00E+00
Solid Waste #3	sw_3	0.00E+00
Solid Waste #4	sw_4	0.00E+00
Solid Waste #5	sw_5	0.00E+00
Waterborne Emissions		
Dissolved Solids	w_ds	4.57E-04
Suspended Solids	w_ss	4.12E-07
BOD	w_bod	4.51E-07
COD	w_cod	2.23E-06
Oil	w_oil	6.11E-06
Sulfuric Acid	w_h2so4	1.12E-03
Iron	w_fe	2.79E-04
Ammonia	w_nh4	6.15E-08
Copper	w_cu	0.00E+00
Cadmium	w_cd	0.00E+00
Arsenic	w_as	0.00E+00
Mercury	w_hg	0.00E+00
Phosphate	w_po4	0.00E+00
Selenium	w_se	0.00E+00
Chromium	w_cr	7.10E-11
Lead	w_pb	6.57E-11
Zinc	w_zn	9.82E-10

APPENDIX B

DEFAULT INPUT VALUES
(FOR VARIABLES WITH SECTOR VARIABILITY)

Solid vertical lines are used in the printout to separate collection options into sets of options that are similar to each other. Lightly shaded cells represent input variables which might be expected to have a unique value for the option in which the shaded cell appears. Darkly shaded cells represent input variables that are used in the area of the spreadsheet shown, but which are entered in some other location in the process model.

Table A1 - 1 Default Collection Sector Related Parameters (Residential Collection)

INPUT PARAMETERS	Refuse collection				Co-Collection				Wet/Dry				Recycling collection						Yard Waste			
	C1		C7		C5		C6		C11		C12		C2		C3		C4		C0		C9	
	Mixed Waste		Residuals		Co-Collection				Wet/Dry				Recyclables						Yard Waste			
Residential Collection Options	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
collection schedule																						
no. of households at one stop (households/stop)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
collection frequency (1 / week)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
collection operation times																						
loading time at one service stop (min/stop)	0.15	0.15	0.15	0.15	0.15	0.15	0.17	0.17	0.17	0.17	0.15	0.15	0.45	0.45	0.45	0.45	0.15	0.15	0.15	0.15	0.15	0.15
travel time between service stops (min/stop)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
time from garage to route (min/day-vhcl)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
travel speeds																						
between collection stops (miles/hour)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
from garage to route in the morning (mile/hour)	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
distances																						
distance between collection stops (miles)	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142
distance btwn garage and collection route (miles)	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667
labor																						
does a driver work as a collector? (y/n)	n	n	n	n	n	n	n	n	n	n	n	n	y	y	y	y	n	n	y	y	y	y
number of collectors per vehicle (person/vehicle)	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0
collection vehicle																						
usable vehicle capacity (yd3)	20	20	20	20	20	20	20	20	20	20	20	20	23	23	23	23	23	23	20	20	20	20
economic life of a vehicle (year)	7	7	7	7	7	7	7	7	7	7	7	7	8	8	8	8	8	8	7	7	7	7
unit price of a vehicle ($/vehicle)	133525	133525	133525	133525	133525	133525	144652	144652	144652	144652	133525	133525	55635	55635	55635	55635	133525	133525	133525	133525	166906	166906
vehicle operation and maint. cost ($/vehicle)	29376	29376	29376	29376	29376	29376	33381	33381	33381	33381	29376	29376	30822	30822	30822	30822	29376	29376	29376	29376	29376	29376

Table A1 - 2 Default Collection Sector Related Parameters (Residential drop-off)

INPUT PARAMETERS	Recyclables C8		Yard Waste C10	
Residential Collection Options	**Recyclables**		**Yard Waste**	
	Sector 1	Sector 2	Sector 1	Sector 2
collection schedule				
no. of households at one stop (households/stop)	N/A	N/A	N/A	N/A
collection frequency (1 / week)	N/A	N/A	N/A	N/A
collection operation times				
loading time at one service stop (min/stop)	20	20	N/A	N/A
travel time between service stops (min/stop)	N/A	N/A	N/A	N/A
time from garage to route (min/day-vhcl)	20	20	N/A	N/A
travel speeds				
between collection stops (miles/hour)	N/A	N/A	N/A	N/A
from garage to route in the morning (mile/hour)	35	35	N/A	N/A
distances				
distance between collection stops (miles)	N/A	N/A	N/A	N/A
distance btwn garage and collection route (miles)	11.667	11.667	N/A	N/A
labor				
does a driver work as a collector? (y/n)	y	y	N/A	N/A
number of collectors per vehicle (person/vehicle)	0	0	N/A	N/A
collection vehicle				
usable vehicle capacity (yd3)	23	23	N/A	N/A
economic life of a vehicle (year)	8	8	N/A	N/A
unit price of a vehicle ($/vehicle)	55635	55635	N/A	N/A
vehicle operation and maint. cost ($/vehicle)	30822	30822	N/A	N/A

Table A1 - 3 Default Collection Sector Related Parameters (Multi-family)

INPUT PARAMETERS	Refuse collection				Wet/Dry				Recyclables			
	C13		C16		C17		C18		C14		C15	
Multi-Family Collection Options	**Refuse collection**				**Wet/Dry**				**Recyclables**			
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
collection schedule												
no. of households at one stop (households/stop)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
collection frequency (1 / week)	1	1	1	1	1	1	1	1	1	1	1	1
collection operation times												
loading time at one service stop (min/stop)	5	5	5	5	5	5	5	5	10	10	10	10
travel time between service stops (min/stop)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
time from garage to route (min/day-vhcl)	20	20	20	20	20	20	20	20	20	20	20	20
travel speeds												
between collection stops (miles/hour)	10	10	10	10	10	10	10	10	10	10	10	10
from garage to route in the morning (mile/hour)	35	35	35	35	35	35	35	35	35	35	35	35
distances												
distance between collection stops (miles)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
distance btwn garage and collection route (miles)	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667	11.667
labor												
does a driver work as a collector? (y/n)	n	n	n	n	n	n	n	n	y	y	n	n
number of collectors per vehicle (person/vehicle)	1	1	1	1	1	1	1	1	0	0	1	1
collection vehicle												
usable vehicle capacity (yd3)	20	20	20	20	20	20	20	20	23	23	23	23
economic life of a vehicle (year)	7	7	7	7	7	7	7	7	8	8	8	8
unit price of a vehicle ($/vehicle)	133525	133525	133525	133525	144652	144652	133525	133525	55635	55635	133525	133525
vehicle operation and maint. cost ($/vehicle)	29376	29376	29376	29376	33381	33381	29376	29376	30822	30822	29376	29376

Table A1 - 4 Default Collection Sector Related Parameters (Commercial)

INPUT PARAMETERS	Recyclables C19			MSW/Residuals C20		
Commercial Collection Options	**Recyclables**			**MSW/Residuals**		
	Sector 1		Sector 10	Sector 1		Sector 10
collection schedule						
no. of households at one stop (households/stop)	N/A	. . . . .	N/A	N/A	. . . . .	N/A
collection frequency (1 / week)	3		3	2		2
collection operation times						
loading time at one service stop (min/stop)	10		10	5		5
travel time between service stops (min/stop)	1.5		1.5	1.5		1.5
time from garage to route (min/day-vhcl)	20	. . . . .	20	20	. . . . .	20
travel speeds						
between collection stops (miles/hour)	10		10	10		10
from garage to route in the morning (mile/hour)	35		35	35		35
distances						
distance between collection stops (miles)	0.25		0.25	0.25		0.25
distance btwn garage and collection route (miles)	11.667		11.667	11.667		11.667
labor						
does a driver work as a collector? (y/n)	y		y	n		n
number of collectors per vehicle (person/vehicle)	0	. . . . .	0	1	. . . . .	1
collection vehicle						
usable vehicle capacity (yd3)	23		23	20		20
economic life of a vehicle (year)	8		8	7		7
unit price of a vehicle ($/vehicle)	55635	. . . . .	55635	133525	. . . . .	133525
vehicle operation and maint. cost ($/vehicle)	30822		30822	29376		29376

APPENDIX C

DEFAULT INPUT VALUES
(FOR VARIABLES WITH SECTOR AND NEXT NODE VARIABILITY)

Solid vertical lines are used in the printout to separate collection options into sets of options that are similar to each other. Lightly shaded cells represent input variables which might be expected to have a unique value for the option in which the shaded cell appears. Darkly shaded cells represent input variables that are used in the area of the spreadsheet shown, but which are entered in some other location in the process model.

It should be noted that several of the collection options for which distances to unloading could be expected to be the same have been grouped to prevent the necessity for the user entering these distances more than once. Collection Options in Group 1 include C1, C7, C5, C6, C11 and C12 while group 2 collection options include C2, C3, and C4. These collection options are similar enough that the garage would be located in the same place regardless of which collection options are implemented and material collected via these options could be expected to flow to the same locations.

Table C2 - 1 Default Collection Distances to Next MSW Node

Relative to Node	TRAVEL PARAMETER	UNITS	Residential												Multi-Family				Commercial				
			Sector 1						Sector 2						Sector 1		Sector 2		Sector 1			Sector 10	
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8	C17/ C18	All Others	C17/ C18	All Others	C19	C20		C19	C20
Rail Transfer (RT1)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
Mixed Refuse Transfer (TR1)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
Commingled Recyclables Transfer (TR2)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	0.00	0.00	. . . . .	0.00	0.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	0.00	0.00		0.00	0.00
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	0.00	0.00		0.00	0.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	0.00	0.00		0.00	0.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
Co-collected Transfer Station (TR3)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	0.00	0.00	. . . . .	0.00	0.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	0.00	0.00		0.00	0.00
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	0.00	0.00		0.00	0.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	0.00	0.00		0.00	0.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
Co-collected Transfer Station (TR4)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	0.00	0.00	. . . . .	0.00	0.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	0.00	0.00		0.00	0.00
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	0.00	0.00		0.00	0.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	0.00	0.00		0.00	0.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
Pre-Sorted Transfer Station (TR5)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
Mixed Refuse MRF (S1)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00

Table C2 - 2 Default Collection Distances to Next MSW Node (Continued)

Pre-sorted MRF (S2)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
Commingled Recyclables (S3)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	0.00	0.00	. . . . .	0.00	0.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	0.00	0.00		0.00	0.00
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	0.00	0.00		0.00	0.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	0.00	0.00		0.00	0.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
Commingled Recyclables (bags, 1 compartment) (S4)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	0.00	0.00	. . . . .	0.00	0.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	0.00	0.00		0.00	0.00
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	0.00	0.00		0.00	0.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	0.00	0.00		0.00	0.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
Commingled Recyclables (bags, 2 compartment) (S5)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	0.00	0.00	. . . . .	0.00	0.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	0.00	0.00		0.00	0.00
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	0.00	0.00		0.00	0.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	0.00	0.00		0.00	0.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00		0.00	0.00
Yard Waste Composting (T1)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	0.00	0.00	0.00	0.00	0.00	. . . . .	0.00	0.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
Combustion (T3)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
RDF (T5)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00

Table C2 - 3 Default Collection Distances to Next MSW Node (Continued)

Mixed Waste Composting (T7)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
Anaerobic Digestion (T8)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
Landfill (D1)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
Enhanced Bioreactor (D3)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	10.00	15.00	12.00	10.00	10.00	. . . . .	10.00	10.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11.67	14.00	14.00	11.67	11.67		11.67	11.67
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	30.00	30.00	31.00	30.00	30.00		30.00	30.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	35.00	35.00	36.00	35.00	35.00		35.00	35.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		20.00	20.00
Waste as Fuel (Leaves)	btwn collection route and facility	Miles	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00	15.00	0.00	0.00	0.00	0.00	0.00	. . . . .	0.00	0.00
	between facility and garage	Miles	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00	14.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	btwn collection route and facility	Miles/Hour	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00	30.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	between facility and garage	Miles/Hour	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00	35.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	time btwn facility and garage	Min/Day-Vech.	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	time btwn route and facility	Min/Trip	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00

APPENDIX D

SAMPLE OUTPUT

The following pages show a printout of Collection Preprocessor output generated from the default input values shown in Appendix A.

Note that the values for “number of collection vehicles” and “Total annual cost” for recyclables collection options C3, C4, C8, and C15 and yard waste collection option C9 are zero. This occurred because the default inputs include zero values for the fraction of the community served (*option_frac*) by these collection options. Only one residential recyclables collection option (C2) and one yard waste collection option (C0) were assigned non-zero *option_frac* values. *Option_frac* for both C2 and C0 is 100%. This satisfies the requirement that the sum of the fractions of the community served by different recyclable or yard waste options not exceed 100%.

Table D - 1 Residential Collection Outputs

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
COLLECTION COSTS												
Breakdown of capital costs												
annual capital cost per vehicle ($/vehicle-year)	C_cap_v	25,845	25,845	25,845		27,999	25,845	9,641	9,641	23,138	25,845	32,306
number of collection vehicles (vehicles)	Nt	32.70	28.64	32.70	52.77	58.42	29.97	36.28	29.32	25.11	14.95	13.98
annualized capital cost per bin ($/bin-year)	Cb					1.04	1.04	1.04	1.04	1.04		
no. of bins per vehicle (bins per vehicle)	Nb					2,603	2,537	2,096	12,970	3,028		
bin annual cost per vehicle ($/vehicle per year)	C_cap_b					2,707	2,638	2,179	13,485	3,149		
Breakdown of operating costs												
labor cost per vehicle ($/vehicle-year)	Cw	69,170	69,170	69,170	69,170	69,170	69,170	40,196	40,196	69,170	40,196	40,196
O&M cost per vehicle ($/vehicle-year)	Cvo	29,376	29,376	29,376	33,381	33,381	29,376	30,822	30,822	29,376	29,376	29,376
other expenses per vehicle ($/vehicle-year)	Coe	16,166	16,166	16,166	16,166	16,166	16,166	8,083	8,083	16,166	8,083	8,083
Annual operating cost ($/vehicle-year)	C_op	128,477	128,477	128,477	132,964	132,964	128,477	88,593	88,593	128,477	86,973	86,973
Total annual cost ($/year) -- capital + operating	C_ann	5,130,639	4,493,754	5,130,639	7,016,753	9,724,864	4,781,791	3,678,136	3,303,465	3,944,580	1,725,301	1,712,497
Total annual cost per house ($/house-year)	C_house	67.47	59.09	67.47	92.27	127.88	62.88	48.37	43.44	51.87	22.69	22.52
Cost per ton of refuse collected ($/ton)	C_ton	**48.81**	**56.57**	**48.81**	**66.75**	**92.51**	**13.95**	**179.46**	**224.51**	**192.46**	**162.24**	**255.30**
Total annual cost per vehicle ($/vehicle-year)	C_vehicle	156,907	156,907	156,907	132,964	166,469	159,545	101,377	112,683	157,078	115,402	122,510
cost coefficient #1	cc_1	1,273.30	1,273.30	1,273.30	1,423.76	1,503.52	1,313.18	1,866.22	2,402.69	1,667.82	1,434.00	1,522.32
cost coefficient #2	cc_2	13,635.77	13,635.77	13,635.77	15,658.74	15,658.74	13,635.77	8,235.38	8,224.56	11,612.79	9,997.79	10,613.53

Table D - 2 Residential Collection Outputs (Continued)

Residential Collection Options		Mixed Waste C_1	Resi-duals C_7	Co-Collection C_5	C_6	Wet/Dry C_11	C_12	Recyclables C_2	C_3	C_4	Yard Waste C_0	C_9
Calculations for collection vehicle activities												
houses per trip	Ht	165.97	219.65	165.97	85.36	73.65	198.58	153.38	162.77	153.38	522.04	827.60
travel time between service stops (min/stop)	Tbet	0.17	0.17	0.17	0.17	0.17	0.17	0.26	0.34	0.26	0.34	0.34
travel time between collection route and facility (min/trip)	Trf	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
travel time from garage to first collection route (min/day-vehicle)	Tgr	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
travel time from disposal facility to garage (min/day-vehicle)	Tfg	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
time per trip (min/trip) -- collection+travel+unload time	Tc	107.94	125.12	107.94	88.85	84.87	118.37	168.88	188.25	117.86	310.46	460.19
trips per day per vehicle (trip/day-vehicle)	RD	2.80	2.42	2.80	3.38	3.53	2.56	1.78	1.59	2.57	0.97	0.66
daily weight of refuse collected per vehicle (tons/vehicle-day)	RefD	12.33	10.64	12.33	7.64	6.90	43.87	2.17	1.93	3.13	2.73	1.84
number of collection stops per day (stops/vehicle-day)	SD	465.13	531.05	465.13	288.21	260.35	507.45	272.48	259.40	393.67	508.66	544.02
Daily collection vehicle activity times												
travel time from garage to first collection route (min/day-vehicle)	Tgr	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
loading time at collection stops (min/day-vehicle)	LD	69.77	79.66	69.77	48.99	44.26	76.12	122.61	116.73	59.05	76.30	81.60
travel time between collection stops (min/day-vehicle)	Tb	78.60	89.87	78.60	48.42	43.66	85.83	70.80	87.65	102.29	172.61	184.74
travel time between route and disposal facility (min/day-vehicle)	F_R	122.10	106.71	122.10	145.06	151.39	112.22	81.06	73.75	112.66	48.97	36.29
unloading time at disposal facility (min/day-vehicle)	UD	49.54	43.77	49.54	77.53	80.69	45.83	45.53	41.87	46.00	22.12	17.36
lunch time (min/day-vehicle)	F1_	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
break time (min/day-vehicle)	F2_	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
travel time from disposal facility to garage (min/day-vehicle)	Tfg	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
total (min/day-vehicle)		**420.00**	**420.00**	**420.00**	**420.00**	**420.00**	**420.00**	**420.00**	**420.00**	**420.00**	**420.00**	**420.00**
service hours per day (hours/day-vehicle)	ShD	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**
Daily miles traveled												
from garage to first collection route(miles/day-vehicle)	Dgr	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
between collection stops (miles/day-vehicle)	Db	6.55	7.49	6.55	4.04	3.64	7.15	5.90	7.30	8.52	14.38	15.40
between route and disposal facility (miles/day-vehicle)	DF_R	61.05	53.35	61.05	72.53	75.69	56.11	40.53	36.87	56.33	24.49	18.15
from disposal facility to garage (miles/day-vehicle)	Dfg	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
total (miles/day-vehicle)	MiD	**90.93**	**84.18**	**90.93**	**99.90**	**102.67**	**86.59**	**69.76**	**67.51**	**88.19**	**62.20**	**56.88**
Daily fuel usage												
from garage to first collection route (gallons/day-vehicle)		2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
loading at collection stops (gallons/day-vehicle)		1.16	1.33	1.16	0.82	0.74	1.27	2.04	1.95	0.98	1.27	1.36
between collection stops (gallons/day-vehicle)		3.27	3.74	3.27	2.02	1.82	3.58	2.95	3.65	4.26	7.19	7.70
between disposal facility and route (gallons/day-vehicle)		12.21	10.67	12.21	14.51	15.14	11.22	8.11	7.37	11.27	4.90	3.63
unloading at disposal facility (gallons/day-vehicle)		0.83	0.73	0.83	1.29	1.34	0.76	0.76	0.70	0.77	0.37	0.29
from disposal facility to garage (gallons/day-vehicle)		2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
total (gallons/day-vehicle)	FuelD	**22.14**	**21.14**	**22.14**	**23.30**	**23.71**	**21.50**	**18.52**	**18.34**	**21.95**	**18.40**	**17.64**

Table D - 3 Residential Collection Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
ENERGY CONSUMPTION												
Energy consumption by collection vehicles												
fuel usage per ton of refuse (gallons/ton)	FuelTon	2	2	2	3	3	0	9	10	7	7	10
fuel energy per ton of refuse (Btu/ton)		245,981	272,238	245,981	417,764	470,575	67,138	1,171,270	1,304,920	960,402	923,798	1,313,242
fuel precombustion energy per ton of refuse (Btu/ton)		**46,503**	**5.15E+04**	**4.65E+04**	**7.90E+04**	**8.90E+04**	**1.27E+04**	**2.21E+05**	**2.47E+05**	**1.82E+05**	**1.75E+05**	**2.48E+05**
total coll. vehicle energy usage per ton of refuse (Btu/ton)		**292,484**	**3.24E+05**	**2.92E+05**	**4.97E+05**	**5.60E+05**	**7.98E+04**	**1.39E+06**	**1.55E+06**	**1.14E+06**	**1.10E+06**	**1.56E+06**
Energy consumption by garage												
daily electricity usage per vehicle (kWh/vehicle-day)	ElecD	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
electricity usage per ton of refuse (kWh/ton)	**ElecTon**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
total garage energy usage per ton of refuse (Btu/ton)		372.20	431.43	372.20	600.69	664.97	104.63	2,118.14	2,384.02	1,466.06	1,682.25	2,493.57
Total energy consumption per ton of refuse (Btu/ton)		2.93E+05	3.24E+05	2.93E+05	4.97E+05	5.60E+05	7.99E+04	1.39E+06	1.55E+06	1.14E+06	1.10E+06	1.56E+06
energy consumption coefficient #1	ec_1	5.13E+06	5.13E+06	5.13E+06	5.40E+06	5.40E+06	5.13E+06	1.05E+07	1.21E+07	6.94E+06	8.50E+06	8.50E+06
energy consumption coefficient #2	ec_2	**1.08E+08**	**1.08E+08**	**1.08E+08**	**1.12E+08**	**1.12E+08**	**1.08E+08**	**9.72E+07**	**9.71E+07**	**9.37E+07**	**1.08E+08**	**1.08E+08**
Total energy consumption per ton of refuse (Btu/ton)		292,856.59	324,136.00	292,856.59	497,343.91	560,202.85	79,935.53	1,394,817.56	1,554,000.04	1,143,433.33	1,100,124.79	1,564,005.12

