DEFAULT DATA AND DATA INPUT REQUIREMENTS FOR THE MUNICIPAL SOLID WASTE MANAGEMENT DECISION SUPPORT TOOL

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1. Introduction to Input Sheets for Process Models

Overview

The municipal solid waste (MSW) management decision support tool was developed to allow solid waste planners and analysts to generate alternative MSW management strategies and evaluate them with respect to cost and life-cycle inventory (LCI) burdens. The tool is comprised of four main components: materials flow model, process models, optimization routine, and user-interface.

The cost and LCI methodologies are implemented as part of the process models. The models represent mathematical representations of waste management processes (e.g., mixed MSW collection, yard waste composting, mixed waste combustion with energy recovery) based on generic design and operating information. The process models generate coefficients for cost and LCI burdens (including energy consumption and air emissions, water pollutants, solid waste), and allocates the cost and burdens to individual components of the MSW stream. By using these models, cost and environmental burdens of managing individual components of MSW in alternative management strategies can be analyzed.

As illustrated in Figure 1, there are multiple places in the decision support tool where the user can input site-specific information. The focus of the input sheets contained in this document is on potential user input values to the process models. Each process model has its own set of data which the user can interact with through the data input manager of the decision support tool, as illustrated in Figure 2. This feature of the tool enables users to access, review, and enter site-specific information for each process model to tailor an analysis to a particular municipality or region.

The data input manager has been structured using sub-interfaces which are grouped in a hierarchical manner to allow users to easily access and input data. The highest level interfaces are grouped by the unit operations (e.g., collection, MRF, composting, and landfill, etc.). The next level interfaces are grouped by data type (e.g., scheduling, labor, equipment, etc.). Subsequent levels allow the user to input data on the details of scheduling, labor, and equipment costs etc. Navigation through these subinterface screens has been made easy through the use of simple mouse operations and pull-down menus.

The data input sheets for each waste management process model have been compiled in this document to give potential users of the decision support tool a sense of the number and types of data that they can enter into the tool to tailor their analysis to site-specific conditions. The input sheets presented in this document include the following:

Section 2 - Variables Common to Multiple Process Models

Section 3 - Collection Process Model

Section 4 - Transfer Station Process Model

Section 5 - Transportation Process Model

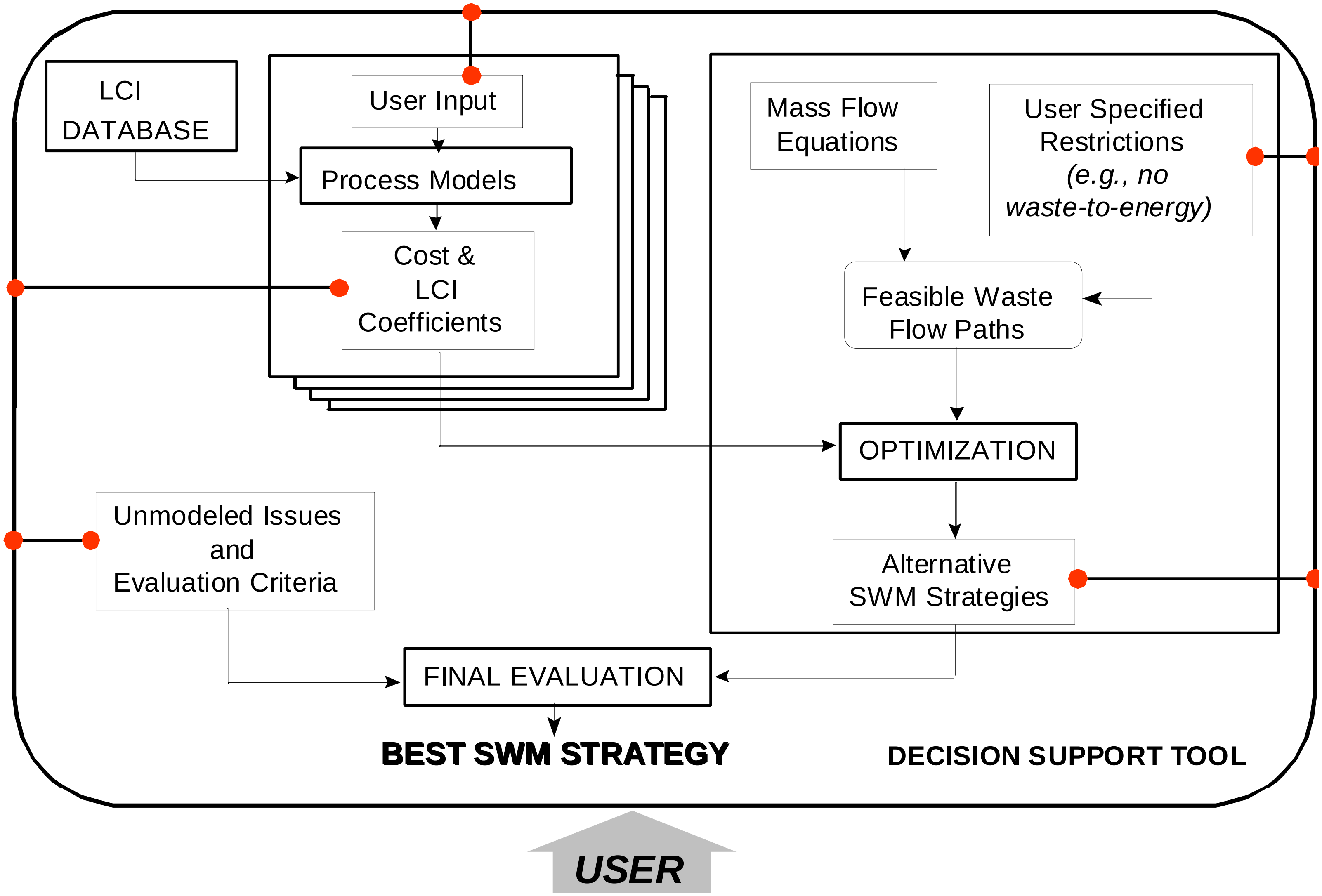

Figure 1. Conceptual Framework of the Decision Support Tool Illustrating User Input Sites.
Users can enter site-specific data at various places in the tool denoted by the bars to the user interface.

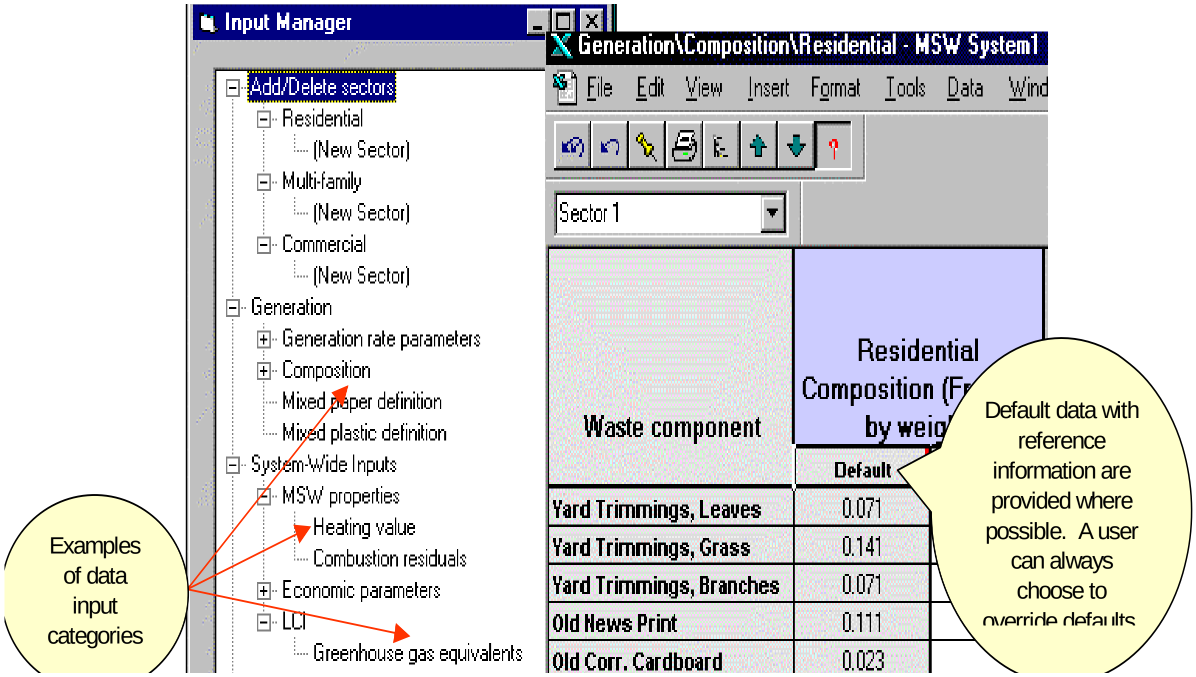

Figure 2. Data Entry

A user can enter site-specific data, e.g., waste composition, using the Input Manager

Section 6 - Material Recovery Facility Process Model

Section 7 - Municipal Waste Combustion Process Model

Section 8 - Landfill Process Model

Each section begins with an overview of the process model and then presents the input sheets. The input sheets are comprised of specific data input cells, and these cells are classified into those required for calculating the cost and those required for calculating the LCI.

Decision support tool users can change any data in the input cells to suit site-specific conditions. However, the large number of existing data input cells can make this a time consuming and difficult task. Therefore, to facilitate the use of the input sheets, some cells have been marked as "sensitive parameters" to indicate that the data in these cells are likely to be more important to the final result (cost or LCI) than cells that are not "sensitive." Note that the selection of cells that have been identified as sensitive was based on the best engineering judgment of the project research team and informal sensitivity analysis. Formal and comprehensive sensitivity analysis has not been performed on the process model variables.

Note that the data spreadsheets included in this document have not been edited for significant figures because the data are raw input or calculated values that are used in various places of the overall decision support tool. The results of an analysis using the decision support tool, and the results for individual process models will be reported with an appropriate number of significant figures.

Table Symbols

A number of different symbols are used throughout the input sheets. To assist the reader, some of the most commonly used symbols are provided below:

Symbol	Definition	Example
	Sensitive parameter. Users should review input value and determine if they should change it to meet their circumstances. (Table cell is displayed with a white font and black background.)	27
	Not as sensitive a parameter. Users *may* change input value. (Table cell is displayed with a black font and white background.)	10
na	Not applicable.	
ND	No data.	
*	In Section 8, single asterisks alert the user to comments listed at the end of tables. For example, an asterisk appears in Cell A4 on page 8-2 (length/width ratio*). Its corresponding comment is listed on page 8-6 as follows: **Cell: A4** **Comment:** Length-to-width ratio. The default value is chosen based on engineering judgment to minimize land requirements.	length/width ratio*

MSW Component Codes

In many of the data sheets, codes have been used to denote placeholder cells to allow for the incorporation of additional MSW components in the future. The key codes for these cells are as follows:

CCCR – commercial sector, combustible, compostable, recyclable material
CCCN – commercial sector, combustible, compostable, non recyclable material
CCNR – commercial sector, combustible, non compostable, recyclable material
CCNN – commercial sector, combustible, non compostable, non recyclable material
CNNR – commercial sector, non combustible, non compostable, recyclable material
CNNN – commercial sector, non combustible, non compostable, non recyclable material

2. Variables Common to Multiple Process Models

Overview

Throughout the decision support tool, there are sets of data that are common to more than one process model. These common data includes such information as populations for different waste generation sectors, waste composition, and physical properties of waste components. The use of common data sets simplifies the data input process for users and ensures consistency throughout the individual process models and the decision support tool.

The common data can be tailored for 2 residential (single-family), 2 multifamily, and 10 commercial waste generation sectors. The spreadsheets included in this section contain the common data input sheets and illustrates the types of data that the user can enter into the input cells for different common data sets.

Definition of Terms

- **Sector**
  A sector is defined as a grouping of waste generators. The user can specify 2 residential sectors, 2 multifamily sectors, and 10 commercial sectors. For instance, a community can be divided into a rural residential sector and an urban residential sector. The urban and rural sectors could have different characteristics, for example, different waste compositions, geographical characteristics, and participation rates in recycling programs. Similarly, commercial waste generators can be grouped together based on similarities such as the composition of waste generated.

Table 2.1. Waste Generation for Community

DESCRIPTION	VALUE	UNIT
Residential (2 sectors)		
Residential Population 1	450,000	people
Residents per House 1	2.63	people/house
Generation Rate 1	2.64	lb./person-day
Residential Population 2	45,000	people
Residents per House 2	2.63	people/house
Generation Rate 2	2.64	lb./person-day
Multifamily (2 sectors)		
Multifamily Population 1	150,000	people
Generation Rate 1	2.64	lb./person-day
Number of Multifamily Collection Locations 1	750	locations
Multifamily Population 2	15,000	people
Generation Rate 2	2.64	lb./person-day
Number of Multifamily Collection Locations 2	75	locations
Commercial (10 sectors)		
Number of Commercial Collection Locations 1	2,000	locations
Number of Commercial Collection Locations 2	200	locations
Number of Commercial Collection Locations 3	100	locations
Number of Commercial Collection Locations 4	100	locations
Number of Commercial Collection Locations 5	100	locations
Number of Commercial Collection Locations 6	100	locations
Number of Commercial Collection Locations 7	100	locations
Number of Commercial Collection Locations 8	100	locations
Number of Commercial Collection Locations 9	100	locations
Number of Commercial Collection Locations 10	100	locations
Commercial Waste Generation Rate 1	3,700	lb./location-week
Commercial Waste Generation Rate 2	3,700	lb./location-week
Commercial Waste Generation Rate 3	2,300	lb./location-week
Commercial Waste Generation Rate 4	2,300	lb./location-week
Commercial Waste Generation Rate 5	2,300	lb./location-week
Commercial Waste Generation Rate 6	2,300	lb./location-week
Commercial Waste Generation Rate 7	2,300	lb./location-week
Commercial Waste Generation Rate 8	2,300	lb./location-week
Commercial Waste Generation Rate 9	2,300	lb./location-week
Commercial Waste Generation Rate 10	2,300	lb./location-week

Table 2.1. Waste Generation for Community

Table 2.2. Municipal Solid Waste Physical Properties
Part 1: Mixed Paper Composition, All-Sector Densities, and Residential Composition

The model user defines the composition of mixed paper once for residential and multifamily dwelling sectors and once for the commercial sector. Within a sector type, the model user may select which items, if any, should be considered as part of the mixed component. For example, the user may include third class mail and phone books in mixed paper. All paper types not included in the user's definition of mixed paper will be treated as individual components by the solid waste management model. Paper types that are included in mixed paper cannot be analyzed as individual components. The same strategy applies to plastics and glass.

MSW COMPONENT	include in residential and multifamily mixtures? (0=no, 1= yes)	include in commercial mixtures? (0=no, 1= yes)	DENSITIES (All Sectors): Uncompacted Density in Recycling Collection Vehicle (lb./yd^3)	RESIDENTIAL COMPOSITION: Sector 1 Default Composition (wt. fraction)	RESIDENTIAL COMPOSITION: Sector 2 Default Composition (wt. fraction)
Yard Trimmings, Leaves	na	na	350	0.056	0.056
Yard Trimmings, Grass	na	na	350	0.093	0.093
Yard Trimmings, Branches	na	na	350	0.037	0.037
Old Newsprint			500	0.067	0.067
Old Corrugated Cardboard			400	0.021	0.021
Office Paper			500	0.013	0.013
Phone Books			500	0.002	0.002
Books		na	500	0.009	0.009
Old Magazines		na	500	0.017	0.017
Third Class Mail			500	0.022	0.022
Paper - Other #1			500	0.000	0.000
Paper - Other #2			500	0.000	0.000
Paper - Other #3			500	0.000	0.000
Paper - Other #4		na	500	0.000	0.000
Paper - Other #5		na	500	0.000	0.000
CCCR - Other	na	na	500	na	na
Mixed Paper	na	na	500	0	0
HDPE - Translucent		na	24	0.004	0.004
HDPE - Pigmented		na	24	0.005	0.005
PET			40	0.004	0.004
Plastic - Other #1		na	50	0.000	0.000

Table 2.2. Municipal Solid Waste Physical Properties
Part 1: Mixed Paper Composition, All-Sector Densities, and Residential Composition

MSW COMPONENT, continued	include in residential and multifamily mixtures? (0=no, 1= yes)	include in commercial mixtures? (0=no, 1= yes)	DENSITIES (All Sectors) Uncompacted Density in Recycling Collection Vehicle (lb./yd^3)	RESIDENTIAL COMPOSITION Sector 1 User Override (wt. fraction)	RESIDENTIAL COMPOSITION Sector 2 User Override (wt. fraction)	
Plastic - Other #2		na	50	0.000	0.000	
Plastic - Other #3		na	50	0.000	0.000	
Plastic - Other #4		na	50	0.000	0.000	
Plastic - Other #5		na	50	0.000	0.000	
Mixed Plastic	na	na	50	0.000	0.000	
CCNR - Other	na	na	50	na	na	
Ferrous Cans	na	na	150	0.015	0.015	
Ferrous Metal - Other	na	na	750	0.000	0.000	
Aluminum Cans	na	na	75	0.009	0.009	
Aluminum - Other #1	na	na	400	0.000	0.000	
Aluminum - Other #2	na	na	400	0.000	0.000	
Glass - Clear			400	0.039	0.039	
Glass - Brown			400	0.016	0.016	
Glass - Green			400	0.010	0.010	
Mixed Glass	na	na	400	0.000	0.000	
CNNR - Other	na	na	150	na	na	
Paper - Nonrecyclable	na	na	500	0.171	0.171	
Food Waste	na	na	800	0.049	0.049	
CCCN - Other	na	na	700	na	na	
Plastic - Nonrecyclable	na	na	50	0.099	0.099	
Misc. (CNNN)	na	na	110	0.075	0.075	
CCNN - Other	na	na	110	na	na	
Ferrous - Nonrecyclable	na	na	750	0.032	0.032	
Aluminum - Nonrecyclable	na	na	400	0.005	0.005	
Glass - Nonrecyclable	na	na	400	0.007	0.007	
Misc. (NNNN)	na	na	300	0.123	0.123	
CNNN - Other	na	na	400	na	na	

Table 2.2. MSW Physical Properties
Part 2: Multifamily Composition

MSW COMPONENT	MULTIFAMILY COMPOSITION		
	Sector 1 User Override (wt. fraction)	Sector 2 User Override (wt. fraction)	
Yard Trimmings, Leaves	0.056	0.056	
Yard Trimmings, Grass	0.093	0.093	
Yard Trimmings, Branches	0.037	0.037	
Old Newsprint	0.067	0.067	
Old Corrugated Cardboard	0.021	0.021	
Office Paper	0.013	0.013	
Phone Books	0.002	0.002	
Books	0.009	0.009	
Old Magazines	0.017	0.017	
Third Class Mail	0.022	0.022	
Paper - Other #1	0	0	
Paper - Other #2	0	0	
Paper - Other #3	0	0	
Paper - Other #4	0	0	
Paper - Other #5	0	0	
CCCR - Other	na	na	
Mixed Paper	0	0	
HDPE - Translucent	0.004	0.004	
HDPE - Pigmented	0.005	0.005	
PET	0.004	0.004	
Plastic - Other #1	0	0	
Plastic - Other #2	0	0	
Plastic - Other #3	0	0	
Plastic - Other #4	0	0	
Plastic - Other #5	0	0	
Mixed Plastic	0	0	
CCNR - Other	na	na	
Ferrous Cans	0.015	0.015	
Ferrous Metal - Other	0	0	
Aluminum Cans	0.009	0.009	
Aluminum - Other #1	0	0	
Aluminum - Other #2	0	0	
Glass - Clear	0.039	0.039	
Glass - Brown	0.016	0.016	
Glass - Green	0.01	0.01	
Mixed Glass	0	0	
CNNR - Other	na	na	
Paper - Nonrecyclable	0.171	0.171	
Food Waste	0.049	0.049	
CCCN - Other	na	na	
Plastic - Nonrecyclable	0.099	0.099	
Misc. (CNNN)	0.075	0.075	
CCNN - Other	na	na	
Ferrous - Nonrecyclable	0.032	0.032	
Aluminum - Nonrecyclable	0.005	0.005	
Glass - Nonrecyclable	0.007	0.007	
Misc. (NNNN)	0.123	0.123	
CNNN - Other	na	na	

Table 2.2. MSW Physical Properties
Part 3: Commercial Composition

MSW COMPONENT	COMMERCIAL COMPOSITION Default Commercial Composition (wt. fraction)	The same waste composition is the default for all 10 commercial sectors
Yard Trimmings, Leaves	na	
Yard Trimmings, Grass	na	
Yard Trimmings, Branches	na	
Old Newsprint	0.022	
Old Corrugated Cardboard	0.360	
Office Paper	0.072	
Phone Books	0.003	
Books	na	
Old Magazines	na	
Third Class Mail	0.023	
Paper - Other #1	0.000	
Paper - Other #2	0.000	
Paper - Other #3	0.000	
Paper - Other #4	na	
Paper - Other #5	na	
CCCR - Other	0.019	
Mixed Paper	na	
HDPE - Translucent	na	
HDPE - Pigmented	na	
PET	0.002	
Plastic - Other #1	na	
Plastic - Other #2	na	
Plastic - Other #3	na	
Plastic - Other #4	na	
Plastic - Other #5	na	
Mixed Plastic	na	
CCNR - Other	0.041	
Ferrous Cans	0.007	
Ferrous Metal - Other	na	
Aluminum Cans	0.004	
Aluminum - Other #1	na	
Aluminum - Other #2	na	
Glass - Clear	0.019	
Glass - Brown	0.008	
Glass - Green	0.005	
Mixed Glass	na	
CNNR - Other	0.024	
Paper - Nonrecyclable	na	
Food Waste	na	
CCCN - Other	0.171	
Plastic - Nonrecyclable	na	
Misc. (CNNN)	na	
CCNN - Other	0.113	
Ferrous - Nonrecyclable	na	
Aluminum - Nonrecyclable	na	
Glass - Nonrecyclable	na	
Misc. (NNNN)	na	
CNNN - Other	0.107	

Table 2.2. MSW Physical Properties
Part 3: Commercial Composition

MSW COMPONENT	COMMERCIAL COMPOSITION, continued		
	Sector 2 User Override (wt. fraction)	Sector 3 User Override (wt. fraction)	Sector 4 User Override (wt. fraction)
Yard Trimmings, Leaves	na	na	na
Yard Trimmings, Grass	na	na	na
Yard Trimmings, Branches	na	na	na
Old Newsprint			
Old Corrugated Cardboard			
Office Paper			
Phone Books			
Books	na	na	na
Old Magazines	na	na	na
Third Class Mail			
Paper - Other #1			
Paper - Other #2			
Paper - Other #3			
Paper - Other #4	na	na	na
Paper - Other #5	na	na	na
CCCR - Other			
Mixed Paper	na	na	na
HDPE - Translucent	na	na	na
HDPE - Pigmented	na	na	na
PET			
Plastic - Other #1	na	na	na
Plastic - Other #2	na	na	na
Plastic - Other #3	na	na	na
Plastic - Other #4	na	na	na
Plastic - Other #5	na	na	na
Mixed Plastic	na	na	na
CCNR - Other			
Ferrous Cans			
Ferrous Metal - Other	na	na	na
Aluminum Cans			
Aluminum - Other #1	na	na	na
Aluminum - Other #2	na	na	na
Glass - Clear			
Glass - Brown			
Glass - Green			
Mixed Glass	na	na	na
CNNR - Other			
Paper - Nonrecyclable	na	na	na
Food Waste	na	na	na
CCCN - Other			
Plastic - Nonrecyclable	na	na	na
Misc. (CNNN)	na	na	na
CCNN - Other			
Ferrous - Nonrecyclable	na	na	na
Aluminum - Nonrecyclable	na	na	na
Glass - Nonrecyclable	na	na	na
Misc. (NNNN)	na	na	na
CNNN - Other			

Table 2.2. MSW Physical Properties
Part 3: Commercial Composition

Table 2.2. MSW Physical Properties
Part 3. Commercial Composition

MSW COMPONENT	COMMERCIAL COMPOSITION, continued		
	Sector 5 User Override (wt. fraction)	Sector 6 User Override (wt. fraction)	Sector 7 User Override (wt. fraction)
Yard Trimmings, Leaves	na	na	na
Yard Trimmings, Grass	na	na	na
Yard Trimmings, Branches	na	na	na
Old Newsprint			
Old Corrugated Cardboard			
Office Paper			
Phone Books			
Books	na	na	na
Old Magazines	na	na	na
Third Class Mail			
Paper - Other #1			
Paper - Other #2			
Paper - Other #3			
Paper - Other #4	na	na	na
Paper - Other #5	na	na	na
CCCR - Other			
Mixed Paper	na	na	na
HDPE - Translucent	na	na	na
HDPE - Pigmented	na	na	na
PET			
Plastic - Other #1	na	na	na
Plastic - Other #2	na	na	na
Plastic - Other #3	na	na	na
Plastic - Other #4	na	na	na
Plastic - Other #5	na	na	na
Mixed Plastic	na	na	na
CCNR - Other			
Ferrous Cans			
Ferrous Metal - Other	na	na	na
Aluminum Cans			
Aluminum - Other #1	na	na	na
Aluminum - Other #2	na	na	na
Glass - Clear			
Glass - Brown			
Glass - Green			
Mixed Glass	na	na	na
CNNR - Other			
Paper - Nonrecyclable	na	na	na
Food Waste	na	na	na
CCCN - Other			
Plastic - Nonrecyclable	na	na	na
Misc. (CNNN)	na	na	na
CCNN - Other			
Ferrous - Nonrecyclable	na	na	na
Aluminum - Nonrecyclable	na	na	na
Glass - Nonrecyclable	na	na	na
Misc. (NNNN)	na	na	na
CNNN - Other			

Table 2.2. MSW Physical Properties
Part 3: Commercial Composition

MSW COMPONENT	COMMERCIAL COMPOSITION, continued		
	Sector 8 User Override (wt. fraction)	Sector 9 User Override (wt. fraction)	Sector 10 User Override (wt. fraction)
Yard Trimmings, Leaves	na	na	na
Yard Trimmings, Grass	na	na	na
Yard Trimmings, Branches	na	na	na
Old Newsprint			
Old Corrugated Cardboard			
Office Paper			
Phone Books			
Books	na	na	na
Old Magazines	na	na	na
Third Class Mail			
Paper - Other #1			
Paper - Other #2			
Paper - Other #3			
Paper - Other #4	na	na	na
Paper - Other #5	na	na	na
CCCR - Other			
Mixed Paper	na	na	na
HDPE - Translucent	na	na	na
HDPE - Pigmented	na	na	na
PET			
Plastic - Other #1	na	na	na
Plastic - Other #2	na	na	na
Plastic - Other #3	na	na	na
Plastic - Other #4	na	na	na
Plastic - Other #5	na	na	na
Mixed Plastic	na	na	na
CCNR - Other			
Ferrous Cans			
Ferrous Metal - Other	na	na	na
Aluminum Cans			
Aluminum - Other #1	na	na	na
Aluminum - Other #2	na	na	na
Glass - Clear			
Glass - Brown			
Glass - Green			
Mixed Glass	na	na	na
CNNR - Other			
Paper - Nonrecyclable	na	na	na
Food Waste	na	na	na
CCCN - Other			
Plastic - Nonrecyclable	na	na	na
Misc. (CNNN)	na	na	na
CCNN - Other			
Ferrous - Nonrecyclable	na	na	na
Aluminum - Nonrecyclable	na	na	na
Glass - Nonrecyclable	na	na	na
Misc. (NNNN)	na	na	na
CNNN - Other			

3. Collection Process Model

Overview

The collection process model calculates cost and LCI coefficients for the collection and transport of MSW and recyclable materials from the curbside (or dropoff) to a downstream waste management operation. There are a large number of different collection options included in the decision support tool which the user can tailor by inputting site-specific data for such parameters as distances between collection points, labor wages, speed of collection vehicles between stops, and compaction factors for recyclables.

The manner in which MSW and recyclable materials are collected affects the cost, resource utilization, environmental releases, and design of both the collection operation and potential downstream processing facilities such as a material recovery facility (MRF). The methodology used for the collection process model is presented in the following sections as a generic methodology. The results of the collection process model are used in the decision support tool to calculate the total system cost and LCI for MSW management alternatives that involving defined collection options.

Conceptual Designs

To account for the many different ways in which MSW and recyclable materials are collected from residential, multifamily dwellings, and commercial sectors, the decision support tool includes 21 different collection options designated as C0 through C20. Definitions for each option are as follows:

- **Collection of Refuse and Recyclables from Residential (single-family dwellings)**
  - <u>Mixed Refuse Collection</u>
    - **C1.** Collection of mixed refuse in a single-compartment truck with no separation of recyclables.
  - <u>Recyclables Collection</u>
    - **C2.** Set out of commingled recyclables that are sorted by the collection vehicle crew at the point of collection into a multicompartment vehicle.
    - **C3.** Collection of recyclables presorted by the generator into a multicompartment vehicle.
    - **C4.** Collection of commingled recyclables in a vehicle with two compartments: one for paper recyclables and the other for nonpaper recyclables.
  - <u>Co-Collection</u>
    - **C5.** Collection of mixed refuse and recyclables in different colored bags for transport in a single compartment of a vehicle. Paper recyclables are placed in one blue bag, and nonpaper recyclables are placed in a separate blue bag. Bags are sorted at a MRF.

- **C6.** Collection of mixed refuse, paper recyclables, and nonpaper recyclables in three separate compartments of the same vehicle. The refuse and recyclables would then be delivered to a MRF, and the mixed refuse would be delivered to a combustion facility, composting facility, refuse-derived fuel (RDF) plant, or landfill.

- <u>Residuals Collection</u>
  - **C7.** If recyclables are collected in options 2, 3, or 4, then residual MSW is collected in a single-compartment vehicle as in option 1.
- <u>Recyclables Drop-Off</u>
  - **C8.** This alternative allows for the waste generator to bring recyclables to a centralized drop-off facility. This could also be a buy-back center.
- <u>Yard Waste Collection</u>
  - **C0.** Curbside collection of miscellaneous yard waste (leaves, grass clippings, branches) in a single-compartment vehicle.
  - **C9.** Curbside collection of leaves only using a leaf vacuum truck.
  - **C10.** Dedicated collection of leaves in a vacuum truck. This alternative allows for the waste generator to bring yard waste to a centralized composting facility.
- <u>Wet/Dry Collection</u>
  - **C11.** Wet/dry collection with recyclables included with the dry portion. The user will be asked to specify whether various paper types are to be included in the wet or dry collection compartments.
  - **C12.** Wet/dry collection with recyclables collected in a separate vehicle. The user will asked if various paper types are to be included in the wet or dry collection compartments.

➢ **Collection of Refuse and Recyclables from Multifamily Dwellings**

- <u>Mixed Refuse Collection</u>
  - **C13.** Collection of mixed refuse from multifamily dwellings in a single-compartment truck. The user will be required to specify the use of hauled or stationary containers.
- <u>Recyclables Collection</u>
  - **C14.** Collection of presorted recyclables into multiple stationary or hauled containers.
  - **C15.** Collection of commingled nonpaper recyclables into a single bin for containers and a second bin for paper recyclables.
- <u>Residuals Collection</u>

- **C16.** If recyclables are collected in options 12 or 13, then residual MSW is collected in a single-compartment vehicle as in option 11.

  - Wet/Dry Collection
    - **C17.** Wet/dry collection with recyclables included with the dry portion. The user will be asked to specify whether various paper types are to be included in the wet or dry collection compartments.
    - **C18.** Wet/dry collection with recyclables collected in a separate vehicle. The user will be asked to specify whether various paper types are to be included in the wet or dry collection compartments.

- **Collection of Waste and Recyclables from Commercial Waste**
  - Recyclables Collection
    - **C19.** Collection of presorted recyclables.
  - Mixed Refuse Collection
    - **C20.** Collection of mixed refuse before or after recycling.

Methodology for Calculating the Number of Vehicles

In order to complete the cost and LCI methods, the number of collection vehicles needed to collect the waste and recyclable materials is needed. This is calculated by determining the number of collection locations at which a collection vehicle can stop along a collection route before it is filled to capacity. This number is multiplied by the amount of time that a vehicle spends stopped at each location and traveling between locations to yield 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.

Next, the number of daily collection vehicle trips is calculated. The number of fully loaded trips that a collection vehicle can make during one workday is calculated 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, for the lunch break, and other break time.

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 at which a vehicle stops during one collection trip to determine the number of trips needed to collect all the MSW generated in that area during one 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.

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. The number of trucks is used to calculate the annual cost and LCI of the collection system, as described in the following sections.

Cost Methodology

The annual cost of collection is calculated from the number of trucks required and economic factors such as a vehicle's annualized capital cost, which is 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. Labor costs include the wages paid to drivers and collection workers. Overhead costs, which include administrative costs, are calculated as a function of the labor costs. Collection costs are divided into capital costs and operation and maintenance costs.

Capital Cost

Capital cost includes the cost of collection vehicles, backup vehicles, and an administrative rate that includes the capital cost of the garage and maintenance facilities. Capital cost is expressed in annual terms using a capital recovery factor that is dependent upon a book lifetime and discount rate.

Operation and Maintenance Cost

The operation and maintenance cost of the collection process includes the labor, overhead, taxes, administration, insurance, indirect costs, fuel cost, electricity cost, and maintenance cost. Overhead costs for labor are calculated as a fraction of labor wages. Overhead includes overtime, office supplies, fringe benefits, and temporary labor. The overhead rate is flexible and can be defined by the user to cover their specific labor situation.

Life-Cycle Inventory Methodology

The number of collection vehicles and other input parameters such as the miles traveled and fuel consumed are used in the collection process model to calculate the costs and release rates for LCI parameters as part of the decision support tool. Default or user inputted 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. These in turn are multiplied by pollutant emission factors to arrive at values for the amounts of air pollutants, water pollutants, and solid wastes generated per ton of waste collected. The LCI calculations also include the consumption of electrical energy at the garage where the collection vehicles are housed and maintained. Resource consumption and environmental releases (air, water, and solid waste) associated with electricity use are accounted for in the LCI. In addition, LCI parameters are allocated by weight to individual components of the waste stream.

Energy

Fuel is consumed by collection vehicles to collect waste and recyclable materials. The quantity of fuel consumed in the collection process is calculated based on the fuel consumption rate of the vehicle type used and the quantity of waste or recyclables collected. Electrical energy is consumed as part of the collection process model for heating and lighting of the garage facility. The amount of electricity consumed is provided by standard consumption rates and is based on the size (square feet) of the garage.

Air Emissions

Air emissions in the collection process are from combustion of fuel in vehicles and from the production of energy used in the collection process. Air emissions data from fuel production processes and fuel combustion in collection vehicles during operation are included in the LCI.

Water Releases

Water releases associated with the collection process are releases from the production of energy used in the collection process and potentially from the washing of collection vehicles. Although the data input sheets include cells for waterborne release rates for washing of vehicles, the defaults are zero because we found this to be an insignificant source of releases.

Solid Waste Releases

Solid wastes due to collection include wastes released due to energy production (collection vehicle fuel and electricity). No process-related solid wastes are considered in the LCI for the collection process model.

Definition of Terms

- **Sector Variable Collection Process Model Input Data**
  To facilitate the ease of data entry for the collection process model, inputs are organized into two categories: data that varies by sector for a particular collection option (sector variable data) and data that does not vary by sector for a collection option (non0sector variable data).

- **Collection Travel Parameters**
  Detailed information about distances between all possible destinations of wastes or recyclables and collection points are required because collection costs are directly proportional to the distance from the end of the route to the waste destination where the collection vehicle unloads.

Table 3.1. Residential Collection Characteristics
Part 1: Co-Collection Capture Rates

Capture Rate: The fraction on average of each waste component removed by participating households from their mixed waste and set out for separate collection. Note that the fraction of households that participate is defined separately.

MSW COMPONENT	CO-COLLECTION CAPTURE RATES			
	C 5		C 6	
	Sector 1	Sector 2	Sector 1	Sector 2
Yard Trimmings, Leaves	na	na	na	na
Yard Trimmings, Grass	na	na	na	na
Yard Trimmings, Branches	na	na	na	na
Old Newsprint	0.68	0.68	0.68	0.68
Old Corrugated Cardboard	0.56	0.56	0.56	0.56
Office Paper	0.49	0.49	0.49	0.49
Phone Books	0.60	0.60	0.60	0.60
Books	0.60	0.60	0.60	0.60
Old Magazines	0.60	0.60	0.60	0.60
Third Class Mail	0.60	0.60	0.60	0.60
Paper - Other #1				
Paper - Other #2				
Paper - Other #3				
Paper - Other #4				
Paper - Other #5				
CCCR - Other				
Mixed Paper				
HDPE - Translucent	0.56	0.56	0.56	0.56
HDPE - Pigmented	0.56	0.56	0.56	0.56
PET	0.56	0.56	0.56	0.56
Plastic - Other #1				
Plastic - Other #2				
Plastic - Other #3				
Plastic - Other #4				
Plastic - Other #5				
Mixed Plastic				
CCNR - Other	na	na	na	na

Table 3.1. Residential Collection Characteristics
Part 1: Co-Collection Capture Rates

MSW COMPONENT, continued	CO-COLLECTION CAPTURE RATES			
	C 5		C 6	
	Sector 1	Sector 2	Sector 1	Sector 2
Ferrous Cans	0.58	0.58	0.58	0.58
Ferrous Metal - Other	0.58	0.58	0.58	0.58
Aluminum - Other #1	0.64	0.64	0.64	0.64
Aluminum - Other #2	0.64	0.64	0.64	0.64
Glass - Clear	0.64	0.64	0.64	0.64
Glass - Brown	0.64	0.64	0.64	0.64
Glass - Green	0.64	0.64	0.64	0.64
Mixed Glass	0.64	0.64	0.64	0.64
CNNR - Other	na	na	na	na
Paper - Nonrecyclable	na	na	na	na
Food Waste	na	na	na	na
CCCN - Other	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na
Misc. (CNNN)	na	na	na	na
CCNN - Other	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na
Glass - Nonrecyclable	na	na	na	na
Misc. (NNNN)	na	na	na	na
CNNN - Other	na	na	na	na
Participation Factor	1.00	1.00	1.00	1.00

Participation factor for a collection option indicates the average percentage of households that set out recyclables for each collection cycle.

Table 3.1. Residential Collection Characteristics
Part 2: Recyclables Capture Rates

MSW COMPONENT	RECYCLABLES CAPTURE RATES					
	C 2		C 3		C 4	
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
Yard Trimmings, Leaves	na	na	na	na	na	na
Yard Trimmings, Grass	na	na	na	na	na	na
Yard Trimmings, Branches	na	na	na	na	na	na
Old Newsprint	0.67	0.67	0.62	0.62	0.67	0.67
Old Corrugated Cardboard	0.55	0.55	0.52	0.52	0.55	0.55
Office Paper	0.48	0.48	0.46	0.46	0.48	0.48
Phone Books	0.59	0.59	0.45	0.45	0.59	0.59
Books	0.59	0.59	0.55	0.55	0.59	0.59
Old Magazines	0.59	0.59	0.55	0.55	0.59	0.59
Third Class Mail	0.59	0.59	0.55	0.55	0.59	0.59
Paper - Other #1						
Paper - Other #2						
Paper - Other #3						
Paper - Other #4						
Paper - Other #5						
CCCR - Other						
Mixed Paper						
HDPE - Translucent	0.55	0.55	0.52	0.52	0.55	0.55
HDPE - Pigmented	0.55	0.55	0.52	0.52	0.55	0.55
PET	0.55	0.55	0.52	0.52	0.55	0.55
Plastic - Other #1						
Plastic - Other #2						
Plastic - Other #3						
Plastic - Other #4						
Plastic - Other #5						
Mixed Plastic						
CCNR - Other	na	na	na	na	na	na
Ferrous Cans	0.57	0.57	0.52	0.52	0.57	0.57
Ferrous Metal - Other	0.57	0.57	0.52	0.52	0.57	0.57
Aluminum Cans	0.63	0.63	0.59	0.59	0.63	0.63
Aluminum - Other #1	0.63	0.63	0.59	0.59	0.63	0.63
Aluminum - Other #2	0.63	0.63	0.59	0.59	0.63	0.63
Glass - Clear	0.63	0.63	0.59	0.59	0.63	0.63
Glass - Brown	0.63	0.63	0.59	0.59	0.63	0.63
Glass - Green	0.63	0.63	0.59	0.59	0.63	0.63

Table 3.1. Residential Collection Characteristics
Part 2: Recyclables Capture Rates

MSW COMPONENT, continued	RECYCLABLES CAPTURE RATES					
	C 2		C 3		C 4	
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
Mixed Glass	0.63	0.63	0.59	0.59	0.63	0.63
CNNR - Other	na	na	na	na	na	na
Paper - Nonrecyclable	na	na	na	na	na	na
Food Waste	na	na	na	na	na	na
CCCN - Other	na	na	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na	na	na
Misc. (CNNN)	na	na	na	na	na	na
CCNN - Other	na	na	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na	na	na
Glass - Nonrecyclable	na	na	na	na	na	na
Misc. (NNNN)	na	na	na	na	na	na
CNNN - Other	na	na	na	na	na	na
Participation Factor	0.65	0.65	0.50	0.50	0.65	0.65

Table 3.1. Residential Collection Characteristics
Part 3: Yard Waste and Recyclables Drop-Off Capture Rates

MSW COMPONENT	YARD WASTE CAPTURE RATES						RECYCLABLES DROP-OFF CAPTURE RATES	
	C 0		C 9		C 10		C 8	
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
Yard Trimmings, Leaves	0.90	0.90	0.90	0.90	0.90	0.90	na	na
Yard Trimmings, Grass	0.90	0.90	na	na	0.90	0.90	na	na
Yard Trimmings, Branches	0.90	0.90	na	na	0.90	0.90	na	na
Old Newsprint	na	na	na	na	na	na	0.59	0.59
Old Corrugated Cardboard	na	na	na	na	na	na	0.59	0.59
Office Paper	na	na	na	na	na	na	0.59	0.59
Phone Books	na	na	na	na	na	na	0.59	0.59
Books	na	na	na	na	na	na	0.59	0.59
Old Magazines	na	na	na	na	na	na	0.59	0.59
Third Class Mail	na	na	na	na	na	na	0.59	0.59
Paper - Other #1	na	na	na	na	na	na		
Paper - Other #2	na	na	na	na	na	na		
Paper - Other #3	na	na	na	na	na	na		
Paper - Other #4	na	na	na	na	na	na		
Paper - Other #5	na	na	na	na	na	na		
CCCR - Other	na	na	na	na	na	na		
Mixed Paper	na	na	na	na	na	na		
HDPE - Translucent	na	na	na	na	na	na	0.59	0.59
HDPE - Pigmented	na	na	na	na	na	na	0.59	0.59
PET	na	na	na	na	na	na	0.59	0.59
Plastic - Other #1	na	na	na	na	na	na		
Plastic - Other #2	na	na	na	na	na	na		
Plastic - Other #3	na	na	na	na	na	na		
Plastic - Other #4	na	na	na	na	na	na		
Plastic - Other #5	na	na	na	na	na	na		
Mixed Plastic	na	na	na	na	na	na		

Table 3.1. Residential Collection Characteristics
Part 3: Yard Waste and Recyclables Drop-Off Capture Rates

MSW COMPONENT, continued	YARD WASTE CAPTURE RATES						RECYCLABLES DROP-OFF CAPTURE RATES	
	C 0		C 9		C 10		C 8	
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
CCNR - Other	na	na	na	na	na	na	na	na
Ferrous Cans	na	na	na	na	na	na	0.59	0.59
Ferrous Metal - Other	na	na	na	na	na	na	0.59	0.59
Aluminum Cans	na	na	na	na	na	na	0.59	0.59
Aluminum - Other #1			na	na	na	na	0.59	0.59
Aluminum - Other #2			na	na	na	na	0.59	0.59
Glass - Clear			na	na	na	na	0.59	0.59
Glass - Brown			na	na	na	na	0.59	0.59
Glass - Green	na	na	na	na	na	na	0.59	0.59
Mixed Glass	na	na	na	na	na	na	0.59	0.59
CNNR - Other	na	na	na	na	na	na	na	na
Paper - Nonrecyclable	na	na	na	na	na	na	na	na
Food Waste	na	na	na	na	na	na	na	na
CCCN - Other	na	na	na	na	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na	na	na	na	na
Misc. (CNNN)	na	na	na	na	na	na	na	na
CCNN - Other	na	na	na	na	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na	na	na	na	na
Glass - Nonrecyclable	na	na	na	na	na	na	na	na
Misc.(NNNN)	na	na	na	na	na	na	na	na
CNNN - Other	na	na	na	na	na	na	na	na
Participation Factor	0.50	0.50	0.50	0.50	0.40	0.40	0.40	0.40

Table 3.2. Multifamily Collection Characteristics

MSW COMPONENT	RECYCLABLES CAPTURE RATES				RECYCLABLES DROP-OFF CAPTURE RATES	
	C 14		C 15		C 8	
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
Yard Trimmings, Leaves	na	na	na	na	na	na
Yard Trimmings, Grass	na	na	na	na	na	na
Yard Trimmings, Branches	na	na	na	na	na	na
Old Newsprint	0.63	0.63	0.68	0.68	0.59	0.59
Old Corrugated Cardboard	0.53	0.53	0.56	0.56	0.59	0.59
Office Paper	0.46	0.46	0.49	0.49	0.59	0.59
Phone Books	0.56	0.56	0.6	0.6	0.59	0.59
Books	0.56	0.56	0.6	0.6	0.59	0.59
Old Magazines	0.56	0.56	0.6	0.6	0.59	0.59
Third Class Mail	0.56	0.56	0.6	0.6	0.59	0.59
Paper - Other #1						
Paper - Other #2						
Paper - Other #3						
Paper - Other #4						
Paper - Other #5						
CCCR - Other						
Mixed Paper						
HDPE - Translucent	0.53	0.53	0.56	0.56	0.59	0.59
HDPE - Pigmented	0.53	0.53	0.56	0.56	0.59	0.59
PET	0.53	0.53	0.56	0.56	0.59	0.59
Plastic - Other #1						
Plastic - Other #2						
Plastic - Other #3						
Plastic - Other #4						
Plastic - Other #5						
Mixed Plastic						
CCNR - Other	na	na	na	na	na	na
Ferrous Cans	0.53	0.53	0.58	0.58	0.59	0.59
Ferrous Metal - Other	0.53	0.53	0.58	0.58	0.59	0.59
Aluminum Cans	0.6	0.6	0.64	0.64	0.59	0.59

Table 3.2. Multifamily Collection Characteristics

MSW COMPONENT, continued	RECYCLABLES CAPTURE RATES				RECYCLABLES DROP-OFF CAPTURE RATES	
	C 14		C 15		C 8	
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
Aluminum - Other #1	0.600	0.600	0.640	0.640	0.590	0.590
Aluminum - Other #2	0.600	0.600	0.640	0.640	0.590	0.590
Glass - Clear	0.600	0.600	0.640	0.640	0.590	0.590
Glass - Brown	0.600	0.600	0.640	0.640	0.590	0.590
Glass - Green	0.600	0.600	0.640	0.640	0.590	0.590
Mixed Glass	0.600	0.600	0.640	0.640	0.590	0.590
CNNR - Other	na	na	na	na	na	na
Paper - Nonrecyclable	na	na	na	na	na	na
Food Waste	na	na	na	na	na	na
CCCN - Other	na	na	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na	na	na
Misc. (CNNN)	na	na	na	na	na	na
CCNN - Other	na	na	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na	na	na
Glass - Nonrecyclable	na	na	na	na	na	na
Misc. (NNNN)	na	na	na	na	na	na
CNNN - Other	na	na	na	na	na	na
Participation Factor	0.80	0.80	0.80	0.80	0.40	0.40

Table 3.3. Commercial Recyclables Capture Rates

MSW COMPONENT	RECYCLABLES CAPTURE RATES									
	C 19									
	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10
Yard Trimmings, Leaves	na	na	na	na	na	na	na	na	na	na
Yard Trimmings, Grass	na	na	na	na	na	na	na	na	na	na
Yard Trimmings, Branches	na	na	na	na	na	na	na	na	na	na
Old Newsprint	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Old Corrugated Cardboard	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Office Paper	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Phone Books	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Books	na	na	na	na	na	na	na	na	na	na
Old Magazines	na	na	na	na	na	na	na	na	na	na
Third Class Mail	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Paper - Other #1										
Paper - Other #2										
Paper - Other #3										
Paper - Other #4	na	na	na	na	na	na	na	na	na	na
Paper - Other #5	na	na	na	na	na	na	na	na	na	na
CCCR - Other										
Mixed Paper	na	na	na	na	na	na	na	na	na	na
HDPE - Translucent	na	na	na	na	na	na	na	na	na	na
HDPE - Pigmented	na	na	na	na	na	na	na	na	na	na
PET	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Plastic - Other #1	na	na	na	na	na	na	na	na	na	na
Plastic - Other #2	na	na	na	na	na	na	na	na	na	na
Plastic - Other #3	na	na	na	na	na	na	na	na	na	na
Plastic - Other #4	na	na	na	na	na	na	na	na	na	na
Plastic - Other #5	na	na	na	na	na	na	na	na	na	na
Mixed Plastic										
CCNR - Other										
Ferrous Cans	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Ferrous Metal - Other	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Aluminum Cans	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Aluminum - Other #1	na	na	na	na	na	na	na	na	na	na

Table 3.3. Commercial Recyclables Capture Rates

MSW COMPONENT, continued	RECYCLABLES CAPTURE RATES									
	C 19									
	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10
Aluminum - Other #2	na	na	na	na	na	na	na	na	na	na
Glass - Clear	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Glass - Brown	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Glass - Green	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Mixed Glass	na	na	na	na	na	na	na	na	na	na
CNNR - Other										
Paper - Nonrecyclable	na	na	na	na	na	na	na	na	na	na
Food Waste	na	na	na	na	na	na	na	na	na	na
CCCN - Other	na	na	na	na	na	na	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na	na	na	na	na	na	na
Misc. (CNNN)	na	na	na	na	na	na	na	na	na	na
CCNN - Other	na	na	na	na	na	na	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na	na	na	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na	na	na	na	na	na	na
Glass - Nonrecyclable	na	na	na	na	na	na	na	na	na	na
Misc. (NNNN)	na	na	na	na	na	na	na	na	na	na
CNNN - Other	na	na	na	na	na	na	na	na	na	na
Participation Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 3.4. Wet/Dry Separation Factors

The user may specify the fraction of each component of MSW that will be collected as wet refuse, dry refuse, and recyclables in the wet/dry collection options by making entries in this table. Component fractions are specified by entering separation factor values between 0.00 and 1.00 in the appropriate cells. Note: The wet, dry, and recyclables separation factors for each component of MSW must sum to 1.00. These factors represent an estimate of human behavior.

MSW COMPONENT	SEPARATION FACTORS				
	Collection Options C11 and C17			Collection Options C12 and C18	
	Wet	Dry	Recyclables	Wet	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 Newsprint	0.00	0.25	0.75	0.20	0.80
Old Corrugated 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
Third Class Mail	0.00	0.25	0.75	0.20	0.80
Paper - Other #1	0.00	1.00	0.00	0.20	0.80
Paper - Other #2	0.00	1.00	0.00	0.20	0.80
Paper - Other #3	0.00	1.00	0.00	0.20	0.80
Paper - Other #4	0.00	1.00	0.00	0.20	0.80
Paper - Other #5	0.00	1.00	0.00	0.20	0.80
CCCR - Other	na	na	na	na	na
Mixed Paper	0.00	1.00	0.00	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	1.00	0.00	0.10	0.90
Plastic - Other #2	0.00	1.00	0.00	0.10	0.90
Plastic - Other #3	0.00	1.00	0.00	0.10	0.90
Plastic - Other #4	0.00	1.00	0.00	0.10	0.90

Table 3.4. Wet/Dry Separation Factors

MSW COMPONENT, continued	SEPARATION FACTORS				
	Collection Options C11 and C17			Collection Options C12 and C18	
	Wet	**Dry**	**Recyclables**	**Wet**	**Dry**
Plastic - Other #5	0.00	1.00	0.00	0.10	0.90
Mixed Plastic	0.00	1.00	0.00	0.10	0.90
CCNR - Other	na	na	na	na	na
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	na	na	na	na	na
Paper - Nonrecyclable	na	na	na	na	na
Food Waste	1.00	0.00	0.00	1.00	0.00
CCCN Other	na	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na	na
Misc. (CNNN)	na	na	na	na	na
CCNN - Other	na	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na	na
Glass - Nonrecyclable	na	na	na	na	na
Misc. (NNNN)	na	na	na	na	na
CNNN - Other	na	na	na	na	na

Table 3.5. Sector Variable Collection Process Model Input Data
Part 1: Residential Refuse Collection and Co-Collection

INPUT PARAMETER	REFUSE COLLECTION				CO-COLLECTION			
	C1		C7		C5		C6	
Residential Collection Options	Mixed Waste		Residuals		Co-Collection			
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
Collection Schedule								
number of households at one stop (household/stop)	1	1	1	1	1	1	1	1
collection frequency (1/wk.)	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
travel time between service stops (min/stop)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
time from garage to route (min/day-vehicle)	20	20	20	20	20	20	20	20
Travel Speeds								
between collection stops (mi./hr)	5	5	5	5	5	5	5	5
from garage to route in the morning (mi./hr)	35	35	35	35	35	35	35	35
Distances								
distance between collection stops (mi.)	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142
distance between garage and collection route (mi.)	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
number of collectors per vehicle (person/vehicle)	1	1	1	1	1	1	1	1
Collection Vehicle								
usable vehicle capacity (yd^3)	20	20	20	20	20	20	20	20
economic life of a vehicle (yr.)	7	7	7	7	7	7	7	7
unit price of a vehicle ($/vehicle)	142,210	142,210	142,210	142,210	142,210	142,210	154,061	154,061
vehicle operation and maintenance cost ($/vehicle)	31,286	31,286	31,286	31,286	31,286	31,286	35,553	35,553

Table 3.5. Sector Variable Collection Process Model Input Data
Part 2: Recycling Collection (C2, C3, C4) and Residential Wet/Dry Collection

INPUT PARAMETER	RECYCLING COLLECTION						WET/DRY			
	C2		C3		C4		C11		C12	
Residential Collection Options	Recyclables						Wet/Dry			
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
Collection Schedule										
number of households at one stop (household/stop)	1	1	1	1	1	1	1	1	1	1
collection frequency (1/wk.)	1	1	1	1	1	1	1	1	1	1
Collection Operation Times										
loading time at one service stop (min/stop)	0.45	0.45	0.45	0.45	0.15	0.15	0.17	0.17	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
time from garage to route (min/day-vehicle)	20	20	20	20	20	20	20	20	20	20
Travel Speeds										
between collection stops (mi./hr)	5	5	5	5	5	5	5	5	5	5
from garage to route in the morning (mi./hr)	35	35	35	35	35	35	35	35	35	35
Distances										
distance between collection stops (mi.)	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142
distance between garage and collection route (mi.)	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)	y	y	y	y	n	n	n	n	n	n
number of collectors per vehicle (person/vehicle)	0	0	0	0	1	1	1	1	1	1
Collection Vehicle										
usable vehicle capacity (yd^3)	23	23	23	23	23	23	20	20	20	20
economic life of a vehicle (yr.)	8	8	8	8	8	8	7	7	7	7
unit price of a vehicle ($/vehicle)	59,254	59,254	59,254	59,254	142,210	142,210	154,061	154,061	142,210	142,210
vehicle operation and maintenance cost ($/vehicle)	32,827	32,827	32,827	32,827	31,286	31,286	35,553	35,553	31,286	31,286

Table 3.5. Sector Variable Collection Process Model Input Data
Part 3: Residential Yard Waste Collection (C0, C9)

INPUT PARAMETER	YARD WASTE			
	C0		C9	
Residential Collection Options	Yard Waste			
	Sector 1	Sector 2	Sector 1	Sector 2
Collection Schedule				
number of households at one stop (household/stop)	1.00	1.00	1.00	1.00
collection frequency (1/wk.)	1.00	1.00	1.00	1.00
Collection Operation Times				
loading time at one service stop (min/stop)	0.15	0.15	0.15	0.15
travel time between service stops (min/stop)	0.17	0.17	0.17	0.17
time from garage to route (min/day-vehicle)	20.00	20.00	20.00	20.00
Travel Speeds				
between collection stops (mi./hr)	5.00	5.00	5.00	5.00
from garage to route in the morning (mi./hr)	35.00	35.00	35.00	35.00
Distances				
distance between collection stops (mi.)	0.01	0.01	0.01	0.01
distance between garage and collection route (mi.)	11.67	11.67	11.67	11.67
Labor				
does a driver work as a collector? (y/n)	y	y	y	y
number of collectors per vehicle (person/vehicle)	0.00	0.00	0.00	0.00
Collection Vehicle				
usable vehicle capacity (yd^3)	20.00	20.00	20.00	20.00
economic life of a vehicle (yr.)	7.00	7.00	7.00	7.00
unit price of a vehicle ($/vehicle)	142,210	142,210	177,763	177,763
vehicle operation and maintenance cost ($/vehicle)	31,286	31,286	31,286	31,286

Table 3.5. Sector Variable Collection Process Model Input Data
Part 4: Residential Recyclables Collection (C8) and Yard Waste Drop-Off (C10)

INPUT PARAMETER	RECYCLABLES		YARD WASTE	
	C8		C10	
Residential Collection Options	**Recyclables**		**Yard Waste**	
	Sector 1	Sector 2	Sector 1	Sector 2
Collection Schedule				
number of households at one stop (household/stop)	na	na	na	na
collection frequency (1/wk.)	na	na	na	na
Collection Operation Times				
loading time at one service stop (min/stop)	20	20	na	na
travel time between service stops (min/stop)	na	na	na	na
time from garage to route (min/day-vehicle)	20	20	na	na
Travel Speeds				
between collection stops (mi./hr)	na	na	na	na
from garage to route in the morning (mi./hr)	35	35	na	na
Distances				
distance between collection stops (mi.)	na	na	na	na
distance between garage and collection route (mi.)	11.667	11.667	na	na
Labor				
does a driver work as a collector? (y/n)	y	y	na	na
number of collectors per vehicle (person/vehicle)	0	0	na	na
Collection Vehicle				
usable vehicle capacity (yd^3)	23	23	na	na
economic life of a vehicle (yr.)	8	8	na	na
unit price of a vehicle ($/vehicle)	59,254	59,254	na	na
vehicle operation and maintenance cost ($/vehicle)	32,827	32,827	na	na

Table 3.5. Sector Variable Collection Process Model Input Data
Part 5: Multifamily Refuse Collection and Wet/Dry Collection

INPUT PARAMETER	REFUSE COLLECTION				WET/DRY			
	C13		C16		C17		C18	
Multifamily Collection Options	Refuse Collection				Wet/Dry			
	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2	Sector 1	Sector 2
Collection Schedule								
number of households at one stop (household/stop)	na	na	na	na	na	na	na	na
collection frequency (1/wk.)	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
travel time between service stops (min/stop)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
time from garage to route (min/day-vehicle)	20	20	20	20	20	20	20	20
Travel Speeds								
between collection stops (mi./hr)	10	10	10	10	10	10	10	10
from garage to route in the morning (mi./hr)	35	35	35	35	35	35	35	35
Distances								
distance between collection stops (mi.)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
distance between garage and collection route (mi.)	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
number of collectors per vehicle (person/vehicle)	1	1	1	1	1	1	1	1
Collection Vehicle								
usable vehicle capacity (yd^3)	20	20	20	20	20	20	20	20
economic life of a vehicle (yr.)	7	7	7	7	7	7	7	7
unit price of a vehicle ($/vehicle)	142,210	142,210	142,210	142,210	154,061	154,061	142,210	142,210
vehicle operation and maintenance cost ($/vehicle)	31,286	31,286	31,286	31,286	35,553	35,553	31,286	31,286

Table 3.5. Sector Variable Collection Process Model Input Data
Part 6: Multifamily Recyclables Collection (C14, C15)

INPUT PARAMETER	RECYCLABLES			
	C14		C15	
Multifamily Collection Options	Recyclables			
	Sector 1	Sector 2	Sector 1	Sector 2
Collection Schedule				
number of households at one stop (household/stop)	na	na	na	na
collection frequency (1/wk.)	1	1	1	1
Collection Operation Times				
loading time at one service stop (min/stop)	10	10	10	10
travel time between service stops (min/stop)	1.5	1.5	1.5	1.5
time from garage to route (min/day-vehicle)	20	20	20	20
Travel Speeds				
between collection stops (mi./hr)	10	10	10	10
from garage to route in the morning (mi./hr)	35	35	35	35
Distances				
distance between collection stops (mi.)	0.25	0.25	0.25	0.25
distance between garage and collection route (mi.)	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 (yd^3)	23	23	23	23
economic life of a vehicle (yr.)	8	8	8	8
unit price of a vehicle ($/vehicle)	59,254	59,254	142,210	142,210
vehicle operation and maintenance cost ($/vehicle)	32,827	32,827	31,286	31,286

Table 3.5. Sector Variable Collection Process Model Input Data
Part 7: Commercial Recyclables Collection

INPUT PARAMETER	RECYCLABLES									
	C19									
Commercial Collection Options	RECYCLABLES COLLECTION									
	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10
Collection Schedule										
number of households at one stop (household/stop)	na	na	na	na	na	na	na	na	na	na
collection frequency (1/wk.)	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	5	5
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
time from garage to route (min/day-vehicle)	20	20	20	20	20	20	20	20	20	20
Travel Speeds										
between collection stops (mi./hr)	10	10	10	10	10	10	10	10	10	10
from garage to route in the morning (mi./hr)	35	35	35	35	35	35	35	35	35	35
Distances										
distance between collection stops (mi.)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
distance between garage and collection route (mi.)	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)	y	y	y	y	y	y	y	y	y	y
number of collectors per vehicle (person/vehicle)	0	0	0	0	0	0	0	0	0	0
Collection Vehicle										
usable vehicle capacity (yd^3)	23	23	23	23	23	23	23	23	23	23
economic life of a vehicle (yr.)	8	8	8	8	8	8	8	8	8	8
unit price of a vehicle ($/vehicle)	59,254	59,254	59,254	59,254	59,254	59,254	59,254	59,254	59,254	59,254
vehicle operation and maintenance cost ($/vehicle)	32,827	32,827	32,827	32,827	32,827	32,827	32,827	32,827	32,827	32,827

Table 3.5. Sector Variable Collection Process Model Input Data
Part 8: Commercial MSW/Residuals Collection

INPUT PARAMETER	MSW/RESIDUALS									
	C20									
Commercial Collection Options	MSW/Residuals									
	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10
Collection Schedule										
number of households at one stop (household/stop)	na	na	na	na	na	na	na	na	na	na
collection frequency (1/wk.)	2	2	2	2	2	2	2	2	2	2
Collection Operation Times										
loading time at one service stop (min/stop)	5	5	5	5	5	5	5	5	5	5
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
time from garage to route (min/day-vehicle)	20	20	20	20	20	20	20	20	20	20
Travel Speeds										
between collection stops (mi./hr)	10	10	10	10	10	10	10	10	10	10
from garage to route in the morning (mi./hr)	35	35	35	35	35	35	35	35	35	35
Distances										
distance between collection stops (mi.)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
distance between garage and collection route (mi.)	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
number of collectors per vehicle (person/vehicle)	1	1	1	1	1	1	1	1	1	1
Collection Vehicle										
usable vehicle capacity (yd^3)	20	20	20	20	20	20	20	20	20	20
economic life of a vehicle (yr.)	7	7	7	7	7	7	7	7	7	7
unit price of a vehicle ($/vehicle)	142,210	142,210	142,210	142,210	142,210	142,210	142,210	142,210	142,210	142,210
vehicle operation and maintenance cost ($/vehicle)	31,286	31,286	31,286	31,286	31,286	31,286	31,286	31,286	31,286	31,286

Table 3.6. Collection Process Model Input Data
Part 1: Residential Collection

An arrow indicates that the same value is used in the adjacent cells for other collection options. Thus, this value is to be entered only once in the first cell.