Table D - 4 Residential Collection Air Release Outputs

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
AIRBORNE RELEASES												
Carbon Monoxide												
CO emissions from collection vehicles (lb/ton)		0.082	0.088	0.082	0.145	0.165	0.022	0.357	0.389	0.312	0.253	0.343
CO precombustion emissions from fuel production (lb/ton)		0.009	0.010	0.009	0.015	0.017	0.002	0.043	0.048	0.035	0.034	0.048
CO emissions from garage electricity generation (lb/ton)		7.62E-05	8.83E-05	7.62E-05	1.23E-04	1.36E-04	2.14E-05	4.34E-04	4.88E-04	3.00E-04	3.44E-04	5.10E-04
total CO releases per ton of refuse (lb/ton)		**0.091**	**0.098**	**0.091**	**0.160**	**0.182**	**0.024**	**0.400**	**0.437**	**0.348**	**0.287**	**0.391**
CO emission coefficient #1	CO_1	1.14E+00	1.14E+00	1.14E+00	1.19E+00	1.19E+00	1.14E+00	2.3016E+00	2.6595E+00	1.5543E+00	1.9106E+00	1.9106E+00
CO emission coefficient #2	CO_2	3.82E+01	3.82E+01	3.82E+01	3.90E+01	3.90E+01	3.82E+01	3.39E+01	3.39E+01	3.32E+01	3.81E+01	3.81E+01
total CO releases per ton of refuse (lb/ton)		**0.091**	**0.098**	**0.091**	**0.160**	**0.182**	**0.024**	**0.400**	**0.437**	**0.348**	**0.287**	**0.391**
Nitrogen Oxides												
NOx emissions from collection vehicles (lb/ton)		0.553	0.594	0.553	0.981	1.116	0.148	2.415	2.631	2.113	1.710	2.318
NOx precombustion emissions from fuel production (lb/ton)		0.013	0.014	0.013	0.022	0.025	0.004	0.061	0.068	0.050	0.048	0.069
NOx emissions from garage electricity generation (lb/ton)		2.30E-04	2.67E-04	2.30E-04	3.72E-04	4.12E-04	6.48E-05	1.31E-03	1.48E-03	9.08E-04	1.04E-03	1.54E-03
total NOx releases per ton of refuse (lb/ton)		**0.566**	**0.608**	**0.566**	**1.003**	**1.141**	**0.152**	**2.478**	**2.701**	**2.164**	**1.760**	**2.388**
NOx emission coefficient #1	NO_1	6.85E+00	6.85E+00	6.85E+00	7.19E+00	7.19E+00	6.85E+00	1.38E+01	1.60E+01	9.37E+00	1.15E+01	1.15E+01
NOx emission coefficient #2	NO_2	2.40E+02	2.40E+02	2.40E+02	2.45E+02	2.45E+02	2.40E+02	2.13E+02	2.13E+02	2.09E+02	2.40E+02	2.40E+02
total NOx releases per ton of refuse (lb/ton)		**0.566**	**0.608**	**0.566**	**1.003**	**1.141**	**0.152**	**2.478**	**2.701**	**2.164**	**1.760**	**2.388**
Total Particulate Matter												
PM emissions from collection vehicles (lb/ton)		0.004	0.004	0.004	0.007	0.008	0.001	0.018	0.019	0.016	0.013	0.017
PM precombustion emissions from fuel production (lb/ton)		0.003	0.004	0.003	0.006	0.006	0.001	0.016	0.017	0.013	0.012	0.017
PM emissions from garage electricity generation (lb/ton)		9.27E-05	1.07E-04	9.27E-05	1.50E-04	1.66E-04	2.61E-05	5.27E-04	5.94E-04	3.65E-04	4.19E-04	6.21E-04
		0.00260	0.04	0.00	0.00							
total PM releases per ton of refuse (lb/ton)		**0.007**	**0.008**	**0.007**	**0.013**	**0.015**	**0.002**	**0.034**	**0.037**	**0.029**	**0.025**	**0.035**
PM emission coefficient #1	PM_1	1.08E-01	1.08E-01	1.08E-01	1.14E-01	1.14E-01	1.08E-01	2.21E-01	2.54E-01	1.47E-01	1.80E-01	1.80E-01
PM emission coefficient #2	PM_2	2.96E+00	2.96E+00	2.96E+00	3.04E+00	3.04E+00	2.96E+00	2.64E+00	2.64E+00	2.57E+00	2.96E+00	2.96E+00
total PM releases per ton of refuse (lb/ton)		**0.007**	**0.008**	**0.007**	**0.013**	**0.015**	**0.002**	**0.034**	**0.037**	**0.029**	**0.025**	**0.035**

Table D - 5 Residential Collection Air Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
PM10												
PM10 emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PM10 precombustion emissions from fuel production (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PM10 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total PM10 releases per ton of refuse (lb/ton)		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
PM10 emission coefficient #1	PM10_1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM10 emission coefficient #2	PM10_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total PM10 releases per ton of refuse (lb/ton)		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Fossil CO2												
CO2-fossil emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2-fossil precombustion emissions from fuel production (lb/ton)		6.453	7.142	6.453	10.959	12.345	1.761	30.727	34.233	25.195	24.235	34.451
CO2-fossil emissions from garage electricity generation (lb/ton)		5.31E-02	6.15E-02	5.31E-02	8.57E-02	9.48E-02	1.49E-02	3.02E-01	3.40E-01	2.09E-01	2.40E-01	3.56E-01
total CO2-fossil releases per ton of refuse (lb/ton)		**6.506**	**7.203**	**6.506**	**11.045**	**12.440**	**1.776**	**31.029**	**34.573**	**25.404**	**24.474**	**34.807**
CO2-fossil emission coefficient #1	CO2f_1	1.14E+02	1.14E+02	1.14E+02	1.20E+02	1.20E+02	1.14E+02	2.35E+02	2.70E+02	1.55E+02	1.89E+02	1.89E+02
CO2-fossil emission coefficient #2	CO2f_2	2.39E+03	2.39E+03	2.39E+03	2.48E+03	2.48E+03	2.39E+03	2.16E+03	2.15E+03	2.08E+03	2.39E+03	2.39E+03
total CO2-fossil releases per ton of refuse (lb/ton)		**6.506**	**7.203**	**6.506**	**11.045**	**12.440**	**1.776**	**31.029**	**34.573**	**25.404**	**24.474**	**34.807**
Biomass CO2												
CO2-biomass emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2-biomass precombustion emissions from fuel production (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO2-biomass emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total CO2-biomass releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
CO2-biomass emission coefficient #1	CO2bm_1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-biomass emission coefficient #2	CO2bm_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total CO2-biomass releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**

Table D - 6 Residential Collection Air Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Sulfur Oxides												
SOx emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SOx precombustion emissions from fuel production (lb/ton)		0.016	0.017	0.016	0.027	0.030	0.004	0.075	0.084	0.062	0.059	0.084
SOx emissions from garage electricity generation (lb/ton)		4.88E-04	5.65E-04	4.88E-04	7.87E-04	8.72E-04	1.37E-04	2.78E-03	3.12E-03	1.92E-03	2.20E-03	3.27E-03
total SOx releases per ton refuse (lb/ton)		**0.016**	**0.018**	**0.016**	**0.028**	**0.031**	**0.004**	**0.078**	**0.087**	**0.064**	**0.062**	**0.088**
SOx emission coefficient #1	SOx_1	2.89E-01	2.89E-01	2.89E-01	3.05E-01	3.05E-01	2.89E-01	5.96E-01	6.83E-01	3.91E-01	4.78E-01	4.78E-01
SOx emission coefficient #2	SOx_2	5.96E+00	5.96E+00	5.96E+00	6.19E+00	6.19E+00	5.96E+00	5.38E+00	5.37E+00	5.18E+00	5.95E+00	5.95E+00
total SOx releases per ton refuse (lb/ton)		**0.016**	**0.018**	**0.016**	**0.028**	**0.031**	**0.004**	**0.078**	**0.087**	**0.064**	**0.062**	**0.088**
Hydrocarbons (less methane)												
HC emissions from collection vehicles (lb/ton)		0.010	0.011	0.010	0.018	0.020	0.003	0.043	0.047	0.038	0.031	0.042
HC precombustion emissions from collection vehicles (lb/ton)		0.121	0.134	0.121	0.206	0.232	0.033	0.577	0.643	0.473	0.455	0.647
HC emissions from garage electricity generation (lb/ton)		3.65E-05	4.23E-05	3.65E-05	5.88E-05	6.51E-05	1.02E-05	2.07E-04	2.34E-04	1.44E-04	1.65E-04	2.44E-04
total HC releases per ton of refuse (lb/ton)		**0.131**	**0.145**	**0.131**	**0.223**	**0.252**	**0.036**	**0.621**	**0.690**	**0.511**	**0.486**	**0.689**
HC emission coefficient #1	HC_1	2.24E+00	2.24E+00	2.24E+00	2.36E+00	2.36E+00	2.24E+00	4.59E+00	5.28E+00	3.04E+00	3.72E+00	3.72E+00
HC emission coefficient #2	HC_2	4.89E+01	4.89E+01	4.89E+01	5.06E+01	5.06E+01	4.89E+01	4.40E+01	4.39E+01	4.25E+01	4.88E+01	4.88E+01
Methane												
CH4 emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CH4 precombustion emissions from fuel production (lb/ton)		8.98E-05	9.94E-05	8.98E-05	1.52E-04	1.72E-04	2.45E-05	4.27E-04	4.76E-04	3.51E-04	3.37E-04	4.79E-04
CH4 emissions from garage electricity generation (lb/ton)		3.51E-07	4.07E-07	3.51E-07	5.67E-07	6.28E-07	9.88E-08	2.00E-06	2.25E-06	1.38E-06	1.59E-06	2.35E-06
total CH4 releases per ton of refuse (lb/ton)		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
CH4 emission coefficient #1	CH4_1	1.58E-03	1.58E-03	1.58E-03	1.66E-03	1.66E-03	1.58E-03	3.24E-03	3.73E-03	2.14E-03	2.62E-03	2.62E-03
CH4 emission coefficient #2	CH4_2	3.32E-02	3.32E-02	3.32E-02	3.44E-02	3.44E-02	3.32E-02	2.99E-02	2.99E-02	2.88E-02	3.31E-02	3.31E-02

Table D - 7 Residential Collection Air Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Lead												
Lead emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lead precombustion emissions from fuel production (lb/ton)		1.98E-08	2.19E-08	1.98E-08	3.35E-08	3.78E-08	5.39E-09	9.40E-08	1.05E-07	7.71E-08	7.42E-08	1.05E-07
Lead emissions from garage electricity generation (lb/ton)		1.75E-12	2.03E-12	1.75E-12	2.83E-12	3.13E-12	4.92E-13	9.96E-12	1.12E-11	6.90E-12	7.91E-12	1.17E-11
total lead releases per ton of refuse (lb/ton)		**1.9752E-08**	2.1861E-08	**1.9752E-08**	3.3546E-08	**3.7787E-08**	5.3912E-09	**9.41E-08**	**1.05E-07**	**7.71E-08**	**7.42E-08**	**1.05E-07**
Pb emission coefficient #1	Pb_a_1	9.51E-06	9.51E-06	9.51E-06	1.02E-05	1.02E-05	9.51E-06	2.13E-05	2.36E-05	1.23E-05	1.46E-05	1.46E-05
PB emission coefficient #2	Pb_a_2	1.05E-04	1.05E-04	1.05E-04	1.16E-04	1.16E-04	1.05E-04	1.00E-04	1.00E-04	9.16E-05	1.05E-04	1.05E-04
Ammonia												
Ammonia emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ammonia precombustion emissions from fuel production (lb/ton)		7.00E-05	7.75E-05	7.00E-05	1.19E-04	1.34E-04	1.91E-05	3.33E-04	3.71E-04	2.73E-04	2.63E-04	3.74E-04
Ammonia emissions from garage electricity generation (lb/ton)		6.28E-09	7.28E-09	6.28E-09	1.01E-08	1.12E-08	1.77E-09	3.58E-08	4.02E-08	2.47E-08	2.84E-08	4.21E-08
total ammonia releases per ton of refuse (lb/ton)		**7.003E-05**	7.7506E-05	**7.003E-05**	0.00011894	**0.00013397**	1.9114E-05	**3.33E-04**	**3.72E-04**	**2.73E-04**	**2.63E-04**	**3.74E-04**
NH3 emission coefficient #1	NH3_1	9.5137E-06	9.5137E-06	9.5137E-06	1.0186E-05	1.0186E-05	9.5137E-06	2.13E-05	2.36E-05	1.23E-05	1.46E-05	1.46E-05
NH3 emission coefficient #2	NH3_2	0.00010546	0.00010546	0.00010546	0.00011557	0.00011557	0.00010546	1.00E-04	1.00E-04	9.16E-05	1.05E-04	1.05E-04
Hydrochloric Acid												
HCl emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HCl precombustion emissions from fuel production (lb/ton)		2.15E-06	2.38E-06	2.15E-06	3.66E-06	4.12E-06	5.88E-07	1.03E-05	1.14E-05	8.41E-06	8.09E-06	1.15E-05
HCl emissions from garage electricity generation (lb/ton)		1.90E-10	2.20E-10	1.90E-10	3.06E-10	3.39E-10	5.33E-11	1.08E-09	1.21E-09	7.47E-10	8.57E-10	1.27E-09
total HCl releases per ton of refuse (lb/ton)		**2.1548E-06**	2.3848E-06	**2.1548E-06**	3.6596E-06	**4.1222E-06**	5.8813E-07	**1.03E-05**	**1.14E-05**	**8.41E-06**	**8.09E-06**	**1.15E-05**
HCl emission coefficient #1	HCl_1	3.7709E-05	3.7709E-05	3.7709E-05	3.9672E-05	3.9672E-05	3.7709E-05	7.74E-05	8.89E-05	5.11E-05	6.25E-05	6.25E-05
HCl emission coefficient #2	HCl_2	0.00079396	0.00079396	0.00079396	0.0008235	0.0008235	0.00079396	7.15E-04	7.15E-04	6.90E-04	7.92E-04	7.92E-04

Table D - 8 Residential Collection Air Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Greenhouse Gas Equivalence												
Carbon dioxide (fossil fuel)		6.51	7.20	6.51	11.05	12.44	1.78	31.03	34.57	25.40	24.47	34.81
Carbon dioxide (biomass)		0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methane		0.01	0.01	0.01	0.01	0.01	0.00	0.03	0.03	0.02	0.02	0.03
Nitrogen oxides		152.91	164.20	152.91	270.83	308.05	40.95	669.04	729.15	584.41	475.17	644.89
Other hydrocarbons		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total greenhouse gas equivalence per ton of refuse		**159.41898**	171.404828	**159.41898**	281.887854	**320.503397**	42.7286583	**700.10**	**763.75**	**609.84**	**499.67**	**679.73**
GHE emission coefficient #1	GHE_1	1964.99802	1964.99802	1964.99802	2060.90254	2060.90254	1964.99802	3.97E+03	4.59E+03	2.68E+03	3.30E+03	3.30E+03
GHE emission coefficient #2	GHE_2	67296.9497	67296.9497	67296.9497	68740.3959	68740.3959	67296.9497	5.97E+04	5.97E+04	5.85E+04	6.72E+04	6.72E+04