INPUT PARAMETER	REFUSE COLLECTION		CO-COLLECTION		WET/DRY		RECYCLING COLLECTION			YARD WASTE	
	C1	C7	C5	C6	C11	C12	C2	C3	C4	C0	C9
Residential Collection Options	**Mixed Waste**	**Residuals**	**Co-Collection**		**Wet/Dry**		**Recyclables**			**Yard Waste**	
Collection Schedule											
number of working days a week (day/wk.)	5	5	5	5	5	5	5	5	5	5	5
actual working hours a day (hr/vehicle-day)	7	7	7	7	7	7	7	7	7	7	7
working hours a day for wage (hr/person-day)	8	8	8	8	8	8	8	8	8	8	8
Collection Operation Times											
time to unload at disposal facility (min/trip)	15	15	15	20	20	15	20	20	15	15	15
lunch time (min/day-vehicle)	30	30	30	30	30	30	30	30	30	30	30
break time (min/day-vehicle)	30	30	30	30	30	30	30	30	30	30	30
Labor											
worker backup rate (backup worker/collection worker)	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 $/wage$)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46

Table 3.6. Collection Process Model Input Data
Part 1: Residential Collection

INPUT PARAMETER, continued	REFUSE COLLECTION		CO-COLLECTION		WET/DRY		RECYCLING COLLECTION			YARD WASTE	
	C1	C7	C5	C6	C11	C12	C2	C3	C4	C0	C9
Residential Collection Options, continued	**Mixed Waste**	**Residuals**	**Co-Collection**		**Wet/Dry**		**Recyclables**			**Yard Waste**	
Economic Data, continued											
other expenses rate ($/worker-yr.)	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579	9,579
administrative rate (administrative expense $ /capital & operating cost $)	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
hourly wage for a collector ($/hr-person)	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25
hourly wage for a driver ($/hr-person)	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25
Collection Vehicle											
backup rate for vehicles (backup vehicle/collection vehicle)	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 yd^3/usable yd^3)	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
MSW compartment compaction density (lb./yd^3)	na	na	na	na	na	na	na	na	na	na	na
recyclables compartment density (lb./yd^3)	na	na	na	500	500	na	will supercede entries for individual component densities if entered			na	na
wet waste compaction density (lb./yd^3)	na	na	na	na			na	na	na	na	na
dry waste compaction density (lb./yd^3)	na	na	na	na			na	na	na	na	na
yard waste compaction density (lb./yd^3)	na	na	na	na	na	na	na	na	na		

Table 3.6. Collection Process Model Input Data
Part 1: Residential Collection

INPUT PARAMETER, continued	REFUSE COLLECTION		CO-COLLECTION		WET/DRY		RECYCLING COLLECTION			YARD WASTE	
	C1	C7	C5	C6	C11	C12	C2	C3	C4	C0	C9
Residential Collection Options, continued	**Mixed Waste**	**Residuals**	**Co-Collection**		**Wet/Dry**		**Recyclables**			**Yard Waste**	
Fuel Usage Rates											
while traveling (mi./gal.)	5	5	5	5	5	5	5	5	5	5	5
between collection stops (mi./gal.)	2	2	2	2	2	2	2	2	2	2	2
while idling (gal./hr)	1	1	1	1	1	1	1	1	1	1	1
Airborne Emission Release Rates											
HC release rate (gm/mi.)	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 (gm/mi.)	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 (gm/mi.)	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 (gm/mi.)	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 (gm/mi.)	0	0	0	0	0	0	0	0	0	0	0
Fossil CO_2 release rate (gm/mi.)	543	543	543	543	543	543	543	543	543	543	543
Biomass CO_2 release rate (gm/mi.)	0	0	0	0	0	0	0	0	0	0	0
SOx release rate (gm/mi.)	0	0	0	0	0	0	0	0	0	0	0
CH_4 release rate (gm/mi.)	0	0	0	0	0	0	0	0	0	0	0
Lead release rate (gm/mi.)	0	0	0	0	0	0	0	0	0	0	0
Ammonia release rate (gm/mi.)	0	0	0	0	0	0	0	0	0	0	0
Hydrochloric acid release rate (gm/mi.)	0	0	0	0	0	0	0	0	0	0	0
Waterborne Release Rates											
Dissolved solids (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Suspended solids (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0

Table 3.6. Collection Process Model Input Data
Part 1: Residential Collection

INPUT PARAMETER, continued	REFUSE COLLECTION		CO-COLLECTION		WET/DRY		RECYCLING COLLECTION			YARD WASTE	
	C1	C7	C5	C6	C11	C12	C2	C3	C4	C0	C9
Residential Collection Options, continued	**Mixed Waste**	**Residuals**	**Co-Collection**		**Wet/Dry**		**Recyclables**			**Yard Waste**	
Waterborne Release Rates, continued											
BOD of washdown water (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
COD of washdown water (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Oil (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Sulfuric acid (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Iron (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Ammonia (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Copper (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Cadmium (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Arsenic (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Mercury (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Phosphate (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Selenium (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Chromium (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Lead (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Zinc (lb./gal.)	0	0	0	0	0	0	0	0	0	0	0
Garage/Office											
maintenance area per collection vehicle (ft^2/vehicle)	400	400	400	400	400	400	400	400	400	400	400
office area per collection vehicle (ft^2/vehicle)	20	20	20	20	20	20	20	20	20	20	20
maintenance area electric consumption rate (kWh/day/ft^2)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Table 3.6. Collection Process Model Input Data
Part 1: Residential Collection

INPUT PARAMETER, continued	REFUSE COLLECTION		CO-COLLECTION		WET/DRY		RECYCLING COLLECTION			YARD WASTE	
	C1	C7	C5	C6	C11	C12	C2	C3	C4	C0	C9
Residential Collection Options, continued	**Mixed Waste**	**Residuals**	**Co-Collection**		**Wet/Dry**		**Recyclables**			**Yard Waste**	
Garage/Office, continued											
office area electric consumption rate (kWh/day/ft^2)	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 (gal./day-ft^2)	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)	na	na	na	na	10.00	10.00	10.00	10.00	10.00	na	na
number of bins for each house (bin/house)	na	na	na	na	2	1	1	5	1	na	na
economic life of a bin (yr.)	na	na	na	na	8	8	8	8	8	na	na

Table 3.6. Collection Process Model Input Data
Part 2: Residential Drop-off

INPUT PARAMETER	RECYCLABLES C8	YARD WASTE C10
Residential Drop-off Options		
Collection Schedule		
number of working day a week (day/wk.)	5	na
actual working hours a day (hr/vehicle-day)	7	na
working hours a day for wage (hr/person-day)	8	na
Collection Operation Times		
time to unload at disposal facility (min/trip)	15	na
lunch time (min/day-vehicle)	30	na
break time (min/day-vehicle)	30	na
Labor		
worker backup rate (backup worker/collection worker)	0.10	na
Economic Data		
fringe benefit rate (fringe benefit $/wage$)	0.46	na
other expenses rate ($/worker-year)	9,579	na
administrative rate (administrative expense $/capital & operating cost $)	0.12	na
hourly wage for a collector ($/hr-person)	0.00	na
hourly wage for a driver ($/hr-person)	12.25	na
Collection Vehicle		
backup rate for vehicles (backup vehicle/collection vehicle)	0.10	na
utilization factor (occupied yd^3/usable yd^3)	0.80	na
recyclables compartment density (lb./yd^3)		na
residual waste compaction density (lb./yd^3)	na	na
wet waste compaction density (lb./yd^3)	na	na
dry waste compaction density (lb./yd^3)	na	na
yard waste compaction density (lb./yd^3)	na	
The Participant's Drop-off Vehicle		
roundtrip distance to drop-off site (mi.)	10	10
frequency of trips to drop-off site (trip/month)	2	2
fraction of trips to drop-off site that are dedicated trips	0.50	0.50
drop-off vehicle fuel efficiency (mi./gal.)	20	20
HC release rate (gm/mi.)	0.41	0.41
CO release rate (gm/mi.)	3.4	3.4
NOx release rate (gm/mi.)	1	1
particulates release rate (gm/mi.)	0	0
PM10 release rate (gm/mi.)	0.2	0.2
fossil CO_2 release rate (gm/mi.)	543	543
biomass CO_2 release rate (gm/mi.)	0	0
SOx release rate (gm/mi.)	0	0
CH_4 release rate (gm/mi.)	0	0
Lead release rate (lb./Btu)	0	0
Ammonia release rate (lb./Btu)	0	0
Hydrochloric acid release rate (lb./Btu)	0	0

Table 3.6. Collection Process Model Input Data
Part 3: Multifamily Collection

INPUT PARAMETER	REFUSE COLLECTION		WET/DRY		RECYCLABLES	
	C13	C16	C17	C18	C14	C15
Multifamily Collection Options						
Collection Schedule						
number of working days a week (day/wk.)	5	5	5	5	5	5
actual working hours a day (hr/vehicle-day)	7	7	7	7	7	7
working hours a day for wage (hr/person-day)	8	8	8	8	8	8
Collection Operation Times						
time to unload at disposal facility (min/trip)	15	15	20	15	20	15
lunch time (min/day-vehicle)	30	30	30	30	30	30
break time (min/day-vehicle)	30	30	30	30	30	30
Labor						
worker backup rate (backup worker/collection worker)	0.10	0.10	0.10	0.10	0.10	0.10
Economic Data						
fringe benefit rate (fringe benefit $/wage$)	0.46	0.46	0.46	0.46	0.46	0.46
other expenses rate ($/worker-year)	9,579	9,579	9,579	9,579	9,579	9,579
administrative rate (administrative expense $/capital & operating cost $)	0.12	0.12	0.12	0.12	0.12	0.12
hourly wage for a collector ($/hr-person)	10.25	10.25	10.25	10.25	10.25	10.25
hourly wage for a driver ($/hr-person)	12.25	12.25	12.25	12.25	12.25	12.25
Collection Vehicle						
backup rate for vehicles (backup vehicle/collection vehicle)	0.10	0.10	0.10	0.10	0.10	0.10
utilization factor (occupied yd^3/usable yd^3)	0.80	0.80	0.80	0.80	0.80	0.80
MSW compartment compaction density (lb./yd^3)	500	na	na	na	na	na
recyclables compartment density (lb./yd^3)	na	na		na		
residual waste compaction density (lb./yd^3)	na		na	na	na	na
wet waste compaction density (lb./yd^3)	na	na			na	na
dry waste compaction density (lb./yd^3)	na	na			na	na

Table 3.6. Collection Process Model Input Data
Part 3: Multifamily Collection

INPUT PARAMETER, continued	REFUSE COLLECTION		WET/DRY		RECYCLABLES	
	C13	C16	C17	C18	C14	C15
Multifamily Collection Options, continued						
Fuel Usage Rates						
while traveling (mi./gal.)	5	5	5	5	5	5
between collection stops (mi./gal.)	2	2	2	2	2	2
while idling (gal./hr)	1	1	1	1	1	1
Airborne Emission Release Rates						
HC release rate (gm/mi.)	0.61	0.61	0.61	0.61	0.61	0.61
CO release rate (gm/mi.)	5.03	5.03	5.03	5.03	5.03	5.03
NOx release rate (gm/mi.)	34.02	34.02	34.02	34.02	34.02	34.02
Total particulates release rate (gm/mi.)	0.25	0.25	0.25	0.25	0.25	0.25
PM10 release rate (gm/mi.)	0	0	0	0	0	0
Fossil CO_2 release rate (gm/mi.)	543	543	543	543	543	543
Biomass CO_2 release rate (gm/mi.)	0	0	0	0	0	0
SOx release rate (gm/mi.)	0	0	0	0	0	0
CH_4 release rate (gm/mi.)	0	0	0	0	0	0
Lead release rate (gm/mi.)	0	0	0	0	0	0
Ammonia release rate (gm/mi.)	0	0	0	0	0	0
Hydrochloric acid release rate (gm/mi.)	0	0	0	0	0	0
Waterborne Release Rates						
Dissolved solids (lb./gal.)	0	0	0	0	0	0
Suspended solids (lb./gal.)	0	0	0	0	0	0
BOD of washdown water (lb./gal.)	0	0	0	0	0	0
COD of washdown water (lb./gal.)	0	0	0	0	0	0
Oil (lb./gal.)	0	0	0	0	0	0
Sulfuric acid (lb./gal.)	0	0	0	0	0	0
Iron (lb./gal.)	0	0	0	0	0	0
Ammonia (lb./gal.)	0	0	0	0	0	0
Copper (lb./gal.)	0	0	0	0	0	0
Cadmium (lb./gal.)	0	0	0	0	0	0
Arsenic (lb./gal.)	0	0	0	0	0	0
Mercury (lb./gal.)	0	0	0	0	0	0
Phosphate (lb./gal.)	0	0	0	0	0	0
Selenium (lb./gal.)	0	0	0	0	0	0
Chromium (lb./gal.)	0	0	0	0	0	0
Lead (lb./gal.)	0	0	0	0	0	0
Zinc (lb./gal.)	0	0	0	0	0	0
Containers						
unit price of a container ($/container)	na	na	102.08	102.1	102.078007	102.078
number of containers per location (container/location)	na	na	3	2	5	1
economic life of a container (yr.)	na	na	8	8	8	8

Table 3.6. Collection Process Model Input Data
Part 4: Commercial Collection

INPUT PARAMETER	RECYCLABLES	MSW/Residuals
	C19	C20
Commercial Collection Options		
Collection Schedule		
number of working days a week (day/wk.)	5	5
actual working hours a day (hr/vehicle-day)	7	7
working hours a day for wage (hr/person-day)	8	8
Collection Operation Times		
time to unload at a facility (min/trip)	20	15
lunch time (min/day-vehicle)	30	30
break time (min/day-vehicle)	30	30
Labor		
worker backup rate (backup worker/collection worker)	0.10	0.10
Economic Data		
fringe benefit rate (fringe benefit $/wage$)	0.46	0.46
other expenses rate ($/worker-year)	9,579	9,579
administrative rate (administrative expense $/capital & operating cost $)	0.12	0.12
hourly wage for a collector ($/hr-person)	10.25	10.25
hourly wage for a driver ($/hr-person)	12.25	12.25
Collection Vehicle		
backup rate for collection vehicles (backup vehicle/collection vehicle)	0.10	0.10
vehicle utilization factor (occupied yd^3/usable yd^3)	0.80	0.80
msw compartment compaction density (lb./yd^3)	na	
recyclables compartment density (lb./yd^3)		na
Fuel Usage Rates		
miles per gallon while traveling (mi./gal.)	5	5
miles per gallon between collection stops (mi./gal.)	2	2
gallons/hour while idling (gal./hr)	1	1
Airborne Emission Release Rates		
HC release rate (gm/mi.)	0.61	0.61
CO release rate (gm/mi.)	5.03	5.03
NOx release rate (gm/mi.)	34.02	34.02
Total particulates release rate (gm/mi.)	0.25	0.25
PM10 release rate (gm/mi.)	0	0
Fossil CO_2 release rate (gm/mi.)	543	543
Biomass CO_2 release rate (gm/mi.)	0	0
SOx release rate (gm/mi.)	0	0
CH_4 release rate (gm/mi.)	0	0
Lead release rate (gm/mi.)	0	0
Ammonia release rate (gm/mi.)	0	0
Hydrochloric acid release rate (gm/mi.)	0	0

Table 3.6. Collection Process Model Input Data
Part 4: Commercial Collection

INPUT PARAMETER, continued	RECYCLABLES C19	MSW/Residuals C20
Commercial Collection Options, continued		
Waterborne Release Rates		
Dissolved solids (lb./gal.)	0	0
Suspended solids (lb./gal.)	0	0
BOD of washdown water (lb./gal.)	0	0
COD of washdown water (lb./gal.)	0	0
Oil (lb./gal.)	0	0
Sulfuric acid (lb./gal.)	0	0
Iron (lb./gal.)	0	0
Ammonia (lb./gal.)	0	0
Copper (lb./gal.)	0	0
Cadmium (lb./gal.)	0	0
Arsenic (lb./gal.)	0	0
Mercury (lb./gal.)	0	0
Phosphate (lb./gal.)	0	0
Selenium (lb./gal.)	0	0
Chromium (lb./gal.)	0	0
Lead (lb./gal.)	0	0
Zinc (lb./gal.)	0	0
Containers		
number of containers at each location (container/location)	5	na

Table 3.7. Compaction Factors for Collection Options

The compaction factor represents the increased density of any components that are compacted during collection. The compaction factor for recyclables component is applied to the user input data.

MSW COMPONENT	COMPACTION FACTORS									
	C2	C3	C4	C6	C8	C11	C14	C15	C17	C19
Leaves	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Grass	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Branches	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Old Newsprint	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Old Corrugated Cardboard	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Office Paper	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Phone Books	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Books	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Old Magazines	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Third Class Mail	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Paper - Other #1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Paper - Other #2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Paper - Other #3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Paper - Other #4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Paper - Other #5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CCCR - Other	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Mixed Paper	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
HDPE - Translucent	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
HDPE - Pigmented	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PET	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Plastic - Other #1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Plastic - Other #2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Plastic - Other #3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Plastic - Other #4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Plastic - Other #5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Mixed Plastic	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CCNR - Other	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ferrous Cans	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ferrous Metal - Other	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Aluminum Cans	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Aluminum - Other #1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 3.7. Compaction Factors for Collection Options

MSW COMPONENT, continued	COMPACTION FACTORS									
	C2	C3	C4	C6	C8	C11	C14	C15	C17	C19
Aluminum - Other #2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Glass - Clear	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Glass - Brown	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Glass - Green	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Mixed Glass	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CNNR - Other	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Paper - Nonrecyclable	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Food Waste	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CCCN - Other	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Plastic - Nonrecyclable	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Misc. (CNNN)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CCNN - Other	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ferrous - Nonrecyclable	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Aluminum - Nonrecyclable	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Glass - Nonrecyclable	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Misc. (NNNN)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CNNN - Other	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 3.8. Part 1: Residential Collection Travel Parameters

Collection Options in Group 1 include those that would have the same collection-related parameters regardless of the destination node. These include C1, C7, C5 and C6. These collection options are similar enough that the garage would be located in the same place regardless of which collection options are implemented.

Collection Options in Group 2 include those that would have the same collection-related parameters regardless of the destination node. These 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.

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential (All residential parameters are sensitive.)											
			Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Rail Transfer (RT1)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Mixed Refuse Transfer (TR1)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	10.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	11.67	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.)											
			Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Mixed Refuse Transfer (TR1), continued	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Commingled Recyclables Transfer (TR2)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Co-collected Transfer Station (TR3)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.)											
			Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Co-collected Transfer Station (TR3), continued	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Co-collected Transfer Station (TR4)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Presorted Transfer Station (TR5)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.)											
			Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Presorted Transfer Station (TR5)	time between facility and garage	min/day-vehicle	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 between 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
Mixed Refuse MRF (S1)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Presorted MRF (S2)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.) Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Commingled Recyclables (S3)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Commingled Recyclables (bags, 1 compartment) (S4)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.)											
			Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Commingled Recyclables (bags, 2 compartment) (S5)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Yard Waste Composting (T1)	distance between collection route and facility	mi.	11.00	11.00	na	10.00	10.00	15.00	12.00	12.00	na	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	na	11.67	11.67	11.67	14.00	14.00	na	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	na	30.00	30.00	30.00	31.00	31.00	na	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	na	35.00	35.00	35.00	36.00	36.00	na	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	20.00	20.00	na	20.00	20.00	20.00	20.00	20.00	na	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	na	20.00	20.00	20.00	20.00	20.00	na	20.00	20.00	20.00

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.)											
			Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Combustion (T3)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Refuse-Derived Fuel (T5)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.) Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Mixed Waste Composting (T7)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Anaerobic Digestion (T8)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.)											
			Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Landfill (D1)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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
Enhanced Bioreactor (D3)	distance between collection route and facility	mi.	11.00	11.00	15.00	10.00	10.00	15.00	12.00	12.00	15.00	12.00	12.00	12.00
	distance between facility and garage	mi.	13.00	13.00	14.00	11.67	11.67	11.67	14.00	14.00	14.00	14.00	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	31.00	31.00	30.00	31.00	31.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	36.00	36.00	35.00	36.00	36.00	36.00
	time between facility and garage	min/day-vehicle	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 between 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

Table 3.8. Part 1: Residential Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	Residential, continued (All residential parameters are sensitive.)											
			Sector 1						Sector 2					
			Group 1	Group 2	C17/ C18	C0	C9	C8	Group 1	Group 2	C17/ C18	C0	C9	C8
Waste as Fuel (Leaves)	distance between collection route and facility	mi.					11.00						12.00	
	distance between facility and garage	mi.					11.67						14.00	
	speed between collection route and facility	mi./hr					30.00						31.00	
	speed between facility and garage	mi./hr					35.00						36.00	
	time between facility and garage	min/day-vehicle					20.00						20.00	
	time between route and facility	min/trip					20.00						20.00	

Table 3.8. Part 2: Multifamily Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	MULTIFAMILY (All multifamily parameters are sensitive.)			
			Sector 1		Sector 2	
			C17/C18	All Others	C17/C18	All Others
Rail Transfer (RT1)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Mixed Refuse Transfer (TR1)	distance between collection route and facility	mi.	15.00	10.00	10.00	12.00
	distance between facility and garage	mi.	14.00	11.67	11.67	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Commingled Recyclables Transfer (TR2)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Co-collected Transfer Station (TR3)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00

Table 3.8. Part 2: Multifamily Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	MULTIFAMILY, continued (All multifamily parameters are sensitive.)			
			Sector 1		Sector 2	
			C17/C18	All Others	C17/C18	All Others
Co-collected Transfer Station (TR3), continued	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Co-collected Transfer Station (TR4)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Presorted Transfer Station (TR5)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Mixed Refuse MRF (S1)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00

Table 3.8. Part 2: Multifamily Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	MULTIFAMILY, continued (All multifamily parameters are sensitive.)			
			Sector 1		Sector 2	
			C17/C18	All Others	C17/C18	All Others
Presorted MRF (S2)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Commingled Recyclables (S3)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Commingled Recyclables (bags, 1 compartment) (S4)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Commingled Recyclables (bags, 2 compartments) (S5)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00

Table 3.8. Part 2: Multifamily Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	MULTIFAMILY, continued (All multifamily parameters are sensitive.)			
			Sector 1		Sector 2	
			C17/C18	All Others	C17/C18	All Others
Commingled Recyclables (bags, 2 compartment) (S5), continued	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Yard Waste Composting (T1)	distance between collection route and facility	mi.	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na
	time between facility and garage	min/day-vechicle	na	na	na	na
	time between route and facility	min/trip	na	na	na	na
Combustion (T3)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Refuse-Derived Fuel (T5)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Mixed Waste Composting (T7)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00

Table 3.8. Part 2: Multifamily Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	MULTIFAMILY, continued (All multifamily parameters are sensitive.)			
			Sector 1		Sector 2	
			C17/C18	All Others	C17/C18	All Others
Mixed Waste Composting (T7), continued	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Anaerobic Digestion (T8)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Landfill (D1)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00
Enhanced Bioreactor (D3)	distance between collection route and facility	mi.	15.00	10.00	15.00	12.00
	distance between facility and garage	mi.	14.00	11.67	14.00	14.00
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	31.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	36.00
	time between facility and garage	min/day-vechicle	20.00	20.00	20.00	20.00
	time between route and facility	min/trip	20.00	20.00	20.00	20.00

Table 3.8. Part 2: Multifamily Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	MULTIFAMILY, continued (All multifamily parameters are sensitive.)			
			Sector 1		Sector 2	
			C17/C18	All Others	C17/C18	All Others
Waste as Fuel (Leaves)	distance between collection route and facility	mi.	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na
	time between facility and garage	min/day-vechicle	na	na	na	na
	time between route and facility	min/trip	na	na	na	na

Table 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Rail Transfer (RT1)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Commingled Recyclables Transfer (TR2)	distance between collection route and facility	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between facility and garage	min/day-vehicle	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between route and facility	min/trip	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Co-collected Transfer Station (TR3)	distance between collection route and facility	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between facility and garage	min/day-vehicle	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between route and facility	min/trip	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

Table 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Co-collected Transfer Station (TR4)	distance between collection route and facility	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between facility and garage	min/day-vehicle	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between route and facility	min/trip	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Presorted Transfer Station (TR5)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Mixed Refuse MRF (S1)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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
Presorted MRF (S2)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Commingled Recyclables (S3)	distance between collection route and facility	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between facility and garage	min/day-vehicle	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between route and facility	min/trip	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Commingled Recyclables (bags, 1 compartment) (S4)	distance between collection route and facility	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between facility and garage	min/day-vehicle	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between route and facility	min/trip	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

Table 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Commingled Recyclables (bags, 2 compartment) (S5)	distance between collection route and facility	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between facility and garage	min/day-vehicle	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between route and facility	min/trip	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Yard Waste Composting (T1)	distance between collection route and facility	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between facility and garage	min/day-vehicle	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between route and facility	min/trip	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

Table 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Combustion (T3)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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
Refuse-Derived Fuel (T5)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Mixed Waste Composting (T7)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Landfill (D1)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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)	distance between collection route and facility	mi.	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	distance between facility and garage	mi.	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67	11.67
	speed between collection route and facility	mi./hr	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	speed between facility and garage	mi./hr	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
	time between facility and garage	min/day-vehicle	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 between 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 3.8. Part 3: Commercial Collection Travel Parameters

RELATIVE TO NODE	TRAVEL PARAMETER	UNIT	COMMERCIAL, continued (All commercial parameters are sensitive.)																			
			Sector 1		Sector 2		Sector 3		Sector 4		Sector 5		Sector 6		Sector 7		Sector 8		Sector 9		Sector 10	
			C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20	C19	C20
Waste as Fuel (Leaves)	distance between collection route and facility	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	distance between facility and garage	mi.	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between collection route and facility	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	speed between facility and garage	mi./hr	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between facility and garage	min/day-vehicle	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	time between route and facility	min/trip	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

4. Transfer Station Process Model

Overview

Transfer stations are used in some MSW management strategies to more efficiently transport waste and recyclable materials from collection vehicles to various management options. The transfer station process model calculates cost and LCI coefficents for MSW and recyclables transfer stations. Costs and LCI parameters are calculated on the basis of user input and default facility design information and incorporates both the quantity and composition of the waste entering transfer stations. The results of the model are used in the decision support tool to calculate the total system cost and LCI for MSW management alternatives that involve transfer stations.

Conceptual Designs

The transfer station process model includes five types of roadway vehicle transfer stations and three types of rail transfer stations:

TR1: **Processing mixed MSW.** For mixed waste transfer stations, the user selects from five design options. The major differences between these design options are single- or multilevel design, the presence or absence of a compactor, and the type of rolling stock required.

TR2: **Processing commingled recyclables.** At a commingled recyclables transfer station, recyclables are loaded from collection vehicles into tractor trailers. As for TR1, the user can select from the same five transfer station designs. However, in all TR2 designs, paper recyclables are processed separately.

TR3: **Processing separately bagged mixed waste, nonpaper recyclables, and paper recyclables in a single compartment.** Single-compartment co-collection vehicles have paper recyclables in one bag, nonpaper recyclables in a second bag, and mixed refuse in a third bag in one compartment of the collection vehicle. Mixed waste is collected in black bags, and recyclables are collected in blue bags. The facility area for TR3 consists of a tipping floor for mixed black and blue bags, a storage area for separated blue bags, and separate loading areas for blue and black bags.

TR4: **Processing separately bagged mixed waste, nonpaper recyclables, and paper recyclables in separate compartments.** Three-compartment collection vehicles deliver source-separated mixed refuse (in black bags), nonpaper commingled recyclables (in blue bags), and paper recyclables (in blue bags) to TR4. Non-paper recyclables are unloaded onto a tipping floor and then paper recyclables are also loaded into a trailer with front-end loaders. Mixed refuse is directly tipped into a compactor via a hopper.

TR5: **Processing presorted recyclables.** A presorted recyclable transfer station is expected to operate at low capacities relative to other transfer stations. The facility is a simple design that includes a roof but no walls. Recyclables are unloaded into separate roll-on/roll-off containers with adequate collection vehicle maneuvering. A small backhoe is used for material handling. Full containers are removed from loading areas and stored on site until transported.

RT1: **Rail transfer of MSW from collection vehicles.** Mixed refuse is transferred from collection vehicles to a rail car at RT1. The user selects from two design options for RT1 transfer stations—the first is a one-level design and the second is a two-level design. For the one-level design, a crane is used to load containers. For the two-level design, refuse is pushed from the tipping floor into a compactor. The cost of rail spurs connecting the transfer station to existing local rail lines is included in the RT1 construction cost.

RT2: **Rail transfer of MSW from trains to landfill.** At the landfill rail haul transfer station, a crane unloads incoming containers of MSW into a storage area. Stored containers are loaded onto tractors, then hauled to the landfill working face. Tippers unload containers by inclining them greater than 60 degrees from horizontal.

RT3: **Rail transfer of MSW from trains to enhanced bioreactor landfill.** The design of rail transfer stations receiving containers at an enhanced bioreactor is the same as the design for RT2.

The following general description applies to all of the transfer station designs. Transfer stations require a covered structure that houses collection vehicle unloading areas, trailer- loading bays, refuse tipping floor space, and office space. Collection vehicles enter through a scale house, then proceed to unloading areas. Therefore, the site is partially paved to accommodate maneuvering of both collection and transport vehicles and container storage. Facility staff operate waste handling equipment to load and distribute refuse in hauling containers and to move refuse on the tipping floor. Office space includes an employee rest area and an administrative work area. The loading bay area includes a trailer footprint and trailer maneuvering space. The cost of refuse drop-off areas open to the general public is included in the construction cost for each design.

Cost Methodology

The cost of a transfer station depends on the design of station, the quantity and type of materials processed, and user input data (e.g., wage rates for transfer station workers). Costs are divided into capital costs and operation and maintenance costs.

Capital Cost

Capital cost consists of construction, land acquisition, engineering, and equipment cost that can be expressed in annual terms using a given capital recovery factor that is dependent upon a book lifetime and discount rate. For example:

- Construction cost includes the cost of the structure, paving, access roads, fencing, landscaping, and various other items. For rail transfer stations, the paving and site work includes the cost of all spurs that connect the facility to local rail lines. The cost of the structure includes support facilities such as office space and weigh stations. Construction cost is obtained by multiplying the floor area of the transfer station by the construction cost rate.

- Total area for a transfer station includes the area for the structure, access roads, fencing, weigh station, landscaping, etc. Total area multiplied with a cost rate gives the land acquisition cost.
- Engineering cost consists of fees paid for consulting and technical services for the transfer station planning and construction, and is estimated to be a fraction of the construction cost.
- Equipment cost consists of the capital and installation cost of equipment such as rolling stock and compactors.

Operation and Maintenance Cost

The operating and maintenance cost of the transfer station includes wages, overhead, equipment and building maintenance, and utilities. For example:

- Labor required for the transfer station consists of management, drivers, and equipment operators. In estimating the labor wages, it is assumed that part-time services can be hired. Management includes managers, supervisors, and secretaries. The wages paid for management are assumed to be a fraction of the wages paid to drivers and equipment operators.
- Overhead costs for labor are calculated as a fraction of labor wages. Overhead includes overtime, office supplies, fringe benefits, and temporary labor. The overhead rate is flexible and can be defined by the user to cover their specific labor situation.
- The cost of maintenance of equipment and structure is assumed to be proportional to the weight of materials processed in the transfer station.
- The cost of utilities (power, fuel, oil, etc.) is proportional to the weight of material processed in the transfer station.

Life-Cycle Inventory Methodology

The LCI methodology calculates energy consumption (or production) and environmental releases (air, water, and solid waste) from a transfer station and allocates these LCI parameters to individual components of the waste stream.

Energy

Transfer stations consume two main types of energy: fuels for rolling stock and electricity for equipment, lighting, and heating. The energy calculations for the LCI include both combustion and precombustion energy consumption. Combustion energy is the fuel or electricity consumed to operate rolling stock, lighting and heating. Precombustion energy refers to the energy consumed to produce the fuel and electricity used to operate the transfer station. The transfer station process model uses default or user-supplied data for fuel consumed by rolling stock, for heating and lighting purposes, and for processing equipment to calculate the total quantity of energy consumed per ton of material processed. Default data on the energy required to produce a unit of electricity, including its precombustion energy, are included in the electrical energy process model documentation.

Air Emissions

The transfer station process model accounts for airborne releases from two sources: (1) the pollutants released when fuel is combusted in a vehicle (combustion releases), and (2) the pollutants emitted when the fuel or electricity was produced (precombustion releases). Data for fuel and electricity generation production are included in the electrical energy process model documentation.