Table D - 9 Residential Collection Water Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
WATERBORNE RELEASES												
Dissolved Solids												
Dissolved solids emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DS precombustion emissions from fuel production (lb/ton)		1.83E-01	2.03E-01	1.83E-01	3.11E-01	3.50E-01	5.00E-02	8.72E-01	9.72E-01	7.15E-01	6.88E-01	9.78E-01
DS emissions from garage electricity generation (lb/ton)		1.63E-05	1.89E-05	1.63E-05	2.63E-05	2.91E-05	4.58E-06	9.28E-05	1.04E-04	6.42E-05	7.37E-05	1.09E-04
total dissolved solids releases per ton of refuse (lb/ton)		**0.1831557**	0.20270685	**0.1831557**	0.31106258	**0.35038435**	0.04999078	**8.72E-01**	**9.72E-01**	**7.15E-01**	**6.88E-01**	**9.78E-01**
DS emission coefficient #1	DS_1	3.20527668	3.20527668	3.20527668	3.37212246	3.37212246	3.20527668	6.57646669	7.55472572	4.341004862	5.314486163	5.314486163
DS emission coefficient #2	DS_2	67.4863809	67.4863809	67.4863809	69.9975546	69.9975546	67.4863809	60.80541147	60.75224522	58.62208513	67.35455532	67.35455532
DS emission coefficient #3	DS_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Suspended Solids												
Suspended solids emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SS precombustion emissions from fuel production (lb/ton)		1.71E-04	1.89E-04	1.71E-04	2.90E-04	3.26E-04	4.66E-05	8.12E-04	9.05E-04	6.66E-04	6.41E-04	9.11E-04
SS emissions from garage electricity generation (lb/ton)		1.47E-08	1.70E-08	1.47E-08	2.37E-08	2.62E-08	4.13E-09	8.36E-08	9.41E-08	5.78E-08	6.64E-08	9.84E-08
total suspended solids releases per ton of refuse (lb/ton)		**0.00017059**	0.0001888	**0.00017059**	0.00028971	**0.00032634**	4.656E-05	**8.12E-04**	**9.05E-04**	**6.66E-04**	**6.41E-04**	**9.11E-04**
SS emission coefficient #1	SS_1	0.00298529	0.00298529	0.00298529	0.00314069	0.00314069	0.00298529	0.006125111	0.007036231	0.004043076	0.004949746	0.004949746
SS emission coefficient #2	SS_2	0.06285482	0.06285482	0.06285482	0.06519365	0.06519365	0.06285482	0.056632356	0.056582839	0.054598878	0.062732043	0.062732043
SS emission coefficient #3	SS_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Biochemical Oxygen Demand												
BOD emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BOD precombustion emissions from fuel production (lb/ton)		1.80E-04	1.99E-04	1.80E-04	3.05E-04	3.43E-04	4.90E-05	8.55E-04	9.52E-04	7.01E-04	6.74E-04	9.59E-04
BOD emissions from garage electricity generation (lb/ton)		1.61E-08	1.87E-08	1.61E-08	2.60E-08	2.87E-08	4.52E-09	9.16E-08	1.03E-07	6.34E-08	7.27E-08	1.08E-07
total BOD releases per ton of refuse (lb/ton)		**0.00017956**	0.00019873	**0.00017956**	0.00030496	**0.00034351**	4.9011E-05	**8.55E-04**	**9.53E-04**	**7.01E-04**	**6.74E-04**	**9.59E-04**
BOD emission coefficient #1	BOD_1	0.00314243	0.00314243	0.00314243	0.00330601	0.00330601	0.00314243	0.006447522	0.007406601	0.004255891	0.005210285	0.005210285
BOD emission coefficient #2	BOD_2	0.06616315	0.06616315	0.06616315	0.06862509	0.06862509	0.06616315	0.059613176	0.059561052	0.057472658	0.066033907	0.066033907
BOD emission coefficient #3	BOD_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 10 Residential Collection Water Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Chemical Oxygen Demand												
COD emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
COD precombustion emissions from fuel production (lb/ton)		8.81E-04	9.75E-04	8.81E-04	1.50E-03	1.69E-03	2.40E-04	4.19E-03	4.67E-03	3.44E-03	3.31E-03	4.70E-03
COD emissions from garage electricity generation (lb/ton)		7.96E-08	9.23E-08	7.96E-08	1.29E-07	1.42E-07	2.24E-08	4.53E-07	5.10E-07	3.14E-07	3.60E-07	5.34E-07
total COD releases per ton of refuse (lb/ton)		**0.00088091**	0.00097494	**0.00088091**	0.00149609	**0.00168521**	0.00024044	**4.19E-03**	**4.67E-03**	**3.44E-03**	**3.31E-03**	**4.70E-03**
COD emission coefficient #1	COD_1	0.01541616	0.01541616	0.01541616	0.01621862	0.01621862	0.01541616	0.031630297	0.036335347	0.020878572	0.025560643	0.025560643
COD emission coefficient #2	COD_2	0.32458337	0.32458337	0.32458337	0.33666116	0.33666116	0.32458337	0.292450508	0.292194798	0.281949535	0.323949335	0.323949335
COD emission coefficient #3	COD_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Oil												
Oil emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Oil precombustion emissions from fuel production (lb/ton)		2.21E-03	2.44E-03	2.21E-03	3.75E-03	4.22E-03	6.03E-04	1.05E-02	1.17E-02	8.62E-03	8.29E-03	1.18E-02
Oil emissions from garage electricity generation (lb/ton)		2.18E-07	2.53E-07	2.18E-07	3.52E-07	3.90E-07	6.13E-08	1.24E-06	1.40E-06	8.59E-07	9.86E-07	1.46E-06
total oil releases per ton of refuse (lb/ton)		**0.00220866**	0.00244443	**0.00220866**	0.00375108	**0.00422526**	0.00060284	**1.05E-02**	**1.17E-02**	**8.62E-03**	**8.29E-03**	**1.18E-02**
oil emission coefficient #1	oil_1	0.03865242	0.03865242	0.03865242	0.04066443	0.04066443	0.03865242	0.079305703	0.091102494	0.05234813	0.064087306	0.064087306
oil emission coefficient #2	oil_2	0.81381234	0.81381234	0.81381234	0.84409474	0.84409474	0.81381234	0.73324744	0.73260631	0.706918571	0.812222658	0.812222658
oil emission coefficient #3	oil_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sulfuric Acid												
Sulfuric acid emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sulfuric acid precombustion emissions from fuel production (lb/ton)		5.57E-04	6.16E-04	5.57E-04	9.45E-04	1.06E-03	1.52E-04	2.65E-03	2.95E-03	2.17E-03	2.09E-03	2.97E-03
Sulfuric acid emissions from garage electricity generation (lb/ton)		4.01E-05	4.65E-05	4.01E-05	6.47E-05	7.16E-05	1.13E-05	2.28E-04	2.57E-04	1.58E-04	1.81E-04	2.68E-04
total sulfuric acid releases per ton of refuse (lb/ton)		**0.00059667**	0.00066246	**0.00059667**	0.00100998	**0.0011364**	0.00016318	**2.88E-03**	**3.21E-03**	**2.33E-03**	**2.27E-03**	**3.24E-03**
H2SO4 emission coefficient #1	H2SO4_1	0.0107857	0.0107857	0.0107857	0.01136729	0.01136729	0.0107857	0.022328432	0.025559729	0.014536119	0.017750762	0.017750762
H2SO4 emission coefficient #2	H2SO4_2	0.21628772	0.21628772	0.21628772	0.2250411	0.2250411	0.21628772	0.19548303	0.195307416	0.18787245	0.215852402	0.215852402
H2SO4 emission coefficient #3	H2SO4_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 11 Residential Collection Water Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Iron												
Iron emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron precombustion emissions from fuel production (lb/ton)		1.45E-04	1.61E-04	1.45E-04	2.47E-04	2.78E-04	3.97E-05	6.93E-04	7.72E-04	5.68E-04	5.46E-04	7.76E-04
Iron emissions from garage electricity generation (lb/ton)		9.97E-06	1.16E-05	9.97E-06	1.61E-05	1.78E-05	2.80E-06	5.67E-05	6.39E-05	3.93E-05	4.51E-05	6.68E-05
total iron releases per ton of refuse (lb/ton)		**0.0001554**	0.00017251	**0.0001554**	0.00026309	**0.00029603**	4.2497E-05	**7.49E-04**	**8.35E-04**	**6.07E-04**	**5.91E-04**	**8.43E-04**
fe emission coefficient #1	fe_1	0.00280511	0.00280511	0.00280511	0.00295614	0.00295614	0.00280511	0.005804851	0.006645921	0.003781311	0.004618056	0.004618056
fe emission coefficient #2	fe_2	0.05637369	0.05637369	0.05637369	0.05864681	0.05864681	0.05637369	0.050943893	0.050898183	0.048967546	0.056260382	0.056260382
fe emission coefficient #3	fe_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia												
Ammonia emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia precombustion emissions from fuel production (lb/ton)		2.51E-05	2.78E-05	2.51E-05	4.27E-05	4.81E-05	6.86E-06	1.20E-04	1.33E-04	9.81E-05	9.44E-05	1.34E-04
Ammonia emissions from garage electricity generation (lb/ton)		2.19E-09	2.54E-09	2.19E-09	3.54E-09	3.92E-09	6.17E-10	1.25E-08	1.41E-08	8.64E-09	9.92E-09	1.47E-08
total ammonia releases per ton of refuse (lb/ton)		**2.5139E-05**	2.7822E-05	**2.5139E-05**	4.2695E-05	**4.8092E-05**	6.8615E-06	**1.20E-04**	**1.33E-04**	**9.82E-05**	**9.44E-05**	**1.34E-04**
NH4 emission coefficient #1	NH4_1	0.00043994	0.00043994	0.00043994	0.00046284	0.00046284	0.00043994	0.00090265	0.00103692	0.000595823	0.000729437	0.000729437
NH4 emission coefficient #2	NH4_2	0.00926282	0.00926282	0.00926282	0.00960749	0.00960749	0.00926282	0.008345829	0.008338532	0.008046158	0.00924473	0.00924473
NH4 emission coefficient #3	NH4_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper												
Copper emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total copper releases per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
cu emission coefficient #1	cu_1	0	0	0	0	0	0	0	0	0	0	0
cu emission coefficient #2	cu_2	0	0	0	0	0	0	0	0	0	0	0
cu emission coefficient #3	cu_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 12 Residential Collection Water Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Cadmium												
Cadmium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total cadmium releases per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
cd emission coefficient #1	cd_1	0	0	0	0	0	0	0	0	0	0	0
cd emission coefficient #2	cd_2	0	0	0	0	0	0	0	0	0	0	0
cd emission coefficient #3	cd_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic												
Arsenic emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total arsenic releases per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
as emission coefficient #1	as_1	0	0	0	0	0	0	0	0	0	0	0
as emission coefficient #2	as_2	0	0	0	0	0	0	0	0	0	0	0
as emission coefficient #3	as_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury												
Mercury emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total mercury releases per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
hg emission coefficient #1	hg_1	0	0	0	0	0	0	0	0	0	0	0
hg emission coefficient #2	hg_2	0	0	0	0	0	0	0	0	0	0	0
hg emission coefficient #3	hg_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 13 Residential Collection Water Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Phosphate												
Phosphate emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphate precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphate emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total phosphate releases per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
po4 emission coefficient #1	po4_1	0	0	0	0	0	0	0	0	0	0	0
po4 emission coefficient #2	po4_2	0	0	0	0	0	0	0	0	0	0	0
po4 emission coefficient #3	po4_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium												
Selenium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total selenium releases per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
se emission coefficient #1	se_1	0	0	0	0	0	0	0	0	0	0	0
se emission coefficient #2	se_2	0	0	0	0	0	0	0	0	0	0	0
se emission coefficient #3	se_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium												
Chromium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium precombustion emissions from fuel production (lb/ton)		6.10E-08	6.76E-08	6.10E-08	1.04E-07	1.17E-07	1.67E-08	2.91E-07	3.24E-07	2.38E-07	2.29E-07	3.26E-07
Chromium emissions from garage electricity generation (lb/ton)		2.53E-12	2.94E-12	2.53E-12	4.09E-12	4.53E-12	7.12E-13	1.44E-11	1.62E-11	9.98E-12	1.14E-11	1.70E-11
total chromium releases per ton of refuse (lb/ton)		**6.1049E-08**	6.7566E-08	**6.1049E-08**	1.0368E-07	**1.1679E-07**	1.6663E-08	**2.91E-07**	**3.24E-07**	**2.38E-07**	**2.29E-07**	**3.26E-07**
cr emission coefficient #1	cr_1	1.0683E-06	1.0683E-06	1.0683E-06	1.124E-06	1.124E-06	1.0683E-06	2.19199E-06	2.51805E-06	1.4469E-06	1.77138E-06	1.77138E-06
cr emission coefficient #2	cr_2	2.2495E-05	2.2495E-05	2.2495E-05	2.3332E-05	2.3332E-05	2.2495E-05	2.02677E-05	2.025E-05	1.954E-05	2.24507E-05	2.24507E-05
cr emission coefficient #3	cr_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 14 Residential Collection Water Release Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
Lead												
Lead emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead precombustion emissions from fuel production (lb/ton)		2.69E-08	2.98E-08	2.69E-08	4.57E-08	5.15E-08	7.35E-09	1.28E-07	1.43E-07	1.05E-07	1.01E-07	1.44E-07
Lead emissions from garage electricity generation (lb/ton)		2.35E-12	2.72E-12	2.35E-12	3.79E-12	4.19E-12	6.59E-13	1.33E-11	1.50E-11	9.24E-12	1.06E-11	1.57E-11
total lead releases per ton of refuse (lb/ton)		**2.6935E-08**	2.981E-08	**2.6935E-08**	4.5744E-08	**5.1527E-08**	7.3516E-09	**1.28E-07**	**1.43E-07**	**1.05E-07**	**1.01E-07**	**1.44E-07**
pb emission coefficient #1	pb_1	4.7136E-07	4.7136E-07	4.7136E-07	4.959E-07	4.959E-07	4.7136E-07	9.67124E-07	1.11099E-06	6.38381E-07	7.8154E-07	7.8154E-07
pb emission coefficient #2	pb_2	9.9245E-06	9.9245E-06	9.9245E-06	1.0294E-05	1.0294E-05	9.9245E-06	8.94196E-06	8.93414E-06	8.62088E-06	9.90507E-06	9.90507E-06
pb emission coefficient #3	pb_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc												
Zinc emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc precombustion emissions from fuel production (lb/ton)		3.95E-07	4.37E-07	3.95E-07	6.71E-07	7.56E-07	1.08E-07	1.88E-06	2.10E-06	1.54E-06	1.48E-06	2.11E-06
Zinc emissions from garage electricity generation (lb/ton)		3.51E-11	4.06E-11	3.51E-11	5.66E-11	6.26E-11	9.85E-12	1.99E-10	2.25E-10	1.38E-10	1.58E-10	2.35E-10
Total zinc releases per ton of refuse (lb/ton)		**3.9504E-07**	4.3721E-07	**3.9504E-07**	6.7092E-07	**7.5573E-07**	1.0782E-07	**1.88E-06**	**2.10E-06**	**1.54E-06**	**1.48E-06**	**2.11E-06**
zn emission coefficient #1	zn_1	6.9133E-06	6.9133E-06	6.9133E-06	7.2732E-06	7.2732E-06	6.9133E-06	1.41845E-05	1.62945E-05	9.36295E-06	1.14626E-05	1.14626E-05
zn emission coefficient #2	zn_2	0.00014556	0.00014556	0.00014556	0.00015098	0.00015098	0.00014556	0.000131149	0.000131034	0.00012644	0.000145274	0.000145274
zn emission coefficient #3	zn_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 15 Residential Collection Solid Waste Outputs (Continued)

Residential Collection Options		Mixed Waste	Resi-duals	Co-Collection		Wet/Dry		Recyclables			Yard Waste	
		C_1	C_7	C_5	C_6	C_11	C_12	C_2	C_3	C_4	C_0	C_9
SOLID WASTE												
Solid Waste #1												
SW#1 precombustion emissions from fuel production (lb/ton)		1.48E-01	1.64E-01	1.48E-01	2.51E-01	2.83E-01	4.04E-02	7.04E-01	7.85E-01	5.78E-01	5.56E-01	7.90E-01
SW#1 emissions from garage electricity generation (lb/ton)		6.80E-03	7.88E-03	6.80E-03	1.10E-02	1.22E-02	1.91E-03	3.87E-02	4.36E-02	2.68E-02	3.07E-02	4.56E-02
total SW#1 generation per ton of refuse (lb/ton)		**0.15475021**	0.17162482	**0.15475021**	0.26224666	**0.29518484**	0.04229312	**7.43E-01**	**8.28E-01**	**6.04E-01**	**5.86E-01**	**8.35E-01**
SW1 emission coefficient #1	SW1_1	2.76647752	2.76647752	2.76647752	2.91390076	2.91390076	2.76647752	5.71E+00	6.54E+00	3.73E+00	4.56E+00	4.56E+00
SW1 emission coefficient #2	SW1_2	56.4151502	56.4151502	56.4151502	58.6339977	58.6339977	56.4151502	5.09E+01	5.09E+01	4.90E+01	5.63E+01	5.63E+01
Solid Waste #2												
SW #2 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW #2 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total SW #2 generation per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
SW2 emission coefficient #2	SW2_2	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Solid Waste #3												
SW #3 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW #3 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total SW #3 generation per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
SW3 emission coefficient #1	SW3_1	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW3 emission coefficient #2	SW3_2	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Solid Waste #4												
SW #4 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW #4 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total SW #4 generation per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
SW4 emission coefficient #1	SW4_1	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW4 emission coefficient #2	SW4_2	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Solid Waste #5												
SW #5 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW #5 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total SW #5 generation per ton of refuse (lb/ton)		**0**	0	**0**	0	**0**	0	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
SW5 emission coefficient #1	SW5_1	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW5 emission coefficient #2	SW5_2	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 16 Residential Drop Off Outputs

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
COLLECTION COSTS			
Breakdown of capital costs			
capital cost per collection vehicle ($/vehicle-yr)	C_cap_v	9,641	N/A
number of collection vehicles	Nt	9.15	N/A
annualized capital cost per bin ($/bin-year)	Cb	N/A	N/A
number of bins per collection vehicle (bins per vehicle)	Nb	N/A	N/A
bin annualized cost per vehicle ($/vehicle per year)	C_cap_b	N/A	N/A
Breakdown of operating costs			
labor cost per vehicle ($/vehicle-year)	Cw	40,196	N/A
O&M cost per vehicle ($/vehicle-year)	Cvo	30,822	N/A
other expenses per vehicle ($/vehicle-year)	Coe	8,083	N/A
Annual operating cost ($/year)	C_op	88,593	N/A
Total annual cost ($/year) -- capital + operating	C_ann	908,077	0
Total annual cost per house ($/house-year)	C_house	11.94	0
Cost per ton of refuse collected ($/ton)	C_ton	**72.16**	**0**
Total annual cost per vehicle ($/vehicle-year)	C_vehicle	99,198	0
cost coefficient #1	cc_1	0	0
cost coefficient #2	cc_2	9,122.91	0

Table D - 17 Residential Drop Off Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Calculations for collection vehicle activities			
volume of recyclables deposited at drop-off site per week (cy/week)	vol_recyc	3817.90	N/A
collection vehicle trips per week (trips/week)	Rt	207.49	N/A
travel time from drop-off site to facility (min/trip)	Trf	20.00	N/A
travel time from garage to drop-off site (min/day-vehicle)	Tgr	20.00	N/A
travel time from facility to garage (min/day-vehicle)	Tfg	20.00	N/A
time per trip (min/trip) -- load+travel+unload time	Tc	75.00	N/A
trips per day per vehicle (trip/day-vehicle)	RD	4.53	N/A
daily weight of refuse collected per vehicle (tons/day-vehicle)	RefD	5.27	N/A
Collection vehicle activity times			
travel time from garage to drop-off site in the morning(min/day-vehicle)	Tgr	20.00	N/A
loading time at drop-off site (min/day-vehicle)	LD	90.67	N/A
travel time between disposal facility and drop-off site (min/day-vehicle)	F_R	161.33	N/A
unloading time at disposal facility (min/day-vehicle)	UD	68.00	N/A
lunch time (min/day-vehicle)	F1_	30.00	N/A
break time (min/day-vehicle)	F2_	30.00	N/A
travel time from disposal facility to garage at end of day (min/day-vehicle)	Tfg	20.00	N/A
actual working time (min/day-vehicle)		**420.00**	N/A
service hours per day (hours/day-vehicle)	ShD	**6.00**	N/A
Daily miles traveled per collection vehicle			
from garage to drop-off site in the morning (miles/day)	Dgr	11.67	N/A
between drop-off site and disposal facility (miles/day)	DF_S	80.67	N/A
from disposal facility to garage at end of day (miles/day)	Dfg	11.67	N/A
total (miles/day-vehicle)	MiD	**104.00**	N/A
Daily fuel usage per collection vehicle			
from garage to drop-off site in the morning (gallons/day)		2.33	N/A
loading at drop-off site (gallons/day)		1.51	N/A
between disposal facility and route (gallons/day-vehicle)		16.13	N/A
unloading at disposal facility (gallons/day)		1.13	N/A
from disposal facility to garage at end of day (gallons/day)		2.33	N/A
total (gallons/day-vehicle)	FuelD	**23.44**	N/A

Table D - 18 Residential Drop Off Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
ENERGY CONSUMPTION			
Energy consumption by collection vehicles			
fuel usage per ton of refuse (gallons/ton)	FuelTon	4	N/A
fuel energy per ton of refuse (Btu/ton)		609,146	N/A
fuel precombustion energy per ton of refuse (Btu/ton)		**1.15E+05**	**N/A**
total coll. vehicle energy usage per ton of refuse (Btu/ton)		**7.24E+05**	**0.00E+00**
Energy consumption by garage			
daily electricity usage (Kwh/day)	ElecD	0.440	N/A
electrical usage per ton (Kwh/ton)	**ElecTon**	**0**	**N/A**
total garage energy usage per ton of refuse (Btu/ton)		870.43	0.00
Total energy consumption per ton of refuse (Btu/ton)		3.23E+06	3.71E+06
energy consumption coefficient #1	ec_1	3.97E+07	3.97E+07
energy consumption coefficient #2	**ec_2**	**9.17E+07**	**0.00E+00**
Total energy consumption per ton of refuse (Btu/ton)		3,229,870.90	3,705,046.53

Table D - 19 Residential Drop Off Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Energy consumption by drop-off vehicles			
fuel usage per trip to drop-off site (gallons/trip)	FuelT	0.25	0.25
weight of refuse delivered per trip (lbs/trip)	RefT	34.48	23.31
fuel usage per ton of refuse (gallons/ton)	FuelTon_dov	14.50	21.45
fuel energy per ton of refuse (Btu/ton)		2.19E+06	3.24E+06
fuel precombustion energy per ton of refuse (Btu/ton)		3.18E+05	4.70E+05
total drop-off vehicle energy usage per ton of refuse (Btu/ton)		**2.50E+06**	**3.71E+06**

Table D - 20 Residential Drop Off Air Release Outputs

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
AIRBORNE RELEASES			
Carbon Monoxide			
CO emissions from collection vehicles (lb/ton)		0.219	N/A
CO precombustion emissions from fuel production (lb/ton)		0.022	N/A
CO emissions from garage electricity generation (lb/ton)		1.78E-04	N/A
CO emissions from drop-off vehicles (lb/ton)		2.17460	3.21676
CO precombustion emissions from drop-off vehicles (lb/ton)		6.09E-02	9.01E-02
total CO releases per ton of refuse (lb/ton)		**2.477**	**3.307**
CO emission coefficient #1	CO_1	3.5473E+01	3.5473E+01
CO emission coefficient #2	CO_2	3.05E+01	0.00E+00
total CO releases per ton of refuse (lb/ton)		**2.477**	**3.307**
Nitrogen Oxides			
NOx emissions from collection vehicles (lb/ton)		1.480	N/A
NOx precombustion emissions from fuel production (lb/ton)		0.032	N/A
NOx emissions from garage electricity generation (lb/ton)		5.39E-04	N/A
NOx emissions from drop-off vehicles (lb/ton)		0.63959	0.94611
NOx precombustion emissions from drop-off vehicles (lb/ton)		8.79E-02	1.30E-01
total NOx releases per ton of refuse (lb/ton)		**2.240**	**1.076**
NOx emission coefficient #1	NO_1	1.15E+01	1.15E+01
NOx emission coefficient #2	NO_2	1.91E+02	0.00E+00
total NOx releases per ton of refuse (lb/ton)		**2.240**	**1.076**
Particulate Matter			
PM emissions from collection vehicles (lb/ton)		0.011	N/A
PM precombustion emissions from fuel production (lb/ton)		0.008	N/A
PM emissions from garage electricity generation (lb/ton)		2.17E-04	N/A
PM emissions from drop-off vehicles (lb/ton)		0.00	0.00
PM precombustion emissions from drop-off vehicles (lb/ton)		0.02	0.03
total PM releases per ton of refuse (lb/ton)		**0.042**	**0.033**
PM emission coefficient #1	PM_1	3.54E-01	3.54E-01
PM emission coefficient #2	PM_2	2.43E+00	0.00E+00

Table D - 21 Residential Drop Off Air Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
PM10			
PM10 emissions from collection vehicles (lb/ton)		0.000	N/A
PM10 precombustion emissions from fuel production (lb/ton)		0.000	N/A
PM10 emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
PM10 emissions from drop-off vehicles (lb/ton)		0.12792	0.18922
PM10 precombustion emissions from drop-off vehicles (lb/ton)		0.00E+00	0.00E+00
total PM10 releases per ton of refuse (lb/ton)		**0.128**	**0.189**
PM10 emission coefficient #1	PM10_1	2.03E+00	2.03E+00
PM10 emission coefficient #2	PM10_2	0.00E+00	0.00E+00
total PM10 releases per ton of refuse (lb/ton)		**0.128**	**0.189**
Fossil CO2			
CO2-fossil emissions from collection vehicles (lb/ton)		0.000	N/A
CO2-fossil precombustion emissions from fuel production (lb/ton)		15.980	N/A
CO2-fossil emissions from garage electricity generation (lb/ton)		1.24E-01	N/A
CO2-fossil emissions from drop-off vehicles (lb/ton)		0.00000	0.00000
CO2-fosssil precombustion emissions from drop-off vehicles (lb/ton)		4.40E+01	6.51E+01
total CO2-fossil releases per ton of refuse (lb/ton)		**60.107**	**65.090**
CO2-fossil emission coefficient #1	CO2f_1	6.98E+02	6.98E+02
CO2-fossil emission coefficient #2	CO2f_2	2.04E+03	0.00E+00
total CO2-fossil releases per ton of refuse (lb/ton)		**60.107**	**65.090**
Biomass CO2			
CO2-biomass emissions from collection vehicles (lb/ton)		0.000	N/A
CO2-biomass precombustion emissions from fuel production (lb/ton)		0.000	N/A
CO2-biomass emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
CO2-biomass emissions from drop-off vehicles (lb/ton)		0.00000	0.00000
CO2-biomass precombustion emissions from drop-off vehicles (lb/ton)		0.00E+00	0.00E+00
total CO2-biomass releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
CO2-biomass emission coefficient #1	CO2bm_1	0.00E+00	0.00E+00
CO2-biomass emission coefficient #2	CO2bm_2	0.00E+00	0.00E+00
total CO2-biomass releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**