Water Releases

The transfer station process model accounts for waterborne pollutant emissions associated with the process related and precombustion water releases. Although there are placeholder cells in the input data sheets or process-related water releases as they relate to facility and equipment wash down but the defaults are currently set at zero. Default values for water releases from energy production are provided in the electrical energy process model documentation.

Solid Waste Releases

The transfer station process model uses the energy consumed by equipment and heat and light of the transfer station building to calculate the solid waste generated. Solid waste generation is expressed in terms of pounds of pollutant per ton of material processed. Note that the solid waste referred to in this section pertains to the waste generated when energy is produced. Default values for solid wastes generated due to energy production are provided in the electrical energy process model.

Table 4.1. Transfer Station Design Types

DESIGN NUMBER	TIPPING FLOOR/ DIRECT TIP	LOADING BAY TYPE	COMPACTION	LOADING EQUIPMENT
1	tipping floor	1 level	no	excavator, front-end loader, loading bay scale
2	tipping floor	2 level	no	front-end loader
3	direct tip	2 level	no	backhoe
4	tipping floor	1 level	yes	front-end loader
5	direct tip	2 level	yes	backhoe

Table 4.2. Mixed Waste Transfer Station (TR1)

INPUT PARAMETER	UNIT	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
Economic						
Life of Transfer Station Structure	yr.	20	20	20	20	20
Operating Hours						
Working Day Length	hr	8	8	8	8	8
Effective Working Day Length	hr	7	7	7	7	7
Number of Workdays per Year	day	260	260	260	260	260
Facility Construction Data						
Construction Rate	$/ft^2$	41	41	41	41	41
Engineering, Permitting, and Contingency Rate (% building and site cost)	%	30	30	30	30	30
Land Acquisition Rate	$/ac	1,089	1,089	1,089	1,089	1,089
Paving and Site Work	$/ft^2$	1.70	1.70	1.70	1.70	1.70
Equipment Installation Rate (% of equipment cost)	%	5	5	5	15	15
Data for Area Calculation						
Height of Refuse on Tipping Floor	ft	10	10	10	10	10
Storage Time on Tipping Floor	day	1	1	0.25	1	0.25
Trailer Load Time for Continuous Loading from Tipping Floor	hr	0.15	0.25	na	0.25	na
Trailer Load Time for Peak Direct Tip Collection Vehicle Traffic	hr	na	na	0.4	na	0.5
Trailer Replace Time	hr	0.2	0.2	0.2	0.2	0.2
Haul Trailer Volume	yd^3	100	100	100	100	100
Transfer Vehicle Density	lb./yd^3	450	450	450	550	550
Area Required for one Trailer/Loading Bay	ft^2	1,800	1,200	1,200	1,500	1,500
Collection Vehicle Unload Time	hr	0.15	0.15	0.15	0.2	0.2

Table 4.2. Mixed Waste Transfer Station (TR1)

Peak Collection Vehicle Arrival Factor	no unit	1.5	1.5	1.5	1.5	1.5
INPUT PARAMETER, continued	**UNIT**	**DESIGN 1**	**DESIGN 2**	**DESIGN 3**	**DESIGN 4**	**DESIGN 5**
Data for Area Calculation, continued						
Weight of Load of Incoming Collection Vehicle	lb.	14,000	14,000	14,000	14,000	14,000
Single Collection Vehicle Unloading Area	ft^2	525	525	525	525	525
Office Area (% of tipping floor)	%	10	10	10	10	10
Land Requirement (multiple of building area)	no unit	10	10	10	10	10
	TPD is defined as ton per day.					
Equipment Cost Data						
Rolling Stock Cost Rate	$/TPD	888	1423	911	541	266
Compactor and Hopper Cost Rate	$/TPD	0	0	0	170	207
Rolling Stock Life	yr.	10	10	10	10	10
Compactor Life	yr.	10	10	10	10	10
Operating and Maintenance						
Labor						
equipment operator requirement	hr/day-TPD	4.68E-02	6.98E-02	9.68E-02	5.12E-02	5.12E-02
equipment operator and labor wage rate	$/hr	11	11	11	11	11
management rate	% of labor	30	30	30	30	30
Maintenance						
equipment	% cost	5	5	5	5	5
building	$/TPD-yr.	3.54	3.54	3.54	3.54	3.54
Fuel and Energy						
building electric energy usage	$kWh/ft^2/day$	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03
compactor electric energy usage	kWh/ton	na	na	na	0.53	0.53
rolling stock fuel usage	gal./ton MSW	8.45E-02	1.41E-01	7.13E-02	7.92E-02	3.76E-02

Table 4.2. Mixed Waste Transfer Station (TR1)

INPUT PARAMETER, continued	UNIT	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
LCI Input Values						
Rolling Stock Emissions						
particulates (PM10)	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total particulates	lb./ton	5.65E-03	9.31E-03	1.05E-02	6.63E-03	5.52E-03
nitrogen oxides	lb./ton	7.59E-02	1.27E-01	9.15E-02	9.90E-02	4.83E-02
hydrocarbons (non-CH_4)	lb./ton	5.32E-03	9.23E-03	1.03E-02	8.65E-03	5.42E-03
sulfur oxides	lb./ton	6.68E-03	1.11E-02	6.08E-03	8.17E-03	3.21E-03
carbon monoxide	lb./ton	1.87E-02	3.10E-02	3.97E-02	2.31E-02	2.10E-02
CO_2 (biomass)	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO_2 (non-biomass)	lb./ton	1.94E+00	3.25E+00	1.64E+00	1.82E+00	8.66E-01
ammonia	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
lead	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
methane	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
hydrochloric acid	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Washdown Rate						
Facility Washdown Water Volume	gal./ft^2-wash	0.2	0.2	0.2	0.2	0.2
Washdown Rate	wash/month	1	1	1	1	1
Waterborne Release Rates						
Dissolved solids	lb./gal.					
Suspended solids	lb./gal.					
BOD of washdown water	lb./gal.					
COD of washdown water	lb./gal.					
Oil	lb./gal.					
Sulfuric acid	lb./gal.					
Iron	lb./gal.					
Ammonia	lb./gal.					
Copper	lb./gal.					

Table 4.2. Mixed Waste Transfer Station (TR1)

INPUT PARAMETER, continued	UNIT	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
Waterborne Release Rates, continued						
Cadmium	lb./gal.					
Arsenic	lb./gal.					
Mercury	lb./gal.					
Phosphate	lb./gal.					
Selenium	lb./gal.					
Chromium	lb./gal.					
Lead	lb./gal.					
Zinc	lb./gal.					

Table 4.3. Commingled Recyclables Transfer Station (TR2)

INPUT PARAMETER	UNIT	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
Economic						
Life of Transfer Station Structure	yr.	20	20	20	20	20
Glass Breakage Factor	fraction	0.3	0.3	0.3	0.3	0.3
Operating Hours						
Working Day Length	hr	8	8	8	8	8
Effective Working Day Length	hr	7	7	7	7	7
Number of Workdays per Year	day	260	260	260	260	260
Facility Construction Data						
Construction Rate	$/ft^2	41	41	41	41	41
Engineering, Permitting, and Contingency Rate	%	30	30	30	30	30
Land Acquisition Rate	$/ac	1,089	1,089	1,089	1,089	1,089
Paving and Site Work	$/ft^2	1.70	1.70	1.70	1.70	1.70
Equipment Installation Rate (% of equipment cost)	%	5	5	5	15	15
Nonfiber Recyclables Processing Area						
Height of Refuse on Tipping Floor	ft	10	10	10	10	10
Storage Time on Tipping Floor	day	1	1	0.25	1	0.25
Trailer Load Time for Continuous Loading	hr	0.15	0.25	na	0.25	na
Trailer Load Time for Peak Direct Tip Vehicle Traffic	hr	na	na	0.4	na	0.5
Trailer Replace Time	hr	0.2	0.2	0.2	0.2	0.2
Haul Trailer Volume	yd^3	100	100	100	100	100
Area Required for one Trailer/Loading Bay	ft^2	1,800	1,200	1,200	1,500	1,500
Collection Vehicle Unload Time	hr	0.15	0.15	0.15	0.2	0.2
Peak Collection Vehicle Arrival Factor	no unit	1.5	1.5	1.5	1.5	1.5
Collection Vehicle Volume	yd^3	22	22	22	22	22
Single Collection Vehicle Unloading Area	ft^2	525	525	525	525	525

Table 4.3. Commingled Recyclables Transfer Station (TR2)

INPUT PARAMETER, continued	UNIT	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
Fibrous Content Material Processing Area						
Height of Refuse on Tipping Floor	ft	10	10	10	10	10
Storage Time on Tipping Floor	day	1	1	1	1	1
Trailer Load Time for Continuous Loading	hr	0.4	0.4	0.4	0.4	0.4
Trailer Replace Time	hr	0.2	0.2	0.2	0.2	0.2
Haul Trailer Volume	yd^3	100	100	100	100	100
Area Required for one Trailer/Loading Bay	ft^2	1200	1200	1200	1200	1200
Collection Vehicle Unload Time	hr	0.15	0.15	0.15	0.15	0.15
Peak Collection Vehicle Arrival Factor	no unit	1.5	1.5	1.5	1.5	1.5
Collection Vehicle Volume	yd^3	6	6	6	6	6
Single Collection Vehicle Unloading Area	ft^2	525	525	525	525	525
General Area						
Office Area (% of tipping floor)	%	10	10	10	10	10
Land Requirement (multiple of building area)	no unit	10	10	10	10	10
Equipment Cost Data						
Recyclables Rolling Stock Cost Rate	$/$yd^3$-day	210	240	115	130	63
Compactor and Hopper Cost Rate	$/$yd^3$-day	0.00	0.00	0.00	40.45	38.10
Fibrous Content Material Rolling Stock Cost Rate	$/TPD	108	108	108	108	108
Rolling Stock Life	yr.	10.00	10.00	10.00	10.00	10.00
Compactor Life	yr.	10.00	10.00	10.00	10.00	10.00
Operating and Maintenance						
Labor						
Recyclables Equipment Operator Requirement	hr/day-CYPD	1.64E-02	9.69E-03	8.29E-03	1.23E-02	1.23E-02
Fibrous Content Material Equipment Operator Requirement	hr/day-CYPD	1.42E-03	1.42E-03	1.42E-03	1.42E-03	1.42E-03

TPD is defined as ton per day.

CYPD is defined as cubic yard per day.

Table 4.3. Commingled Recyclables Transfer Station (TR2)

INPUT PARAMETER, continued	UNIT	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
Operating and Maintenance, continued						
Labor, continued						
Equipment Operator and Labor Wage Rate	\$/hr	11	11	11	11	11
Management Rate	% of labor	30	30	30	30	30
Maintenance						
Equipment	% cost	5	5	5	5	5
Building	\$/yr./yd^3/day of waste	3.5	3.5	3.5	3.5	3.5
Fuel and Energy						
Building Electric Energy Usage	kWh/ft^2/day	0.001	0.001	0.001	0.001	0.001
Compactor Electric Energy Usage	kWh/yd^3	na	na	na	0.53	0.53
Recyclables Rolling Stock Fuel Usage	gal./yd^3 MSW	1.95E-02	2.27E-02	8.99E-03	2.60E-02	8.99E-03
Fibrous Content Material Rolling Stock Fuel Usage	gal./ton ONP	1.41E-02	1.41E-02	1.41E-02	1.41E-02	1.41E-02
LCI Input Values						
Recyclables Rolling Stock Emissions						
particulates (PM10)	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total particulates	lb./yd^3	1.29E-03	1.52E-03	1.32E-03	1.58E-03	1.32E-03
nitrogen oxides	lb./yd^3	1.75E-02	2.10E-02	1.15E-02	2.36E-02	1.15E-02
hydrocarbons (non-CH_4)	lb./yd^3	1.27E-03	1.58E-03	1.29E-03	2.06E-03	1.29E-03
sulfur oxides	lb./yd^3	1.53E-03	1.82E-03	7.66E-04	1.95E-03	7.66E-04
carbon monoxide	lb./yd^3	4.28E-03	5.10E-03	5.01E-03	5.50E-03	5.01E-03
CO_2 (biomass)	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO_2 (non-biomass)	lb./yd^3	4.48E-01	5.21E-01	2.07E-01	5.98E-01	2.07E-01
ammonia	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
lead	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
methane	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
hydrochloric acid	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 4.3. Commingled Recyclables Transfer Station (TR2)

INPUT PARAMETER, continued	UNIT	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
LCI Input Values, continued						
Fibrous Content Material Rolling Stock Emissions						
particulates (PM10)	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total particulates	lb./yd^3	8.58E-04	8.58E-04	8.58E-04	8.58E-04	8.58E-04
nitrogen oxides	lb./yd^3	1.28E-02	1.28E-02	1.28E-02	1.28E-02	1.28E-02
hydrocarbons (non-CH_4)	lb./yd^3	1.12E-03	1.12E-03	1.12E-03	1.12E-03	1.12E-03
sulfur oxides	lb./yd^3	1.06E-03	1.06E-03	1.06E-03	1.06E-03	1.06E-03
carbon monoxide	lb./yd^3	2.98E-03	2.98E-03	2.98E-03	2.98E-03	2.98E-03
CO_2 (biomass)	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO_2 (non-biomass)	lb./yd^3	3.24E-01	3.24E-01	3.24E-01	3.24E-01	3.24E-01
ammonia	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
lead	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
methane	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
hydrochloric acid	lb./yd^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Washdown Rate						
Facility Washdown Water Volume	gal./ft^2	0.2	0.2	0.2	0.2	0.2
Washdown Rate	wash/month	1	1	1	1	1
Waterborne Release Rates						
Dissolved solids	lb./gal.					
Suspended solids	lb./gal.					
BOD of washdown water	lb./gal.					
COD of washdown water	lb./gal.					
Oil	lb./gal.					
Sulfuric acid	lb./gal.					
Iron	lb./gal.					
Ammonia	lb./gal.					
Copper	lb./gal.					

Table 4.3. Commingled Recyclables Transfer Station (TR2)

INPUT PARAMETER, continued	UNIT	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
Waterborne Release Rates, continued						
Cadmium	lb./gal.					
Arsenic	lb./gal.					
Mercury	lb./gal.					
Phosphate	lb./gal.					
Selenium	lb./gal.					
Chromium	lb./gal.					
Lead	lb./gal.					
Zinc	lb./gal.					

Table 4.4. Transfer Stations TR3 and TR4

TR3: Single-compartment co-collection transfer station, ONP separate (C5).
TR4: Co-collection in separate-compartment transfer station, ONP separate

INPUT PARAMETER	UNIT	TR3	TR4
Economic			
Life of Transfer Station Structure	yr.	20	20
Operating Hours			
Working Day Length	hr	8	8
Effective Working Day Length	hr	7	7
Number of Workdays per Year	day	260	260
Facility Construction Data			
Construction Rate	$\$/ft^2$	41	41
Engineering, Permitting, and Contingency Rate (% building and site cost)	%	30	30
Land Acquisition Rate	$/ac	1,089	1,089
Paving and Site Work	$\$/ft^2$	1.70	1.70
Equipment Installation Rate (% of equipment cost)	%	15	15
Data for Area Calculation			
Collection Vehicle Unloading Area			
Collection Vehicle Unload Time	hr	0.15	0.15
Collection Vehicle Weight of Load	lb.	500	500
Co-collection Compartment Usable Volume	yd^3	16	16
Peak Collection Vehicle Arrival Factor	no unit	1.5	1.5
Single Collection Vehicle Unloading Area	ft^2	525	525
Mixed Refuse Tipping Floor Area			
Height of Refuse on Tipping Floor	ft	10	10
Storage Time on Tipping Floor	day	1	1
Mixed Refuse Trailer Loading Area			
Trailer Load Time for Continuous Loading	hr	0.25	0.25
Trailer Replace Time	hr	0.2	0.2
Haul Trailer Volume	yd^3	100	100
Transfer Vehicle Density	$lb./yd^3$	500	500
Area Required for one Trailer/Loading Bay	ft^2	1500	1500
Recyclable Storage Area			
Height of Blue Bags	ft	10	10

Table 4.4. Transfer Stations TR3 and TR4

INPUT PARAMETER, continued	UNIT	TR3	TR4
Data for Area Calculation, continued			
Recyclable Storage Area, continued			
Loose Aggregate Blue Bag Density	lb./yd^3	133	133
Storage Time on Tipping Floor	day	0.25	0.25
Recyclable Trailer Loading Area			
Recyclables Haul Vehicle Load Time	hr	1.5	1.5
Trailer Replace Time	hr	0.25	0.25
Haul Trailer Volume	yd^3	100	100
Transfer Vehicle Density	lb./yd^3	162	162
Fibrous Content Material (FCM) Processing Area			
Collection Vehicle Unloading Area			
fibrous material collection vehicle unload time	hr	0.15	0.15
fibrous material compartment usable volume	yd^3	16	16
peak collection vehicle arrival factor	no unit	1.5	1.5
single collection vehicle unloading area	ft^2	525	525
FCM Tipping Floor Area			
height of refuse on tipping floor	ft	10	10
storage time on tipping floor	day	1	1
FCM Trailer Loading Area			
trailer load time for continuous loading	hr	0.25	0.25
trailer replace time	hr	0.2	0.2
haul trailer volume	yd^3	100	100
transfer vehicle density	lb./yd^3	500	500
area required for one trailer/loading bay	ft^2	1,500	1,500
General Area Input Values			
Office Area (% of tipping floor)	%	10	10
Land Requirement(multiple of building area)	no unit	10	10
Equipment Cost Data			
Mixed Refuse Rolling Stock Cost Rate	$/TPD	837	837
Mixed Refuse Compactor and Hopper Cost Rate	$/TPD	194	194
Recyclables Rolling Stock Cost Rate	$/yd^3-day	238	238
Mixed Refuse Compactor and Hopper Cost Rate	$/yd^3-day	56	56
FCM Rolling Stock Cost Rate	$/yd^3-day	108	108
Rolling Stock Life	yr.	10	10
Compactor Life	yr.	10	10

TPD is defined as ton per day.

Table 4.4. Transfer Stations TR3 and TR4

CYPD is defined as cubic yard per day.

INPUT PARAMETER, continued	UNIT	TR3	TR4
Operating and Maintenance			
Labor			
manual separation rate	ton/hr	4	na
mixed refuse equipment operator requirement	hr/day-TPD	0.069	0.069
recyclables equipment operator requirement	hr/day-CYPD	0.020	0.020
FCM equipment operator requirement	hr/day-CYPD	0.003	0.003
equipment operator and labor wage rate	$/hr	11	11
management rate	% of labor	30	30
Maintenance			
equipment	% cost	5	5
building	$/TPD-yr.	3.5	3.5
Fuel and Energy			
building electric energy usage	$kWh/ft^2/day$	0.001	0.001
mixed refuse compactor electric energy usage	kWh/ton	0.002	0.002
recyclables compactor electric energy usage	kWh/ton	0.002	0.002
mixed refuse rolling stock fuel usage	gal./ton MSW	0.112	0.112
recyclables rolling stock fuel usage	gal./yd^3 MSW	0.032	0.032
FCM rolling stock fuel usage	gal./ton MSW	0.002	0.002
LCI Input Values			
Mixed Refuse Rolling Stock Emissions			
particulates (PM10)	lb./ton	0.00E+00	0.00E+00
total particulates	lb./ton	9.25E-03	9.25E-03
nitrogen oxides	lb./ton	1.12E-01	1.12E-01
hydrocarbons (non-CH_4)	lb./ton	1.07E-02	1.07E-02
sulfur oxides	lb./ton	8.66E-03	8.66E-03
carbon monoxide	lb./ton	3.35E-02	3.35E-02
CO_2 (biomass)	lb./ton	0.00E+00	0.00E+00
CO_2 (non-biomass)	lb./ton	2.57E+00	2.57E+00
ammonia	lb./ton	0.00E+00	0.00E+00
lead	lb./ton	0.00E+00	0.00E+00
methane	lb./ton	0.00E+00	0.00E+00
hydrochloric acid	lb./ton	0.00E+00	0.00E+00
Recyclables Rolling Stock Emissions			
particulates (PM10)	lb./yd^3	0.00E+00	0.00E+00
total particulates	lb./yd^3	2.63E-03	2.63E-03
nitrogen oxides	lb./yd^3	3.19E-02	3.19E-02
hydrocarbons (non-CH_4)	lb./yd^3	3.05E-03	3.05E-03
sulfur oxides	lb./yd^3	2.46E-03	2.46E-03
carbon monoxide	lb./yd^3	9.54E-03	9.54E-03

Table 4.4. Transfer Stations TR3 and TR4

INPUT PARAMETER, continued	UNIT	TR3	TR4
LCI Input Values, continued			
Recyclables Rolling Stock Emissions, continued			
CO_2 (biomass)	lb./yd^3	0.00E+00	0.00E+00
CO_2 (non-biomass)	lb./yd^3	7.31E-01	7.31E-01
ammonia	lb./yd^3	0.00E+00	0.00E+00
lead	lb./yd^3	0.00E+00	0.00E+00
methane	lb./yd^3	0.00E+00	0.00E+00
hydrochloric acid	lb./yd^3	0.00E+00	0.00E+00
FCM Rolling Stock Emissions			
particulates (PM10)	lb./ton	0.00E+00	0.00E+00
total particulates	lb./ton	8.58E-04	8.58E-04
nitrogen xxides	lb./ton	1.28E-02	1.28E-02
hydrocarbons (non-CH_4)	lb./ton	1.12E-03	1.12E-03
sulfur oxides	lb./ton	1.06E-03	1.06E-03
carbon monoxide	lb./ton	2.98E-03	2.98E-03
CO_2 (biomass)	lb./ton	0.00E+00	0.00E+00
CO_2 (non-biomass)	lb./ton	4.63E-02	4.63E-02
ammonia	lb./ton	0.00E+00	0.00E+00
lead	lb./ton	0.00E+00	0.00E+00
methane	lb./ton	0.00E+00	0.00E+00
hydrochloric acid	lb./ton	0.00E+00	0.00E+00
Washdown Rate			
Facility Washdown Water Volume	gal./ft^2-wash	0.2	0.2
Washdown Rate	wash/month	1	1
Waterborne Release Rates			
Dissolved solids	lb./gal.		
Suspended solids	lb./gal.		
BOD of washdown water	lb./gal.		
COD of washdown water	lb./gal.		
Oil	lb./gal.		
Sulfuric acid	lb./gal.		
Iron	lb./gal.		
Ammonia	lb./gal.		
Copper	lb./gal.		
Cadmium	lb./gal.		
Arsenic	lb./gal.		
Mercury	lb./gal.		
Phosphate	lb./gal.		
Selenium	lb./gal.		
Chromium	lb./gal.		

Table 4.4. Transfer Stations TR3 and TR4

INPUT PARAMETER, continued	UNIT	TR3	TR4
Waterborne Release Rates, continued			
Lead	lb./gal.		
Zinc	lb./gal.		

Table 4.5. Presorted Recyclables Transfer station (TR5)

INPUT PARAMETER	UNIT	PRESORTED RECYCLABLES
Economic		
Life of Transfer Station Structure	yr.	20
Operating Hours		
Working Day Length	hr	8
Effective Working Day Length	hr	7
Number of Workdays per Year	day	260
Facility Construction Data		
Construction Rate	$\$/ft^2$	41
Engineering, Permitting, and Contingency Rate	%	30
Land Acquisition Rate	$/ac	1,089
Paving and Site Work	$\$/ft^2$	1.70
Equipment Installation Rate (% of equipment cost)	%	5
Data for Area Calculation		
Single Maneuvering Space and Trailer Area	ft^2	160
Haul Vehicle Load Time	hr	0.25
Trailer Replace Time	hr	0.2
Haul Trailer Volume	yd^3	35
General Area Input Values		
Office Area (% of tipping floor)	%	10
Land Requirement (multiple of building area)	no unit	10
Equipment Cost Data		
Rolling Stock Cost Rate	$\$/yd^3$-day	30
Rolling Stock Life	yr.	10
	CYPD is defined as cubic yard per day.	
Operating and Maintenance		
Labor		
equipment operator requirement	hr/day-CYPD	0.003
equipment operator and labor wage rate	$/hr	11
management rate	% of labor	0.3
Maintenance		
equipment	% cost	5
building	$/CYPD-yr.	53.2

Table 4.5. Presorted Recyclables Transfer station (TR5)

INPUT PARAMETER, continued	UNIT	PRESORTED RECYCLABLES
Operating and Maintenance, continued		
Fuel and Energy		
building electric energy usage	kWh/ft^2/day	0.001
rolling stock fuel usage	gal./yd^3 MSW	0.004
LCI Input Values		
Rolling Stock Emissions		
particulates (PM10)	lb./yd^3	0.00E+00
total particulates	lb./yd^3	6.40E-04
nitrogen oxides	lb./yd^3	5.60E-03
hydrocarbons (non-CH_4)	lb./yd^3	6.28E-04
sulfur oxides	lb./yd^3	3.72E-04
carbon monoxide	lb./yd^3	2.43E-03
CO_2 (biomass)	lb./yd^3	0.00E+00
CO_2 (non biomass)	lb./yd^3	1.00E-01
ammonia	lb./yd^3	0.00E+00
lead	lb./yd^3	0.00E+00
methane	lb./yd^3	0.00E+00
hydrochloric acid	lb./yd^3	0.00E+00
Washdown Rate		
Facility Washdown Water Volume	gal./ft^2-wash	0.2
Washdown Rate	wash/month	1
Waterborne Release Rates		
Dissolved solids	lb./gal.	
Suspended solids	lb./gal.	
BOD of washdown water	lb./gal.	
COD of washdown water	lb./gal.	
Oil	lb./gal.	
Sulfuric acid	lb./gal.	
Iron	lb./gal.	
Ammonia	lb./gal.	
Copper	lb./gal.	
Cadmium	lb./gal.	
Arsenic	lb./gal.	
Mercury	lb./gal.	
Phosphate	lb./gal.	
Selenium	lb./gal.	
Chromium	lb./gal.	
Lead	lb./gal.	
Zinc	lb./gal.	
Methane	lb./ton	

Table 4.6. Rail Transfer Station

RT1: Transfer of MSW from collection vehicles to rail cars. There are two design types: design 1 is a one-level design and design 2 is a two-level design. For the one-level design, a crane is used to load containers. For the two-level design, refuse is pushed from the tipping floor into a compactor.
RT2: Transfer of MSW from rail cars to landfill.
RT3: MSW rail transfer from trains to enhanced bioreactor.

INPUT PARAMETER	UNIT	RT1		RT2	RT3
		Design 1	Design 2		
Economic					
Life of Transfer Station Structure	yr.	20	20	20	20
Operating Hours					
Working Day Length	hr	8	8	8	8
Effective Working Day Length	hr	7	7	7	7
Number of Workdays per Year	days	260	260	260	260
Facility Construction Data					
Construction Rate	$\$/ft^2$	41	41	41	41
Engineering, Permitting, and Contingency Rate (% building and site cost)	%	30	30	30	30
Land Acquisition Rate	$/ac	1,089	1,089	1,089	1,089
Paving and Site Work	$\$/ft^2$	1.70	1.70	1.70	1.70
Equipment Installation Rate (% of equipment cost)	%	5	5	5	5
Data for Area Calculation					
Height of Refuse on Tipping Floor	ft	10	10	10	10
Storage Time on Tipping Floor	day	1	1	1	1

Table 4.6. Rail Transfer Station

INPUT PARAMETER, continued	UNIT	RT1		RT2	RT3
		Design 1	Design 2		
Data for Area Calculation, continued					
Trailer Load Time for Continuous Loading from Tipping F	hr	0.25	0.4	0.25	0.25
Trailer Replace Time	hr	0.3	0.3	0.3	0.3
Haul Trailer Volume	yd^3	100	100	100	100
Transfer Vehicle Density	$lb./yd^3$	500	500	500	500
Area Required for One Trailer/Loading Bay	ft^2	2,000	2,000	2,000	2,000
Collection Vehicle Unload Time	hr	0.15	0.15	0.15	0.15
Peak Collection Vehicle Arrival Factor	no unit	1.5	1.5	1.5	1.5
Weight of Incoming Vehicle Load	lb.	14,000	14,000	14,000	14,000
Single Collection Vehicle Unloading Area	ft^2	525	525	525	525
Office Area (% of tipping floor)	%	10	10	10	10
Land Requirement (multiple of building area)	no unit	10	10	10	10
	TPD is defined as ton per day.				
Equipment Cost Data					
Rolling Stock Cost Rate	$/TPD	697	430	1,447	1,447
Compactor and Hopper Cost Rate	$/TPD	n/a	935	n/a	n/a
Rolling Stock Life	yr.	10	10	10	10
Compactor Life	yr.	n/a	10	n/a	n/a
Operating and Maintenance					
Labor					
equipment operator requirement	hr/day-TPD	0.034	0.025	0.044	0.044
equipment operator and labor wage rate	$/hr	11.9	11.9	11.9	11.9
management rate	% of labor	30	30	30	30
Maintenance					
equipment	% cost	5	5	5	5
building	$/TPD-yr.	3.9	3.9	3.9	3.9

Table 4.6. Rail Transfer Station

INPUT PARAMETER, continued	UNIT	RT1		RT2	RT3
		Design 1	Design 2		
Operating and Maintenance, continued					
Maintenance, continued					
Fuel and Energy					
building electric energy usage	kWh/ft^2/day	0.001	0.001	0.001	0.001
compactor electric energy usage	kWh/ton	na	1.5	na	na
rolling stock fuel usage	gal./ton MSW	0.127	0.081	0.186	0.186
LCI Input Values					
Rolling Stock Emissions					
particulates (PM10)	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00
total particulates	lb./ton	7.80E-03	5.32E-03	8.10E-03	8.10E-03
nitrogen oxides	lb./ton	1.03E-01	7.25E-02	9.85E-02	9.85E-02
hydrocarbons (non-CH_4)	lb./ton	6.85E-03	5.27E-03	5.13E-03	5.13E-03
sulfur oxides	lb./ton	9.15E-03	6.33E-03	9.23E-03	9.23E-03
carbon monoxide	lb./ton	2.56E-02	1.77E-02	2.56E-02	2.56E-02
CO_2 (biomass)	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO_2 (non-biomass)	lb./ton	2.93E+00	1.85E+00	4.27E+00	4.27E+00
ammonia	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00
lead	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00
methane	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00
hydrochloric acid	lb./ton	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Washdown Rate					
Facility Washdown Water Volume	gal./ft^2-wash	0.2	0.2	0.2	0.2
Washdown Rate	wash/month	1	1	1	1

Table 4.6. Rail Transfer Station

INPUT PARAMETER, continued	UNIT	RT1		RT2	RT3
		Design 1	Design 2		
Waterborne Release Rates					
Dissolved solids	lb./gal.				
Suspended solids	lb./gal.				
BOD of washdown water	lb./gal.				
COD of washdown water	lb./gal.				
Oil	lb./gal.				
Sulfuric acid	lb./gal.				
Iron	lb./gal.				
Ammonia	lb./gal.				
Copper	lb./gal.				
Cadmium	lb./gal.				
Arsenic	lb./gal.				
Mercury	lb./gal.				
Phosphate	lb./gal.				
Selenium	lb./gal.				
Chromium	lb./gal.				
Lead	lb./gal.				
Zinc	lb./gal.				

Table 4.7. Compaction Factor for Selected Design

Compaction factors are used to determine density of compacted materials in transfer vehicles.