Table D - 22 Residential Drop Off Air Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Sulfur Oxides			
SOx emissions from collection vehicles (lb/ton)		0.000	N/A
SOx precombustion emissions from fuel production (lb/ton)		0.039	N/A
SOx emissions from garage electricity generation (lb/ton)		1.14E-03	N/A
SOx emissions from drop-off vehicles (lb/ton)		0.00000	0.00000
SOx precombustion emissions from drop-off vehicle fuel production (lb/ton)		1.08E-01	1.60E-01
total SOx releases per ton refuse (lb/ton)		**0.148**	**0.160**
SOx emission coefficient #1	SOx_1	1.71E+00	1.71E+00
SOx emission coefficient #2	SOx_2	5.09E+00	0.00E+00
total SOx releases per ton refuse (lb/ton)		**0.148**	**0.160**
Hydrocarbons (less methane)			
HC emissions from collection vehicles (lb/ton)		0.027	N/A
HC precombustion emissions from collection vehicles (lb/ton)		0.300	N/A
HC emissions from garage electricity generation (lb/ton)		8.53E-05	N/A
HC emissions from drop-off vehicles (lb/ton)		2.62E-01	3.88E-01
HC precombustion emissions from drop-off vehicles (lb/ton)		8.31E-01	1.23E+00
total HC releases per ton of refuse (lb/ton)		**1.420**	**1.617**
HC emission coefficient #1	HC_1	1.73E+01	1.73E+01
HC emission coefficient #2	HC_2	4.13E+01	0.00E+00
Methane			
CH4 emissions from collection vehicles (lb/ton)		0.000	N/A
CH4 precombustion emissions from fuel production (lb/ton)		2.22E-04	N/A
CH4 emissions from garage electricity generation (lb/ton)		8.22E-07	N/A
CH4 emissions from drop-off vehicles (lb/ton)		0.00E+00	0.00E+00
CH4 precombustion emissions from drop-off vehicle fuel production (lb/ton)		6.24E-04	9.23E-04
total CH4 releases per ton of refuse (lb/ton)		**0.001**	**0.001**
CH4 emission coefficient #1	CH4_1	9.90E-03	9.90E-03
CH4 emission coefficient #2	CH4_2	2.82E-02	0.00E+00

Table D - 23 Residential Drop Off Air Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Lead			
Lead emissions from collection vehicles (lb/ton)		0.000	N/A
Lead precombustion emissions from fuel production (lb/ton)		4.89E-08	N/A
Lead emissions from garage electricity generation (lb/ton)		4.09E-12	N/A
Lead emissions from drop-off vehicles (lb/ton)		0.00E+00	0.00E+00
Lead precombustion emissions from drop-off vehicle fuel production (lb/ton)		1.32E-07	1.95E-07
total Lead releases per ton of refuse (lb/ton)		**1.81E-07**	**1.95E-07**
Pb emission coefficient #1	Pb_a_1	2.09E-06	2.09E-06
PB emission coefficient #2	Pb_a_2	1.10E-04	0.00E+00
Ammonia			
Ammonia emissions from collection vehicles (lb/ton)		0.000	N/A
Ammonia precombustion emissions from fuel production (lb/ton)		1.73E-04	N/A
Ammonia emissions from garage electricity generation (lb/ton)		1.47E-08	N/A
Ammonia emissions from drop-off vehicles (lb/ton)		0.00E+00	0.00E+00
Ammonia precombustion emissions from drop-off vehicle fuel production (lb/ton)		4.79E-04	7.08E-04
total ammonia releases from refuse (lb/ton)		**6.52E-04**	**7.08E-04**
NH3 emission coefficient #1	NH3_1	2.09E-06	2.09E-06
NH3 emission coefficient #2	NH3_2	1.10E-04	0.00E+00
Hydrochloric Acid			
HCl emissions from collection vehicles (lb/ton)		0.000	N/A
HCl precombustion emissions from fuel production (lb/ton)		5.34E-06	N/A
HCl emissions from garage electricity generation (lb/ton)		4.43E-10	N/A
HCl emissions from drop-off vehicles (lb/ton)		0.00E+00	0.00E+00
total HCl releases from refuse (lb/ton)		**5.34E-06**	**0.00E+00**
HCl emission coefficient #1	HCl_1	2.26E-04	2.26E-04
HCl emission coefficient #2	HCl_2	6.75E-04	0.00E+00

Table D - 24 Residential Drop Off Air Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Greenhouse Gas Equivalence			
Carbon dioxide (fossil fuel)		60.11	65.09
Carbon dioxide (biomass)		0.00	0.00
Methane		0.05	0.06
Nitrous oxide		604.68	290.55
Other hydrocarbons		0.00	0.00
total greenhouse gas equivalence per ton of refuse		**664.84**	**355.70**
GHE emission coefficient #1	GHE_1	3.82E+03	3.82E+03
GHE emission coefficient #2	GHE_2	5.37E+04	0.00E+00

Table D - 25 Residential Drop Off Water Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
WATERBORNE RELEASES			
Dissolved Solids			
Dissolved solids emissions from washdown water (lb/ton)		0.00E+00	N/A
DS precombustion emissions from fuel production (lb/ton)		4.54E-01	N/A
DS emissions from garage electricity generation (lb/ton)		3.81E-05	N/A
DS precombustion emissions from drop-off vehicle fuel (lb/ton)		1.26E+00	1.86E+00
total dissolved solids releases per ton of refuse (lb/ton)		**1.71E+00**	**1.86E+00**
DS emission coefficient #1	DS_1	19.99890411	19.99890411
DS emission coefficient #2	DS_2	57.34177796	0
DS emission coefficient #3	DS_3	0.00E+00	0.00E+00
Suspended Solids			
Suspended solids emissions from washdown water (lb/ton)		0.00E+00	N/A
SS precombustion emissions from fuel production (lb/ton)		4.22E-04	N/A
SS emissions from garage electricity generation (lb/ton)		3.43E-08	N/A
SS precombustion emissions from drop-off vehicle fuel (lb/ton)		1.17E-03	1.74E-03
total suspended solids releases per ton of refuse (lb/ton)		**1.60E-03**	**1.74E-03**
SS emission coefficient #1	SS_1	0.018641096	0.018641096
SS emission coefficient #2	SS_2	0.053406409	0
SS emission coefficient #3	SS_3	0.00E+00	0.00E+00
Biochemical Oxygen Demand			
BOD emissions from washdown water (lb/ton)		0.00E+00	N/A
BOD precombustion emissions from fuel production (lb/ton)		4.45E-04	N/A
BOD emissions from garage electricity generation (lb/ton)		3.76E-08	N/A
BOD precombustion emissions from drop-off vehicle fuel (lb/ton)		1.29E-03	1.91E-03
total BOD releases per ton of refuse (lb/ton)		**1.74E-03**	**1.91E-03**
BOD emission coefficient #1	BOD_1	0.020482192	0.020482192
BOD emission coefficient #2	BOD_2	0.05621746	0
BOD emission coefficient #3	BOD_3	0.00E+00	0.00E+00

Table D - 26 Residential Drop Off Water Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Chemical Oxygen Demand			
COD emissions from washdown water (lb/ton)		0.00E+00	N/A
COD precombustion emissions from fuel production (lb/ton)		2.18E-03	N/A
COD emissions from garage electricity generation (lb/ton)		1.86E-07	N/A
COD precombustion emissions from drop-off vehicle fuel (lb/ton)		6.10E-03	9.02E-03
total COD releases per ton of refuse (lb/ton)		**8.28E-03**	**9.02E-03**
COD emission coefficient #1	COD_1	0.096772603	0.096772603
COD emission coefficient #2	COD_2	0.275791824	0
COD emission coefficient #3	COD_3	0.00E+00	0.00E+00
Oil			
Oil emissions from washdown water (lb/ton)		0.00E+00	N/A
Oil precombustion emissions from fuel production (lb/ton)		5.47E-03	N/A
Oil emissions from garage electricity generation (lb/ton)		5.10E-07	N/A
Oil precombustion emissions from drop-off vehicle fuel (lb/ton)		1.52E-02	2.25E-02
total oil releases per ton of refuse (lb/ton)		**2.07E-02**	**2.25E-02**
oil emission coefficient #1	oil_1	0.241643836	0.241643836
oil emission coefficient #2	oil_2	0.69148071	0
oil emission coefficient #3	oil_3	0.00E+00	0.00E+00
Sulfuric Acid			
Sulfuric acid emissions from washdown water (lb/ton)		0.00E+00	N/A
Sulfuric acid precombustion emissions from fuel production (lb/ton)		1.38E-03	N/A
Sulfuric acid emissions from garage electricity generation (lb/ton)		9.37E-05	N/A
Sulfuric acid precombustion emissions from drop-off vehicle fuel (lb/ton)		3.77E-03	5.58E-03
total sulfuric acid releases per ton of refuse (lb/ton)		**5.24E-03**	**5.58E-03**
H2SO4 emission coefficient #1	H2SO4_1	0.059835616	0.059835616
H2SO4 emission coefficient #2	H2SO4_2	0.186107528	0
H2SO4 emission coefficient #3	H2SO4_3	0.00E+00	0.00E+00

Table D - 27 Residential Drop Off Water Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Iron			
Iron emissions from washdown water (lb/ton)		0.00E+00	N/A
Iron precombustion emissions from fuel production (lb/ton)		3.60E-04	N/A
Iron emissions from garage electricity generation (lb/ton)		2.33E-05	N/A
Iron precombustion emissions from drop-off vehicle fuel (lb/ton)		9.86E-04	1.46E-03
total iron releases per ton of refuse (lb/ton)		**1.37E-03**	**1.46E-03**
fe emission coefficient #1	fe_1	0.015649315	0.015649315
fe emission coefficient #2	fe_2	0.048479732	0
fe emission coefficient #3	fe_3	0.00E+00	0.00E+00
Ammonia			
Ammonia emissions from washdown water (lb/ton)		0.00E+00	N/A
Ammonia precombustion emissions from fuel production (lb/ton)		6.22E-05	N/A
Ammonia emissions from garage electricity generation (lb/ton)		5.13E-09	N/A
Ammonia precombustion emissions from drop-off vehicle fuel (lb/ton)		1.74E-04	2.57E-04
total ammonia releases per ton of refuse (lb/ton)		**2.36E-04**	**2.57E-04**
NH4 emission coefficient #1	NH4_1	0.002761644	0.002761644
NH4 emission coefficient #2	NH4_2	0.007870427	0
NH4 emission coefficient #3	NH4_3	0.00E+00	0.00E+00
Copper			
Copper emissions from washdown water (lb/ton)		0.00E+00	N/A
Copper precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
Copper emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
Copper precombustion emissions from drop-off vehicle fuel (lb/ton)		0.00E+00	0.00E+00
total copper releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
cu emission coefficient #1	cu_1	0	0
cu emission coefficient #2	cu_2	0	0
cu emission coefficient #3	cu_3	0.00E+00	0.00E+00

Table D - 28 Residential Drop Off Water Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Cadmium			
Cadmium emissions from washdown water (lb/ton)		0.00E+00	N/A
Cadmium precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
Cadmium emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
Cadmium precombustion emissions from drop-off vehicle fuel (lb/ton)		0.00E+00	0.00E+00
total cadmium releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
cd emission coefficient #1	cd_1	0	0
cd emission coefficient #2	cd_2	0	0
cd emission coefficient #3	cd_3	0.00E+00	0.00E+00
Arsenic			
Arsenic emissions from washdown water (lb/ton)		0.00E+00	N/A
Arsenic precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
Arsenic emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
Arsenic precombustion emissions from drop-off vehicle fuel (lb/ton)		0.00E+00	0.00E+00
total arsenic releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
as emission coefficient #1	as_1	0	0
as emission coefficient #2	as_2	0	0
as emission coefficient #3	as_3	0.00E+00	0.00E+00
Mercury			
Mercury emissions from washdown water (lb/ton)		0.00E+00	N/A
Mercury precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
Mercury emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
Mercury precombustion emissions from drop-off vehicle fuel (lb/ton)		0.00E+00	0.00E+00
total mercury releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
hg emission coefficient #1	hg_1	0	0
hg emission coefficient #2	hg_2	0	0
hg emission coefficient #3	hg_3	0.00E+00	0.00E+00

Table D - 29 Residential Drop Off Water Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Phosphate			
Phosphate emissions from washdown water (lb/ton)		0.00E+00	N/A
Phosphate precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
Phosphate emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
Phosphate precombustion emissions from drop-off vehicle fuel (lb/ton)		0.00E+00	0.00E+00
total phosphate releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
po4 emission coefficient #1	po4_1	0	0
po4 emission coefficient #2	po4_2	0	0
po4 emission coefficient #3	po4_3	0.00E+00	0.00E+00
Selenium			
Selenium emissions from washdown water (lb/ton)		0.00E+00	N/A
Selenium precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
Selenium emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
Selenium precombustion emissions from drop-off vehicle fuel (lb/ton)		0.00E+00	0.00E+00
total selenium releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
se emission coefficient #1	se_1	0	0
se emission coefficient #2	se_2	0	0
se emission coefficient #3	se_3	0.00E+00	0.00E+00
Chromium			
Chromium emissions from washdown water (lb/ton)		0.00E+00	N/A
Chromium precombustion emissions from fuel production (lb/ton)		1.51E-07	N/A
Chromium emissions from garage electricity generation (lb/ton)		5.92E-12	N/A
Chromium precombustion emissions from drop-off vehicle fuel (lb/ton)		0.00E+00	0.00E+00
total chromium releases per ton of refuse (lb/ton)		**1.51E-07**	**0.00E+00**
cr emission coefficient #1	cr_1	0	0
cr emission coefficient #2	cr_2	1.91131E-05	0
cr emission coefficient #3	cr_3	0.00E+00	0.00E+00

Table D - 30 Residential Drop Off Water Release Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
Lead			
Lead emissions from washdown water (lb/ton)		0.00E+00	N/A
Lead precombustion emissions from fuel production (lb/ton)		6.67E-08	N/A
Lead emissions from garage electricity generation (lb/ton)		5.49E-12	N/A
Lead precombustion emissions from drop-off vehicle fuel (lb/ton)		1.89E-07	2.79E-07
total lead releases per ton of refuse (lb/ton)		**2.55E-07**	**2.79E-07**
pb emission coefficient #1	pb_1	2.99178E-06	2.99178E-06
pb emission coefficient #2	pb_2	8.4326E-06	0
pb emission coefficient #3	pb_3	0.00E+00	0.00E+00
Zinc			
Zinc emissions from washdown water (lb/ton)		0.00E+00	N/A
Zinc precombustion emissions from fuel production (lb/ton)		9.78E-07	N/A
Zinc emissions from garage electricity generation (lb/ton)		8.20E-11	N/A
Zinc precombustion emissions from drop-off vehicle fuel (lb/ton)		2.76E-06	4.08E-06
Total zinc releases per ton of refuse (lb/ton)		**3.73E-06**	**4.08E-06**
zn emission coefficient #1	zn_1	4.3726E-05	4.3726E-05
zn emission coefficient #2	zn_2	0.000123678	0
zn emission coefficient #3	zn_3	0.00E+00	0.00E+00

Table D - 31 Residential Drop Off Solid Waste Outputs (Continued)

Residential Drop-off Options		Recyc-labels C_8	Yard Waste C_10
SOLID WASTE			
Solid Waste #1			
SW#1 precombustion emissions from fuel production (lb/ton)		3.66E-01	N/A
SW#1 emissions from garage electricity generation (lb/ton)		1.59E-02	N/A
SW#1 precombustion emissions from drop-off vehicle fuel production (lb/ton)		1.01E+00	1.50E+00
total SW#1 generation per ton of refuse (lb/ton)		**1.39E+00**	**1.50E+00**
SW1 emission coefficient #1	SW1_1	1.60E+01	1.60E+01
SW1 emission coefficient #2	SW1_2	4.83E+01	0.00E+00
Solid Waste #2			
SW #2 precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
SW #2 emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
SW #2 precombustion emissions from drop-off vehicle fuel production (lb/ton)		0.00E+00	0.00E+00
total SW #2 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
SW2 emission coefficient #2	SW2_2	0.00E+00	0.00E+00
Solid Waste #3			
SW #3 precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
SW #3 emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
SW #3 precombustion emissions from drop-off vehicle fuel production (lb/ton)		0.00E+00	0.00E+00
total SW #3 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
SW3 emission coefficient #1	SW3_1	0.00E+00	0.00E+00
SW3 emission coefficient #2	SW3_2	0.00E+00	0.00E+00
Solid Waste #4			
SW #4 precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
SW #4 emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
SW #4 precombustion emissions from drop-off vehicle fuel production (lb/ton)		0.00E+00	0.00E+00
total SW #4 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
SW4 emission coefficient #1	SW4_1	0.00E+00	0.00E+00
SW4 emission coefficient #2	SW4_2	0.00E+00	0.00E+00
Solid Waste #5			
SW #5 precombustion emissions from fuel production (lb/ton)		0.00E+00	N/A
SW #5 emissions from garage electricity generation (lb/ton)		0.00E+00	N/A
SW #5 precombustion emissions from drop-off vehicle fuel production (lb/ton)		0.00E+00	0.00E+00
total SW #5 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
SW5 emission coefficient #1	SW5_1	0.00E+00	0.00E+00
SW5 emission coefficient #2	SW5_2	0.00E+00	0.00E+00

Table D - 32 Multi-Family Collection Outputs

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	Wet/Dry C_18	Recyclables C_14	Recyclables C_15
COLLECTION COSTS							
Breakdown of capital costs							
annualized capital cost per vehicle ($/vehicle-year)	C_cap_v	25,845	25,845	27,999	25,845	9,641	23,138
number of collection vehicles (vehicles)	Nt	2.05	1.67	4.44	1.67	2.07	2.01
annualized capital cost per bin ($/bin-year)	Cb			17.33	17.33	17.33	17.33
number of bins per collection vehicle (bins per vehicle)	Nb			68	119	193	40
bin annualized cost per vehicle ($/vehicle per year)	C_cap_b			1,171	2,070	3,347	689
Breakdown of operating costs							
labor cost per vehicle ($/vehicle-year)	Cw	69,170	69,170	69,170	69,170	40,196	69,170
O&M cost per vehicle ($/vehicle-year)	Cvo	29,376	29,376	33,381	29,376	30,822	29,376
other expenses per vehicle ($/vehicle-year)	Coe	16,166	16,166	16,166	16,166	8,083	16,166
Annual operating cost ($/year)	C_op	128,477	128,477	132,964	128,477	88,593	128,477
Total annual cost ($/year) -- capital + operating	C_ann	321,726	262,738	731,998	266,204	212,370	310,971
Total annual cost per collection location ($/location-year)	C_location	3,217.26	2,627.38	7,319.98	2,662.04	2,123.70	3,109.71
Cost per ton of refuse collected ($/ton)	C_ton	**30.61**	**32.54**	**69.63**	**16.49**	**90.21**	**123.28**
Total annual cost per vehicle ($/vehicle-year)	C_vehicle	156,907	156,907	164,934	158,976	102,545	154,619
cost coefficient #1	cc_1	25,863.94	25,863.94	29,212.94	27,193.28	32,493.93	45,555.71
cost coefficient #2	cc_2	13,305.01	13,305.01	15,310.65	13,305.01	8,064.65	11,350.05

Table D - 33 Multi-Family Collection Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	Wet/Dry C_18	Recyclables C_14	Recyclables C_15
Calculations for collection vehicle activities							
locations per trip	Ht	2.18	2.84	0.97	2.84	2.14	2.02
travel time between collection locations (min/stop)	Tbet	1.50	1.50	1.50	1.50	1.50	1.50
travel time from collection route to disposal facility (min/trip)	Trf	20.00	20.00	20.00	20.00	20.00	20.00
travel time from garage to first collection route (min/day-vehicle)	Tgr	20.00	20.00	20.00	20.00	20.00	20.00
travel time from disposal facility to garage (min/day-vehicle)	Tfg	20.00	20.00	20.00	20.00	20.00	20.00
time per trip (min/trip) -- collection+travel+unload time	Tc	67.69	71.97	64.83	71.97	83.11	76.70
trips per day per vehicle (trips/day-vehicle)	RD	4.47	4.20	4.63	4.20	3.61	3.94
daily weight of refuse collected per vehicle (tons/day)	RefD	19.66	18.49	9.08	36.99	4.36	4.81
number of collection stops per day (stops/vehicle-day)	SD	9.75	11.94	4.51	11.94	7.73	7.96
Collection vehicle activity times							
travel time from garage to first collection route (min/day-vehicle)	Tgr	20.00	20.00	20.00	20.00	20.00	20.00
loading time at collection stops (min/day-vehicle)	LD	48.77	59.72	22.53	59.72	77.26	79.55
travel time between collection stops (min/day-vehicle)	Tb	7.93	11.61	-0.18	11.61	6.17	6.02
travel time between disposal facility and route (min/day-vehicle)	F_R	188.77	178.12	195.10	178.12	154.38	167.77
unloading time at disposal facility (min/day-vehicle)	UD	74.54	70.55	102.55	70.55	82.19	66.66
lunch time (min/day-vehicle)	F1_	30.00	30.00	30.00	30.00	30.00	30.00
break time (min/day-vehicle)	F2_	30.00	30.00	30.00	30.00	30.00	30.00
travel time from disposal facility to garage (min/day-vehicle)	Tfg	20.00	20.00	20.00	20.00	20.00	20.00
actual working time (min/day-vehicle)		**420.00**	**420.00**	**420.00**	**420.00**	**420.00**	**420.00**
service hours per day (hours/day-vehicle)	ShD	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**
Daily miles traveled per collection vehicle							
from garage to first collection route (miles/day)	Dgr	11.67	11.67	11.67	11.67	11.67	11.67
between collection stops (miles/day)	Db	1.32	1.94	-0.03	1.94	1.03	1.00
between disposal facility and route (miles/day)	DF_R	94.38	89.06	97.55	89.06	77.19	83.88
from disposal facility to garage (miles/day)	Dfg	11.67	11.67	11.67	11.67	11.67	11.67
total (miles/day)	Mi	**119.04**	**114.33**	**120.85**	**114.33**	**101.55**	**108.22**
Daily fuel usage per collection vehicle							
from garage to first collection route (gallons/day)		2.33	2.33	2.33	2.33	2.33	2.33
loading at collection stops (gallons/day)		0.81	1.00	0.38	1.00	1.29	1.33
between collection stops (gallons/day)		0.66	0.97	-0.02	0.97	0.51	0.50
between disposal facility and route (gallons/day)		18.88	17.81	19.51	17.81	15.44	16.78
unloading at disposal facility (gallons/day)		1.24	1.18	1.71	1.18	1.37	1.11
from disposal facility to garage (gallons/day)		2.33	2.33	2.33	2.33	2.33	2.33
total (gallons/day)	FuelD	**26.26**	**25.62**	**26.25**	**25.62**	**23.28**	**24.38**