MSW COMPONENT	TR2	TR3	TR4	TR5
Old Newsprint	1	1	1	1
Old Corrugated Cardboard	1	1	1	1
Office Paper	1	1	1	1
Phone Books	1	1	1	1
Books	1	1	1	1
Old Magazines	1	1	1	1
Third Class Mail	1	1	1	1
Paper - Other #1	1	1	1	1
Paper - Other #2	1	1	1	1
Paper - Other #3	1	1	1	1
Paper - Other #4	1	1	1	1
Paper - Other #5	1	1	1	1
CCCR - Other	na	na	na	1
Mixed Paper	1	1	1	1
HDPE - Translucent	1	1	1	1
HDPE - Pigmented	1	1	1	1
PET	1	1	1	1
Plastic - Other #1	1	1	1	1
Plastic - Other #2	1	1	1	1
Plastic - Other #3	1	1	1	1
Plastic - Other #4	1	1	1	1
Plastic - Other #5	1	1	1	1
Mixed Plastic	1	1	1	1
CCNR - Other	na	na	na	1
Ferrous Cans	1	1	1	1
Ferrous Metal - Other	1	1	1	1
Aluminum Cans	1	1	1	1
Aluminum - Other #1	1	1	1	1
Aluminum - Other #2	1	1	1	1
Glass - Clear	1	1	1	1
Glass - Brown	1	1	1	1
Glass - Green	1	1	1	1
Mixed Glass	1	1	1	1
CNNR - Other	na	na	na	1
Paper - Nonrecyclable	na	na	na	na
Food Waste	na	na	na	na
CCCN - Other	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na
Misc. (CNNN)	na	na	na	na
CCNN - Other	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na
Glass - Nonrecyclable	na	na	na	na
Misc. (NNNN)	na	na	na	na
CNNN - Other	na	na	na	na

5. Transportation Process Model

Overview

The transportation process model calculates the cost and LCI coefficients associated with the transport of materials between the various unit processes included in the decision support tool. Note that transportation is different and separate from waste collection. Collection and drop-off processes for MSW, yard waste, and recyclable materials are addressed in the collection process model. Costs and LCI coefficients for transportation are calculated on the basis of user input and default design information that is described in this section. The factors take into account the composition of MSW transported and are used in the overall system to calculate the total system cost and environmental burdens for solid waste management alternatives as part of the decision support tool solution.

Conceptual Designs

Transportation modes included in the decision support tool are rail, heavy-duty diesel (tractor-trailers), light-duty diesel vehicles, and light-duty gasoline vehicles. The type of roadway transportation mode utilized between any two given nodes is site specific. However, typically tractor-trailers are utilized for long-distance hauling to economize on transportation costs, while light-duty vehicles are utilized for shorter distances and more frequent trips.

Cost and LCI coefficients for transport of mixed MSW, fuel, and compost are calculated per ton of aggregate mass flow between nodes. In contrast, recyclable materials are often shipped separately and have item-specific densities. For example, loose glass has a density much greater than plastic. For this reason, item-specific cost and LCI factors are calculated for recyclable materials transport. Connections for which item-specific factors are determined for recyclable materials include transport from transfer stations to separation facilities and from separation facilities to remanufacturing facilities.

For each nodal connection, unique cost and LCI factors are calculated based on user input values pertaining to transportation modes and connections between facilities. The governing equations presented in this section fall into three categories:

1. Rail transport of mixed refuse.
2. Roadway transport of non-recyclable materials (e.g., mixed refuse, refuse recovered for fuel, and compost).
3. Roadway transportation of recyclable materials.

Cost Methodology

Costs of mixed refuse rail transport, non-recyclable materials roadway transport, and recyclable materials roadway transport are calculated based on the default rate charged for hauling MSW. Factors contributing to transport cost include fuel consumption, vehicles, vehicle maintenance, licensing, and taxes. Rail transportation costs also include fees for the use of existing local rail lines between a community and a landfill. The cost for spurs built to connect existing rail lines to a transfer station and rail lines within transfer station sites are included in transfer station cost factors. Costs associated with moving MSW from the landfill rail transfer stations to the working face of the landfill are accounted for in the transfer station process model.

Rail Transport of Mixed Refuse

Cost factors for rail transportation of mixed MSW are calculated on a per ton basis from the user input hauling rate in units of dollars per ton per mile and the distances between nodes.

Roadway Transport of Non-Recyclable Materials

Cost factors for roadway transportation of non-recyclable materials are calculated on a per ton basis from the user input hauling rate in units of dollars per mile, vehicle weight capacity, and the distances between nodes.

Roadway Transport of Recyclable Materials

Item-specific factors are determined for recyclable materials because their densities vary. To calculate weight- based factors, volume-based costs for each transportation connection between nodes are first calculated. Volume-based costs are divided by item-specific densities to give weight-based factors. Costs per ton are then calculated for each recyclable item.

Life-Cycle Inventory Methodology

LCI coefficients in the transportation process model account for production and combustion of fuel utilized by transportation vehicles. If the user selects a two-way trip as input for roadway transport connections, then calculated factors will account for empty vehicles returning to the origin. The LCI methodology calculates energy consumption and environmental releases (air, water, and solid waste) from transportation activities and allocates these burdens to individual MSW components to derive LCI coefficients that are used in the decision support tool.

Energy

Transportation accounts for the consumption of two main types of energy: fuels consumed by mode of transportation and electricity consumed in the production of fuels. The energy calculations for the LCI include both combustion and precombustion energy consumption. Combustion energy is the fuel or electricity consumed to operate rolling stock, lighting and heating. Precombustion energy refers to the energy consumed to produce the fuel used by the transportation mode. The transportation process model uses default or user-supplied data on fuel consumed for rail haul and roadway transport to calculate the total quantity of energy consumed per ton of material processed. Default data on the energy required to produce a unit of electricity, including its precombustion energy, are included in the electrical energy process model documentation.

Air Emissions

The transportation process model accounts for airborne releases from two sources: (1) the pollutants released when fuel is combusted in a vehicle (combustion releases) and (2) the pollutants emitted when the fuel was produced. Default value for air emission resulting from fuel production are included in the Electrical Energy process model documentation.

Water Releases

The transportation process model accounts for waterborne pollutant emissions associated production of energy (fuel) consumed during transportation of recyclable materials and waste. There are no process related water releases. Default values for water releases from energy production are provided in the Electrical Energy process model documentation.

Solid Waste Releases

Solid waste releases from the transportation process model are from the production of fuel consumed by vehicles to transport materials. Solid waste generation is expressed in terms of pounds of pollutant per ton of material transported. Default values for solid wastes generated due to energy production are provided in the electrical energy process model.

Table 5.1. Economic Data on Rail and Roadway Transport

INPUT PARAMETER	UNIT	RAIL	ROADWAY VEHICLES			
			Heavy-Duty Deisel	Light-Duty Deisel	Light-Duty Gasoline	Collection Vehicle Diesel
Economic Data						
Rail Transport						
rail unit cost per ton-mi.	$/ton-mi.	0.028				
Roadway Transport						
cost per mile	$/mi.		3.0	2.3	2.7	2.2
vehicle volume	yd^3		100	40	40	24

Table 5.2. Combustion Emissions for Rail and Roadway Transport

COMBUSTION EMISSIONS (lbs. per 1,000 gal. fuel)	RAIL (lb./1,000 gal.)	HEAVY-DUTY DIESEL (lb./1,000 gal.)	LIGHT-DUTY DIESEL (lb./1,000 gal.)	LIGHT-DUTY GASOLINE (lb./1,000 gal.)	COLLECTION VEHICLE DIESEL (lb./mi.)
Atmospheric Emissions					
Particulates (PM10)					
Total Particulates	7.5E+01	3.0E+01	6.9E+01	6.3E+01	5.5E-04
Nitrogen Oxides	2.7E+02	2.1E+02	3.1E+02	7.7E+01	7.5E-02
Hydrocarbons (non-CH_4)	9.4E+01	3.8E+01	5.4E+01	7.7E+01	1.3E-03
Sulfur Oxides	3.6E+01	3.6E+01	3.6E+01	4.3E+00	
Carbon Monoxide	1.3E+02	2.1E+02	3.0E+02	5.3E+02	1.1E-02
CO_2 (biomass)					
CO_2 (non-biomass)	2.3E+04	2.3E+04	2.3E+04	1.8E+04	1.2E+00
Ammonia					
Lead					
Methane					
Hydrochloric acid					

Table 5.3. Description of Facilities

Abbreviation	DESCRIPTION
Transfer Stations	
RT1	Origin rail transfer station for collected MSW
RT2	Destination rail transfer station for traditional landfill
RT3	Destination rail transfer station for enhanced bioreactor landfill
TR1	Transfer station for mixed refuse
TR2	Transfer station for commingled recyclables
TR3	Transfer station for co-collected MSW in single compartment
TR4	Transfer station for co-collected MSW in three compartments
TR5	Transfer station for presorted recyclables
Separation Facilities	
S1	Sorting of mixed refuse
S2	Processing of presorted recyclables
S3	Sorting of commingled recyclables
S4	Sorting of co-collected MSW in single compartment
S5	Sorting of co-collected MSW in three compartments
S1T5	Separation facility preceding refuse-derived fuel facility
S1T7	Separation facility preceding refuse composting facility
S1T8	Separation facility preceding anaerobic digestion
Treatment Processes	
T1	Yardwaste composting
T3	Combustion with electric power generation
T5	Refuse-derived fuel facility
T7	Mixed refuse composting
T8	Anaerobic digestion
Disposal	
D1	Traditional landfill
D2	Ash landfill
D3	Enhanced bioreactor landfill
Product Destinations:	
f	Refuse components recovered for use as fuel
r	Remanufacturing facilities
c	Compost final use

Table 5.4. Internodal Distances by Roadway Transport

1 = empty truck on return
2 = truck used for alternate job on

NODAL CONNECTION INPUT VALUES	UTILIZED WEIGHT CAPACITY (ton)	ONE-WAY DISTANCE BETWEEN NODES (mi.)	FUEL REQUIREMENT (mi./gal.)	ONE- OR TWO-WAY HAUL (1 or 2)
Origin_Destination				
tr1_s1	20	15	5.5	1
tr1_t3	20	15	5.5	1
tr1_t5	20	15	5.5	1
tr1_t7	20	15	5.5	1
tr1_t8	20	15	5.5	1
tr1_d1	20	15	5.5	1
tr1_d3	20	15	5.5	1
tr3_t3	20	15	5.5	1
tr3_t5	20	15	5.5	1
tr3_t7	20	15	5.5	1
tr3_t8	20	15	5.5	1
tr3_d1	20	15	5.5	1
tr3_d3	20	15	5.5	1
tr4_t3	20	15	5.5	1
tr4_t5	20	15	5.5	1
tr4_t7	20	15	5.5	1
tr4_t8	20	15	5.5	1
tr4_d1	20	15	5.5	1
tr4_d3	20	15	5.5	1
s1_t3	20	15	5.5	1
s1_d1	20	15	5.5	1
s1_d3	20	15	5.5	1
s1_fuel	20	15	5.5	1
s2_fuel	20	15	5.5	1
s3_t3	20	15	5.5	1
s3_d1	20	15	5.5	1

Table 5.4. Internodal Distances by Roadway Transport

NODAL CONNECTION INPUT VALUES, continued	UTILIZED WEIGHT CAPACITY (ton)	ONE-WAY DISTANCE BETWEEN NODES (mi.)	FUEL REQUIREMENT (mi./gal.)	ONE- OR TWO-WAY HAUL (1 or 2)
s3_d3	20	15	5.5	1
Origin_Destination, continued				
s3_fuel	20	15	5.5	1
s4_t3	20	15	5.5	1
s4_t5	20	15	5.5	1
s4_t7	20	15	5.5	1
s4_t8	20	15	5.5	1
s4_d1	20	15	5.5	1
s4_d3	20	15	5.5	1
s4_fuel	20	15	5.5	1
s5_t3	20	15	5.5	1
s5_t5	20	15	5.5	1
s5_t7	20	15	5.5	1
s5_t8	20	15	5.5	1
s5_d1	20	15	5.5	1
s5_d3	20	15	5.5	1
s5_fuel	20	15	5.5	1
t1_compost	20	15	5.5	1
t3_d2	20	15	5.5	1
t5_d1	20	15	5.5	1
t5_d3	20	15	5.5	1
t5_fuel	20	15	5.5	1
t7_d1	20	15	5.5	1
t7_d3	20	15	5.5	1
t7_compost	20	15	5.5	1
t7_fuel	20	15	5.5	1
t8_d1	20	15	5.5	1
t8_d3	20	15	5.5	1
t8_compost	20	15	5.5	1
t8_fuel	20	15	5.5	1
tr2_s3	na	15	5.5	1
tr3_s4	na	15	5.5	1

Table 5.4. Internodal Distances by Roadway Transport

NODAL CONNECTION INPUT VALUES, continued	UTILIZED WEIGHT CAPACITY (ton)	ONE-WAY DISTANCE BETWEEN NODES (mi.)	FUEL REQUIREMENT (mi./gal.)	ONE- OR TWO-WAY HAUL (1 or 2)
Origin_Destination, continued				
tr4_s5	na	15	5.5	1
tr5_s2	na	15	5.5	1
s1_remanufact.	na	na	5.5	1
s2_remanufact.	na	na	5.5	1
s3_remanufact.	na	na	5.5	1
s4_remanufact.	na	na	5.5	1
s5_remanufact.	na	na	5.5	1
t3_remanufact.	na	na	5.5	1
s1t5_remanufact.	na	na	5.5	1
s1t7_remanufact.	na	na	5.5	1
s1t8_remanufact.	na	na	5.5	1

TABLE 5.4 INTERNODAL DISTANCES BY RAILWAY TRANSPORT

			DEFAULT NODAL CONNECTION INPUT VALUES	
RAIL TRANSPORT			**From origin rail station to:**	
		Units	**Rail transfer to dry landfill**	**Rail transfer to wet landfill**
One-way Distance Between Nodes	tr_di	miles	500	500
Fuel Requirment	rail_mg	gal/ton/mile	0.0031	0.0031
1 or 2 Way Haul	rt_trip	1 or 2	1	1
Model Coefficients for Rail Haul				
fuel usage	fuel	gal/ton	1.55	1.55

6. Material Recovery Facility Process Model

Overview

The materials recovery facility (MRF) process model calculates cost and LCI coefficients for the recovery of specific waste materials (e.g., aluminum, glass, paper, plastic, steel) from the MSW stream. The cost and LCI coefficients are calculated as a function of the quantity and composition of mixed or separated waste processed , user-defined inputs (e.g., number of hand sorters and their wage rates), and default information on the design of a MRF.

Conceptual Designs

MRFs are used to recover recyclable materials from the MSW stream. The process flow in a MRF depends on the materials processed and the manner in which they are collected (e.g., mixed waste, mixed recyclable materials, separated recyclable materials). This is achieved by allowing the user to input a wide range of site-specific data about how waste and recyclable materials are collected. A critical element of the MRF design is the flexibility to process any composition of recyclable materials. This is necessary to allow the decision support tool solution to specify the materials to be recovered for a given objective. For example, the tool solution for a scenario run that designed to find the lowest cost solution will specify the specific materials and amounts to be recovered to meet the lowest cost solution.

There are eight possible MRF designs that may be included in the waste management system:

1. **Mixed waste MRF.** This MRF processes mixed municipal solid waste.
2. **Presorted recyclables MRF.** This MRF processes recyclables collected either presorted by the resident or sorted at the curbside by the operator of the collection vehicle.
3. **Commingled recyclables MRF.** This MRF receives recyclables from a commingled recyclables collection program. All paper recyclables are collected in one compartment and nonpaper recyclables are collected in a separate compartment on the collection vehicle.
4. **Co-collection MRF (single-compartment truck).** This MRF processes commingled recyclables and mixed waste collected in a single- compartment truck. Recyclables are collected in a color-coded bag (blue) with mixed waste collected in a bag of a different color (black). All paper recyclables are placed in one bag and all nonpaper recyclables are placed in another bag. The colors of bags used in a city can be different, but blue and black are the two colors chosen for the discussions in this document and in the model.
5. **Co-collection MRF (three-compartment truck).** This MRF processes commingled recyclables and mixed waste collected in a three-compartment truck. All paper recyclables are collected in bags that are placed in one compartment. Bags containing nonpaper recyclables are placed in the second compartment, and bags with residual mixed waste are placed in a third compartment. Recyclables are collected in blue bags and mixed waste is collected in black bags.

6. **Front-end MRF to a composting facility.** This MRF is at the front end of a mixed waste composting facility (i.e., material recovery operations that precede composting operations). The MRF is similar to a mixed waste MRF but includes provisions for additional sorting to remove contaminants from mixed waste that affect the composting process or product quality.
7. **Front-end MRF to an anaerobic digestion facility.** This MRF is at the front end of an anaerobic digestion facility (i.e., material recovery operations that precede anaerobic digestion operations). The MRF is similar to a mixed waste MRF but includes additional sorting to remove contaminants that could adversely affect the anaerobic digestion process or product quality.
8. **Front-end MRF to a RDF facility.** This MRF is at the front end of a RDF facility (i.e., material recovery operations that precede RDF operations). The MRF is similar to a mixed waste MRF but does not include a magnet and eddy current separator for recovery of ferrous cans and aluminum cans. These waste components are recovered in a RDF facility.

All MRFs are based a the basic design (MRF 1) with minor differences to the other MRF designs based on the process flows of MRFs, which in turn depend on the type of MRF and the material being processed. For the basic design, mixed waste or recyclables are collected at curbside. Waste or recyclables that are collected in bags will pass through a debagging point in the MRF. The opening of bags can be done manually or mechanically. Loose material from the bag opening operation is then conveyed into an elevated and enclosed sorting room where the recyclables are recovered. The elevation of the sort room provides for space underneath for placement of bins into which separated recyclables are dropped. In a presorted MRF, non-glass incoming material is baled without sorting, and glass recyclables are loaded into trailers. For recycling collection options, paper recyclables, collected in separate bags, are conveyed to a paper sorting line.

In the sort room, pickers are positioned on both sides of a conveyer. Recyclables picked from mixed waste on the conveyer are dropped into chutes that lead into bins under the sort room. When a bin is full, it is replaced with an empty bin. The operation of moving a filled bin and replacing it with an empty one is done by rolling stock in the MRF. For non-glass recyclables, after a sufficient quantity of recyclables for making one bale is collected, these bins are emptied into the hopper of the baler that compacts the recyclables into a bale. The bale is then moved into a trailer at a loading dock. Storage space for bales is not provided within the MRF to conserve floor area.

Paper entering the mixed waste MRF as part of mixed waste is wet and contaminated. Thus, it is assumed that in a mixed waste MRF, only major components like cardboard and newsprint can be recovered separately. The remaining paper can be recovered only as mixed paper from mixed waste. In other MRFs, components of paper can be recovered individually from the paper sorting line. The “other” items for paper, plastic, ferrous, and aluminum allow the user to include recycling of additional components.

Glass recyclables are crushed as they pass through a crusher in the chute. Crushed glass is stored in bins. Once a bin is full, it is replaced with an empty bin. The filled bin is emptied into a trailer.

Metal cans remain in the refuse on the conveyer at the end of the sort room. Here cross belt arrangements are provided so that metal cans in the residue from all sort lines can be recovered by the same equipment (magnet for ferrous cans and eddy current separator for aluminum cans). Separation of aluminum cans can be manual or automated. If automated, an eddy current separator is used to recover aluminum cans.

The cross belt arrangements (used for metal recovery) can also be adjusted to lead recyclables directly into the hopper of a baler. This arrangement allows for a second sorting (for better quality) and baling of a separated recyclable. The second sort of recyclables can be done at the end of the workday. The user can specify the time required to remove contaminants from recovered materials.

Please refer to the complete MRF process model document for process flow diagrams and details for the eight MRF designs.

Cost Methodology

The cost of a MRF depends on the type of MRF, the quantity and type of materials processed, and user input data. Costs are divided into capital costs, operation and maintenance costs, and revenue from the sale of recyclable materials.

Capital Cost

Capital cost consists of construction, land acquisition, engineering, and equipment cost expressed as an annual cost using a capital recovery factor that is dependent upon a book lifetime and discount rate. For example:

- Construction cost includes the cost of the structure, access roads, fencing, landscaping, etc. The cost of the structure includes support facilities such as office space, a weigh station, and the loading conveyer. Construction cost is obtained by multiplying the floor area of the MRF by the construction cost rate.
- Total area for a MRF includes area for the structure, access roads, fencing, weigh station, landscaping, etc. Total area multiplied with a cost rate gives the land acquisition cost.
- Engineering cost consists of fees paid for consulting and technical services for the MRF planning and construction, and is estimated to be a fraction of the construction cost.
- Equipment cost consists of the capital and installation cost of equipment.

Operation and Maintenance Cost

Operating cost of the MRF include wages, overhead, utilities cost, and equipment and building maintenance. For example:

- Labor required for the transfer station consists of management, drivers, and equipment operators. In estimating the labor wages, it is assumed that part-time services can be hired. Management includes managers, supervisors, and secretaries. The wages paid for management are assumed to be a fraction of the wages paid to drivers and equipment operators.

- Overhead costs for labor are calculated as a fraction of labor wages. Overhead includes overtime, office supplies, fringe benefits, and temporary labor. The overhead rate is flexible and can be defined by the user to cover their specific labor situation.
- Utilities (power, fuel, oil, etc.) cost is proportional to the weight of recyclable materials processed in the MRF.
- The cost of maintenance of equipment and structure is assumed proportional to the weight of recyclable materials recovered in the MRF.

Residue Disposal Cost

Residue from the MRF is a result of the sorting efficiency being less than 100% and recovery of less than 100% of a recyclable. The cost of disposal of residue is based on the type of treatment or disposal facility (e.g., combustion or landfill) used.

Revenue from Sale of Recyclable Materials

Materials recovered in the MRF provide revenue that offset some of the cost of the MRF. The user can enter the sale price of recyclable materials from different MRFs in their MSW management system.

Life-Cycle Inventory Methodology

The LCI methodology calculates energy consumption or production, and environmental releases (air, water, and solid waste) from a MRF and allocates these LCI parameters to the individual waste materials that are managed at the MRF.

Energy

MRF operations consume two main types of energy: fuels for rolling stock and electricity for equipment, lighting, and heating. The energy calculations for the LCI include both combustion and precombustion energy consumption. Combustion energy is the fuel or electricity consumed to operate rolling stock, lighting and heating. Precombustion energy refers to the energy consumed to produce the fuel and electricity used to operate the transfer station. The MRF process model uses default or user-supplied data for fuel consumed by rolling stock, for heating and lighting purposes, and for processing equipment to calculate the total quantity of energy consumed per ton of material processed. Default data on the energy required to produce a unit of electricity, including its precombustion energy, are included in the electrical energy process model documentation.

Air Emissions

The MRF process model accounts for airborne releases from two sources: (1) the pollutants released when fuel is combusted in a vehicle (combustion releases), and (2) the pollutants emitted when the fuel or electricity was produced (precombustion releases). Data for fuel and electricity production are included in the electrical energy process model documentation.

Water Releases

The MRF process model accounts for waterborne pollutant emissions associated production of energy (electricity and fuel) consumed at the MRF. There are no process related water releases. Default values for water releases from energy production are provided in the Electrical Energy process model documentation.

Solid Waste Releases

The MRF process model uses the energy consumed by equipment and for heating and lighting the MRF building to calculate the solid waste generated. Solid waste generation is expressed in terms of pounds of pollutant per ton of material processed. Note that the solid waste referred to in this section pertains to the waste generated from energy production processes. Default values for solid wastes generated due to energy production are provided in the Electrical Energy process model. Solid waste remaining after recyclables are removed (residue) is routed to a treatment or disposal facility. The LCI of residue is accounted for in these treatment and disposal facilities.

Table 6.1. Economic Data on a MRF
Part 1: Mixed Waste, Presorted Recyclables, Commingled Recyclables, and Bags in One Compartment

A front-end MRF is at the front end of a composting, RDF, or anaerobic digestion facility. In a front-end MRF, the material recovery operations precede the composting, RDF, or anaerobic digestion operations.

Clean Design: If the user specifies that the decomposed solids from composting are to be used as daily cover at a landfill, then the model solution will only specify the removal of materials from mixed refuse when their removal is consistent with the model objective function (minimize cost or an LCI parameter across the solid waste management system).

Dirty Design: If the user specifies that the decomposed solids are to be used in an application where product quality is important, then the user must specify sorting efficiencies for materials to be removed by hand

INPUT PARAMETER	UNIT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPARTMENT
Design Options					
1.1. Bag Opening: Manual = 1, Mechanical = 0, Bins = N		0	na	0	0
1.2. Aluminum Sorting: Manual = 1, Mechanical = 0		1	na	0	0
1.3. Front-end MRF Sorting Option: Clean Design = 1, Dirty Design = 0					
Working Time					
Working Day Length	hr	8.5	8.5	8.5	8.5
Breaks and Stoppages Time	hr/day	0.5	na	0.5	0.5
Second Sort Time	hr/day	0.5	na	0.5	0.5
Effective Working Day Length	hr/day	7.5	na	7.5	7.5
Tipping Floor Storage	day	0.5	1	1	1
Number of Workdays per Year	day	260	260	260	260

Table 6.1. Economic Data on a MRF
Part 1: Mixed Waste, Presorted Recyclables, Commingled Recyclables, and Bags in One Compartment

INPUT PARAMETER, continued	UNIT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPARTMENT
Bag Miscellaneous Data					
Bag Breakage Factor	%	na	na	na	10%
Weight per Bag	lb.	8	na	5	5
Economic Parameters					
Life of MRF Structure	yr.	20	20	20	20
Annual Interest Rate	%	5.00%	5.00%	5.00%	5.00%
Construction Rate Cost	$/ft^2	41.48	41.48	41.48	41.48
Engineering Rate	% of structure cost	30%	30%	30%	30%
Land Acquisition Cost	$/ac	592.54	592.54	592.54	592.54
Equipment Installation Rate	% of equipment cost	10%	10%	10%	10%
Data for Area Calculation					
Land Requirement	multiple of MRF floor area	5	3	3	4.5
Height of Refuse on Tipping Floor	ft	10	10	10	10
Sort Room Width	ft	28	na	20	20
Area Required for Balers	ft^2/TPD	8	8	8	8
Bag Opener Machine Loading Area	ft^2/TPD bag	20	na	20	20
Manual Bag Opening Area	ft^2/TPD bag	15	na	15	15
Office Area Rate	ft^2/TPD	11	11	11	11

TPD is defined as ton per

Table 6.1. Economic Data on a MRF
Part 1: Mixed Waste, Presorted Recyclables, Commingled Recyclables, and Bags in One Compartment

INPUT PARAMETER, continued	UNIT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPARTMENT
Operating and Maintenance Cost data					
Labor Requirement/Capacities					
driver and operator requirement	hr/ton	0.32	0.24	0.32	0.32
capacity of manual bag opener	ton/hr	4	na	4	4
Labor Wages and Rates					
Labor Overhead Rate	% of labor cost	40%	40%	40%	40%
Management Wages	% of labor wages	25%	25%	25%	25%
Bag Opener Wage Rate	$/hr	7.62	na	7.62	7.62
Picker Wage Rate	$/hr	7.62	na	7.62	7.62
Driver and Operator Wage Rate	$/hr	11.98	11.98	11.98	11.98
Utilities and Maintenance Cost Data					
Utility Cost Rate	$/ton recovered	1.63	1.63	1.63	1.63
Maintenance Cost Rate	$/ton recovered	5.44	5.44	5.44	5.44
Equipment Cost Data					
Bunker Cost Rate	$/bunker	32,659	32,659	32,659	32,659
Conveyer Cost Rate	$/ft	1,422	na	1,422	1,422
Bins Cost Rate	$/bin	474	474	474	474

Table 6.1. Economic Data on a MRF
Part 1: Mixed Waste, Presorted Recyclables, Commingled Recyclables, and Bags in One Compartment

Chutes Cost Rate	$/chute	237	na	237	232
Rolling Stock Cost Rate	$/TPD	1,007	830	830	813
Baler Cost Rate	$/TPD baled	1,778	1,778	1,778	1,741

Table 6.1. Economic Data on a MRF
Part 1: Mixed Waste, Presorted Recyclables, Commingled Recyclables, and Bags in One Compartment

INPUT PARAMETER, continued	UNIT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPARTMENT
Equipment Cost Data, continued					
Magnet Cost Rate	$/TPD ferrous	3,792	na	3,792	3,792
Cost of Bag Opener	$/TPD	1,778	na	1,778	1,778
Cost of Eddy Current Separator	$/TPD aluminum	16,935	na	16,935	16,935
Trommel Cost	$/TPD of recyclables	na	na	9,481	9,481
Equipment Lifetime					
Bunker Life	yr.	15	na	5	5
Conveyer Life	yr.	5	na	5	5
Bins Life	yr.	5	5	5	5
Chutes Life	yr.	5	na	5	5
Rolling Stock Life	yr.	10	5	5	5
Baler Life	yr.	10	5	5	5
Magnet Life	yr.	5	na	5	5
Bag Opener Life	yr.	5	na	5	5
Eddy Current Separator Life	yr.	5	na	5	5
Trommel Life	yr.	na	na	5	5
Data for Equipment Requirement					
Volume of Bins Used	yd^3	90	90	90	90
Height of Bin	ft	5	5	5	5

Table 6.1. Economic Data on a MRF
Part 2: Bags in Two Compartments, YW/MSW Composting, RDF Facility, and Anaerobic Digestion

INPUT PARAMETER	UNIT	BAGS IN TWO COMPARTMENTS	FRONT-END MRF TO YW/MSW COMPOSTING	FRONT-END MRF TO RDF FACILITY	FRONT-END MRF TO ANAEROBIC DIGESTION
Design Options					
1.1. Bag Opening: Manual = 1, Mechanical = 0, Bins = N		0	na	na	na
1.2. Aluminum Sorting: Manual = 1, Mechanical = 0		0	na	na	na
1.3. Front End MRF Sorting Option: Clean Design = 1, Dirty Design = 0			0	0	0
Working Time					
Working Day Length	hr	8.5			
Breaks and Stoppages Time	hr/day	0.5			
Second Sort Time	hr/day	0.5			
Effective Working Day Length	hr/day	7.5			
Tipping Floor Storage	day	1			
Number of Workdays per Year	day	260			
Bag Miscellaneous data					
Bag Breakage Factor	%				
Weight per Bag	lb.	5			
Economic Parameters					
Life of MRF Structure	yr.	20			
Annual Interest Rate	%	5.00%			
Construction Rate Cost	$\$/ft^2$	41.48			

Table 6.1. Economic Data on a MRF
Part 2: Bags in Two Compartments, YW/MSW Composting, RDF Facility, and Anaerobic Digestion

INPUT PARAMETER, continued	UNIT	BAGS IN TWO COMPARTMENTS	FRONT-END MRF TO YW/MSW COMPOSTING	FRONT-END MRF TO RDF FACILITY	FRONT-END MRF TO ANAEROBIC DIGESTION
Economic Parameters, continued					
Engineering Rate	% of structure cost	30%			
Land Acquisition Cost	$/ac	592.54			
Equipment Installation Rate	% of equipment cost	10%			
Data for Area Calculation					
Land Requirement	multiple of MRF floor area	4			
Height of Refuse on Tipping Floor	ft	10			
Sort Room Width	ft	20			
Area Required for Balers	ft^2/TPD	8			
Bag Opener Machine Loading Area	ft^2/TPD bag	20			
Manual Bag Opening Area	ft^2/TPD bag	15			
Office Area Rate	ft^2/TPD	11			
Operating and Maintenance Cost Data					
Labor Requirement/Capacities					
driver and operator requirement	hr/ton	0.32			
capacity of manual bag opener	ton/hr	4			

TPD is defined as ton per day.

Table 6.1. Economic Data on a MRF
Part 2: Bags in Two Compartments, YW/MSW Composting, RDF Facility, and Anaerobic Digestion

INPUT PARAMETER, continued	UNIT	BAGS IN TWO COMPARTMENTS	FRONT-END MRF TO YW/MSW COMPOSTING	FRONT-END MRF TO RDF FACILITY	FRONT-END MRF TO ANAEROBIC DIGESTION
Labor Wages and Rates					
Labor Overhead Rate	% of labor cost	40%			
Management Wages	% of labor wages	25%			
Bag Opener Wage Rate	$/hr	7.62			
Picker Wage Rate	$/hr	7.62			
Driver and Operator Wage Rate	$/hr	11.98			
Utilities and Maintenance Cost Data					
Utility Cost Rate	$/ton recovered	1.63			
Maintenance Cost Rate	$/ton recovered	5.44			
Equipment Cost Data					
Bunker Cost Rate	$/bunker	32,659			
Conveyer Cost Rate	$/ft	1,422			
Bins Cost Rate	$/bin	474			
Chutes Cost Rate	$/chute	237			
Rolling Stock Cost Rate	$/TPD	830			
Baler Cost Rate	$/TPD baled	1,778			
Magnet Cost Rate	$/TPD ferrous	3,792			
Cost of Bag Opener	$/TPD	1,778			
Cost of Eddy Current Separator	$/TPD aluminum	16,935			
Trommel Cost	$/TPD of recyclables	9,481			

Table 6.1. Economic Data on a MRF
Part 2: Bags in Two Compartments, YW/MSW Composting, RDF Facility, and Anaerobic Digestion

INPUT PARAMETER, continued	UNIT	BAGS IN TWO COMPARTMENTS	FRONT-END MRF TO YW/MSW COMPOSTING	FRONT-END MRF TO RDF FACILITY	FRONT-END MRF TO ANAEROBIC DIGESTION
Equipment Lifetime					
Bunker Life	yr.	5			
Conveyer Life	yr.	5			
Bins Life	yr.	5			
Chutes Life	yr.	5			
Rolling Stock Life	yr.	5			
Baler Life	yr.	5			
Magnet Life	yr.	5			
Bag Opener Life	yr.	5			
Eddy Current Separator Life	yr.	5			
Trommel Life	yr.	5			
Data for Equipment Requirement					
Volume of Bins Used	yd^3	90			
Height of Bin	ft	5			

Table 6.2. Sorting Efficiency (%)

Note: Sorting Efficiency of recyclable i is defined as the weight of i recovered from the conveyer divided by the weight of i that enters the MRF.

MSW COMPONENT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPART-MENT	BAGS IN TWO COMPART-MENTS	DIRTY FRONT-END MRF	CLEAN FRONT-END MRF
Yard Trimmings, Leaves	na	na	na	na	na	na	0.90
Yard Trimmings, Grass	na	na	na	na	na	na	0.90
Yard Trimmings, Branches	na	na	na	na	na	na	0.90
Old Newsprint	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Old Corrugated Cardboard	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Office Paper	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Phone Books	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Books	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Old Magazines	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Third Class Mail	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Paper - Other #1	na	1.00	1.00	0.90	1.00	na	na
Paper - Other #2	na	1.00	1.00	0.90	1.00	na	na
Paper - Other #3	na	1.00	1.00	0.90	1.00	na	na
Paper - Other #4	na	1.00	1.00	0.90	1.00	na	na
Paper - Other #5	na	1.00	1.00	0.90	1.00	na	na
CCCR - Other	na	1.00	na	na	na	na	na
Mixed Paper	na	1.00	1.00	0.90	1.00	na	na
HDPE - Translucent	0.70	1.00	1.00	0.90	1.00	0.70	0.90
HDPE - Pigmented	0.70	1.00	1.00	0.90	1.00	0.70	0.90
PET	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Plastic - Other #1	na	1.00	1.00	0.90	1.00	na	na
Plastic - Other #2	na	1.00	1.00	0.90	1.00	na	na
Plastic - Other #3	na	1.00	1.00	0.90	1.00	na	na

Table 6.2. Sorting Efficiency (%)

MSW COMPONENT, continued	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPART-MENT	BAGS IN TWO COMPART-MENTS	DIRTY FRONT-END MRF	CLEAN FRONT-END MRF
Plastic - Other #4	na	1.00	1.00	0.90	1.00	na	na
Plastic - Other #5	na	1.00	1.00	0.90	1.00	na	na
Mixed Plastic	na	1.00	1.00	0.90	1.00	na	na
CCNR - Other	na	1.00	na	na	na	na	na
Ferrous Cans	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Ferrous Metal - Other	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Aluminum Cans	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Aluminum - Other #1	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Aluminum - Other #2	0.70	1.00	1.00	0.90	1.00	0.70	0.90
Glass - Clear	0.70	1.00	0.94	0.85	0.94	0.70	0.90
Glass - Brown	0.70	1.00	0.94	0.85	0.94	0.70	0.90
Glass - Green	0.70	1.00	0.94	0.85	0.94	0.70	0.90
Mixed Glass	0.70	1.00	0.94	0.85	0.94	0.70	0.90
CNNR - Other	na	1.00	na	na	na	na	na
Paper - Nonrecyclable	na	na	na	na	na	na	0.90
Food Waste	na	na	na	na	na	na	0.90
CCCN - Other	na	na	na	na	na	na	0.90
Plastic - Nonrecyclable	na	na	na	na	na	na	0.90
Misc. (CNNN)	na	na	na	na	na	na	0.90
CCNN - Other	na	na	na	na	na	na	0.90
Ferrous - Nonrecyclable	na	na	na	na	na	na	0.90
Aluminum - Nonrecyclable	na	na	na	na	na	na	0.90
Glass - Nonrecyclable	na	na	na	na	na	na	0.90
Misc. (NNNN)	na	na	na	na	na	na	0.90
CNNN - Other	na	na	na	na	na	na	0.90

Table 6.3. Picking Rate

Note: Picking Rate is defined as the weight of a recyclable (in tons) that is recovered by a picker in one hour (ton/picker-hr).

MSW COMPONENT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPART-MENT	BAGS IN TWO COMPART-MENTS	DIRTY FRONT-END MRF	CLEAN FRONT-END MRF
Yard Trimmings, Leaves	na	na	na	na	na	na	0.250
Yard Trimmings, Grass	na	na	na	na	na	na	0.250
Yard Trimmings, Branches	na	na	na	na	na	na	0.250
Old Newsprint	0.250	na	No sorting	No sorting	No sorting	0.250	0.250
Old Corrugated Cardboard	0.250	na	0.750	0.100	0.100	0.250	0.250
Office Paper	0.250	na	0.750	0.750	0.750	0.250	0.250
Phone Books	0.250	na	0.750	0.750	0.750	0.250	0.250
Books	0.250	na	0.750	0.750	0.750	0.250	0.250
Old Magazines	0.250	na	0.750	0.750	0.750	0.250	0.250
Third Class Mail	0.250	na	0.750	0.750	0.750	0.250	0.250
Paper - Other #1	0.250	na	0.750	0.750	0.750	0.250	0.250
Paper - Other #2	0.250	na	0.750	0.750	0.750	0.250	0.250
Paper - Other #3	0.250	na	0.750	0.750	0.750	0.250	0.250
Paper - Other #4	0.250	na	0.750	0.750	0.750	0.250	0.250
Paper - Other #5	0.250	na	0.750	0.750	0.750	0.250	0.250
CCCR - Other	0.025	na	na	na	na	0.025	0.025
Mixed Paper	0.500	na	0.750	0.750	0.750	0.500	0.500
HDPE - Translucent	0.025	na	0.060	0.060	0.060	0.025	0.025
HDPE - Pigmented	0.040	na	0.100	0.100	0.100	0.040	0.040
PET	0.025	na	0.060	0.060	0.060	0.025	0.025
Plastic - Other #1	0.025	na	0.060	0.060	0.060	0.025	0.025
Plastic - Other #2	0.025	na	0.060	0.060	0.060	0.025	0.025
Plastic - Other #3	0.025	na	0.060	0.060	0.060	0.025	0.025

Table 6.3. Picking Rate

MSW COMPONENT, continued	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPART-MENT	BAGS IN TWO COMPART-MENTS	DIRTY FRONT-END MRF	CLEAN FRONT-END MRF
Plastic - Other #4	0.025	na	0.060	0.060	0.060	0.025	0.025
Plastic - Other #5	0.025	na	0.060	0.060	0.060	0.025	0.025
Mixed Plastic	0.025	na	0.060	0.060	0.060	0.025	0.025
CCNR - Other	0.025	na	na	na	na	0.025	0.025
Ferrous Cans	Magnet	na	Magnet	Magnet	Magnet	Magnet	Magnet
Ferrous Metal - Other	Magnet	na	Magnet	Magnet	Magnet	Magnet	Magnet
Aluminum Cans	0.010	na	0.025	0.025	0.025	0.010	0.010
Aluminum - Other #1	0.010	na	0.025	0.025	0.025	0.010	0.010
Aluminum - Other #2	0.010	na	0.025	0.025	0.025	0.010	0.010
Glass - Clear	0.150	na	0.250	0.250	0.250	0.150	0.150
Glass - Brown	0.100	na	0.150	0.150	0.150	0.100	0.100
Glass - Green	0.025	na	0.050	0.050	0.050	0.025	0.025
Mixed Glass	0.025	na	0.050	0.050	0.050	0.025	0.025
CNNR - Other	0.025	na	na	na	na	0.025	0.025
Paper - Nonrecyclable	na	na	na	na	na	na	0.250
Food Waste	na	na	na	na	na	na	0.250
CCCN - Other	na	na	na	na	na	na	0.250
Plastic - Nonrecyclable	na	na	na	na	na	na	0.250
Misc. (CNNN)	na	na	na	na	na	na	0.250
CCNN - Other	na	na	na	na	na	na	0.250
Ferrous - Nonrecyclable	na	na	na	na	na	na	0.250
Aluminum - Nonrecyclable	na	na	na	na	na	na	0.250
Glass - Nonrecyclable	na	na	na	na	na	na	0.250
Misc. (NNNN)	na	na	na	na	na	na	0.250
CNNN - Other	na	na	na	na	na	na	0.250

Table 6.4. Density in a Bin (lb./ft^3)

MSW COMPONENT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPART-MENT	BAGS IN TWO COMPART-MENTS	DIRTY FRONT-END MRF	CLEAN FRONT-END MRF
Yard Trimmings, Leaves	na	na	na	na	na	na	5.0
Yard Trimmings, Grass	na	na	na	na	na	na	5.0
Yard Trimmings, Branches	na	na	na	na	na	na	5.0
Old Newsprint	5.0	na	6.2	6.2	6.2	5.0	5.0
Old Corrugated Cardboard	5.0	na	1.9	1.9	1.9	5.0	5.0
Office Paper	5.0	na	3.5	3.5	3.5	5.0	5.0
Phone Books	5.0	na	3.5	3.5	3.5	5.0	5.0
Books	5.0	na	3.5	3.5	3.5	5.0	5.0
Old Magazines	5.0	na	3.5	3.5	3.5	5.0	5.0
Third Class Mail	5.0	na	3.5	3.5	3.5	5.0	5.0
Paper - Other #1	5.0	na	3.5	3.5	3.5	5.0	5.0
Paper - Other #2	5.0	na	3.5	3.5	3.5	5.0	5.0
Paper - Other #3	5.0	na	3.5	3.5	3.5	5.0	5.0
Paper - Other #4	5.0	na	3.5	3.5	3.5	5.0	5.0
Paper - Other #5	5.0	na	3.5	3.5	3.5	5.0	5.0
CCCR - Other	2.4	na	na	na	na	2.4	2.4
Mixed Paper	5.0	na	2.4	2.4	2.4	5.0	5.0
HDPE - Translucent	2.4	na	2.4	2.4	2.4	2.4	2.4
HDPE - Pigmented	2.4	na	2.4	2.4	2.4	2.4	2.4
PET	2.4	na	2.4	2.4	2.4	2.4	2.4
Plastic - Other #1	2.4	na	2.4	2.4	2.4	2.4	2.4
Plastic - Other #2	2.4	na	2.4	2.4	2.4	2.4	2.4
Plastic - Other #3	2.4	na	2.4	2.4	2.4	2.4	2.4
Plastic - Other #4	2.4	na	2.4	2.4	2.4	2.4	2.4
Plastic - Other #5	2.4	na	2.4	2.4	2.4	2.4	2.4
Mixed Plastic	2.4	na	2.4	2.4	2.4	2.4	2.4
CCNR - Other	2.4	na	na	na	na	2.4	2.4
Ferrous Cans	4.9	na	4.9	4.9	4.9	4.9	4.9

Table 6.4. Density in a Bin (lb./ft^3)

MSW COMPONENT, continued	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPART-MENT	BAGS IN TWO COMPART-MENTS	DIRTY FRONT-END MRF	CLEAN FRONT-END MRF
Ferrous Metal - Other	4.9	na	4.9	4.9	4.9	4.9	4.9
Aluminum Cans	2.4	na	2.4	2.4	2.4	2.4	2.4
Aluminum - Other #1	2.4	na	2.4	2.4	2.4	2.4	2.4
Aluminum - Other #2	2.4	na	2.4	2.4	2.4	2.4	2.4
Glass - Clear	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Glass - Brown	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Glass - Green	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Mixed Glass	14.0	14.0	14.0	14.0	14.0	14.0	14.0
CNNR - Other	2.4	na	na	na	na	2.4	2.4
Paper - Nonrecyclable	na	na	na	na	na	na	5.0
Food Waste	na	na	na	na	na	na	5.0
CCCN - Other	na	na	na	na	na	na	5.0
Plastic - Nonrecyclable	na	na	na	na	na	na	5.0
Misc. (CNNN)	na	na	na	na	na	na	5.0
CCNN - Other	na	na	na	na	na	na	5.0
Ferrous - Nonrecyclable	na	na	na	na	na	na	5.0
Aluminum - Nonrecyclable	na	na	na	na	na	na	5.0
Glass - Nonrecyclable	na	na	na	na	na	na	5.0
Misc. (NNNN)	na	na	na	na	na	na	5.0
CNNN - Other	na	na	na	na	na	na	5.0

Table 6.5. Weight of a Bale (ton)

MSW COMPONENT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPARTMENT	BAGS IN TWO COMPARTMENTS
Yard Trimmings, Leaves	na	na	na	na	na
Yard Trimmings, Grass	na	na	na	na	na
Yard Trimmings, Branches	na	na	na	na	na
Old Newsprint	0.60	0.68	0.68	0.68	0.68
Old Corrugated Cardboard	0.60	0.88	0.88	0.88	0.88
Office Paper	0.60	0.73	0.73	0.73	0.73
Phone Books	0.60	0.73	0.73	0.73	0.73
Books	0.60	0.60	0.73	0.73	0.73
Old Magazines	0.60	0.73	0.73	0.73	0.73
Third Class Mail	0.60	0.73	0.73	0.73	0.73
Paper - Other #1	0.60	0.73	0.73	0.73	0.73
Paper - Other #2	0.60	0.60	0.73	0.73	0.73
Paper - Other #3	0.60	0.60	0.73	0.73	0.73
Paper - Other #4	0.60	0.73	0.73	0.73	0.73
Paper - Other #5	0.60	0.73	0.73	0.73	0.73
CCCR - Other	0.59	0.59	na	na	na
Mixed Paper	0.60	0.60	0.60	0.60	0.60
HDPE - Translucent	0.59	0.59	0.59	0.59	0.59
HDPE - Pigmented	0.59	0.59	0.59	0.59	0.59
PET	0.59	0.59	0.59	0.59	0.59
Plastic - Other #1	0.59	0.59	0.59	0.59	0.59
Plastic - Other #2	0.59	0.59	0.59	0.59	0.59
Plastic - Other #3	0.59	0.59	0.59	0.59	0.59
Plastic - Other #4	0.59	0.59	0.59	0.59	0.59
Plastic - Other #5	0.59	0.59	0.59	0.59	0.59
Mixed Plastic	0.59	0.59	0.59	0.59	0.59
CCNR - Other	0.59	0.59	na	na	na
Ferrous Cans	0.95	0.95	0.95	0.95	0.95

Table 6.5. Weight of a Bale (ton)

MSW COMPONENT, continued	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPARTMENT	BAGS IN TWO COMPARTMENTS
Ferrous Metal - Other	0.95	0.95	0.95	0.95	0.95
Aluminum Cans	0.95	0.95	0.95	0.95	0.95
Aluminum - Other #1	0.95	0.95	0.95	0.95	0.95
Aluminum - Other #2	0.95	0.95	0.95	0.95	0.95
Glass - Clear	0.50	0.50	0.50	0.50	0.50
Glass - Brown	0.50	0.50	0.50	0.50	0.50
Glass - Green	0.50	0.50	0.50	0.50	0.50
Mixed Glass	0.50	0.50	0.50	0.50	0.50
CNNR - Other	0.59	0.95	na	na	na
Paper - Nonrecyclable	na	na	na	na	na
Food Waste	na	na	na	na	na
CCCN - Other	na	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na	na
Misc. (CNNN)	na	na	na	na	na
CCNN - Other	na	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na	na
Glass - Nonrecyclable	na	na	na	na	na
Misc. (NNNN)	na	na	na	na	na
CNNN - Other	na	na	na	na	na

Table 6.6. Market Price of Recyclable Materials ($/ton)

The market price for a recyclable can vary based on its quality. For example, newsprint from a commingled recyclables MRF may be "cleaner" than newsprint from a mixed waste MRF. Thus, newsprint from a commingled recyclables MRF may have a higher market price compared to newsprint from a mixed waste MRF.

MSW COMPONENT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPARTMENT	BAGS IN TWO COMPARTMENTS
Yard Trimmings, Leaves	na	na	na	na	na
Yard Trimmings, Grass	na	na	na	na	na
Yard Trimmings, Branches	na	na	na	na	na
Old Newsprint	67.00	67.00	67.00	67.00	67.00
Old Corrugated Cardboard	85.00	85.00	85.00	85.00	85.00
Office Paper	137.00	137.00	137.00	137.00	137.00
Phone Books	111.00	111.00	111.00	111.00	111.00
Books	41.00	41.00	41.00	41.00	41.00
Old Magazines	41.00	41.00	41.00	41.00	41.00
Third Class Mail	41.00	41.00	41.00	41.00	41.00
Paper - Other #1	41.00	41.00	41.00	41.00	41.00
Paper - Other #2	41.00	41.00	41.00	41.00	41.00
Paper - Other #3	41.00	41.00	41.00	41.00	41.00
Paper - Other #4	41.00	41.00	41.00	41.00	41.00
Paper - Other #5	41.00	41.00	41.00	41.00	41.00
CCCR - Other	41.00	41.00	na	na	na
Mixed Paper	41.00	41.00	41.00	41.00	41.00
HDPE - Translucent	300.00	300.00	300.00	300.00	300.00
HDPE - Pigmented	160.00	160.00	160.00	160.00	160.00
PET	140.00	140.00	140.00	140.00	140.00
Plastic - Other #1	40.00	40.00	40.00	40.00	40.00
Plastic - Other #2	40.00	40.00	40.00	40.00	40.00
Plastic - Other #3	40.00	40.00	40.00	40.00	40.00
Plastic - Other #4	40.00	40.00	40.00	40.00	40.00
Plastic - Other #5	40.00	40.00	40.00	40.00	40.00

Table 6.6. Market Price of Recyclable Materials ($/ton)

MSW COMPONENT, continued	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPARTMENT	BAGS IN TWO COMPARTMENTS
Mixed Plastic	40.00	40.00	40.00	40.00	40.00
CCNR - Other	40.00	40.00	na	na	na
Ferrous Cans	79.00	79.00	79.00	79.00	79.00
Ferrous Metal - Other	67.00	67.00	67.00	67.00	67.00
Aluminum Cans	1,080.00	1,080.00	1,080.00	1,080.00	1,080.00
Aluminum - Other #1	1,080.00	1,080.00	1,080.00	1,080.00	1,080.00
Aluminum - Other #2	1,080.00	1,080.00	1,080.00	1,080.00	1,080.00
Glass - Clear	39.00	39.00	39.00	39.00	39.00
Glass - Brown	24.00	24.00	24.00	24.00	24.00
Glass - Green	14.00	14.00	14.00	14.00	14.00
Mixed Glass	14.00	14.00	14.00	14.00	14.00
CNNR - Other	14.00	14.00	na	na	na
Paper - Nonrecyclable	na	na	na	na	na
Food Waste	na	na	na	na	na
CCCN - Other	na	na	na	na	na
Plastic - Nonrecyclable	na	na	na	na	na
Misc. (CNNN)	na	na	na	na	na
CCNN - Other	na	na	na	na	na
Ferrous - Nonrecyclable	na	na	na	na	na
Aluminum - Nonrecyclable	na	na	na	na	na
Glass - Nonrecyclable	na	na	na	na	na
Misc. (NNNN)	na	na	na	na	na
CNNN - Other	na	na	na	na	na

Table 6.7. Constants

INPUT PARAMETERS	UNIT	MIXED WASTE MRF	PRESORTED RECYCLABLES	COMM. RECYCLABLES	BAGS IN ONE COMPART-MENT	BAGS IN TWO COMPART-MENTS
Number of Days of Storage for	day	1	1	1	1	1
Distance Between Pickers	ft	4	na	na	na	na
Pickers on Both Sides of Conveyer Belt? (Yes = 2)	pickers	2	na	na	na	na
Redundancy Factor for Conveyer	no unit	2	na	na	na	na
Maneuverability Factors	no unit	2.5	2.5	2.5	4	4
Footprint of Bales	ft^2	20	20	20	20	20
Number of Stacked Bales (on top of each other)	no unit	3	3	3	3	3

Redundancy Factor for Conveyer: A factor that allows for redundancy in the conveyor length required.

Maneuverability Factors: A factor that allows for vehicle, machinery, and maintenance access.

Table 6.8. Life-Cycle Inventory Input Data

INPUT PARAMETER	UNIT	MIXED WASTE	PRESORTED RECYCLABLES	COMMINGLED RECYCLABLES	BAGS IN ONE COMPART-MENT	BAGS IN TWO COMPART-MENTS
Energy consumption						
Rolling Stock	gal./ton	0.347	0.347	0.347	0.347	0.347
Warehouse Type Areas	kWH/yr.-ft^2	14.03	14.03	14.03	14.03	14.03
Office Type Areas	kWH/yr.-ft^2	34	34	34	34	34
Conveyer	kWH/ton	0.8	na	0.8	0.8	0.8
Magnet	kWH/ton ferrous	5	5	5	5	5
Eddy Current Separator	kWH/ton aluminum	8	8	8	8	8
Balers	kWH/ton	12	12	12	12	12
Mechanical Bag Opener	kWH/ton	8	8	8	8	8
Trommel	kWH/ton	1.03	1.03	1.03	1.03	1.03
Airborne Releases from Rolling Stock Fuel Usage						
Carbon Monoxide	lb./gal.	0.0986	0.0986	0.0986	0.0986	0.0986
Nitrogen Oxides	lb./gal.	0.1545	0.1545	0.1545	0.1545	0.1545
Particulates (PM10)	lb./gal.					
Total particulates	lb./gal.	0.0164	0.0164	0.0164	0.0164	0.0164
Carbon dioxide (biomass fuel)	lb./gal.					
Carbon dioxide (non-biomass fue	lb./gal.	26.5	26.5	26.5	26.5	26.5
Sulfur oxides	lb./gal.	0.0122	0.0122	0.0122	0.0122	0.0122
Hydrocarbons (except methane)	lb./gal.	0.0245	0.0245	0.0245	0.0245	0.0245
Methane	lb./gal.					
Lead	lb./gal.					
Ammonia	lb./gal.					
Hydrochloric acid	lb./gal.					

7. Combustion Process Model

Overview

The MSW combustion process model includes sets of equations that utilize default (or user input) facility design information to calculate cost and LCI coefficients for combusting waste components in either an existing or new combustion facility, and with or without electrical energy recovery. These coefficients are used in the decision support tool to calculate the total system cost and environmental burdens for solid waste management alternatives that involve combustion.

Conceptual Designs

The user of the decision support tool can choose whether the combustion facility to be included in the system is an existing facility or would have to be constructed. Default cost estimates for a new combustion facility are provided and are based on four basic designs of varying capacities. All designs assume that the facility will be operated to maintain compliance with all applicable regulations. Based on forecasts of the industry, combustion facilities of smaller capacities are assumed to be of modular design. Larger facilities are assumed to be of mass burn/waterwall design. Energy recovery is included for all designs.

Cost assumptions for the four designs are based on a 1989 study to estimate the cost implications for proposed emission standards [1]. The four designs include:

- Modular/starved air facility with a 100-ton-per-day (TPD) capacity.
- modular/excess air facility with a 240 TPD capacity.
- Mass burn/waterwall facility with a 800 TPD capacity.
- Mass burn/waterwall facility with a 2,250 TPD capacity.

The conceptual design of these four facilities is similar. For the larger mass burn combustors (800, 2250 TPD), unprocessed waste (after removal of large, bulky items) is delivered by an overhead crane from a tipping floor to a feed hopper that conveys the waste into a combustion chamber. Hydraulic rams push the refuse from the fuel chute onto the first of several grates. The first section, or drying grate, is intended to remove the moisture content of the waste prior to ignition. The second section, or burning grate, is where the majority of active burning takes place. The third grate is where remaining combustibles in the waste are burned. Bottom ash is discharged from the finishing grate into a water-filled ash quench pit or ram discharger. From there, the moist ash is discharged to a conveyor system and transported to an ash load-out area prior to disposal. Water-filled tubes located in the walls of the combustor recover the waste heat that is used to generate electricity.

Combustion air is added from beneath the grate by way of under-fire air plenums. Typically, mass burn waterwall combustors are operated with 80 to 100 percent excess air. The flue gas exits the combustor and passes through additional heat recovery sections to one or more air pollution control devices.

The air pollution control equipment assumed to be present in a modern combustion facility includes a spray dryer for acid gas control, injection of activated carbon for mercury control, ammonia or urea injection for NOx control (by conventional selective noncatalytic reduction), and a fabric filter for PM control. After the air pollution control equipment, the flue gas is released to the atmosphere through the plant stack. The fly ash is collected, mixed with the bottom ash, and sent to a landfill. In addition, air pollution monitoring equipment is installed in the facility.

The basic design of a modular-starved air combustor includes two separate combustion chambers, referred to as the "primary" and "secondary" chambers. Waste is batch-fed to the primary chamber by a hydraulically activated ram. Waste moves through the primary chamber slowly and retention times are long, lasting up to 12 hours. Auxiliary fuels may be added during startup or if there are problems. Air is supplied to the primary chamber at substoichiometric levels, resulting in a flue gas rich in unburned hydrocarbons. Air is mixed with the hot flue gas before entering the second combustion chamber to complete the burning. Energy is recovered in a waste heat boiler. The flue gas then passes through air pollution control equipment that is assumed to include the same processes described above.

Modular excess air combustors are similar to modular-starved air combustors except that the air is supplied in excess of stoichiometric requirements, and a portion of the flue gas is recirculated to maintain desired temperatures in the primary and secondary chambers.

Cost Methodology

The methodology used to estimate the costs associated with combustion options are described in the following sections. Default values for new combustion facilities are based on a regression of the four model plants described above. The regression was performed to derive linear cost functions. Therefore the cost of the combustion facility is assumed to be proportional to the facility capacity, though the revenue from energy recovery is a function of the Btu input to the plant. Costs associated with combustion include capital costs, operation and maintenance costs, residue disposal costs, ferrous recovery revenue, and electricity generation revenue.

Capital Cost

The plant's capital cost includes the cost of combustors, ash handling system, turbine, and air pollution control and monitoring devices. The capital cost of a combustion facility is calculated from a unit capital cost with units of dollars per Btu/yr. feed rate. It is adjusted with a capacity factor because the plant cannot operate at full capacity at all times. In addition, it can be expressed in annual terms using a given capital recovery factor that is dependent upon a book lifetime and discount rate.

Operation and Maintenance Cost

The operation and maintenance (O&M) costs of a combustion facility include labor, overhead, taxes, administration, insurance, indirect costs, auxiliary fuel cost, electricity cost, and maintenance. The O&M cost function depends upon the unit O&M cost, the rate at which waste enters the plant (expressed in energy per unit time), the capacity factor, and the cost of ash disposal.

Combustion Residue Disposal Cost

Combustion residue includes residue from flue-gas cleaning and combustion ash (including fly and bottom ash). An assumption is made that the combustion disposed of at an ash landfill and the cost for combustion residue disposal is not calculated and reported as part of the combustion process model but rather as part of the ash landfill model (see Section 8).

Revenue from Electricity Generation

Electricity that is generated by recovery of heat from combustion of waste is sold to an end user. The recovery of the heat is not perfectly efficient. This inefficiency is represented by the heat rate of the plant that is an input parameter. The default value for revenue from electricity generation is set at the national average of per kWh.

Revenue from Recovery of Ferrous Metal

Ferrous metal can be recovered from the bottom ash and can provide some revenue to help offset the costs of the combustion facility. Based on calculations shown in the combustion process model documentation, the cost of a magnet to separate the iron from the bottom ash is sufficiently small in comparison to the imprecise estimate of the ferrous scrap price that it can be ignored. The default value for revenue from scrap is based on the national market price for ferrous scrap.

Life-Cycle Inventory Methodology

The LCI methodology calculates energy consumption or production, and environmental releases (air, water, and solid waste) from the combustion process and allocates these LCI parameters to individual components of the waste stream.

Energy

Energy recovered by the combustion facility is credited as an energy gain in the LCI inventory, and it is assumed to displace a similar amount of electricity produced from conventional fuels (e.g., coal and natural gas). However, the exact mix of the energy that is offset can be specified by the user if it is known.

Air Emissions

Net emissions from the combustion facility are the post-treatment emissions from the combustion facility minus the emissions that would have otherwise been produced by the type of utility generation being displaced.

Different sets of default emission factors for combustion of MSW are provided in the process model. Included are sets of defaults based on existing combustors in compliance with standards for existing facilities. We encourage the users to override these values with values based on the existing facility because there is considerable variation among individual combustors. In addition, defaults with emissions corresponding to the regulatory limits for existing combustion facilities may be selected. Similarly, for new facilities, defaults are provided based on actual performance of new facilities and a different set corresponding to the regulatory limits for new combustion facilities. For unregulated pollutants, defaults based on actual performance are provided.

Although emissions may be based on performance or regulatory limits, the composition of the waste still impacts emission levels. For example, while a pollutant may be controlled to a particular emission concentration, the volume of flue gas produced from the combustion of the waste components will dictate the mass emission rates of the pollutants. Since flue-gas production per ton varies considerably from component to component, the mass emission rates per ton of aggregate waste will vary with composition based on this methodology.

Metals content by waste component and the partitioning of metals to the flue gas as observed in the Burnaby study [2] is used in conjunction with metals removal efficiencies based on multiple modern combustion facilities to form the basis for the calculations of mass metals emission rates. For lack of sufficient theory and empirical studies relating metals volatilization to waste composition, an underlying, albeit crude, assumption is made that metals emissions vary in proportion to metals input to the combustor. This approach was deemed to be preferable to the simpler approach that would have metals emissions vary with mass input alone with no sensitivity to the metals content of the waste.

Water Releases

Water releases associated with the combustion process are post-treatment releases from publicly operated treatment works of water used in the process and of water offset by generation of electricity. Net releases from the combustion facility are the releases from water use in the combustion facility minus the releases that would otherwise have been produced by the type of utility generation displaced.

Solid Waste Releases

Solid wastes from the combustion process include the solid wastes offset by generation of electricity. Ash residue is transported to a dedicated ash landfill for disposal.

References

1. Municipal Waste Combustors—Background Information for Proposed Standards iIII(b) Model Plant Description and Cost Report, U.S. EPA, 1989.
2. Chandler & Associates Ltd.; Compass Environmental Inc.; Rigo & Rigo Associates, Inc.; The Environmental Research Group-University of New Hampshire; Wastewater Technology Centre; Waste Analysis, Sampling, Testing and Evaluation (WASTE) Program. Effect of Waste Stream Characteristics on MSW Incineration: The Fate and Behavior of Metals. The Final Report of the Mass Burn MSW Incineration Study (Burnaby, B.C.). Volume II, Technical Report, April 1993.

Table 7.1. Combustion Economic Input Parameters

DESCRIPTION	INPUT	UNIT
Combustor Lifetime	20	yr.
Combustor Capacity Factor	0.91	fraction of total capable generation provided annually
Heat Rate	18,000	Btu/kWh
Unit WTE Capital Cost	288.6	$/design ton per yr.
Unit WTE Operating and Maintenance Cost	60.5	($/yr.)/(design ton per yr.)
Electricity Price	0.0262	$/kWh

Table 7.2. Nonmetal Emissions at the Combustion Plant

NONMETAL EMISSIONS	CONCENTRATION IN STACK GAS				
	User-Defined	Default Data		Unit	
		U.S. EPA Standard	Average at New Facilities		
Sulfur dioxide		30	8	ppmv @ 7% oxygen, dry	
HCl		25	8.9	ppmv @ 7% oxygen, dry	
NOx		150	136	ppmv @ 7% oxygen, dry	
CO		100	26	ppmv @ 7% oxygen, dry	
PM		24	4	mg/dscm @ 7% oxygen, dry	
Dioxins/Furans		13	4.5	ng/dscm @ 7% oxygen, dry	
Methane	0.003			lb. emitted/ton MSW	
Ammonia				lb. emitted/ton MSW	
Hydrocarbons				lb. emitted/ton MSW	

Table 7.3. Metal-Removal Efficiency

Note: Metal-removal efficiency is the removal efficiency of metal m (%) by the air pollution control equipment.