Table D - 34 Multi-Family Collection Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
ENERGY CONSUMPTION							
Energy consumption by collection vehicles							
fuel usage per ton of refuse (gallons/ton)	FuelTon	1	1	3	1	5	5
fuel energy per ton of refuse (Btu/ton)		182,946	189,776	395,792	94,888	731,352	694,325
fuel precombustion energy per ton of refuse (Btu/ton)		**3.46E+04**	**3.59E+04**	**7.48E+04**	**1.79E+04**	**1.38E+05**	**1.31E+05**
total coll. vehicle energy usage per ton of refuse (Btu/ton)		**2.18E+05**	**2.26E+05**	**4.71E+05**	**1.13E+05**	**8.70E+05**	**8.26E+05**
Energy consumption by garage							
daily electricity usage (kWh/day)	ElecD	0.440	0.440	0.440	0.440	0.440	0.440
electricity usage per ton of refuse (kWh/ton)		**0**	**0**	**0**	**0**	**0**	**0**
total garage energy usage per ton of refuse (Btu/ton)		233.40	248.17	505.19	124.09	1,052.59	954.00
Total energy consumption per ton of refuse (Btu/ton)		2.18E+05	2.26E+05	4.71E+05	1.13E+05	8.71E+05	8.27E+05
energy consumption coefficient #1	ec_1	1.09E+08	1.09E+08	1.09E+08	1.09E+08	1.68E+08	1.67E+08
energy consumption coefficient #2	**ec_2**	**1.05E+08**	**1.05E+08**	**1.09E+08**	**1.05E+08**	**9.48E+07**	**9.13E+07**
Total energy consumption per ton of refuse (Btu/ton)		217,764.95	225,901.18	471,122.18	112,950.59	870,667.99	826,541.48

Table D - 35 Multi-Family Collection Air Release Outputs

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
AIRBORNE RELEASES							
Carbon Monoxide							
CO emissions from collection vehicles (lb/ton)		0.067	0.069	0.148	0.034	0.258	0.249
CO precombustion emissions from fuel production (lb/ton)		0.007	0.007	0.014	0.003	0.027	0.025
CO emissions from garage electricity generation (lb/ton)		4.78E-05	5.08E-05	1.03E-04	2.54E-05	2.15E-04	1.95E-04
total CO releases per ton of refuse (lb/ton)		**0.074**	**0.076**	**0.162**	**0.038**	**0.285**	**0.275**
CO emission coefficient #1	CO_1	2.2425E+01	2.2425E+01	2.2558E+01	2.2425E+01	3.4873E+01	3.4639E+01
CO emission coefficient #2	CO_2	3.76E+01	3.76E+01	3.84E+01	3.76E+01	3.34E+01	3.27E+01
total CO releases per ton of refuse (lb/ton)		**0.074**	**0.076**	**0.162**	**0.038**	**0.285**	**0.275**
Nitrogen Oxides							
NOx emissions from collection vehicles (lb/ton)		0.454	0.464	0.998	0.232	1.747	1.687
NOx precombustion emissions from fuel production (lb/ton)		0.010	0.010	0.021	0.005	0.038	0.036
NOx emissions from garage electricity generation (lb/ton)		1.45E-04	1.54E-04	3.13E-04	7.68E-05	6.52E-04	5.91E-04
total NOx releases per ton of refuse (lb/ton)		**0.464**	**0.474**	**1.019**	**0.237**	**1.786**	**1.724**
NOx emission coefficient #1	NO_1	1.34E+02	1.34E+02	1.35E+02	1.34E+02	2.08E+02	2.07E+02
NOx emission coefficient #2	NO_2	2.37E+02	2.37E+02	2.42E+02	2.37E+02	2.10E+02	2.06E+02
total NOx releases per ton of refuse (lb/ton)		**0.464**	**0.474**	**1.019**	**0.237**	**1.786**	**1.724**
Particulate Matter							
PM emissions from collection vehicles (lb/ton)		0.003	0.003	0.007	0.002	0.013	0.012
PM precombustion emissions from fuel production (lb/ton)		0.002	0.003	0.005	0.001	0.010	0.009
PM emissions from garage electricity generation (lb/ton)		5.81E-05	6.18E-05	1.26E-04	3.09E-05	2.62E-04	2.38E-04
total PM releases per ton of refuse (lb/ton)		**0.006**	**0.006**	**0.013**	**0.003**	**0.023**	**0.022**
PM emission coefficient #1	PM_1	2.21E+00	2.21E+00	2.22E+00	2.21E+00	3.44E+00	3.41E+00
PM emission coefficient #2	PM_2	2.90E+00	2.90E+00	2.99E+00	2.90E+00	2.60E+00	2.52E+00

Table D - 36 Multi-Family Collection Air Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
PM10							
PM10 emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
PM10 precombustion emissions from fuel production (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
PM10 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total PM10 releases per ton of refuse (lb/ton)		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
PM10 emission coefficient #1	PM10_1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM10 emission coefficient #2	PM10_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total PM10 releases per ton of refuse (lb/ton)		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Fossil CO2							
CO2-fossil emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
CO2-fossil precombustion emissions from fuel production (lb/ton)		4.799	4.978	10.383	2.489	19.186	18.215
CO2-fossil emissions from garage electricity generation (lb/ton)		3.33E-02	3.54E-02	7.21E-02	1.77E-02	1.50E-01	1.36E-01
total CO2-fossil releases per ton of refuse (lb/ton)		**4.833**	**5.014**	**10.455**	**2.507**	**19.336**	**18.351**
CO2-fossil emission coefficient #1	CO2f_1	2.42E+03	2.42E+03	2.43E+03	2.42E+03	3.75E+03	3.73E+03
CO2-fossil emission coefficient #2	CO2f_2	2.33E+03	2.33E+03	2.42E+03	2.33E+03	2.10E+03	2.02E+03
total CO2-fossil releases per ton of refuse (lb/ton)		**4.833**	**5.014**	**10.455**	**2.507**	**19.336**	**18.351**
Biomass CO2							
CO2-biomass emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
CO2-biomass precombustion emissions from fuel production (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
CO2-biomass emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total CO2-biomass releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
CO2-biomass emission coefficient #1	CO2bm_1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO2-biomass emission coefficient #2	CO2bm_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total CO2-biomass releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**

Table D - 37 Multi-Family Collection Air Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
Sulfur Oxides							
SOx emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
SOx precombustion emissions from fuel production (lb/ton)		0.012	0.012	0.025	0.006	0.047	0.045
SOx emissions from garage electricity generation (lb/ton)		3.06E-04	3.25E-04	6.62E-04	1.63E-04	1.38E-03	1.25E-03
total SOx releases per ton refuse (lb/ton)		**0.012**	**0.013**	**0.026**	**0.006**	**0.048**	**0.046**
SOx emission coefficient #1	SOx_1	6.12E+00	6.12E+00	6.15E+00	6.12E+00	9.53E+00	9.47E+00
SOx emission coefficient #2	SOx_2	5.80E+00	5.80E+00	6.03E+00	5.80E+00	5.24E+00	5.04E+00
total SOx releases per ton refuse (lb/ton)		**0.012**	**0.013**	**0.026**	**0.006**	**0.048**	**0.046**
Hydrocarbons (less methane)							
HC emissions from collection vehicles (lb/ton)		0.008	0.008	0.018	0.004	0.031	0.030
HC precombustion emissions from collection vehicles (lb/ton)		0.090	0.093	0.195	0.047	0.360	0.342
HC emissions from garage electricity generation (lb/ton)		2.29E-05	2.43E-05	4.95E-05	1.22E-05	1.03E-04	9.34E-05
total HC releases per ton of refuse (lb/ton)		**0.098**	**0.102**	**0.213**	**0.051**	**0.392**	**0.372**
HC emission coefficient #1	HC_1	4.72E+01	4.72E+01	4.75E+01	4.72E+01	7.32E+01	7.27E+01
HC emission coefficient #2	HC_2	4.76E+01	4.76E+01	4.94E+01	4.76E+01	4.29E+01	4.14E+01
Methane							
CH4 emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
CH4 precombustion emissions from fuel production (lb/ton)		6.68E-05	6.93E-05	1.44E-04	3.46E-05	2.67E-04	2.53E-04
CH4 emissions from garage electricity generation (lb/ton)		2.20E-07	2.34E-07	4.77E-07	1.17E-07	9.94E-07	9.01E-07
total CH4 releases per ton of refuse (lb/ton)		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
CH4 emission coefficient #1	CH4_1	3.35E-02	3.35E-02	3.37E-02	3.35E-02	5.19E-02	5.15E-02
CH4 emission coefficient #2	CH4_2	3.23E-02	3.23E-02	3.35E-02	3.23E-02	2.91E-02	2.81E-02

Table D - 38 Multi-Family Collection Air Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
Lead							
Lead emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
Lead precombustion emissions from fuel production (lb/ton)		1.47E-08	1.52E-08	3.18E-08	7.62E-09	5.87E-08	5.57E-08
Lead emissions from garage electricity generation (lb/ton)		1.10E-12	1.17E-12	2.38E-12	5.84E-13	4.95E-12	4.49E-12
total lead releases per ton of refuse (lb/ton)		**1.47E-08**	**1.52E-08**	**3.18E-08**	**7.62E-09**	**5.87E-08**	**5.58E-08**
Pb emission coefficient #1	Pb_a_1	1.94E-04	1.94E-04	1.95E-04	1.94E-04	3.44E-04	3.41E-04
PB emission coefficient #2	Pb_a_2	1.03E-04	1.03E-04	1.13E-04	1.03E-04	9.82E-05	8.95E-05
Ammonia							
Ammonia emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
Ammonia precombustion emissions from fuel production (lb/ton)		5.21E-05	5.40E-05	1.13E-04	2.70E-05	2.08E-04	1.98E-04
Ammonia emissions from garage electricity generation (lb/ton)		3.94E-09	4.19E-09	8.53E-09	2.09E-09	1.78E-08	1.61E-08
total ammonia releases per ton of refuse (lb/ton)		**5.21E-05**	**5.40E-05**	**1.13E-04**	**2.70E-05**	**2.08E-04**	**1.98E-04**
NH3 emission coefficient #1	NH3_1	1.94E-04	1.94E-04	1.95E-04	1.94E-04	3.44E-04	3.41E-04
NH3 emission coefficient #2	NH3_2	1.03E-04	1.03E-04	1.13E-04	1.03E-04	9.82E-05	8.95E-05
Hydrochloric Acid							
HCl emissions from collection vehicles (lb/ton)		0.000	0.000	0.000	0.000	0.000	0.000
HCl precombustion emissions from fuel production (lb/ton)		1.60E-06	1.66E-06	3.47E-06	8.31E-07	6.41E-06	6.08E-06
HCl emissions from garage electricity generation (lb/ton)		1.19E-10	1.26E-10	2.57E-10	6.32E-11	5.36E-10	4.86E-10
total HCl releases per ton of refuse (lb/ton)		**1.60E-06**	**1.66E-06**	**3.47E-06**	**8.31E-07**	**6.41E-06**	**6.08E-06**
HCl emission coefficient #1	HCl_1	7.99E-04	7.99E-04	8.03E-04	7.99E-04	1.24E-03	1.23E-03
HCl emission coefficient #2	HCl_2	7.72E-04	7.72E-04	8.02E-04	7.72E-04	6.97E-04	6.72E-04

Table D - 39 Multi-Family Collection Air Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
Greenhouse Gas Equivalence							
Carbon dioxide (fossil fuel)		4.83	5.01	10.46	2.51	19.34	18.35
Carbon dioxide (biomass)		0.00	0.00	0.00	0.00	0.00	0.00
Methane		0.00	0.00	0.01	0.00	0.02	0.02
Nitrous oxide		125.24	127.94	275.12	63.97	482.26	465.61
Other hydrocarbons		0.00	0.00	0.00	0.00	0.00	0.00
total greenhouse gas equivalence per ton of refuse		**130.07**	**132.96**	**285.59**	**66.48**	**501.61**	**483.97**
GHE emission coefficient #1	GHE_1	3.85E+04	3.85E+04	3.88E+04	3.85E+04	5.99E+04	5.95E+04
GHE emission coefficient #2	GHE_2	6.63E+04	6.63E+04	6.77E+04	6.63E+04	5.89E+04	5.76E+04

Table D - 40 Multi-Family Collection Water Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
WATERBORNE RELEASES							
Dissolved Solids							
Dissolved solids emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DS precombustion emissions from fuel production (lb/ton)		1.36E-01	1.41E-01	2.95E-01	7.06E-02	5.45E-01	5.17E-01
DS emissions from garage electricity generation (lb/ton)		1.02E-05	1.09E-05	2.21E-05	5.44E-06	4.61E-05	4.18E-05
total dissolved solids releases per ton of refuse (lb/ton)		**1.36E-01**	**1.41E-01**	**2.95E-01**	**7.07E-02**	**5.45E-01**	**5.17E-01**
DS emission coefficient #1	DS_1	67.89624502	67.89624502	68.29204706	67.89624502	105.1320833	104.4318181
DS emission coefficient #2	DS_2	65.65816451	65.65816451	68.16427647		59.27328389	57.09405609
DS emission coefficient #3	DS_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Suspended Solids							
Suspended solids emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SS precombustion emissions from fuel production (lb/ton)		1.27E-04	1.32E-04	2.74E-04	6.58E-05	5.07E-04	4.81E-04
SS emissions from garage electricity generation (lb/ton)		9.21E-09	9.79E-09	1.99E-08	4.90E-09	4.15E-08	3.76E-08
total suspended solids releases per ton of refuse (lb/ton)		**1.27E-04**	**1.32E-04**	**2.74E-04**	**6.58E-05**	**5.07E-04**	**4.82E-04**
SS emission coefficient #1	SS_1	0.063236431	0.063236431	0.063605068	0.063236431	0.097916659	0.097264455
SS emission coefficient #2	SS_2	0.061152074	0.061152074	0.063486184	0.061152074	0.055205378	0.053175717
SS emission coefficient #3	SS_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Biochemical Oxygen Demand							
BOD emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BOD precombustion emissions from fuel production (lb/ton)		1.34E-04	1.39E-04	2.89E-04	6.93E-05	5.34E-04	5.07E-04
BOD emissions from garage electricity generation (lb/ton)		1.01E-08	1.07E-08	2.18E-08	5.36E-09	4.55E-08	4.12E-08
total BOD releases per ton of refuse (lb/ton)		**1.34E-04**	**1.39E-04**	**2.89E-04**	**6.93E-05**	**5.34E-04**	**5.07E-04**
BOD emission coefficient #1	BOD_1	0.066565001	0.066565001	0.066953043	0.066565001	0.103070768	0.102384233
BOD emission coefficient #2	BOD_2	0.064370778	0.064370778	0.066827753	0.064370778	0.05811109	0.055974589
BOD emission coefficient #3	BOD_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 41 Multi-Family Collection Water Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
Chemical Oxygen Demand							
COD emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
COD precombustion emissions from fuel production (lb/ton)		6.55E-04	6.80E-04	1.42E-03	3.40E-04	2.62E-03	2.49E-03
COD emissions from garage electricity generation (lb/ton)		4.99E-08	5.31E-08	1.08E-07	2.66E-08	2.25E-07	2.04E-07
total COD releases per ton of refuse (lb/ton)		**6.55E-04**	**6.80E-04**	**1.42E-03**	**3.40E-04**	**2.62E-03**	**2.49E-03**
COD emission coefficient #1	COD_1	0.326554955	0.326554955	0.328458613	0.326554955	0.505645239	0.502277229
COD emission coefficient #2	COD_2	0.315790354	0.315790354	0.327843803	0.315790354	0.285081568	0.274600308
COD emission coefficient #3	COD_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Oil							
Oil emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Oil precombustion emissions from fuel production (lb/ton)		1.64E-03	1.70E-03	3.55E-03	8.52E-04	6.57E-03	6.23E-03
Oil emissions from garage electricity generation (lb/ton)		1.37E-07	1.45E-07	2.96E-07	7.27E-08	6.17E-07	5.59E-07
total oil releases per ton of refuse (lb/ton)		**1.64E-03**	**1.70E-03**	**3.55E-03**	**8.52E-04**	**6.57E-03**	**6.23E-03**
oil emission coefficient #1	oil_1	0.81876018	0.81876018	0.823533182	0.81876018	1.267789476	1.259344935
oil emission coefficient #2	oil_2	0.791766054	0.791766054	0.821987415	0.791766054	0.714771665	0.688492221
oil emission coefficient #3	oil_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sulfuric Acid							
Sulfuric acid emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sulfuric acid precombustion emissions from fuel production (lb/ton)		4.14E-04	4.29E-04	8.96E-04	2.15E-04	1.65E-03	1.57E-03
Sulfuric acid emissions from garage electricity generation (lb/ton)		2.51E-05	2.67E-05	5.44E-05	1.34E-05	1.13E-04	1.03E-04
total sulfuric acid releases per ton of refuse (lb/ton)		**4.39E-04**	**4.56E-04**	**9.50E-04**	**2.28E-04**	**1.77E-03**	**1.67E-03**
H2SO4 emission coefficient #1	H2SO4_1	0.227561132	0.227561132	0.228940808	0.227561132	0.357356815	0.35491585
H2SO4 emission coefficient #2	H2SO4_2	0.210460134	0.210460134	0.219195871	0.210460134	0.190605106	0.183008812
H2SO4 emission coefficient #3	H2SO4_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 42 Multi-Family Collection Water Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
Iron							
Iron emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron precombustion emissions from fuel production (lb/ton)		1.08E-04	1.12E-04	2.34E-04	5.61E-05	4.32E-04	4.11E-04
Iron emissions from garage electricity generation (lb/ton)		6.25E-06	6.65E-06	1.35E-05	3.32E-06	2.82E-05	2.56E-05
total iron releases per ton of refuse (lb/ton)		**1.14E-04**	**1.19E-04**	**2.48E-04**	**5.94E-05**	**4.61E-04**	**4.36E-04**
fe emission coefficient #1	fe_1	0.0591936	0.0591936	0.05955188	0.0591936	0.092899481	0.092265601
fe emission coefficient #2	fe_2	0.0548544	0.0548544	0.057122933	0.0548544	0.049672115	0.047699478
fe emission coefficient #3	fe_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia							
Ammonia emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia precombustion emissions from fuel production (lb/ton)		1.87E-05	1.94E-05	4.04E-05	9.70E-06	7.47E-05	7.10E-05
Ammonia emissions from garage electricity generation (lb/ton)		1.38E-09	1.46E-09	2.98E-09	7.31E-10	6.20E-09	5.62E-09
total ammonia releases per ton of refuse (lb/ton)		**1.87E-05**	**1.94E-05**	**4.04E-05**	**9.70E-06**	**7.47E-05**	**7.10E-05**
NH4 emission coefficient #1	NH4_1	0.009319069	0.009319069	0.009373394	0.009319069	0.014429852	0.014333737
NH4 emission coefficient #2	NH4_2	0.009011893	0.009011893	0.009355868	0.009011893	0.008135537	0.007836429
NH4 emission coefficient #3	NH4_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper							
Copper emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total copper releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
cu emission coefficient #1	cu_1	0	0	0	0	0	0
cu emission coefficient #2	cu_2	0	0	0	0	0	0
cu emission coefficient #3	cu_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 43 Multi-Family Collection Water Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
Cadmium							
Cadmium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total cadmium releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
cd emission coefficient #1	cd_1	0	0	0	0	0	0
cd emission coefficient #2	cd_2	0	0	0	0	0	0
cd emission coefficient #3	cd_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic							
Arsenic emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total arsenic releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
as emission coefficient #1	as_1	0	0	0	0	0	0
as emission coefficient #2	as_2	0	0	0	0	0	0
as emission coefficient #3	as_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury							
Mercury emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total mercury releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
hg emission coefficient #1	hg_1	0	0	0	0	0	0
hg emission coefficient #2	hg_2	0	0	0	0	0	0
hg emission coefficient #3	hg_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 44 Multi-Family Collection Water Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
Phosphate							
Phosphate emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphate precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphate emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total phosphate releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
po4 emission coefficient #1	po4_1	0	0	0	0	0	0
po4 emission coefficient #2	po4_2	0	0	0	0	0	0
po4 emission coefficient #3	po4_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium							
Selenium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total selenium releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
se emission coefficient #1	se_1	0	0	0	0	0	0
se emission coefficient #2	se_2	0	0	0	0	0	0
se emission coefficient #3	se_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium							
Chromium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium precombustion emissions from fuel production (lb/ton)		4.54E-08	4.71E-08	9.82E-08	2.35E-08	1.82E-07	1.72E-07
Chromium emissions from garage electricity generation (lb/ton)		1.59E-12	1.69E-12	3.44E-12	8.44E-13	7.16E-12	6.49E-12
total chromium releases per ton of refuse (lb/ton)		**4.54E-08**	**4.71E-08**	**9.82E-08**	**2.35E-08**	**1.82E-07**	**1.72E-07**
cr emission coefficient #1	cr_1	2.26305E-05	2.26305E-05	2.27625E-05	2.26305E-05	3.50413E-05	3.48079E-05
cr emission coefficient #2	cr_2	2.18853E-05	2.18853E-05	2.27206E-05	2.18853E-05	1.9757E-05	1.90307E-05
cr emission coefficient #3	cr_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 45 Multi-Family Collection Water Release Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
Lead							
Lead emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead precombustion emissions from fuel production (lb/ton)		2.00E-08	2.08E-08	4.33E-08	1.04E-08	8.01E-08	7.60E-08
Lead emissions from garage electricity generation (lb/ton)		1.47E-12	1.56E-12	3.18E-12	7.82E-13	6.63E-12	6.01E-12
total lead releases per ton of refuse (lb/ton)		**2.00E-08**	**2.08E-08**	**4.33E-08**	**1.04E-08**	**8.01E-08**	**7.60E-08**
pb emission coefficient #1	pb_1	9.98471E-06	9.98471E-06	1.00429E-05	9.98471E-06	1.54606E-05	1.53576E-05
pb emission coefficient #2	pb_2	9.6556E-06	9.6556E-06	1.00241E-05	9.6556E-06	8.71665E-06	8.39617E-06
pb emission coefficient #3	pb_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc							
Zinc emissions from washdown water (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc precombustion emissions from fuel production (lb/ton)		2.94E-07	3.05E-07	6.36E-07	1.52E-07	1.17E-06	1.11E-06
Zinc emissions from garage electricity generation (lb/ton)		2.20E-11	2.34E-11	4.76E-11	1.17E-11	9.91E-11	8.99E-11
Total zinc releases per ton of refuse (lb/ton)		**2.94E-07**	**3.05E-07**	**6.36E-07**	**1.52E-07**	**1.17E-06**	**1.12E-06**
zn emission coefficient #1	zn_1	0.000146443	0.000146443	0.000147297	0.000146443	0.000226755	0.000225245
zn emission coefficient #2	zn_2	0.000141616	0.000141616	0.000147021	0.000141616	0.000127844	0.000123144
zn emission coefficient #3	zn_3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 46 Multi-Family Collection Solid Waste Outputs (Continued)