METAL	REMOVAL EFFICIENCY
As	99.90%
B	76.50%
Cd	99.70%
Cr	99.30%
Cu	99.60%
Hg	92.70%
Ni	96.60%
Pb	99.80%
Sb	96.70%
Se	92.90%
Zn	99.70%

Table 7.4. Waterborne Emissions at the Combustion Plant

WATERBORNE EMISSIONS	INPUT	UNIT
Dissolved Solids	0	lb./ton waste item
Suspended solids	0	lb./ton waste item
BOD	0	lb./ton waste item
COD	0	lb./ton waste item
Oil	0	lb./ton waste item
Sulfuric acid	0	lb./ton waste item
Iron	0	lb./ton waste item
Ammonia	0	lb./ton waste item
Copper	0	lb./ton waste item
Cadmium	0	lb./ton waste item
Arsenic	0	lb./ton waste item
Mercury	0	lb./ton waste item
Phosphate	0	lb./ton waste item
Selenium	0	lb./ton waste item
Chromium	0	lb./ton waste item
Lead	0	lb./ton waste item
Zinc	0	lb./ton waste item

Table 7.5. Other Life-Cycle Input Parameters

DESCRIPTION	INPUT	UNIT
WTE Ton Lime per Won Waste	0.0071	ton lime/ton MSW
WTE Ton Ammonia per Ton Waste	0.0015	ton ammonia/ton MSW
WTE Ferrous Ash Recovery Rate	90	%

Table 7.6. Emission Factors for MSW Components
Part 1: Controlled Emissions for Nonmetals

A controlled emission factor for a nonmetal is the emission per ton of waste component after stack gas treatment (lb. emitted/ton waste component).

MSW Component	CONTROLLED EMISSIONS (lb. pollutant/ton waste): NONMETALS											
	CO_2	Biomass CO_2	Fossil CO_2	SO_2	HCl	NOx (as NO)	CO	Total PM	PM10	CH_4	NH_3 (air)	Hydrocarbons
Yard Trimmings, Leaves	1,290	1,290	-	0.4404	0.20931	1.03222	0.6422714	0.12332		0.003	0	0
Yard Trimmings, Grass	1,182	1,182	-	0.4094	0.19459	0.95963	0.5971019	0.11464		0.003	0	0
Yard Trimmings, Branch	1,290	1,290	-	0.4404	0.20931	1.0322	0.6422558	0.12331		0.003	0	0
Old Newsprint	3,174	3,174	-	1.0427	0.49555	2.44379	1.5205817	0.29195		0.003	0	0
Old Corrugated Cardboa	2,949	2,949	-	0.9663	0.45925	2.26482	1.4092195	0.27057		0.003	0	0
Office Paper	2,481	2,481	-	0.8399	0.39917	1.96851	1.2248491	0.23517		0.003	0	0
Phone Books	3,029	3,029	-	1.0024	0.4764	2.34938	1.4618343	0.28067		0.003	0	0
Books	2,887	2,887	-	0.9604	0.45645	2.25099	1.400619	0.26892		0.003	0	0
Old Magazines	1,723	1,723	-	0.5769	0.27418	1.35214	0.8413318	0.16154		0.003	0	0
Third Class Mail	2,111	2,111	-	0.7304	0.34714	1.71195	1.0652105	0.20452		0.003	0	0
Paper - Other #1	2,481	2,481	-	0.84	0.3992	1.96864	1.2249288	0.23519		0.003	0	0
Paper - Other #2	2,481	2,481	-	0.84	0.3992	1.96864	1.2249288	0.23519		0.003	0	0
Paper - Other #3	2,481	2,481	-	0.84	0.3992	1.96864	1.2249288	0.23519		0.003	0	0
Paper - Other #4	2,481	2,481	-	0.84	0.3992	1.96864	1.2249288	0.23519		0.003	0	0
Paper - Other #5	2,481	2,481	-	0.84	0.3992	1.96864	1.2249288	0.23519		0.003	0	0
CCCR - Other	2,481	2,481	-	0.84	0.3992	1.96864	1.2249288	0.23519		0.003	0	0
Mixed Paper	2,471	2,471	-	0.8365	0.39757	1.96061	1.2199382	0.23423		0.003	0	0
HDPE - Translucent	5,828	-	5,828	2.5493	1.21158	5.9749	3.7177181	0.7138		0.003	0	0
HDPE - Pigmented	5,828	-	5,828	2.5493	1.21158	5.9749	3.7177181	0.7138		0.003	0	0
PET	4,250	-	4,250	1.3321	0.63311	3.12219	1.9426981	0.373		0.003	0	0
Plastic - Other #1	2,611	-	2,611	1.0659	0.50657	2.49817	1.5544186	0.29845		0.003	0	0
Plastic - Other #2	6,052	-	6,052	2.4532	1.1659	5.74964	3.5775558	0.68689		0.003	0	0
Plastic - Other #3	6,052	-	6,052	2.4532	1.1659	5.74964	3.5775558	0.68689		0.003	0	0
Plastic - Other #4	6,052	-	6,052	2.4532	1.1659	5.74964	3.5775558	0.68689		0.003	0	0

Table 7.6. Emission Factors for MSW Components
Part 1: Controlled Emissions for Nonmetals

MSW Component, continued	CONTROLLED EMISSIONS (lb. pollutant/ton waste): NONMETALS											
	CO_2	Biomass CO_2	Fossil CO_2	SO_2	HCl	NOx (as NO)	CO	Total PM	PM10	CH_4	NH_3 (air)	Hydrocarbons
Plastic - Other #5	6,052	-	6,052	2.4532	1.1659	5.74964	3.5775558	0.68689		0.003	0	0
Mixed Plastic	5,469	-	5,469	2.2169	1.05361	5.19589	3.2329961	0.62074		0.003	0	0
CCNR - Other	6,052	-	6,052	2.4534	1.166	5.75011	3.5778491	0.68695		0.003	0	0
Ferrous Cans	96	96	-	0.0312	0.01481	0.07302	0.0454332	0.00872		0.003	0	0
Ferrous Metal - Other	96	96	-	0.0312	0.01481	0.07302	0.0454332	0.00872		0.003	0	0
Aluminum Cans	97	97	-	0.0315	0.01496	0.07377	0.0459016	0.00881		0.003	0	0
Aluminum - Other #1	97	97	-	0.0315	0.01496	0.07377	0.0459016	0.00881		0.003	0	0
Aluminum - Other #2	97	97	-	0.0315	0.01496	0.07377	0.0459016	0.00881		0.003	0	0
Glass - Clear	34	34	-	0.0134	0.00638	0.03148	0.0195873	0.00376		0.003	0	0
Glass - Brown	34	34	-	0.0134	0.00638	0.03148	0.0195873	0.00376		0.003	0	0
Glass - Green	34	34	-	0.0134	0.00638	0.03148	0.0195873	0.00376		0.003	0	0
Mixed Glass	34	34	-	0.0134	0.00638	0.03148	0.0195873	0.00376		0.003	0	0
CNNR - Other	-	-	-	0	0	0	0	0		0.003	0	0
Paper - Nonrecyclable	2,481	2,481	-	0.84	0.3992	1.96864	1.2249288	0.23519		0.003	0	0
Food Waste	1,009	1,009	-	0.3582	0.17022	0.83945	0.5223257	0.10029		0.003	0	0
CCCN - Other	998	998	-	0.3544	0.16843	0.83062	0.5168276	0.09923		0.003	0	0
Plastic - Nonrecyclable	5,469	-	5,469	2.2169	1.05361	5.19589	3.2329961	0.62074		0.003	0	0
Misc. (CNNN)	2,689	2,689	-	0.9355	0.44462	2.19263	1.3643015	0.26195		0.003	0	0
CCNN - Other	2,689	2,689	-	0.9355	0.44462	2.19263	1.3643015	0.26195		0.003	0	0
Ferrous - Nonrecyclable	96	96	-	0.0312	0.01481	0.07302	0.0454332	0.00872		0.003	0	0
Aluminum - Nonrecyclab	97	97	-	0.0315	0.01496	0.07377	0.0459016	0.00881		0.003	0	0
Glass - Nonrecyclable	34	34	-	0.0134	0.00638	0.03148	0.0195873	0.00376		0.003	0	0
Misc. (NNNN)	-	-	-	0	0	0	0	0		0.003	0	0
CNNN - Other	-	-	-	0	0	0	0	0		0.003	0	0

Note that the emission factors for non-metal emissions in WTE are not user enterable data, and are calculated based on chemical composition of the waste component, the quantity of air used, and stoichiometric calcualtions.

Table 7.6. Emission Factors for MSW Components
Part 2: Nonmetal Air Emissions for Lime

The nonmetal air emissions for lime correspond to emissions from extraction and production of lime per ton of waste component (lb. nonmetal emitted/ton waste component). The value is the same for all MSW components.

MSW COMPONENT	LIME AIR EMISSIONS (lb. pollutant/ton waste): NONMETALS											
	CO_2	Biomass CO_2	Fossil CO_2	SO_2	HCl	NOx (as NO)	CO	Total PM	PM10	CH_4	NH_3 (air)	Hydro-carbons
All Components	0.0007	18.0462	0.052	2E-08	0.0183	0	0.00494	0.0381		0.0134	2.8E-06	0.00416

Note that the emission factors for emissions from Lime in WTE are not user enterable data, and are calculated based on energy used in Lime manufacture and precombustion energy emissions.

Table 7.6. Emission Factors for MSW Components
Part 3: Uncontrolled Metal Air Emissions

An uncontrolled emission factor is the emissions of metal per ton of waste component before stack gas treatment (lb. metal emitted/ton waste component).

MSW COMPONENT	UNCONTROLLED METAL AIR EMISSIONS (lb. pollutant/ton waste)										
	As	B	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Zn
Yard Trimmings, Leaves	2.6E-05	1.3E-02	1.5E-03	1.1E-03	3.0E-04	1.4E-03	8.0E-04	1.6E-02	4.6E-04	2.6E-07	1.7E-02
Yard Trimmings, Grass	2.6E-05	1.3E-02	1.5E-03	1.1E-03	3.0E-04	1.4E-03	8.0E-04	1.6E-02	4.6E-04	2.6E-07	1.7E-02
Yard Trimmings, Branch	3.2E-06	5.5E-04	2.7E-04	2.6E-04	1.9E-05	3.9E-04	3.7E-04	6.5E-03	6.9E-05	1.5E-07	5.8E-03
Old Newsprint	2.4E-06	2.2E-04	2.4E-05	5.7E-04	7.8E-06	2.1E-03	1.0E-03	6.8E-04	2.0E-05	3.8E-07	9.5E-04
Old Corrugated Cardboa	2.1E-06	7.5E-05	2.4E-05	1.9E-05	1.3E-06	9.8E-05	1.3E-04	4.0E-04	1.3E-05	1.5E-07	4.6E-04
Office Paper	4.6E-06	5.3E-05	2.4E-05	3.7E-05	3.4E-06	3.0E-04	2.7E-04	4.7E-04	2.0E-05	9.4E-07	9.6E-03
Phone Books	2.8E-06	1.5E-04	2.4E-05	1.4E-05	4.3E-06	3.0E-04	1.5E-04	2.5E-04	1.1E-05	4.1E-07	3.7E-04
Books	1.4E-06	9.1E-04	9.8E-05	9.4E-05	1.7E-05	2.0E-04	4.7E-05	5.3E-07	2.6E-07	4.9E-07	4.1E-03
Old Magazines	5.1E-06	1.2E-04	3.5E-05	1.2E-04	1.3E-05	3.0E-04	4.4E-04	3.2E-04	4.2E-04	3.9E-07	1.3E-03
Third Class Mail	4.2E-06	1.6E-04	4.1E-04	3.6E-04	1.0E-05	3.9E-04	2.5E-04	2.4E-02	4.4E-05	1.1E-07	3.8E-03
Paper - Other #1	3.2E-06	2.4E-04	9.2E-05	1.7E-04	8.2E-06	5.2E-04	3.3E-04	3.7E-03	7.6E-05	4.1E-07	2.9E-03
Paper - Other #2	3.2E-06	2.4E-04	9.2E-05	1.7E-04	8.2E-06	5.2E-04	3.3E-04	3.7E-03	7.6E-05	4.1E-07	2.9E-03
Paper - Other #3	3.2E-06	2.4E-04	9.2E-05	1.7E-04	8.2E-06	5.2E-04	3.3E-04	3.7E-03	7.6E-05	4.1E-07	2.9E-03
Paper - Other #4	3.2E-06	2.4E-04	9.2E-05	1.7E-04	8.2E-06	5.2E-04	3.3E-04	3.7E-03	7.6E-05	4.1E-07	2.9E-03
Paper - Other #5	3.2E-06	2.4E-04	9.2E-05	1.7E-04	8.2E-06	5.2E-04	3.3E-04	3.7E-03	7.6E-05	4.1E-07	2.9E-03
CCCR - Other	3.2E-06	2.4E-04	9.2E-05	1.7E-04	8.2E-06	5.2E-04	3.3E-04	3.7E-03	7.6E-05	4.1E-07	2.9E-03
Mixed Paper	3.2E-06	2.4E-04	9.2E-05	1.7E-04	8.2E-06	5.2E-04	3.3E-04	3.7E-03	7.6E-05	4.1E-07	2.9E-03
HDPE - Translucent	1.8E-06	7.1E-04	7.1E-04	1.6E-04	1.0E-05	2.0E-04	2.4E-04	6.4E-03	4.6E-04	1.9E-07	6.6E-03
HDPE - Pigmented	1.8E-06	7.1E-04	7.1E-04	1.6E-04	1.0E-05	2.0E-04	2.4E-04	6.4E-03	4.6E-04	1.9E-07	6.6E-03
PET	2.8E-06	4.7E-03	1.3E-03	1.8E-04	1.3E-05	2.0E-04	2.8E-04	6.5E-03	1.5E-03	1.9E-07	4.5E-03
Plastic - Other #1	2.1E-06	2.0E-03	9.0E-04	1.7E-04	1.1E-05	2.0E-04	2.5E-04	6.4E-03	8.2E-04	1.9E-07	5.9E-03
Plastic - Other #2	2.1E-06	2.0E-03	9.0E-04	1.7E-04	1.1E-05	2.0E-04	2.5E-04	6.4E-03	8.2E-04	1.9E-07	5.9E-03
Plastic - Other #3	2.1E-06	2.0E-03	9.0E-04	1.7E-04	1.1E-05	2.0E-04	2.5E-04	6.4E-03	8.2E-04	1.9E-07	5.9E-03
Plastic - Other #4	2.1E-06	2.0E-03	9.0E-04	1.7E-04	1.1E-05	2.0E-04	2.5E-04	6.4E-03	8.2E-04	1.9E-07	5.9E-03
Plastic - Other #5	2.1E-06	2.0E-03	9.0E-04	1.7E-04	1.1E-05	2.0E-04	2.5E-04	6.4E-03	8.2E-04	1.9E-07	5.9E-03
Mixed Plastic	2.1E-06	2.0E-03	9.0E-04	1.7E-04	1.1E-05	2.0E-04	2.5E-04	6.4E-03	8.2E-04	1.9E-07	5.9E-03
CCNR - Other	2.1E-06	2.0E-03	9.0E-04	1.7E-04	1.1E-05	2.0E-04	2.5E-04	6.4E-03	8.2E-04	1.9E-07	5.9E-03

Table 7.6. Emission Factors for MSW Components
Part 3: Uncontrolled Metal Air Emissions

MSW COMPONENT, continued	UNCONTROLLED METAL AIR EMISSIONS (lb. pollutant/ton waste)										
	As	B	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Zn
Ferrous Cans	2.5E-05	3.8E-03	1.1E-02	2.1E-03	4.9E-05	7.6E-03	5.4E-03	3.5E-02	7.7E-04	1.6E-07	2.0E-01
Ferrous Metal - Other	2.0E-02	3.3E-03	5.4E-03	2.9E-03	1.9E-01	5.8E-03	2.8E-03	5.4E-02	7.4E-04	4.6E-05	2.7E-01
Aluminum Cans	1.1E-06	3.8E-04	1.2E-03	9.9E-04	4.8E-04	3.6E-04	7.6E-04	4.9E-03	1.7E-04	3.8E-08	1.0E-02
Aluminum - Other #1	2.8E-06	3.6E-04	1.2E-02	1.5E-03	1.2E-04	7.9E-04	1.4E-03	4.2E-07	2.6E-07	3.8E-08	5.6E-03
Aluminum - Other #2	5.3E-03	4.3E-04	3.2E-03	7.6E-03	1.9E-04	3.3E-04	6.6E-04	7.3E-03	1.7E-04	2.1E-05	8.6E+00
Glass - Clear	3.5E-06	2.2E-03	1.2E-03	3.0E-04	9.4E-06	2.0E-04	3.4E-04	1.1E-02	1.3E-03	2.9E-06	2.8E-03
Glass - Brown	2.4E-05	7.1E-04	4.1E-04	5.0E-04	3.9E-05	5.9E-04	7.7E-04	1.1E-02	2.2E-04	1.8E-06	1.2E-02
Glass - Green	3.5E-05	1.1E-03	7.3E-05	1.0E-02	2.6E-06	9.8E-05	2.1E-03	2.1E-03	3.2E-04	2.3E-07	9.7E-04
Mixed Glass	3.5E-05	1.1E-03	7.3E-05	1.0E-02	2.6E-06	9.8E-05	2.1E-03	2.1E-03	3.2E-04	2.3E-07	9.7E-04
CNNR - Other	5.3E-03	4.3E-04	3.2E-03	7.6E-03	1.9E-04	3.3E-04	6.6E-04	7.3E-03	1.7E-04	2.1E-05	8.6E+00
Paper - Nonrecyclable	4.2E-06	1.6E-04	4.1E-04	3.6E-04	1.0E-05	3.9E-04	2.5E-04	2.4E-02	4.4E-05	1.1E-07	3.8E-03
Food Waste	4.2E-06	8.0E-03	4.9E-04	2.4E-04	1.8E-05	3.0E-04	1.6E-04	7.6E-03	1.1E-04	1.9E-07	8.6E-03
CCCN - Other	4.2E-06	8.0E-03	4.9E-04	2.4E-04	1.8E-05	3.0E-04	1.6E-04	7.6E-03	1.1E-04	1.9E-07	8.6E-03
Plastic - Nonrecyclable	2.2E-06	4.2E-04	7.8E-03	1.7E-03	1.4E-05	2.1E-04	5.8E-04	3.4E-02	1.1E-03	1.9E-07	2.2E-02
Misc. (CNNN)	2.6E-03	3.3E-03	6.2E-03	2.6E-03	2.4E-02	1.5E-03	9.9E-04	3.8E-02	1.3E-03	2.6E-04	6.7E-02
CCNN - Other	2.6E-03	3.3E-03	6.2E-03	2.6E-03	2.4E-02	1.5E-03	9.9E-04	3.8E-02	1.3E-03	2.6E-04	6.7E-02
Ferrous - Nonrecyclable	2.0E-02	3.3E-03	5.4E-03	2.9E-03	1.9E-01	5.8E-03	2.8E-03	5.4E-02	7.4E-04	4.6E-05	2.7E-01
Aluminum - Nonrecyclab	5.3E-03	4.3E-04	3.2E-03	7.6E-03	1.9E-04	3.3E-04	6.6E-04	7.3E-03	1.7E-04	2.1E-05	8.6E+00
Glass - Nonrecyclable	9.4E-06	1.8E-03	9.6E-04	1.5E-03	1.2E-05	2.3E-04	6.0E-04	1.0E-02	1.0E-03	2.4E-06	5.1E-03
Misc. (NNNN)	2.6E-03	3.3E-03	6.2E-03	2.6E-03	2.4E-02	1.5E-03	9.9E-04	3.8E-02	1.3E-03	2.6E-04	6.7E-02
CNNN - Other	2.6E-03	3.3E-03	6.2E-03	2.6E-03	2.4E-02	1.5E-03	9.9E-04	3.8E-02	1.3E-03	2.6E-04	6.7E-02

Table 7.6. Emission Factors for MSW Components
Part 4: Metal Air Emissions for Lime

The metal air emissions for lime correspond to emissions from extraction and production of lime per ton of waste component (lb. metal emitted/ton waste

MSW COMPONENT	LIME METAL AIR EMISSIONS (lb. pollutant/ton waste)										
	As	B	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Zn
All Components	2.12E-06	0	7.1E-07	4.37E-06	0	6.1E-08	3E-06	2.6E-07	1.03E-08	1.1E-08	0

Note that the emission factors for emissions from Lime in WTE are not user enterable data, and are calculated based on energy used in Lime manufacture and precombustion energy emissions.

Table 7.6. Emission Factors for MSW Components
Part 5: Water Pollutant Emissions for Limestone

The water releases for lime correspond to emissions from extraction and production of lime per ton of waste component (lb. emitted/ton waste component).

MSW COMPONENT	LIMESTONE:WATER POLLUTANT EMISSIONS (lb. pollutant/ton waste)									
	Dissolved Solids	Suspended Solids	BOD	COD	Oil	Sulfuric acid	Iron	Ammonia	Copper	Cadmium
All Components	0.015448	0.0006062	1.651E-05	0.000225	0.0002742	5.4769E-05	0.0003	8.29E-07	0	7.27E-07

MSW COMPONENT	LIMESTONE:WATER POLLUTANT EMISSIONS, continued (lb. pollutant/ton waste)							LIME ADDITION lb. solid waste per ton waste i (lb./ton)	LIME BTUs energy per ton waste i
	Arsenic	Mercury	Phosphate	Selenium	Chromium	Lead	Zinc		
All Components	0	5.59E-11	2.738E-05	0	7.011E-07	2.17E-10	2.4E-07	1.164041096	36,110.33688

Note that the emission factors for emissions from Lime in WTE are not user enterable data, and are calculated based on energy used in Lime manufacture and precombustion energy emissions.

8. Landfill Process Models

Overview

The objective of the landfill process model is to calculate the cost and life-cycle inventory (LCI) for the burial of one ton of municipal solid waste (MSW) or combustion ash in a landfill. The model is designed to calculate the cost and LCI for one ton of waste in consideration of user-input and default values for a traditional, enhanced bioreactor, and ash landfill and can also to specify whether the landfill includes liner, landfill gas collection, and leachate collection systems. The formats for the three types of landfills are similar and areas of divergence are addressed in the following section.

Conceptual Designs

Three types of landfill designs are considered in the decision support tool:

1) traditional landfills operated to minimize moisture infiltration,
2) bioreactor landfills operated to enhance decomposition, and
3) ash landfills.

These landfills are primarily defined by their physical characteristics and by the waste that they receive. All landfills are designed and operated in compliance with RCRA Subtitle D regulations. Bioreactor landfills use leachate recycling to enhance waste decomposition, leachate stabilization, and gas production. Ash landfills accept MSW incinerator ash.

All three landfill process models contain five different phases in the landfill lifecycle:

- ***Operations:*** considers fuel use and equipment emissions associated with landfill operation.
- ***Closure:*** considers fuel use and equipment emissions associated with landfill closure.
- ***Post-closure:*** This section details the post-closure phase of a modern MSW landfill including cover maintenance and monitoring.
- ***Landfill Gas:*** This section describes gas generation, treatment, and utilization.
- ***Landfill Leachate:*** This section describes leachate generation and treatment.

Contrary to other waste management options, which generally have instantaneous, landfill emissions occur over time. The emissions associated with disposal of a ton of waste in a landfill are reported for one of three user selected time horizons beginning from when the waste is placed in the site:

- A ***short-term time frame (20 years)*** corresponding roughly to the landfill's period of active decomposition.
- An ***intermediate-term time frame (100 years)*** corresponding roughly to the life span of a given generation.

- A ***long-term time frame (500 years)*** corresponding to an indefinite time reference, at which point the emission of any given environmental flow will have likely reached its theoretical yield.

Emissions are estimated for one time horizon which the user selects.

Cost Methodology

The methodology used to estimate the costs associated with the three landfill options are described in the following sections. Landfill costs fall into four main categories: initial construction, cell construction, operations, and closure. To calculate the cost for each of these categories, the size of the landfill is needed. In order to size the landfill, the waste flowing to the landfill must be known. However, the waste flow to the landfill is specified by the decision support tool solution. Thus, to use the landfill process model, the size is based on user input values for the facility life and daily waste flow. As input by the user, these parameters are used to provide a rough estimate of landfill size which is used to calculate costs.

Landfills represent a unique problem relative to other MSW management unit operations in that all other operations have a useful life and assumed replacement cost equal to its original cost. The same assumption is made for replacing a landfill.

Initial Construction Cost

Included in the initial construction cost are land acquisition; site fencing; building and structures required to support operation of the landfill and for a flare required for landfill gas treatment; platform scales; site utilities installation; site access roads; monitoring wells; initial landscaping; leachate pump and storage (in accordance with 40CFR258.40); site suitability study, planning and licensing. A multiplier is applied to the overall initial construction cost to account for engineering costs. The total cost is then amortized over the operating period of the facility and normalized to the annual volume of waste received.

Cell Construction Cost

The section summarizes the costs applicable to the development and preparation of each individual cell of the landfill. Cell construction costs include site clearing and excavation; site berm construction; liner systems (if specified and in accordance with 40CFR258.40); leachate control materials for traditional and ash landfills; leachate collection and recirculation materials for bioreactor landfills; and any cell pre-operational costs (e.g., engineering design, hydrogeologic studies). The total cell construction cost is amortized over the operating period of the facility and normalized to the annual volume of waste received.

Operation and Maintenance Cost

The operation and maintenance (O&M) costs of a landfill include labor, equipment procurement, leachate treatment, daily cover overhead, taxes, administration, insurance, indirect costs, auxiliary fuel cost, utilities, and maintenance. The O&M cost function depends upon the unit O&M cost, the rate at which waste enters the landfill. There is no amortization of the annual operation and maintenance because they are annual, recurring costs.

Closure and Postclosure Cost

Closure costs for the landfill model include costs associated with the installation of the final landfill gas extraction system (in accordance with 40CFR258.23); final cover (can include soil, geotextile, sand, HDPE, and clay as specified by the user); cost of replacing final cover; and perpetual care. The total closure cost is amortized over the operating period of the facility and normalized to the annual volume of waste received.

Revenue from Landfill Gas

If a turbine, boiler, or internal combustion engine is used to treat landfill gas, it may result in a revenue stream for the landfill. Three gas collection periods are defined in the model. Within each of the gas collection periods, the user has five options for landfill gas treatment: vent, flare, turbine, direct use, and internal combustion engine.. The electricity that is generated is assumed to be sold to an end user. The default value for revenue from electricity generation is set at the national average per kWh. The yearly revenue generated during each landfill gas treatment period is converted to the present value and then annualized over the operating life of the landfill. The amortized revenues are for each period are then summed to obtain the total revenue from landfill gas treatment. This total revenue offsets the cost of landfill construction, operation, and closure.

Life-Cycle Inventory Methodology

The LCI methodology calculates the net energy consumption and environmental releases (air, water, and solid waste) from the landfill construction, operation, closure and post closure and allocates these LCI parameters to individual components of the waste stream.

Energy

Energy is consumed during the operation, closure and post-closure phases of the landfill. Energy that is recovered is credited as an energy gain in the LCI inventory, and it is assumed to displace a similar amount of electricity produced from conventional fuels (e.g., coal and natural gas). However, the exact mix of the energy that is offset can be specified by the user if it is known. In addition, the user can specify whether or not energy is actually recovered.

Air Emissions

Air emissions are associated with equipment use during each phase of the landfill as well as with decomposition of the buried waste and emissions during leachate treatment. Where energy is recovered, some air emissions associated with electrical energy production from fossil fuel is avoided.

Water Releases

Water releases associated with the landfill are post-treatment releases from publicly operated treatment works (POTW) of leachate. Net releases from the landfill are the releases from the POTW plus uncontrolled leachate. If energy if recovered from the landfill, then water releases would net out the releases that would otherwise have been produced by the type of utility generation displaced.

Solid Waste Releases

Solid wastes from the landfill processes include the solid wastes associated with energy utilization, treatment of landfill leachate, and production of landfill materials. If energy is captured at the landfill, then total solid waste is calculated by netting out the solid waste that would have otherwise been produced by the type of utility generation being displaced.