Multi-Family Collection Options		Mixed Waste C_13	Resi-duals C_16	Wet/Dry C_17	0 C_18	Recyclables C_14	0 C_15
SOLID WASTE							
Solid Waste #1							
SW#1 precombustion emissions from fuel production (lb/ton)		1.10E-01	1.14E-01	2.38E-01	5.71E-02	4.40E-01	4.18E-01
SW#1 emissions from garage electricity generation (lb/ton)		4.27E-03	4.54E-03	9.23E-03	2.27E-03	1.92E-02	1.74E-02
total SW#1 generation per ton of refuse (lb/ton)		**1.14E-01**	**1.19E-01**	**2.47E-01**	**5.93E-02**	**4.59E-01**	**4.35E-01**
SW1 emission coefficient #1	SW1_1	5.84E+01	5.84E+01	5.88E+01	5.84E+01	9.13E+01	9.07E+01
SW1 emission coefficient #2	SW1_2	5.49E+01	5.49E+01	5.71E+01	5.49E+01	4.97E+01	4.77E+01
Solid Waste #2							
SW #2 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW #2 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total SW #2 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
SW2 emission coefficient #2	SW2_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Solid Waste #3							
SW #3 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW #3 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total SW #3 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
SW3 emission coefficient #1	SW3_1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW3 emission coefficient #2	SW3_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Solid Waste #4							
SW #4 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW #4 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total SW #4 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
SW4 emission coefficient #1	SW4_1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW4 emission coefficient #2	SW4_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Solid Waste #5							
SW #5 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW #5 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total SW #5 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
SW5 emission coefficient #1	SW5_1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SW5 emission coefficient #2	SW5_2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D - 47 Commercial Collection Outputs

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
COLLECTION COSTS			
Breakdown of capital costs			
capital cost per vehicle ($/vehicle-year)	Ct	9,641	25,845
number of collection vehicles (vehicles)	Nt	1.63	1.65
		12.28	
Breakdown of operating costs			
labor cost per vehicle ($/vehicle-year)	Cw	40,196	69,170
O&M cost per vehicle ($/vehicle-year)	Cvo	30,822	29,376
other expenses per vehicle ($/vehicle-year)	Coe	8,083	16,166
Annual operating cost ($/year)	C_op	88,593	128,477
Total annual cost ($/year) -- capital + operating	C_ann	161,339	258,360
Total annual cost per location ($/location-year)	C_location	1,613.39	2,583.60
Cost per ton of refuse collected ($/ton)	C_ton	**181.01**	**50.61**
Total annual cost per vehicle ($/vehicle-year)	C_vehicle	99,198	156,907
cost coefficient #1	cc_1	87,511.77	51,727.89
cost coefficient #2	cc_2	8,064.65	13,305.01

Table D - 48 Commercial Collection Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Calculations for collection vehicle activities			
locations per trip	Ht	12.28	8.99
travel time between collection locations (min/stop)	Tbet	1.50	1.50
travel time from collection route to disposal facility (min/trip)	Trf	20.00	20.00
travel time from garage to first collection route (min/day-vehicle)	Tgr	20.00	20.00
travel time from disposal facility to garage (min/day-vehicle)	Tfg	20.00	20.00
time per trip (min/trip) -- collection+travel+unload time	Tc	199.71	111.92
trips per day per vehicle (trips/day-vehicle)	RD	1.50	2.70
daily weight of refuse collected per vehicle (tons/day)	RefD	2.10	11.89
number of collection stops per day (stops/vehicle-day)	SD	18.45	24.29
Collection vehicle activity times			
travel time from garage to first collection route (min/day-vehicle)	Tgr	20.00	20.00
loading time at collection stops (min/day-vehicle)	LD	184.45	121.46
travel time between collection stops (min/day-vehicle)	Tb	25.41	32.39
travel time between disposal facility and route (min/day-vehicle)	F_R	70.09	118.11
unloading time at disposal facility (min/day-vehicle)	UD	40.04	48.04
lunch time (min/day-vehicle)	F1_	30.00	30.00
break time (min/day-vehicle)	F2_	30.00	30.00
travel time from disposal facility to garage (min/day-vehicle)	Tfg	20.00	20.00
actual working time (min/day-vehicle)		**420.00**	**420.00**
service hours per day (hours/day-vehicle)	ShD	**6.00**	**6.00**
Daily miles traveled per collection vehicle			
from garage to first collection route (miles/day)	Dgr	11.67	11.67
between collection stops (miles/day)	Db	4.24	5.40
between disposal facility and route (miles/day)	DF_R	35.04	59.05
from disposal facility to garage (miles/day)	Dfg	11.67	11.67
total (miles/day)	Mi	**62.61**	**87.79**
Daily fuel usage per collection vehicle			
from garage to first collection route (gallons/day)		2.33	2.33
loading at collection stops (gallons/day)		3.07	2.02
between collection stops (gallons/day)		2.12	2.70
between disposal facility and route (gallons/day)		7.01	11.81
unloading at disposal facility (gallons/day)		0.67	0.80
from disposal facility to garage (gallons/day)		2.33	2.33
total (gallons/day)	FuelD	**17.54**	**22.00**

Table D - 49 Commercial Collection Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
ENERGY CONSUMPTION			
Energy consumption by collection vehicles			
fuel usage per ton of refuse (gallons/ton)	FuelTon	8	2
fuel energy per ton of refuse (Btu/ton)		1,142,875	253,463
fuel precombustion energy per ton of refuse (Btu/ton)		**2.16E+05**	**4.79E+04**
total coll. vehicle energy usage per ton of refuse (Btu/ton)		**1.36E+06**	**3.01E+05**
Energy consumption by garage			
daily electricity usage (kWh/day)	ElecD	0.440	0.440
electricity usage per ton of refuse (kWh/ton)		**0**	**0**
total garage energy usage per ton of refuse (Btu/ton)		2,183.45	385.93
Total energy consumption per ton of refuse (Btu/ton)		1.36E+06	3.02E+05
energy consumption coefficient #1	ec_1	5.05E+08	2.17E+08
energy consumption coefficient #2	**ec_2**	**9.48E+07**	**1.05E+08**
Total energy consumption per ton of refuse (Btu/ton)		1,361,120.69	301,766.41

Table D - 50 Commercial Collection Air Release Outputs

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
AIRBORNE RELEASES			
Carbon Monoxide			
CO emissions from collection vehicles (lb/ton)		0.330	0.082
CO precombustion emissions from fuel production (lb/ton)		0.042	0.009
CO emissions from garage electricity generation (lb/ton)		4.47E-04	7.90E-05
total CO releases per ton of refuse (lb/ton)		**0.373**	**0.091**
CO emission coefficient #1	CO_1	1.0462E+02	4.4851E+01
CO emission coefficient #2	CO_2	3.34E+01	3.76E+01
total CO releases per ton of refuse (lb/ton)		**0.373**	**0.091**
Nitrogen Oxides			
NOx emissions from collection vehicles (lb/ton)		2.235	0.554
NOx precombustion emissions from fuel production (lb/ton)		0.060	0.013
NOx emissions from garage electricity generation (lb/ton)		1.35E-03	2.39E-04
total NOx releases per ton of refuse (lb/ton)		**2.296**	**0.567**
NOx emission coefficient #1	NO_1	6.24E+02	2.68E+02
NOx emission coefficient #2	NO_2	2.10E+02	2.37E+02
total NOx releases per ton of refuse (lb/ton)		**2.296**	**0.567**
Particulate Matter			
PM emissions from collection vehicles (lb/ton)		0.016	0.004
PM precombustion emissions from fuel production (lb/ton)		0.015	0.003
PM emissions from garage electricity generation (lb/ton)		5.44E-04	9.61E-05
total PM releases per ton of refuse (lb/ton)		**0.032**	**0.008**
PM emission coefficient #1	PM_1	1.03E+01	4.41E+00
PM emission coefficient #2	PM_2	2.60E+00	2.90E+00

Table D - 51 Commercial Collection Air Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
PM10			
PM10 emissions from collection vehicles (lb/ton)		0.000	0.000
PM10 precombustion emissions from fuel production (lb/ton)		0.000	0.000
PM10 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total PM10 releases per ton of refuse (lb/ton)		**0.000**	**0.000**
PM10 emission coefficient #1	PM10_1	0.00E+00	0.00E+00
PM10 emission coefficient #2	PM10_2	0.00E+00	0.00E+00
total PM10 releases per ton of refuse (lb/ton)		**0.000**	**0.000**
Fossil CO2			
CO2-fossil emissions from collection vehicles (lb/ton)		0.000	0.000
CO2-fossil precombustion emissions from fuel production (lb/ton)		29.982	6.649
CO2-fossil emissions from garage electricity generation (lb/ton)		3.11E-01	5.50E-02
total CO2-fossil releases per ton of refuse (lb/ton)		**30.293**	**6.704**
CO2-fossil emission coefficient #1	CO2f_1	1.13E+04	4.84E+03
CO2-fossil emission coefficient #2	CO2f_2	2.10E+03	2.33E+03
total CO2-fossil releases per ton of refuse (lb/ton)		**30.293**	**6.704**
Biomass CO2			
CO2-biomass emissions from collection vehicles (lb/ton)		0.000	0.000
CO2-biomass precombustion emissions from fuel production (lb/ton)		0.000	0.000
CO2-biomass emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total CO2-biomass releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
CO2-biomass emission coefficient #1	CO2bm_1	0.00E+00	0.00E+00
CO2-biomass emission coefficient #2	CO2bm_2	0.00E+00	0.00E+00
total CO2-biomass releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**

Table D - 52 Commercial Collection Air Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Sulfur Oxides			
SOx emissions from collection vehicles (lb/ton)		0.000	0.000
SOx precombustion emissions from fuel production (lb/ton)		0.073	0.016
SOx emissions from garage electricity generation (lb/ton)		2.86E-03	5.06E-04
total SOx releases per ton refuse (lb/ton)		**0.076**	**0.017**
SOx emission coefficient #1	SOx_1	2.86E+01	1.22E+01
SOx emission coefficient #2	SOx_2	5.24E+00	5.80E+00
total SOx releases per ton refuse (lb/ton)		**0.076**	**0.017**
Hydrocarbons (less methane)			
HC emissions from collection vehicles (lb/ton)		0.040	0.010
HC precombustion emissions from collection vehicles (lb/ton)		0.563	0.125
HC emissions from garage electricity generation (lb/ton)		2.14E-04	3.78E-05
total HC releases per ton of refuse (lb/ton)		**0.603**	**0.135**
HC emission coefficient #1	HC_1	2.20E+02	9.45E+01
HC emission coefficient #2	HC_2	4.29E+01	4.76E+01
Methane			
CH4 emissions from collection vehicles (lb/ton)		0.000	0.000
CH4 precombustion emissions from fuel production (lb/ton)		4.17E-04	9.25E-05
CH4 emissions from garage electricity generation (lb/ton)		2.06E-06	3.64E-07
total CH4 releases per ton of refuse (lb/ton)		**0.000**	**0.000**
CH4 emission coefficient #1	CH4_1	1.56E-01	6.69E-02
CH4 emission coefficient #2	CH4_2	2.91E-02	3.23E-02

Table D - 53 Commercial Collection Air Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Lead			
Lead emissions from collection vehicles (lb/ton)		0.000	0.000
Lead precombustion emissions from fuel production (lb/ton)		9.18E-08	2.04E-08
Lead emissions from garage electricity generation (lb/ton)		1.03E-11	1.82E-12
total lead releases per ton of refuse (lb/ton)		**9.18E-08**	**2.04E-08**
Pb emission coefficient #1	Pb_a_1	1.03E-03	3.87E-04
PB emission coefficient #2	Pb_a_2	9.82E-05	1.03E-04
Ammonia			
Ammonia emissions from collection vehicles (lb/ton)		0.000	0.000
Ammonia precombustion emissions from fuel production (lb/ton)		3.25E-04	7.22E-05
Ammonia emissions from garage electricity generation (lb/ton)		3.69E-08	6.51E-09
total ammonia releases per ton of refuse (lb/ton)		**3.25E-04**	**7.22E-05**
NH3 emission coefficient #1	NH3_1	1.03E-03	3.87E-04
NH3 emission coefficient #2	NH3_2	9.82E-05	1.03E-04
Hydrochloric Acid			
HCl emissions from collection vehicles (lb/ton)		0.000	0.000
HCl precombustion emissions from fuel production (lb/ton)		1.00E-05	2.22E-06
HCl emissions from garage electricity generation (lb/ton)		1.11E-09	1.97E-10
total HCl releases per ton of refuse (lb/ton)		**1.00E-05**	**2.22E-06**
HCl emission coefficient #1	HCl_1	3.71E-03	1.60E-03
HCl emission coefficient #2	HCl_2	6.97E-04	7.72E-04

Table D - 54 Commercial Collection Air Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Greenhouse Gas Equivalence			
Carbon dioxide (fossil fuel)		30.29	6.70
Carbon dioxide (biomass)		0.00	0.00
Methane		0.03	0.01
Nitrous oxide		619.88	153.17
Other hydrocarbons		0.00	0.00
total greenhouse gas equivalence per ton of refuse		**650.20**	**159.88**
GHE emission coefficient #1	GHE_1	1.80E+05	7.71E+04
GHE emission coefficient #2	GHE_2	5.89E+04	6.63E+04

Table D - 55 Commercial Collection Water Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
WATERBORNE RELEASES			
Dissolved Solids			
Dissolved solids emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
DS precombustion emissions from fuel production (lb/ton)		8.51E-01	1.89E-01
DS emissions from garage electricity generation (lb/ton)		9.57E-05	1.69E-05
total dissolved solids releases per ton of refuse (lb/ton)		**8.51E-01**	**1.89E-01**
DS emission coefficient #1	DS_1	315.3962498	135.79249
DS emission coefficient #2	DS_2	59.27328389	65.65816451
DS emission coefficient #3	DS_3	0.00E+00	0.00E+00
Suspended Solids			
Suspended solids emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
SS precombustion emissions from fuel production (lb/ton)		7.93E-04	1.76E-04
SS emissions from garage electricity generation (lb/ton)		8.61E-08	1.52E-08
total suspended solids releases per ton of refuse (lb/ton)		**7.93E-04**	**1.76E-04**
SS emission coefficient #1	SS_1	0.293749977	0.126472863
SS emission coefficient #2	SS_2	0.055205378	0.061152074
SS emission coefficient #3	SS_3	0.00E+00	0.00E+00
Biochemical Oxygen Demand			
BOD emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
BOD precombustion emissions from fuel production (lb/ton)		8.34E-04	1.85E-04
BOD emissions from garage electricity generation (lb/ton)		9.44E-08	1.67E-08
total BOD releases per ton of refuse (lb/ton)		**8.34E-04**	**1.85E-04**
BOD emission coefficient #1	BOD_1	0.309212305	0.133130003
BOD emission coefficient #2	BOD_2	0.05811109	0.064370778
BOD emission coefficient #3	BOD_3	0.00E+00	0.00E+00

Table D - 56 Commercial Collection Water Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Chemical Oxygen Demand			
COD emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
COD precombustion emissions from fuel production (lb/ton)		4.09E-03	9.08E-04
COD emissions from garage electricity generation (lb/ton)		4.67E-07	8.26E-08
total COD releases per ton of refuse (lb/ton)		**4.09E-03**	**9.08E-04**
COD emission coefficient #1	COD_1	1.516935717	0.653109911
COD emission coefficient #2	COD_2	0.285081568	0.315790354
COD emission coefficient #3	COD_3	0.00E+00	0.00E+00
Oil			
Oil emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Oil precombustion emissions from fuel production (lb/ton)		1.03E-02	2.28E-03
Oil emissions from garage electricity generation (lb/ton)		1.28E-06	2.26E-07
total oil releases per ton of refuse (lb/ton)		**1.03E-02**	**2.28E-03**
oil emission coefficient #1	oil_1	3.803368427	1.637520361
oil emission coefficient #2	oil_2	0.714771665	0.791766054
oil emission coefficient #3	oil_3	0.00E+00	0.00E+00
Sulfuric Acid			
Sulfuric acid emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Sulfuric acid precombustion emissions from fuel production (lb/ton)		2.59E-03	5.74E-04
Sulfuric acid emissions from garage electricity generation (lb/ton)		2.35E-04	4.16E-05
total sulfuric acid releases per ton of refuse (lb/ton)		**2.82E-03**	**6.15E-04**
H2SO4 emission coefficient #1	H2SO4_1	1.072070445	0.455122265
H2SO4 emission coefficient #2	H2SO4_2	0.190605106	0.210460134
H2SO4 emission coefficient #3	H2SO4_3	0.00E+00	0.00E+00

Table D - 57 Commercial Collection Water Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Iron			
Iron emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Iron precombustion emissions from fuel production (lb/ton)		6.76E-04	1.50E-04
Iron emissions from garage electricity generation (lb/ton)		5.85E-05	1.03E-05
total iron releases per ton of refuse (lb/ton)		**7.34E-04**	**1.60E-04**
fe emission coefficient #1	fe_1	0.278698443	0.118387201
fe emission coefficient #2	fe_2	0.049672115	0.0548544
fe emission coefficient #3	fe_3	0.00E+00	0.00E+00
Ammonia			
Ammonia emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Ammonia precombustion emissions from fuel production (lb/ton)		1.17E-04	2.59E-05
Ammonia emissions from garage electricity generation (lb/ton)		1.29E-08	2.27E-09
total ammonia releases per ton of refuse (lb/ton)		**1.17E-04**	**2.59E-05**
NH4 emission coefficient #1	NH4_1	0.043289555	0.018638138
NH4 emission coefficient #2	NH4_2	0.008135537	0.009011893
NH4 emission coefficient #3	NH4_3	0.00E+00	0.00E+00
Copper			
Copper emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Copper precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
Copper emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total copper releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
cu emission coefficient #1	cu_1	0	0
cu emission coefficient #2	cu_2	0	0
cu emission coefficient #3	cu_3	0.00E+00	0.00E+00

Table D - 58 Commercial Collection Water Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Cadmium			
Cadmium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Cadmium precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
Cadmium emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total cadmium releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
cd emission coefficient #1	cd_1	0	0
cd emission coefficient #2	cd_2	0	0
cd emission coefficient #3	cd_3	0.00E+00	0.00E+00
Arsenic			
Arsenic emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Arsenic precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
Arsenic emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total arsenic releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
as emission coefficient #1	as_1	0	0
as emission coefficient #2	as_2	0	0
as emission coefficient #3	as_3	0.00E+00	0.00E+00
Mercury			
Mercury emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Mercury precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
Mercury emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total mercury releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
hg emission coefficient #1	hg_1	0	0
hg emission coefficient #2	hg_2	0	0
hg emission coefficient #3	hg_3	0.00E+00	0.00E+00

Table D - 59 Commercial Collection Water Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Phosphate			
Phosphate emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Phosphate precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
Phosphate emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total phosphate releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
po4 emission coefficient #1	po4_1	0	0
po4 emission coefficient #2	po4_2	0	0
po4 emission coefficient #3	po4_3	0.00E+00	0.00E+00
Selenium			
Selenium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Selenium precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
Selenium emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total selenium releases per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
se emission coefficient #1	se_1	0	0
se emission coefficient #2	se_2	0	0
se emission coefficient #3	se_3	0.00E+00	0.00E+00
Chromium			
Chromium emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Chromium precombustion emissions from fuel production (lb/ton)		2.84E-07	6.29E-08
Chromium emissions from garage electricity generation (lb/ton)		1.49E-11	2.63E-12
total chromium releases per ton of refuse (lb/ton)		**2.84E-07**	**6.29E-08**
cr emission coefficient #1	cr_1	0.000105124	4.52611E-05
cr emission coefficient #2	cr_2	1.9757E-05	2.18853E-05
cr emission coefficient #3	cr_3	0.00E+00	0.00E+00

Table D - 60 Commercial Collection Water Release Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
Lead			
Lead emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Lead precombustion emissions from fuel production (lb/ton)		1.25E-07	2.78E-08
Lead emissions from garage electricity generation (lb/ton)		1.38E-11	2.43E-12
total lead releases per ton of refuse (lb/ton)		**1.25E-07**	**2.78E-08**
pb emission coefficient #1	pb_1	4.63817E-05	1.99694E-05
pb emission coefficient #2	pb_2	8.71665E-06	9.6556E-06
pb emission coefficient #3	pb_3	0.00E+00	0.00E+00
Zinc			
Zinc emissions from washdown water (lb/ton)		0.00E+00	0.00E+00
Zinc precombustion emissions from fuel production (lb/ton)		1.84E-06	4.07E-07
Zinc emissions from garage electricity generation (lb/ton)		2.06E-10	3.63E-11
Total zinc releases per ton of refuse (lb/ton)		**1.84E-06**	**4.07E-07**
zn emission coefficient #1	zn_1	0.000680266	0.000292886
zn emission coefficient #2	zn_2	0.000127844	0.000141616
zn emission coefficient #3	zn_3	0.00E+00	0.00E+00

Table D - 61 Commercial Collection Solid Waste Outputs (Continued)

Commercial Collection Options		Recyc-labels C_19	MSW / Residuals C_20
SOLID WASTE			
Solid Waste #1			
SW#1 precombustion emissions from fuel production (lb/ton)		6.87E-01	1.52E-01
SW#1 emissions from garage electricity generation (lb/ton)		3.99E-02	7.05E-03
total SW#1 generation per ton of refuse (lb/ton)		**7.27E-01**	**1.60E-01**
SW1 emission coefficient #1	SW1_1	2.74E+02	1.17E+02
SW1 emission coefficient #2	SW1_2	4.97E+01	5.49E+01
Solid Waste #2			
SW #2 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
SW #2 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total SW #2 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
SW2 emission coefficient #2	SW2_2	0.00E+00	0.00E+00
Solid Waste #3			
SW #3 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
SW #3 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total SW #3 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
SW3 emission coefficient #1	SW3_1	0.00E+00	0.00E+00
SW3 emission coefficient #2	SW3_2	0.00E+00	0.00E+00
Solid Waste #4			
SW #4 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
SW #4 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total SW #4 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
SW4 emission coefficient #1	SW4_1	0.00E+00	0.00E+00
SW4 emission coefficient #2	SW4_2	0.00E+00	0.00E+00
Solid Waste #5			
SW #5 precombustion emissions from fuel production (lb/ton)		0.00E+00	0.00E+00
SW #5 emissions from garage electricity generation (lb/ton)		0.00E+00	0.00E+00
total SW #5 generation per ton of refuse (lb/ton)		**0.00E+00**	**0.00E+00**
SW5 emission coefficient #1	SW5_1	0.00E+00	0.00E+00
SW5 emission coefficient #2	SW5_2	0.00E+00	0.00E+00

APPENDIX E

COEFFICIENTS FOR OPTIMIZATION

The Collection Preprocessor provides sets of coefficients for selected collection cost, consumption and release rates. The coefficient sets effectively condense all of the Collection Preprocessor calculations associated with the selected rate into two or three coefficients except for calculations involving waste generation rates and densities. Waste generation rates and, in some cases, densities are functions of variables such as per capita waste generation rates and residential/multi-family population figures. Operating in stand-alone mode as presented in this report, the Collection Preprocessor worksheet obtains waste generation rates from the Generation Preprocessor that apply to the entire community. By contrast, the Optimization Model can use the coefficients to evaluate collection costs and other optimization parameters for fractions of the community. The Collection Preprocessor can model the results of such an optimization by assigning values other than 100% or 0% to the fraction of the community served by a particular collection option using the *option_frac* variable. However, as stated earlier in this document, it is important to understand the limitations of the results of a stand alone analysis using the collection preprocessor. Use of the process model in this mode should be attempted only by a user that thoroughly understands the workings of the model and these limitations.

COLLECTION COST COEFFICIENTS

The collection cost per ton of waste collected for all waste collection options can be expressed as:

$$C\_ton = \frac{cc\_1}{G\_total} + \frac{cc\_2}{D\_avg} \quad ,$$

where:

$cc\_1 =$ cost coefficient #1 $\left(\frac{\$ - pound}{household - week - ton}\right)$

$cc\_2 =$ cost coefficient #2 $\left(\frac{\$ - pound}{cubic\ yard - ton}\right)$

$G\_total =$ total waste generation rate for all waste types (pounds per household per week)

$D\_avg =$ average density of waste in all compartments of the collection vehicle (pounds per cubic yard)

The equations for cost coefficients #1 and #2 vary slightly for different collection options, as shown below.

<u>Mixed Waste, Yard Waste, Residuals, and Co-Collection Options</u>

Cost coefficients #1 and #2 for residential waste collection options C0, C1, C5, C6, C7,and C9, multi-family waste collection options C13 and C16, and commercial collection options C19 and C20 are defined as:

$$cc\_1 = \frac{Fr}{CD \times HS} \times \left[\frac{(Tbet + TL) \times a_1}{a_2}\right] \times 2{,}000 \times 7/365$$

$$cc\_2 = \frac{1}{CD \times Ut \times Vt} \times \left[\frac{(-Tbet + 2 \times Trf + S) \times a_1}{a_2}\right] \times 2{,}000 \times 7/365$$

where:

$$a_1 = (1+e) \times \{(1+bv) \times CRF \times Pt + (1+a) \times [(1+bw) \times (Wa \times Nw + Wd) \times WP \times CD \times 365/7] + c + d \times (Nw+1)\}$$

$$a_2 = \left[WV \times 60 - \left(F1 + F2 + Tgr + Tfg\right) - 0.5 \times \left(Trf + S\right)\right]$$

Wet/Dry Collection Options

Cost coefficients #1 and #2 for residential waste collection options C11 and C12 are defined as:

$$cc\_1 = \left\{ \frac{Fr}{CD \times HS} \times \left[\frac{\left(Tbet + TL\right) \times a_1}{a_2} \right] + a_3 \right\} \times 2{,}000 \times 7/365$$

$$cc\_2 = \frac{1}{CD \times Ut \times Vt} \times \left[\frac{\left(-Tbet + 2 \times Trf + S\right) \times a_1}{a_2} \right] \times 2{,}000 \times 7/365$$

where:

$$a_1 = \left(1+e\right) \times \left\{ \left(1+bv\right) \times CRF \times Pt + \left(1+a\right) \times \left[\left(1+bw\right) \times \left(Wa \times Nw + Wd\right) \times WP \times CD \times 365/7\right] + c + d \times \left(Nw+1\right) \right\}$$

$$a_2 = \left[WV - \left(F1 + F2\_\ Tgr + Tfg\right) - 0.5 \times \left(Trf + S\right)\right]$$

$$a_3 = \left(1+e\right) \times CRF\_b \times Pb \times Rb$$

Residential Recyclables Collection Options C2, C3, and C4

Cost coefficients #1 and #2 for residential waste collection options C2, C3, and C4 are defined as:

$$cc\_1 = \left\{ \frac{Fr}{CD \times HS} \times \left[\frac{\left(Tbet + TL\right) \times a_1}{a_2} \right] + \frac{a_3}{PF} \right\} \times 2{,}000 \times 7/365$$

$$cc\_2 = \frac{1}{CD \times Ut \times Vt} \times \left[\frac{\left(-Tbet + 2 \times Trf + S\right) \times a_1}{a_2} \right] \times 2{,}000 \times 7/365$$

where:

$$a_1 = \left(1+e\right) \times \left\{ \left(1+bv\right) \times CRF \times Pt + \left(1+a\right) \times \left[\left(1+bw\right) \times \left(Wa \times Nw + Wd\right) \times WP \times CD \times 365/7\right] + c + d \times \left(Nw+1\right) \right\}$$

$$\alpha_2 = \left[WV \times 60 - \left(F1 + F2 + Tgr + Tfg\right) - 0.5 \times \left(Trf + S\right)\right]$$

$$\alpha_3 = \left(1 + e\right) \times CRF\_b \times Pb \times Rb$$

<u>Multi-Family Recyclables Collection Options C14 and C15</u>

Cost coefficients #1 and #2 for multi-family waste collection options C14 and C15 are defined as:

$$cc\_1 = \left\{ \frac{Fr}{CD \times HS} \times \left[\frac{\left(Tbet + TL\right) \times PF \times \alpha_1}{\alpha_2} \right] + \alpha_3 \right\} \times 2{,}000 \times \tfrac{7}{365}$$

$$cc\_2 = \frac{1}{CD \times Ut \times Vt} \times \left[\frac{\left(-Tbet + 2 \times Trf + S\right) \times \alpha_1}{\alpha_2} \right] \times 2{,}000 \times \tfrac{7}{365}$$

where:

$$\alpha_1 = \left(1 + e\right) \times \left\{ \left(1 + bv\right) \times CRF \times Pt + \left(1 + a\right) \times \left[\left(1 + bw\right) \times \left(Wa \times Nw + Wd\right) \times WP \times CD \times \tfrac{365}{7} \right] + c + d \times \left(Nw + 1\right) \right\}$$

$$\alpha_2 = \left[WV \times 60 - \left(F1 + F2 + Tgr + Tfg\right) - 0.5 \times \left(Trf + S\right)\right]$$

$$\alpha_3 = \left(1 + e\right) \times CRF\_b \times Pb \times Rb$$

<u>Recyclables Drop-Off Option</u>

Cost coefficients #1 and #2 for residential recyclables drop-off option C8 are defined as:

$$cc\_1 = 0$$

$$cc\_2 = \frac{1}{CD \times Ut \times Vt} \times \left[\frac{\left(TL + 2 \times Trf + S\right) \times \alpha_1}{\alpha_2} \right] \times 2{,}000 \times \tfrac{7}{365}$$

where:

$$\alpha_1 = \left(1 + e\right) \times \left\{ \left(1 + bv\right) \times CRF \times Pt + \left(1 + a\right) \times \left[\left(1 + bw\right) \times \left(Wa \times Nw + Wd\right) \times WP \times CD \times \tfrac{365}{7} \right] + c + d \times \left(Nw + 1\right) \right\}$$

$$\alpha_2 = \left[WV \times 60 - \left(F1 + F2 + Tgr + Tfg\right) + Trf\right]$$

Yard Waste Drop-Off Option

Cost coefficients #1 and #2 for residential yard waste drop-off option C10 are defined as:

$$cc\_1 = 0$$

$$cc\_2 = 0$$

ENERGY CONSUMPTION COEFFICIENTS

The energy consumption per ton of waste collected for all waste collection options can be expressed as:

$$E\_ton = \frac{ec\_1}{G\_total} + \frac{ec\_2}{D\_avg} \quad ,$$

where:

$ec\_1 =$ energy consumption coefficient #1 $\left(\frac{Btu - pound}{household - week - ton}\right)$

$ec\_2 =$ energy consumption coefficient #2 $\left(\frac{Btu - pound}{cubic\ yard - ton}\right)$

$G\_total =$ total waste generation rate for all waste types (pounds per household per week)

$D\_avg =$ average density of waste in all compartments of the collection vehicle (pounds per cubic yard)

The equations for energy consumption coefficients #1 and #2 vary slightly for different collection options, as shown below.

<u>Mixed Waste, Recyclables, Yard Waste, Residuals, Co-Collection, and Wet/Dry Collection Options</u>

Energy consumption coefficients #1 and #2 for residential waste collection options C0, C1, C2, C3, C4, C5, C6, C7, C9, C11, and C12, multi-family waste collection options C13, C14, C15, and C16, and commercial collection options C19 and C20 are defined as:

$$ec\_1 = \frac{Fr}{HS} \times \left[\frac{(b_1 + b_2) \times (Tbet + TL)}{b_3} + b_4 \right] \times 2{,}000$$

$$ec\_2 = \frac{1}{Vt \times Ut} \times \left[\frac{(b_1 + b_2) \times (-Tbet + 2 \times Trf + S)}{b_3} + b_5 \right] \times 2{,}000$$

where:

$$b_1 = (grg\_area \times grg\_enrg + off\_area \times off\_enrg) \times region\_btu\_per\_elec\_kwh$$

$$b_2 = (dsl\_enrg + dsl\_pc\_enrg) \times \left[\frac{(Tgr \times Vgr) + (0.5 \times Trf \times Vrf) + (Tfg \times Vfg)}{60 \times MPG\_trav\_cv} + \frac{(0.5 \times S \times GPH\_idle\_cv)}{60} \right]$$

$$b_3 = [WV \times 60 - (F1 + F2 + Tgr + Tfg) + Trf]$$

$$b_4 = (dsl\_enrg + dsl\_pc\_enrg) \times \left[\frac{(TL \times GPH\_idle\_cv)}{60} + \frac{(Tbet \times Vbet)}{60 \times MPG\_btwn\_cv} \right]$$

$$b_5 = (dsl\_enrg + dsl\_pc\_enrg) \times \left[\frac{(S \times GPH\_idle\_cv)}{60} - \frac{(Tbet \times Vbet)}{60 \times MPG\_btwn\_cv} + \frac{(2 \times Trf \times Vrf)}{60 \times MPG\_trav\_cv} \right]$$

Recyclables Drop-Off Option

Energy consumption coefficients #1 and #2 for residential recyclables drop-off option C8 are defined as:

$$ec\_1 = \frac{RTDdos \times DED \times FREQdos \times \left(gas\_enrg\_gas\_pc\_enrg\right)}{MPG\_dov} \times 2{,}000 \times {}^{7}\!/_{365} \times 12$$

$$ec\_2 = \frac{1}{Vt \times Ut} \times \left[\frac{\left(b_1 + b_2\right) \times \left(2 \times Trf + TL + S\right)}{b_3} + b_5 \right] \times 2{,}000$$

where:

$$b_1 = \left(grg\_area \times grg\_enrg + off\_area \times off\_enrg\right) \times region\_btu\_per\_elec\_kwh$$

$$b_2 = \left(dsl\_enrg + dsl\_pc\_enrg\right) \times \left[\frac{\left(Tgr \times Vgr\right) - \left(Trf \times Vrf\right) + \left(Tfg \times Vfg\right)}{60 \times MPG\_trav\_cv} + \frac{\left(LD + UD\right) \times GPH\_idle\_cv}{60} \right]$$

$$b_3 = \left[WV \times 60 - \left(F1 + F2 + Tgr + Tfg\right) + Trf\right]$$

$$b_5 = \left(dsl\_enrg + dsl\_pc\_enrg\right) \times \left[\frac{\left(2 \times Trf \times Vrf\right)}{60 \times MPG\_trav\_cv} \right]$$

Yard Waste Drop-Off Option

Energy consumption coefficients #1 and #2 for yard waste drop-off option C-10 are defined as:

$$ec\_1 = \frac{RTDdos \times DED \times FREQdos \times \left(gas\_enrg\_gas\_pc\_enrg\right)}{MPG\_dov} \times 2{,}000 \times {}^{7}\!/_{365} \times 12$$

$$ec\_2 = 0$$

AIRBORNE RELEASE COEFFICIENTS

The amount (by weight) of airborne pollutant *p* released per ton of waste collected for all waste collection options can be expressed as:

$$A\_ton_p = \frac{A\_1_p}{G\_total} + \frac{A\_2_p}{D\_avg} \quad ,$$

where:

$A\_1_p =$ release coefficient #1 for airborne pollutant *p* $\left(\frac{pound\ \ pollutant - pound\ \ waste}{household - week - ton\ waste}\right)$

$A\_2_p =$ release coefficient #2 for airborne pollutant *p* $\left(\frac{pound\ \ pollutant - pound\ \ waste}{cubic\ \ yard - ton\ waste}\right)$

$G\_total =$ total waste generation rate for all waste types (pounds per household per week)

$D\_avg =$ average density of waste in all compartments of the collection vehicle (pounds per cubic yard)

The equations for airborne release coefficients #1 and #2 vary slightly for different collection options, as shown below.

Mixed Waste, Recyclables, Yard Waste, Residuals, Co-Collection, and Wet/Dry Collection Options

Energy consumption coefficients #1 and #2 for residential waste collection options C0, C1, C2, C3, C4, C5, C6, C7, C9, C11, and C12, multi-family waste collection options C13, C14, C15, and C16, and commercial collection options C19 and C20 are defined as:

$$A\_1_p = \frac{Fr}{HS} \times \left[\frac{(g_1 + g_2 + g_3) \times (Tbet + TL)}{g_4} + g_5 + g_6 \right] \times 2{,}000$$

$$A\_2_p = \frac{1}{Vt \times Ut} \times \left[\frac{(g_1 + g_2 + g_3) \times (-Tbet + 2 \times Trf + S)}{g_4} + g_7 + g_8 \right]$$

where:

$$g_1 = (grg\_area \times grg\_enrg + off\_area \times off\_enrg) \times r\_tot_p$$

$$g_2 = \frac{d\_em_p}{1{,}000} \times \left[\frac{(Tgr \times Vgr) + (0.5 \times Trf \times Vrf) + (Tfg \times Vfg)}{60 \times MPG\_trav\_cv} + \frac{(0.5 \times S) \times GPH\_idle\_cv}{60} \right]$$

$$g_3 = EF_p \times 0.002205 \times \left[\frac{(Tgr \times Vgr) + (0.5 \times Trf \times Vrf) + (Tfg \times Vfg)}{60} \right]$$

$$g_4 = [WV \times 60 - (F1 + F2 + Tgr + Tfg) + Trf]$$

$$g_5 = EF_p \times 0.002205 \times \frac{(Tbet \times Vbet)}{60}$$

$$g_6 = \frac{d\_em_p}{1{,}000} \times \left[\frac{(TL \times GPH\_idle\_cv)}{60} + \frac{(Tbet \times Vbet)}{60 \times MPG\_btwn\_cv} \right]$$

$$g_7 = EF_p \times 0.002205 \times \left[\frac{(2 \times Trf \times Vrf) - (Tbet \times Vbet)}{60} \right]$$

$$g_8 = \frac{d\_em_p}{1{,}000} \times \left[\frac{(S \times GPH\_idle\_cv)}{60} - \frac{(Tbet \times Vbet)}{60 \times MPG\_btwn\_cv} + \frac{(2 \times Trf \times Vrf)}{60 \times MPG\_trav\_cv} \right]$$

Recyclables Drop-Off Option

Airborne release coefficients #1 and #2 for residential recyclables drop-off option C8 are defined as:

$$A\_1_p = RTDdos \times DED \times FREQdos \times \left[\left(EF\_dov_p \times 0.002205 \right) + \frac{g\_em_p}{1{,}000 \times Fdov} \right] \times 2{,}000 \times 7/365 \times 12$$

$$A\_2_p = \frac{1}{Vt \times Ut} \times \left[\frac{(g_1 + g_2 + g_3) \times (-Tbet + 2 \times Trf + S)}{g_4} + g_7 + g_8 \right]$$

$$g_1 = (grg\_area \times grg\_enrg + off\_area \times off\_enrg) \times r\_tot_p$$

$$g_2 = \frac{d\_em_p}{1{,}000} \times \left[\frac{(Tgr \times Vgr) + (0.5 \times Trf \times Vrf) + (Tfg \times Vfg)}{60 \times MPG\_trav\_cv} + \frac{(0.5 \times S) \times GPH\_idle\_cv}{60} \right]$$

$$g_3 = EF_p \times 0.002205 \times \left[\frac{(Tgr \times Vgr) + (0.5 \times Trf \times Vrf) + (Tfg \times Vfg)}{60} \right]$$

$$g_4 = \left[WV \times 60 - (F1 + F2 + Tgr + Tfg) + Trf \right]$$

$$g_7 = EF_p \times 0.002205 \times \left[\frac{(2 \times Trf \times Vrf) - (Tbet \times Vbet)}{60} \right]$$

$$g_8 = \frac{d\_em_p}{1{,}000} \times \left[\frac{(S \times GPH\_idle\_cv)}{60} - \frac{(Tbet \times Vbet)}{60 \times MPG\_btwn\_cv} + \frac{(2 \times Trf \times Vrf)}{60 \times MPG\_trav\_cv} \right]$$

Yard Waste Drop-Off Option

Airborne coefficients #1 and #2 for yard waste drop-off option C-10 are defined as:

$$A\_1_p = RTDdos \times DED \times FREQdos \times \left[\left(EF\_dov_p \times 0.002205 \right) + \frac{g\_em_p}{1{,}000 \times Fdov} \right] \times 2{,}000 \times 7/365 \times 12$$

$$A\_2_p = 0$$

WATERBORNE RELEASE COEFFICIENTS

Similar to airborne releases, the amount (by weight) of waterborne pollutant *p* released per ton of waste collected for all waste collection options can be expressed as:

$$W\_ton_p = \frac{W\_1_p}{G\_total} + \frac{W\_2_p}{D\_avg} + W\_3_p \quad ,$$

where:

$W\_1_p =$ release coefficient #1 for waterborne pollutant *p* $\left(\frac{pound\ \ pollutant - pound\ \ waste}{household - week - ton\ waste}\right)$

$W\_2_p =$ release coefficient #2 for waterborne pollutant *p* $\left(\frac{pound\ \ pollutant - pound\ \ waste}{cubic\ \ yard - ton\ waste}\right)$

$W\_3_p =$ release coefficient #3 for waterborne pollutant *p* $\left(\frac{pound\ pollutant}{ton waste}\right)$

The equations for waterborne release coefficients #1 and #2 vary slightly for different collection options, as shown for airborne pollutants above. For release coefficient #3, for each collection option, this coefficient is simply:

$$W\_3_p = WaterTon \times RR_p$$

where:

$WaterTon =$ Gallons of wash water (garage and vehicle) used per ton of material collected (See Section 6).

$RR_p =$ User entered release rate of pollutant *p* in wash water (lb./gal.)

APPENDIX F

VARIABLE NAMES

The following tables list all of the variable names used in the Collection Preprocessor. The list is divided into three sections. The first section includes names of variables in the Input Parameters section of the Collection Preprocessor spreadsheet. The second section lists the names of all variables for which values are calculated by the preprocessor. The third section lists the names of variables from other preprocessor spreadsheets that are linked to cell formulas in the Collection Preprocessor. Each list is arranged alphabetically.

INPUT DATA PARAMETERS - Collection Preprocessor

a = fringe benefit rate (fringe benefit $ per $ of wages)
As = waterborne arsenic release rate (pounds per gallon)
BOD = biochemical oxygen demand of washdown water (pounds per gallon)
bv = backup rate for collection vehicles (number of backup vehicles per collection vehicle)
bw = backup rate for workers (backup workers per collection worker)
c = collection vehicle operation and maintenance costs ($ per collection vehicle)
Cad = waterborne cadmium release rate (pounds per gallon)
CD = number of workdays per week (days per week)
CF_i = compaction factor for waste component *i* (pound per cubic yard compacted density per pound per cubic yard as-collected density)
CH_4_mile_cv = airborne methane release rate from collection vehicles (grams per mile)
CH_4_mile_dov = airborne methane release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
CO_mile_cv = airborne carbon monoxide release rate from collection vehicles (grams per mile)
CO_mile_dov = airborne carbon monoxide release rate from residential recyclables/yard waste drop-off vehicle (grams per mile)
CO_2bm_mile_cv = airborne biomass carbon dioxide release rate from collection vehicles (grams per mile)
CO_2bm_mile_dov = airborne biomass carbon dioxide release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
CO_2f_mile_cv = airborne fossil carbon dioxide release rate from collection vehicles (grams per mile)
CO_2f_mile_dov = airborne fossil carbon dioxide release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
COD = chemical oxygen demand washdown water (pounds per gallon)
cr_i = recyclable material capture rate for component *i* of a mixed waste stream
Cr = waterborne chromium release rate (pounds per gallon)
Cu = waterborne copper release rate (pounds per gallon)
d = other expenses associated with collection operations ($ per collection worker per year)
d_dry = user-specified collection vehicle dry waste compartment compaction density (pounds per cubic yard)
d_msw = user-specified collection vehicle mixed waste compartment compaction density (pounds per cubic yard)
d_recyc = user-specified collection vehicle recyclables compartment compaction density (pounds per cubic yard)
d_residual = user-specified collection vehicle residual waste compartment compaction density (pounds per cubic yard)
d_wet = user-specified collection vehicle wet waste compartment compaction density (pounds per cubic yard)

d_yw = user-specified yard waste compaction density (pounds per cubic yard)
Dbet = distance between collection stops (miles)
INPUT DATA PARAMTERS, cont.

DED = fraction of trips made by residents to a recyclables drop-off location that are dedicated solely to recylables drop-off
Dfg = distance between a solid waste treatment or disposal facility and the collection vehicle garage (miles)
Dgr = distance between the collection vehicle garage and the starting location of a vehicle's first daily collection route (miles)
Drf = distance between the end of a collection vehicle's collection route and the solid waste treatment or disposal facility where it unloads (miles)
DS = waterborne dissolved solids release rate (pounds per gallon)
e = administrative expense rate ($ of administrative expense per $ of collection vehicle capital or operating cost)
EoMi = miles between collection vehicle engine oil changes (miles per vehicle)
EoSh = service hours between collection vehicle engine oil changes (hours per vehicle)
EoVol = collection vehicle engine oil volume per oil change (quarts per vehicle)
F1 = off-route time for lunch (minutes per day per collection vehicle)
F2 = off-route time for breaks (minutes per day per collection vehicle)
Fe = waterborne iron release rate (pounds per gallon)
FbMi = miles between collection vehicle belt changes (miles per vehicle)
FbSh = service hours between collection vehicle belt changes (service hours per vehicle)
FfMi = miles between collection vehicle fuel filter changes (miles per vehicle)
FfSh = service hours between collection vehicle fuel filter changes (service hours per vehicle)
Fr = frequency that waste is collected from a collection location ($week^{-1}$)
FREQdos = frequency that residents make trips to a recyclables drop-off location (trips per month)
GPH_idle_cv = gallons of diesel fuel used per hour by a collection vehicle while idling at collection stops or while unloading at a treatment or disposal facility (gallons per hour)
H_2SO_4 = waterborne sulfuric acid release rate (pounds per gallon)
HC_mile_cv = airborne hydrocarbon release rate from collection vehicles (grams per mile)
HC_mile_dov = airborne hydrocarbon release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
HCl_mile_cv = airborne hydrochloric acid release rate from collection vehicles (grams per mile)
HCl_mile_dov = airborne hydrochloric acid release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
HffMi = miles between collection vehicle hydraulic fluid filter changes (miles per vehicle)

HffSh = service hours between collection vehicle hydraulic fluid filter changes (miles per vehicle)
HfMi = miles between collection vehicle hydraulic fluid changes (miles per vehicle)
HfSh = service hours between collection vehicle hydraulic fluid changes (miles per vehicle)
HfVol = collection vehicle hydraulic fluid volume per change (quarts per vehicle)
Hg = waterborne mercury release rate (pounds per gallon)

INPUT DATA PARMETERS, cont.

HS = number of households whose waste is collected at one collection location (households per location)
Lb = economic life of a recyclables bin (years)
Lt = economic life of a collection vehicle (years)
maint_area = collection vehicle garage maintenance area per vehicle (square feet per vehicle)
maint_elec = collection vehicle garage maintenance area electricity consumption rate (kilowatts per day per square foot)
maint_wd_vol = water volume required to wash down the collection vehicle garage maintenance area (gallons per day per square foot)
MPG_btwn_cv = collection vehicle diesel fuel usage rate while traveling between collection locations (miles per gallon)
MPG_dov = gasoline usage rate of vehicles driven by residents while transporting recylables to a drop-off location (miles per gallon)
MPG_trav_cv = collection vehicle diesel fuel usage rate while traveling between the garage and the start of the first collection route; the end of a collection route and the treatment or disposal facility; or the treatment or disposal facility and the garage (miles per gallon)
NO_x_mile_cv = airborne nitrogen oxides release rate from collection vehicles (grams per mile)
NO_x_mile_dov = airborne nitrogen oxides release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
NH_3_mile_cv = airborne ammonia release rate from collection vehicles (grams per mile)
NH_3_mile_dov = airborne ammonia release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
Nw = number of collection workers (excluding the driver) on one collection vehicle (workers per vehicle)
off_area = collection vehicle garage office area per collection vehicle (square feet per vehicle)
off_elec = collection vehicle office area electricity consumption rate (kilowatt hours per day per square foot)
OfMi = miles between collection vehicle engine oil filter changes (miles per vehicle)
OfSh = service hours between collection vehicle engine oil filter changes (service hours per vehicle)
Oil = waterborne oil release rate (pounds per gallon)

option_frac = fraction of residential households, multi-family dwelling residents, or commercial businesses served by a collection option
P_x = waterborne phosphate release rate (pounds per gallon)
Pb = unit price of a recyclables bin ($ per bin)
Pb_mile_cv = airborne lead release rate from collection vehicles (grams per mile)
Pb_mile_dov = airborne lead release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)

INPUT DATA PARAMETERS, cont.

PF = participation factor (fraction of residential households, multi-family dwelling residents, or commercial businesses participating in a recyclable material or yard waste collection or drop-off program)
PM_mile_cv = airborne total particulates release rate from collection vehicles (grams per mile)
PM_mile_dov = airborne total particulates release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
PM_{10}_mile_cv = airborne release rate of particulates smaller than 10 microns from collection vehicles (grams per mile)
PM_{10}_mile_dov = airborne release rate of particulates smaller than 10 microns from residential recyclables/yard waste drop-off vehicles (grams per mile)
Pt = unit price of a collection vehicle ($ per vehicle)
Rb = number of recylables bins per household (bins per household)
RTDdos = round trip distance driven by resident while transporting recylables to a drop-off location (miles per trip)
S = time to unload a collection vehicle at a treatment or disposal facility (minutes per trip)
Se = waterborne selenium release rate (pounds per gallon)
SS = waterborne suspended solids release rate (pounds per gallon)
SO_x_mile_cv = airborne sulfur oxides release rate from collection vehicles (grams per mile)
SO_x_mile_dov = airborne sulfur oxides release rate from residential recyclables/yard waste drop-off vehicles (grams per mile)
Tbtw = collection vehicle travel time between collection locations (minutes per location)
Tfg = collection vehicle travel time between the treatment or disposal facility and the garage (minutes per day per vehicle)
TfMi = miles between collection vehicle transmission fluid changes (miles per vehicle)
TfSh = service hours between collection vehicle transmission fluid changes (service hours per vehicle)
Tgr = collection vehicle travel time between garage and start of first collection route (minutes per day per vehicle)
TireMi = miles between collection vehicle tire change (miles per vehicle)
TireNum = number of tires on a collection vehicle (tires per vehicle)
TireSh = service hours between collection vehicle tire change (service hours per vehicle)
TL = collection vehicle loading time at collection location (minutes per location)

Trf = collection vehicle travel time between end of collection route and solid waste treatment or disposal facility)
Ut = collection vehicle utilization factor (useable cubic yards of vehicle capacity per total cubic yards of vehicle capacity)
Vbet = collection vehicle travel speed between collection locations (miles per hour)
Vfg = collection vehicle speed while traveling between the solid waste treatment or disposal facility and the garage
Vgr = collection vehicle speed while traveling between the garage and the start of the first collection route (miles per hour)

INPUT DATA PARAMETERS, cont.

Vrf = collection vehicle speed while traveling between the end of a collection route and the solid waste treatment or disposal facility (miles per hour)
Vt = collection vehicle capacity (cubic yards)
W_NH_3 = waterborne ammonia release rate (pounds per gallon)
W_Pb = waterborne lead release rate (pounds per gallon)
Wa = hourly wage for a collection worker other than a vehicle driver ($ per hour)
Wd = hourly wage for a collection vehicle driver ($ per hour)
WdMi = miles between collection vehicle washdowns (miles per vehicle)
WdSh = service hours between collection vehicle washdowns (service hours per vehicle)
WdVol = water volume per collection vehicle washdown (gallons per vehicle)
WP = working hours per day for which collection workers and vehicle drivers receive wages (hours per day)
WV = hours per day that collection vehicle are in use (hours per day)
Zn = waterborne zinc release rate (pounds per gallon)

CALCULATED PARAMETERS - Collection Preprocessor

C_ann = annual collection cost, including capital and operating costs ($ per year)
C_cap_b = annualized capital cost of recyclables bins at locations served by one collection vehicle ($ per vehicle per year)
C_cap_v = annualized capital cost of a collection vehicle ($ per vehicle per year)
C_house = annual collection cost per residential household ($ per household)
C_location = annual collection cost per multi-family or commercial waste collection location ($ per location)
C_op = annual collection vehicle operating costs ($ per vehicle per year)
C_ton = collection cost per ton of material collected ($ per ton)
C_vehicle = annual collection cost per collection vehicle ($ per vehicle)
Cb = annualized capital cost of a recylables bin ($ per bin per year)
Coe = annual cost of other collection vehicle operating expenses ($ per vehicle per year)
Cvo = annual collection vehicle operating and maintenance costs ($ per vehicle per year)
Cw = annual collection vehicle labor costs ($ per vehicle per year)
D_avg = average density of all waste collected in a multi-compartment collection vehicle (pounds per cubic yard)
D_dry = in-truck density of dry waste (pounds per cubic yard)
D_msw = in-truck density of mixed waste (pounds per cubic yard)
D_recyc = in-truck density of recyclables (pounds per cubic yard)
D_residual = in-truck density of residual waste (pounds per cubic yard)
D_wet = in-truck density of wet waste (pounds per cubic yard)
D_yw = in-truck density of yard waste (pounds per cubic yard)
Db = cumulative distance that a collection vehicle travels between collection stops per day (miles per vehicle per day)
DF_R = cumulative distance that a collection vehicle travels between the start/end points of its collection routes and the solid waste treatment or disposal facility (miles per vehicle per day)
DF_S = cumulative distance that a collection vehicle travels between a residential recyclables drop-off site and the material recovery facility per day (miles per vehicle per day)
ElecD = daily amount of electricity consumed at the collection vehicle garage per vehicle (kilowatts per vehicle per day)
ElecTon = collection vehicle garage electricity usage per ton of material collected (kilowatts per ton)
F_R = cumulative collection vehicle travel time between the start/end points of its collection routes and the solid waste treatment or disposal facility (minutes per vehicle per day)
frac_cap_recyc = captured recyclables fraction (pounds of recyclables separated from the waste stream per total pounds of waste material)
frac_dry = fraction of waste collected in the dry compartment of a wet/dry or wet/dry/recyclables collection vehicle (pounds of dry waste per total pounds of waste material)

CALCULATED PARAMETERS, cont.

frac_wet = fraction of waste collected in the wet compartment of a wet/dry or wet/dry/recyclables collection vehicle (pounds of dry waste per total pounds of waste material)
frac_yw = fraction of yard waste (pounds of yard waste per total pounds of waste material)
FuelD = daily volume of fuel consumed by a collection vehicle (gallons per vehicle per day)
FuelT = residential recyclables/yard waste drop-off vehicle fuel usage per round trip to and from the drop-off site (gallons per trip)
FuelTon = collection vehicle fuel usage per ton of material collected (gallons per ton)
FuelTon_dov = residential recyclables/yard waste drop-off vehicle fuel usage per ton of material delivered to the drop-off site (gallons per ton)
G_dry = dry waste generation rate (pounds per household or collection location per week)
G_msw = mixed waste generation rate (pounds per household or collection location per week)
G_recyc = recyclables generation rate (pounds per household or collection location per week)
G_residual = residual waste generation rate (pounds per household or collection location per week)
G_total = total generation rate for all waste categories (pounds per household or collection location per week)
G_wet = wet waste generation rate (pounds per household or collection location per week)
G_yw = yard waste generation rate (pounds per household or collection location per week)
Ht = number of collection locations that a collection vehicle stops at to collect material during one collection trip (locations per trip)
LD = cumulative time that a collection vehicle spends loading material at collection stops per day (minutes per vehicle per day)
MiD = daily miles traveled by a collection vehicle (miles per vehicle per day)
Nb = number of recyclables bins at locations served by one collection vehicle (bins per vehicle)
Nt = number of collection vehicles (vehicles)
RD = daily number of collection trips by one collection vehicle (trips per vehicle per day)
RefD = daily weight of material collected by one collection vehicle (tons per vehicle per day)
RefT = weight of residential recyclables or yard waste delivered to the drop-off site per trip (pounds per trip)
Rt = number of collection vehicle trips needed to collect all of the recyclable material that collects at a residential recyclables drop-off location in one week (trips per week)

RT = number of collection vehicle trips needed to service all of the collection locations served by a particular collection option during one collection cycle (trips per cycle)

CALCULATED PARAMETERS, cont.

ShD = number of service hours per day for one collecti0n vehicle (hours per vehicle per day)
SD = number of collection locations that a collection vehicle stops at to collect material per day (locations per vehicle per day)
Tb = cumulative collection vehicle travel time between collection locations per day (minutes per vehicle per day)
Tbet = collection vehicle travel time between two consecutive collection locations (minutes per location)
Tc = time required for a collection vehicle to make one complete collection trip (minutes per trip)
UD = cumulative time that a collection vehicle spends unloading material at a solid waste treatment or disposal facility per day (minutes per vehicle per day)
vol_recyc = volume of recyclables deposited at a residential drop-off site per week (cubic yards per week)
W_cv = daily volume of water used to wash down a collection vehicle (gallons per vehicle per day)
W_gar = daily volume of water used to wash down the vehicle garage (gallons per vehicle per day)
WaterTon = collection vehicle water usage per ton of material collected (gallons per ton)

VARIABLE NAMES FROM OTHER PREPROCESSORS

Common Preprocessor

CH4_GWP = relative 20-year Global Warming Potential for methane
CO2_GWP = relative 20-year Global Warming Potential for carbon dioxide
$COM\_WT\_FRAC\_1_i$ = weight fraction of waste component *i* in Sector #1 commercial waste
comm_name = community name
d_em_p = precombustion emission rate for pollutant *p* associated with the production of diesel fuel (pounds of pollutant per 1,000 gallons of diesel fuel)
dsl_enrg = energy content of diesel fuel (Btu per gallon)
dsl_pc_enrg = precombustion energy content of diesel fuel (Btu per gallon)
g_em_p = precombustion emission rate for pollutant *p* associated with the production of gasoline (pounds of pollutant per 1,000 gallons of gasoline)
gas_enrg = energy content of gasoline (Btu per gallon)
gas_pc_enrg = precombustion energy content of gasoline (Btu per gallon)
HC_GWP = relative 20-year Global Warming Potential for other hydrocarbons
i = annual interest rate *or* yearly discount rate ($year^{-1}$)
mf_pop = multi-family population (persons)
$MF\_WT\_FRAC\_1_i$ = weight fraction of waste component *i* in Sector #1 multi-family waste
NO_GWP = relative 20-year Global Warming Potential for nitrous oxide
res_pop = residential population (persons)
$RES\_WT\_FRAC\_1_i$ = weight fraction of waste component *i* in Sector #1 residential waste
$sf\_WD\_dry_i$ = weight fraction of waste component *i* separated from the waste stream and placed in a dry waste collection container for wet/dry collection options C12 and C18
$sf\_WD\_wet_i$ = weight fraction of waste component *i* separated from the waste stream and placed in a wet waste collection container for wet/dry collection options C12 and C18
$sf\_WDR\_dry_i$ = weight fraction of waste component *i* separated from the waste stream and placed in a dry waste collection container for wet/dry/recyclable collection options C11 and C17
$sf\_WDR\_recyc_i$ = weight fraction of waste component *i* separated from the waste stream and placed in a recyclables waste collection container for wet/dry/recyclable collection options C11 and C17
$sf\_WDR\_wet_i$ = weight fraction of waste component *i* separated from the waste stream and placed in a wet waste collection container for wet/dry/recyclable collection options C11 and C17

VARIABLE NAMES FROM OTHER PREPROCESSORS, cont.

Generation Preprocessor

D_cv = compacted density of waste component *i* in a collection vehicle (pounds per cubic yard)
D_rcv = density of waste component *i* in a recyclables collection vehicle (pounds per cubic yard)
G_com = commercial waste generation rate (pounds per collection location per week)
G_mf = multi-family waste generation rate (pounds per collection location per week)
G_res = residential waste generation rate (pounds per household per week)
GR = per capita daily waste generation rate (pounds per person per day)
H_com = number of commercial waste collection locations (locations)
H_mf = number of multi-family waste collection locations (locations)
H_res = number of residential households (households)
Pd = number of persons per multi-family collection location (persons per location)
Ph = number of persons per residential household (persons per household)

Electric Energy Preprocessor

r_tot_p = regional total emission rate of pollutant *p* per aggregate kilowatt hour of electricity (pound per kilowatt hour)
region_btu_per_elec_kwh = regional Btu value per aggregate kilowatt hour of electricity (Btu per kilowatt hour)

APPENDIX G

COST ESCALATION DATA

Appendix G - 1

COST INDEX TABLE		
DESCRIPTION	**VARIABLE NAME**	**VALUE**
Cost Index for 1980	CI_1980	0.858
Cost Index for 1981	CI_1981	0.946
Cost Index for 1982	CI_1982	1.000
Cost Index for 1983	CI_1983	1.028
Cost Index for 1984	CI_1984	1.052
Cost Index for 1985	CI_1985	1.075
Cost Index for 1986	CI_1986	1.097
Cost Index for 1987	CI_1987	1.117
Cost Index for 1988	CI_1988	1.143
Cost Index for 1989	CI_1989	1.180
Cost Index for 1990	CI_1990	1.229
Cost Index for 1991	CI_1991	1.267
Cost Index for 1992	CI_1992	1.291
Cost Index for 1993	CI_1993	1.314
Cost Index for 1994	CI_1994	1.341
Cost Index for 1995	CI_1995	1.367
Cost Index for 1996	CI_1996	1.399
Cost Index for 1997	CI_1997	1.430
Cost Index for 1998	CI_1998	1.462
Cost Index for 1999	CI_1999	1.494
Cost Index for 2000	CI_2000	1.526
Cost Index for 2001	CI_2001	1.557
Cost Index for 2002	CI_2002	1.589
Cost Index for 2003	CI_2003	1.621
Cost Index for 2004	CI_2004	1.652
Cost Index for 2005	CI_2005	1.684
Model Year Override	Model_year	
Current Year	Cur_year	1998
Base Year Cost Index	Base_index	1.31
Current Year Cost Index	CI_cur_year	1.46
Cost Index Factor	CI_Factor	1.11