Table 8.1. Cost Estimation

INPUT PARAMETER	UNIT	TRADITIONAL	BIOREACTOR	ASH
Site Characteristics and Layout				
General Characteristics				
length/width ratio*		1.00	1.00	1.00
buffer zone*	ft	300	300	300
fraction of buffer zone cleared/landscaped*	%	5%	5%	105%
height of waste above grade*	ft	40	40	40
slope of above grade region (rise over run)*		0.33	0.33	0.33
slope of below grade region (rise over run)*		0.33	0.33	0.33
off-site road upgrade for heavy vehicles*	mi.	1.00	1.00	1.00
onsite roads*	ft	600	600	600
Excavation and Soil Characteristics				
excavation depth*	ft	40	40	40
fraction of below-grade volume required to be excavated*		100%	100%	100%
fraction of excavated volume considered difficult to excavate*		10%	10%	10%
fraction of excavation usable for liner, top soil and vegetative cover, berms, fill cover, and daily cover*	%	90%	90%	90%
Berm Characteristics				
height above site grade*	ft	10	10	10
grade of sides (rise over run)*		0.33	0.33	0.33
width at top*	ft	12	12	12
Design Options - Liner				
Liner? Yes = 1, No = 0*		1	1	1
Fraction of Clay Additive to Achieve Minimum Permeability*		4%	4%	4%
Depth of Soil in Primary Liner*	ft	2.0	2.0	2.0
Single Composite = 0, Double Composite = 1*		0	1	0
Depth of Secondary Liner*	ft	2.00	0.00	2.00
Design Options - Leachate Collection System				
Design Characteristics				
collection trenches: sand = 1, gravel = 0		1 *	1	1 *
depth of sand/gravel in trenches	ft	1.00 *	1.00	1.00 *
distance between collection pipes	ft	500 *	500	500 *
depth of soil protecting leachate collection system	ft	2.00 *	2.00	2.00 *

Table 8.1. Cost Estimation

INPUT PARAMETER, continued	UNIT	TRADITIONAL	BIOREACTOR	ASH
Design Options - Site Utilities				
Sewage: Septic System = 1, Public Sewer = 0*		0	0	0
Water Supply: Onsite Well Water = 1, Public Water = 0*		0	0	0
Gas Utility? Yes = 1, No = 0*		0	0	0
Length of Sanitary Sewer Piping Run*	ft	5,280	5,280	5,280
Depth of Potable Water Well*	ft	50	50	50
Methane Extraction and Groundwater Monitoring				
Distance Between Groundwater Monitoring Wells*	ft	500	500	500
Number of Gas Extraction Vents per Acre*	#/ac	1	1	1
Operating Characteristics				
Expected Mass Flow*	ton/day	1,350	1,350	1,350
Compacted Waste Density*	lb./yd^3	1,500	1,500	3.50E+03
Years' Perpetual Care*	yr.	30	30	30
Percent of the Landfill Airspace Occupied by Daily Cover*		10	10	0
Number of Weighing Scales*		1	1	0
Economic Calculations				
Life of Facility*	yr.	20	20	20
Number of Cells*		5	5	5
Engineering Rate (capital)*		0.10	0.10	0.10
Engineering Rate (operations)*		0.10	0.10	0.10
Operating Costs				
Labor				
minimum labor costs*	$/yr.	$308,000	$332,000	$111,000
maximum daily waste handled by minimum labor costs*	ton/day	400	400	400
incremental labor cost per ton per day (TPD) above maximum*	$/yr.-TPD	$356	$356	$356
utilities rate (as fraction of labor costs)*		0.01	0.01	0.01
overhead costs (overhead costs $/wage $)*		0.46	0.46	0.46
Other				
equipment and maintenance*	$/yr.-TPD	$2,000	$2,000	$2,000
leachate treatment/disposal*	$/gal.	$0.40	$0.40	$0.40
groundwater monitoring*	$/well-yr.	$2,000	$2,000	$2,000
perpetual care*	$/yr.	$258,000	$258,000	$36,000

Table 8.1. Cost Estimation

INPUT PARAMETER, continued	UNIT	TRADITIONAL	BIOREACTOR	ASH
Construction Costs				
Land Preparation				
land costs*	$/ac	$2,000	$2,000	$2,000
land clearing*	$/ac	$3,000	$3,000	$3,000
low-level landscaping*	$/ac	$2,000	$2,000	$2,000
high-level landscaping*	$	$6,000	$6,000	$6,000
Earthwork				
standard excavation*	$/yd^3	$2.37	$2.37	$2.37
difficult excavation (i.e., muck, clay, etc.)*	$/yd^3	$3.56	$3.56	$3.56
onsite earth hauling*	$/yd^3-mi.	$2.17	$2.17	$2.17
off-site earth hauling*	$/yd^3-mi.	$0.59	$0.59	$0.59
distance for disposal of excess soil*	mi.	1	1	1
berms*	$/yd^3	$2.96	$2.96	$2.96
mixing and compacting soil for liners*	$/yd^3	$5.93	$5.93	$5.93
Purchased Material for Berms, Liners, Fill Covers				
soil for berm*	$/yd^3	$3.16	$3.16	$3.16
clay for fill cover or liner*	$/yd^3	$8.30	$8.30	$8.30
clay additive for liner permeability*	$/yd^3	$136.28	$136.28	$136.28
sand*	$/yd^3	$9.54	$9.54	$9.54
gravel*	$/yd^3	$9.84	$9.84	$9.84
geotextile for fill cover - cost of procurement*	$/ft^2	$0.11	$0.11	$0.11
geotextile for fill cover - cost of installation*	$/ft^2	$0.70	$0.70	$0.70
HDPE for fill cover - cost of procurement and installation*	$/ft^2	$1.78	$1.78	$1.78
Daily Cover - Cost of Procurement				
daily cover - onsite soil*	$/yd^3	$0.00	$0.00	$0.00
daily cover - HDPE*	$/ft^2	$1.78	$1.78	$1.78
daily cover - revenue-generating cover*	$/yd^3	-5	-5	-5
daily cover - off-site soil*	$/yd^3	$3.16	$3.16	$3.16
Liner and Leachate Collection				
flexible membrane liner (includes installation)	$/ft^2	* $1.78	* $1.78	* $1.78
leachate pump(s), piping, and electrical	$	*$12,000	*$12,000	0
leachate storage tank	$	*$142,000	*$284,000	0
Roads				
new road construction (heavy vehicle)*	$/lin. ft	$41.48	$41.48	$41.48
existing road upgrade (heavy vehicle)*	$/lin. ft	$41.48	$41.48	$41.48

Table 8.1. Cost Estimation

INPUT PARAMETER, continued	UNIT	TRADITIONAL	BIOREACTOR	ASH
Construction Costs, continued				
Structures				
maintenance building*	$/ft^2	$26	$26	$25.83
gatehouse/personnel facility*	$	$398,000	$398,000	$31,000
Utilities				
electrical connection*	$	$12,000	$12,000	$12,000
sanitary sewer connection and piping*	$/lin. ft	$12	$12	$12
septic system*	$	$49,000	$49,000	$49,000
public water connection*	$	$12,000	$12,000	$12,000
well drilling and installation*	$/lin. ft	$26	$26	$26
well water connection*	$	$59,000	$59,000	$59,000
gas connection*	$	$12,000	$12,000	$12,000
Miscellaneous				
industrial fencing*	$/lin. ft	$14.16	$14.16	$14
industrial truck scale (50-ton capacity)*	$	$83,000	$83,000	$83,000.00
public convenience transfer structure*	$	$0.00	$0.00	$0.00
PVC piping*	$/lin. ft	$12.09	$12.09	$12.09
site preoperational studies and activities*	$	$296,000	$296,000	$296,000
cell-one preoperational studies and activities*	$	$296,000	$296,000	$296,000
Gas Extraction and Disposal Costs				
Capital Cost of Turbine*	$	$4,453,278	$4,453,278	0
Capital Cost of Internal Combustion Engine*	$	$1,335,983	$1,335,983	0
Revenue from Electric Buy-Back Rates*	$/kWh	$0.03	$0.03	$0.03
Revenue from Thermal Energy*	$/MMBtu	$1.37	$1.37	$1.37

Table 8.2. LCI Factors
Part 1: Material Production

INPUT PARAMETER	SOIL	SAND	HDPE	GEOTEXTILE	PVC
	lb. emission per lb. soil produced	lb. emission per lb. sand produced	lb. emission per lb. HDPE produced	lb. emission per lb. geotextile produced	lb. emission per lb. PVC produced
Atmospheric Emissions					
Particulates (PM10)	ND	ND	ND	ND	ND
Particulates (Total)	1.30E-05	1.30E-05	2.00E-03	5.70E-03	5.10E-03
Nitrogen Oxides	1.60E-04	1.60E-04	1.00E-02	1.30E-02	1.80E-02
Hydrocarbons (non-CH_4)	1.60E-05	1.60E-05	2.09E-02	1.40E-02	2.20E-02
Sulfur Oxides	1.90E-05	1.90E-05	6.12E-03	1.70E-02	1.70E-02
Carbon Monoxide	6.10E-05	6.10E-05	5.17E-04	9.50E-04	2.80E-03
CO_2 (biomass)	0.00E+00	0.00E+00	3.26E-04	0.00E+00	0.00E+00
CO_2 (non-biomass)	4.30E-03	4.30E-03	1.92E+00	2.94E+00	2.20E+00
Ammonia			5.90E-07		
Lead			6.25E-09		
Methane	1.90E-06	1.90E-06	2.82E-04	2.60E-03	
Hydrochloric acid	2.10E-08	2.10E-08	5.95E-05	2.10E-04	2.70E-04
Solid Waste					
Solid Waste #1	ND	ND	ND	ND	ND
Solid Waste #2	ND	ND	ND	ND	ND
Solid Waste #3	ND	ND	ND	ND	ND
Solid Waste #4	ND	ND	ND	ND	ND
Solid Waste #5	ND	ND	4.67E-02	ND	ND
Waterborne Emissions					
Dissolved Solids			7.20E-04		
Suspended Solids	2.20E-06	2.20E-06	2.86E-04	2.20E-04	2.30E-03
BOD	4.80E-07	4.80E-07	1.00E-04	6.50E-05	8.00E-05
COD	4.10E-06	4.10E-06	2.04E-04	4.40E-04	1.10E-03
Oil	1.30E-03	1.30E-03	3.42E-05	1.30E+00	5.40E-01
Sulfuric Acid			1.16E-06		
Iron			7.15E-06		

Table 8.2. LCI Factors
Part 1: Material Production

INPUT PARAMETER, continued	SOIL	SAND	HDPE	GEOTEXTILE	PVC
	lb. emission per lb. soil produced	lb. emission per lb. sand produced	lb. emission per lb. HDPE produced	lb. emission per lb. geotextile produced	lb. emission per lb. PVC produced
Waterborne Emissions, continued					
Ammonia	7.10E-08	7.10E-08	1.01E-05	1.10E-05	
Copper			0.00E+00		
Cadmium			0.00E+00		
Arsenic			0.00E+00		
Mercury			0.00E+00		
Phosphate	1.20E-15	1.20E-15	1.61E-06	2.10E-05	
Selenium			0.00E+00		
Chromium	4.80E-14	4.80E-14	1.39E-08	1.30E-11	
Lead			3.37E-12		
Zinc			4.81E-09		
Additional Parameters					
Water Metals					
barium					
silver					
metals unspecified	3.10E-08	3.10E-08	3.00E-04	3.10E-04	
Water Hydrocarbons					
benzene	1.30E-23	1.30E-23			
chloroform					
carbon tetrachloride					
ethylene dichloride					
methylene chloride					
trichloroethene					
tetrachloroethene					
vinyl chloride					
toluene					
xylenes					
ethylbenzene					

Table 8.2. LCI Factors
Part 1: Material Production

INPUT PARAMETER, continued	SOIL lb. emission per lb. soil produced	SAND lb. emission per lb. sand produced	HDPE lb. emission per lb. HDPE produced	GEOTEXTILE lb. emission per lb. geotextile produced	PVC lb. emission per lb. PVC produced
Additional Parameters, continued					
Water Hydrocarbons, continued					
hydrocarbons unspecified	1.20E-09	1.20E-09	1.50E-04	3.10E-04	2.00E-06
Raw Materials					
coal	4.00E-05	4.00E-05	2.80E-01	3.70E-01	2.60E-01
tural gas	9.70E-05	9.70E-05	7.70E-01	4.40E-01	5.90E-01
uranium	7.60E-10	7.60E-10	4.00E-06	6.00E-06	1.80E-05
bauxite					
sodium chloride					
sand					
clay					
limestone	6.10E-06	6.10E-06	3.20E-02	4.90E-02	1.60E-02
Air Hydrocarbons					
benzene	2.80E-08	2.80E-08	5.10E-06	7.60E-06	
chloroform					
carbon tetrachloride					
ethylene dichloride					
methylene chloride					
trichloroethene					
tetrachloroethene					
vinyl chloride					
toluene	5.10E-12	5.10E-12	2.40E-08	3.60E-08	
xylenes	1.90E-12	1.90E-12	3.70E-09	5.50E-09	
ethylbenzene					
Energy (Btu/lb.)	2.58E+01	2.58E+01	1.44E+04	3.96E+04	3.05E+04

Table 8.2. LCI Factors
Part 2: Heavy Equipment

INPUT PARAMETER	WHEEL TRACTOR	BULLDOZER	SCRAPER	GRADER	WHEEL LOADER	TRUCK	ROLLER	MISC.
	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used
Atmospheric Emissions								
Particulates (PM10)								
Particulates (Total)	4.60E-02	1.50E-02	2.70E-02	2.20E-02	2.90E-02	1.80E-02	2.40E-02	3.00E-02
Nitrogen Oxides	4.37E-01	2.86E-01	2.59E-01	2.54E-01	3.21E-01	2.86E-01	4.05E-01	3.68E-01
Hydrocarbons (non-CH_4)	6.50E-02	1.30E-02	1.90E-02	1.30E-02	4.30E-02	1.30E-02	3.00E-02	3.40E-02
Sulfur Oxides	3.10E-02	3.10E-02	3.10E-02	3.10E-02	3.10E-02	3.10E-02	3.10E-02	3.10E-02
Carbon Monoxide	2.68E-01	1.23E-01	8.50E-02	5.50E-02	9.80E-02	1.23E-01	1.89E-01	1.54E-01
CO_2 (biomass)								
CO_2 (non-biomass)	2.21E+01	2.21E+01	2.21E+01	2.21E+01	2.21E+01	2.21E+01	2.21E+01	2.21E+01
Ammonia								
Lead								
Methane								
Hydrochloric acid								
Solid Waste								
Solid Waste #1	ND	ND	ND	ND	ND	ND	ND	ND
Solid Waste #2	ND	ND	ND	ND	ND	ND	ND	ND
Solid Waste #3	ND	ND	ND	ND	ND	ND	ND	ND
Solid Waste #4	ND	ND	ND	ND	ND	ND	ND	ND
Solid Waste #5	ND	ND	ND	ND	ND	ND	ND	ND

Table 8.2. LCI Factors
Part 2: Heavy Equipment

INPUT PARAMETER, continued	WHEEL TRACTOR	BULLDOZER	SCRAPER	GRADER	WHEEL LOADER	TRUCK	ROLLER	MISC.
	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used
Waterborne Emissions								
Dissolved Solids	ND	ND	ND	ND	ND	ND	ND	ND
Suspended Solids	ND	ND	ND	ND	ND	ND	ND	ND
BOD	ND	ND	ND	ND	ND	ND	ND	ND
COD	ND	ND	ND	ND	ND	ND	ND	ND
Oil	ND	ND	ND	ND	ND	ND	ND	ND
Sulfuric Acid	ND	ND	ND	ND	ND	ND	ND	ND
Iron	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND	ND
Phosphate	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	ND	ND	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ND	ND	ND	ND	ND	ND	ND	ND

Table 8.2. LCI Factors
Part 2: Heavy Equipment

INPUT PARAMETER, continued	WHEEL TRACTOR	BULLDOZER	SCRAPER	GRADER	WHEEL LOADER	TRUCK	ROLLER	MISC.
	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used
Additional Parameters								
Water Metals								
barium	ND	ND	ND	ND	ND	ND	ND	ND
silver	ND	ND	ND	ND	ND	ND	ND	ND
metals unspecified	ND	ND	ND	ND	ND	ND	ND	ND
Water Hydrocarbons								
benzene	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	ND	ND	ND	ND	ND	ND	ND	ND
carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND
ethylene dichloride	ND	ND	ND	ND	ND	ND	ND	ND
methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND
toluene	ND	ND	ND	ND	ND	ND	ND	ND
xylenes	ND	ND	ND	ND	ND	ND	ND	ND
ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND
hydrocarbons unspecified	ND	ND	ND	ND	ND	ND	ND	ND
solid waste	ND	ND	ND	ND	ND	ND	ND	ND

Table 8.2. LCI Factors
Part 2: Heavy Equipment

INPUT PARAMETER, continued	WHEEL TRACTOR	BULLDOZER	SCRAPER	GRADER	WHEEL LOADER	TRUCK	ROLLER	MISC.
	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used
Additional Parameters, continued								
Raw Materials								
coal	ND	ND	ND	ND	ND	ND	ND	ND
tural gas	ND	ND	ND	ND	ND	ND	ND	ND
uranium	ND	ND	ND	ND	ND	ND	ND	ND
bauxite	ND	ND	ND	ND	ND	ND	ND	ND
sodium chloride	ND	ND	ND	ND	ND	ND	ND	ND
sand	ND	ND	ND	ND	ND	ND	ND	ND
clay	ND	ND	ND	ND	ND	ND	ND	ND
limestone	ND	ND	ND	ND	ND	ND	ND	ND
Air Hydrocarbons								
benzene	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	ND	ND	ND	ND	ND	ND	ND	ND
carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND
ethylene dichloride	ND	ND	ND	ND	ND	ND	ND	ND
methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND
toluene	ND	ND	ND	ND	ND	ND	ND	ND
xylenes	ND	ND	ND	ND	ND	ND	ND	ND
ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND

Table 8.2. LCI Factors
Part 2: Heavy Equipment

INPUT PARAMETER, continued	WHEEL TRACTOR	BULLDOZER	SCRAPER	GRADER	WHEEL LOADER	TRUCK	ROLLER	MISC.
	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used
Additional Parameters, continued								
Energy (Btu/lb.)					ND	ND	ND	ND

Table 8.2. LCI Factors
Part 3: Transport Vehicles

Input Parameter	HEAVY TRUCK lb. emission per gal. of fuel used	DUMP TRUCK lb. emission per gal. of fuel used
Atmospheric Emissions		
Particulates (PM10)		
Particulates (Total)	5.63E-02	1.77E-02
Nitrogen Oxides	5.14E-02	2.86E-01
Hydrocarbons (non-CH_4)	0.00E+00	1.32E-02
Sulfur Oxides	7.01E-03	3.12E-02
Carbon Monoxide	1.53E-02	1.23E-01
CO_2 (biomass)	0.00E+00	0.00E+00
CO_2 (non-biomass)	2.21E+01	2.21E+01
Ammonia		
Lead		
Methane		
Hydrochloric acid		
Solid Waste		
Solid Waste #1	ND	ND
Solid Waste #2	ND	ND
Solid Waste #3	ND	ND
Solid Waste #4	ND	ND
Solid Waste #5	ND	ND
Waterborne Emissions		
Dissolved Solids	ND	ND
Suspended Solids	0	0
BOD	0	0
COD	0	0
Oil	ND	ND
Sulfuric Acid	ND	ND
Iron	ND	ND
Ammonia	0	0
Copper	ND	ND
Cadmium	ND	ND
Arsenic	ND	ND
Mercury	ND	ND
Phosphate	0	0
Selenium	ND	ND

Table 8.2. LCI Factors
Part 3: Transport Vehicles

Input Parameter, continued	HEAVY TRUCK lb. emission per gal. of fuel used	LIGHT TRUCK lb. emission per gal. of fuel used
Waterborne Emissions, continued		
Chromium	ND	ND
Lead	ND	ND
Zinc	ND	ND
Additional Parameters		
Water Metals		
barium	ND	ND
silver	ND	ND
metals unspecified	0	0
Water Hydrocarbons		
benzene	ND	ND
chloroform	ND	ND
carbon tetrachloride	ND	ND
ethylene dichloride	ND	ND
methylene chloride	ND	ND
trichloroethene	ND	ND
tetrachloroethene	ND	ND
vinyl chloride	ND	ND
toluene	ND	ND
xylenes	ND	ND
ethylbenzene	ND	ND
hydrocarbons unspecified	0	0
solid waste	ND	ND
Raw Materials		
coal	ND	ND
tural gas	ND	ND
uranium	ND	ND
bauxite	ND	ND
sodium chloride	ND	ND
sand	ND	ND
clay	ND	ND
limestone	ND	ND

Table 8.2. LCI Factors
Part 3: Transport Vehicles

Input Parameter, continued	HEAVY TRUCK lb. emission per gal. of fuel used	LIGHT TRUCK lb. emission per gal. of fuel used
Additional Parameters, continued		
Air Hydrocarbons		
benzene	ND	ND
chloroform	ND	ND
carbon tetrachloride	ND	ND
ethylene dichloride	ND	ND
methylene chloride	ND	ND
trichloroethene	ND	ND
tetrachloroethene	ND	ND
vinyl chloride	ND	ND
toluene	ND	ND
xylenes	ND	ND
ethylbenzene	ND	ND
hydrogen chloride	ND	ND
Energy (Btu/lb.)	ND	ND

Table 8.2. LCI Factors
Part 4: Postclosure Equipment

INPUT PARAMETER	LIGHT DUTY TRUCK	4-STROKE LAWN MOWER
	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used
Atmospheric Emissions		
Particulates (PM10)		
Particulates (Total)	6.68E-02	6.26E-03
Nitrogen Oxides	3.07E-03	4.51E-02
Hydrocarbons (non-CH_4)	6.17E-02	3.25E-01
Sulfur Oxides	8.34E-03	5.26E-03
Carbon Monoxide	2.34E-02	3.95E+00
CO_2 (biomass)	0.00E+00	0.00E+00
CO_2 (non-biomass)	2.63E+01	5.84E+00
Ammonia		
Lead		
Methane		
Hydrochloric acid		
Solid Waste		
Solid Waste #1	ND	ND
Solid Waste #2	ND	ND
Solid Waste #3	ND	ND
Solid Waste #4	ND	ND
Solid Waste #5	ND	ND
Waterborne Emissions		
Dissolved Solids	ND	ND
Suspended Solids	ND	ND
BOD	ND	ND
COD	ND	ND
Oil	ND	ND
Sulfuric Acid	ND	ND
Iron	ND	ND
Ammonia	ND	ND
Copper	ND	ND
Cadmium	ND	ND
Arsenic	ND	ND
Mercury	ND	ND
Phosphate	ND	ND
Selenium	ND	ND

Table 8.2. LCI Factors
Part 4: Postclosure Equipment

INPUT PARAMETER, continued	LIGHT DUTY TRUCK	4-STROKE LAWN MOWER
	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used
Waterborne Emissions, continued		
Chromium	ND	ND
Lead	ND	ND
Zinc	ND	ND
Additional Parameters		
Water Metals		
barium	ND	ND
silver	ND	ND
metals unspecified	ND	ND
Water Hydrocarbons		
benzene	ND	ND
chloroform	ND	ND
carbon tetrachloride	ND	ND
ethylene dichloride	ND	ND
methylene chloride	ND	ND
trichloroethene	ND	ND
tetrachloroethene	ND	ND
vinyl chloride	ND	ND
toluene	ND	ND
xylenes	ND	ND
ethylbenzene	ND	ND
hydrocarbons unspecified	ND	ND
solid waste	ND	ND
Raw Materials		
coal	ND	ND
tural gas	ND	ND
uranium	ND	ND
bauxite	ND	ND
sodium chloride	ND	ND
sand	ND	ND
clay	ND	ND
limestone	ND	ND

Table 8.2. LCI Factors
Part 4: Postclosure Equipment

INPUT PARAMETER, continued	LIGHT DUTY TRUCK	4-STROKE LAWN MOWER
	lb. emission per gal. of fuel used	lb. emission per gal. of fuel used
Additional Parameters, continued		
Air Hydrocarbons		
benzene	ND	ND
chloroform	ND	ND
carbon tetrachloride	ND	ND
ethylene dichloride	ND	ND
methylene chloride	ND	ND
trichloroethene	ND	ND
tetrachloroethene	ND	ND
vinyl chloride	ND	ND
toluene	ND	ND
xylenes	ND	ND
ethylbenzene	ND	ND
hydrogen chloride	ND	ND
Energy (Btu/lb.)	ND	ND

TABLE 8.3. Parameters Describing Landfill Operation

INPUT PARAMETER	TRADITIONAL	BIOREACTOR	ASH	UNIT
Waste Characteristics				
Density of Compacted Pure Waste*	**<<Input in Table 8.1.>>**		3.50E+03	lb./bank yd^3
Density of Daily Cover Soil	115	115	1.15E+02	lb./ft^3
Density of HDPE	59.6	59.6	5.96E+01	lb./ft^3
Time after Initial Waste Placement*	100	100	100	yr.
Daily Cover Materials				
% Soil*	70	70	0	%
% HDPE*	15	15	0	%
% Revenue-Generating Cover*	15	15	0	%
% No Daily Cover*	0	0	100	%
% Volume Used by Daily Cover*	**<<Input in Table 8.1.>>**			%
HDPE Thickness*	15	15	0	mils
Area of HDPE*	4.36E+04	4.36E+04	0.00E+00	ft^2/ac
Fuel Use				
Total Fuel Use at a Site with Daily Cover	0.28	0.28	0.28	gal./ton
Fuel Use at a Site with No Daily Cover	0.19	0.19	0.19	gal./ton
INPUT PARAMETER	**TRADITIONAL**		**BIOREACTOR**	
Percent Fuel Use	**with daily cover**	**without daily cover**	**with daily cover**	**without daily cover**
Scraper	4.0		4.0	
Bulldozer	20.0	8	20.0	8
Backhoe	2.7		2.7	
Landfill Compactor	48.0	68	48.0	68
Grader	3.1		3.1	
Wheel Loader	0.5	16	0.5	16
Loader	0.4	8	0.4	8
Water Truck	2.4		2.4	
Water Pull	2.2		2.2	
Haul Truck	0.2		0.2	
Dump Truck	10.0		10.0	
Pick-up	2.9		2.9	
Misc.	3.6		3.6	

TABLE 8.3. Parameters Describing Landfill Operation

INPUT PARAMETER	TRADITIONAL	BIOREACTOR	ASH	UNIT
Transportation Distances				
Fuel	50	50	50	mi.
Soil	10	10	10	mi.
HDPE	250	250	250	mi.
Transport				
Heavy Duty Truck Specific Consumption	6.4	6.4	6.4	mi./gal.
Heavy Duty Truck Actual Load	6.62E+04	6.62E+04	6.62E+04	lb.
Heavy Duty Truck Maximum Load	6.62E+04	6.62E+04	6.62E+04	lb.
Heavy Duty Truck Empty Return	1	1	1	
Dump Truck Specific Consumption	6.4	6.4	6.4	mpg
Dump Truck Actual Load	3.97E+04	3.97E+04	3.97E+04	lb.
Dump Truck Maximum Load	3.97E+04	3.97E+04	3.97E+04	lb.
Dump Truck Empty Return*	1	1	1	

Table 8.4. Parameters Describing Landfill Closure and Postclosure

		CLOSURE		
INPUT PARAMETER	**UNIT**	**TRADITIONAL**	**BIOREACTOR**	**ASH**
Density of Construction Materials				
Geotextiles	lb./ft^3	5.9	5.90E+00	5.90E+00
Sand	lb./ft^3	97.5	9.75E+01	9.75E+01
PVC	lb./ft^3	84.3	8.43E+01	8.43E+01
Fill Cover Materials*				
Thickness of Soil Layer*	ft	2	2	2
Thickness of Geotextile Layer	mils	0	0	0
Thickness of First Sand Layer	ft	0	0	0
Thickness of HDPE Layer	mils	0	0	0
Thickness of Clay Layer	ft	0	0	0
Thickness of Second Sand Layer	ft	0	0	0
Gas Collection System				
Amount HDPE	lb./ton MSW	1.6E-02	1.6E-02	0
Amount PVC	lb./ton MSW	8.1E-03	8.1E-03	0
Gas Monitoring System				
Amount PVC	lb./ton MSW	1.50E-04	1.50E-04	0
Equipment Emissions				
Fuel Use During Closure	gal./ton MSW	1.60E-02	1.60E-02	1.60E-02
Percent Fuel Use				
scraper	%	54	54	54
bulldozer	%	24	24	24
backhoe	%	1	1	1
wheel loader	%	7	7	7
drum roller	%	2	2	2
water truck	%	4	4	4
pick-up	%	6	6	6
tractor/disk	%	2	2	2
Transportation Distances				
clay and soil	mi.	5	5	5
sand	mi.	20	20	20
geotextiles	mi.	250	250	250
HDPE (fill cover)	mi.	250	250	250
HDPE (nonfill cover)	mi.	250	250	250
fuel	mi.	50	50	50
PVC	mi.	250	250	250

Table 8.4. Parameters Describing Landfill Closure and Postclosure

INPUT PARAMETER, continued	CLOSURE			
	UNIT	TRADITIONAL	BIOREACTOR	ASH
Equipment Emissions, continued				
Transport				
heavy duty truck specific consumption	mi./gal.	**<<Input in Table 8.3>>**		
heavy duty truck actual load	lb.	**<<Input in Table 8.3>>**		
heavy duty truck maximum load	lb.	**<<Input in Table 8.3>>**		
heavy duty truck empty return		**<<Input in Table 8.3>>**		
dump truck specific consumption	mi./gal.	**<<Input in Table 8.3>>**		
dump truck actual load	lb.	**<<Input in Table 8.3>>**		
dump truck maximum load	lb.	**<<Input in Table 8.3>>**		
dump truck empty return		**<<Input in Table 8.3>>**		

INPUT PARAMETER	POSTCLOSURE			
	UNIT	TRADITIONAL	BIOREACTOR	ASH
Materials Consumption				
Postclosure Period	yr.	30	30	30
Percent of Fil Cover Replaced	%	10	10	5
Fuel Used for Inspections				
Amount of Fuel Used per Year	gal./yr. - ton MSW	4.00E-06	4.00E-06	4.00E-06
Fuel Used for Mowing				
Amount of Fuel Used per Year	gal./yr. - ton MSW	9.20E-07	9.20E-07	9.20E-07

Table 8.5. Landfill Gas
Part 1: Production and Utilization Factors

INPUT PARAMETER	TRADITIONAL			BIOREACTOR			ASH		
	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)
Waste Components									
Yard Trimmings, Leaves	60		0.49	30		0.49	60		0.49
Yard Trimmings, Grass	60		2.18	60		2.18	60		2.18
Yard Trimmings, Branches	60		1.00	50		1.00	60		1.00
Old Newsprint	6		1.19	6		1.19	6		1.19
Old Corrugated Cardboard	5		2.44	5		2.44	5		2.44
Office Paper	6		3.49	6		3.49	6		3.49
Phone Books (used old newsprint)	6		1.19	6		1.19	6		1.19
Books (used office paper)	6		3.49	6		3.49	6		3.49
Old Magazines (used coated paper lab data)	6		1.35	6		1.35	6		1.35
Third Class Mail (used coated paper lab data)	6		1.35	6		1.35	6		1.35
Paper - Other #1	6		2.12	6		2.12	6		2.12
Paper - Other #2	6		2.12	6		2.12	6		2.12
Paper - Other #3	6		2.12	6		2.12	6		2.12
Paper - Other #4	6		2.12	6		2.12	6		2.12
Paper - Other #5	6		2.12	6		2.12	6		2.12
CCCR - Other*	6		2.12	6		2.12	6		2.12
Mixed Paper (average of newsprint, office paper, boxes, and coated paper)	6		2.12	6		2.12	6		2.12
HDPE - Translucent (used HDPE)	2		0.00	2		0.00	2		0.00
HDPE - Pigmented (used HDPE)	2		0.00	2		0.00	2		0.00
PET (used PET)	2		0.00	2		0.00	2		0.00
Plastic - Other # 1	2		0.00	2		0.00	2		0.00
Plastic - Other # 2	2		0.00	2		0.00	2		0.00

Table 8.5. Landfill Gas
Part 1: Production and Utilization Factors

INPUT PARAMETER, continued	TRADITIONAL			BIOREACTOR			ASH		
	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)
Waste Components, continued									
Plastic - Other # 3	2		0.00	2		0.00	2		0.00
Plastic - Other # 4	2		0.00	2		0.00	2		0.00
Plastic - Other # 5	2		0.00	2		0.00	2		0.00
Mixed Plastic	2		0.00	2		0.00	2		0.00
CCNR - Other*	2		0.00	2		0.00	2		0.00
Ferrous Cans	3		0.00	3		0.00	3		0.00
Ferrous Metal - Other	3		0.00	3		0.00	3		0.00
Aluminum Cans	2		0.00	2		0.00	2		0.00
Aluminum - Other #1 (used aluminum cans)	2		0.00	2		0.00	2		0.00
Aluminum - Other #2 (used aluminum cans)	2		0.00	2		0.00	2		0.00
Glass - Clear	2		0.00	2		0.00	2		0.00
Glass - Brown	2		0.00	2		0.00	2		0.00
Glass - Green	2		0.00	2		0.00	2		0.00
Mixed Glass (used glass - clear)	2		0.00	2		0.00	2		0.00
CNNR - Other*	2		0.00	2		0.00	2		0.00
Paper - Nonrecyclable	6		2.12	6		2.12	6		2.12
Food Waste	70		4.83	70		4.83	70		4.83
CCCN - Other*	6		4.83	6		4.83	6		4.83
Plastic - Nonrecyclable	2		0.00	2		0.00	2		0.00
Misc. (CNNN)	6		0.00	6		0.00	6		0.00
CCNN - Other*	0		0.00	0		0.00	0		0.00
Ferrous - Nonrecyclable	3		0.00	3		0.00	3		0.00
Aluminum - Nonrecyclable	2		0.00	2		0.00	2		0.00

Table 8.5. Landfill Gas
Part 1: Production and Utilization Factors

INPUT PARAMETER, continued	TRADITIONAL			BIOREACTOR			ASH		
	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)	% moisture*		LAB DATA - Component CH_4 Yield (ft^3/dry lb.)
Waste Components, continued									
Glass - Nonrecyclable (used glass - clear)	2		0.00	2		0.00	2		0.00
Misc. (NNNN)	20		0.00	20		0.00	20		0.00
CNNN - Other*	15		0.00	15		0.00	15		0.00

INPUT PARAMETER	TRADITIONAL	BIOREACTOR	ASH	UNIT
Quantity of Landfill Gas				
Gas Yield*	0	0	0	
Lag Time	1	0	1	yr.
First-Order Decay Rate Constant	0.03	0.15	0.03	1/yr.
First-Order Rise Phase Constant	1	0.3	1	1/yr.
R Value	8.2E-02	8.2E-02	0.0821	(L-atm)/(mol-K)
Temperature	2.98E+02	2.98E+02	298	K
Pressure	1.0E+00	1.0E+00	1	atm
Landfill Gas Production Quality - Percent of Total Landfill Gas				
Carbon Dioxide (biomass)	45	45	45	%
Methane	55	55	55	%
Benzene	1.9E-04	1.9E-04	1.9E-04	%
Chloroform	3.0E-06	3.0E-06	3.0E-06	%
Carbon Tetrachloride	4.0E-07	4.0E-07	4.0E-07	%

Table 8.5. Landfill Gas
Part 1: Production and Utilization Factors

INPUT PARAMETER, continued	TRADITIONAL	BIOREACTOR	ASH	UNIT
Landfill Gas Production Quality - Percent of Total Landfill Gas, continued				
Ethylene Dichloride	4.1E-05	4.1E-05	4.1E-05	%
Methylene Chloride	1.4E-03	1.4E-03	1.4E-03	%
Trichloroethene	2.8E-04	2.8E-04	2.8E-04	%
Tetrachloroethene	3.7E-04	3.7E-04	3.7E-04	%
Vinyl Chloride	7.3E-04	7.3E-04	7.3E-04	%
Toluene	3.9E-03	3.9E-03	3.9E-03	%
Xylenes	1.2E-03	1.2E-03	1.2E-03	%
Ethylbenzene	4.6E-04	4.6E-04	4.6E-04	%
Landfill Gas Treatment - Uncollected Gas*				
Time Between Waste Placement and Implementation of Gas Collection System*	2	2	2	yr.
Time Between Waste Placement and Conversion to 2nd Gas Collection System*	5	5	5	yr.
Time Between Waste Placement and Conversion to 3rd Gas Collection System*	40	40	40	yr.

Table 8.5. Landfill Gas
Part 1: Production and Utilization Factors

INPUT PARAMETER, continued	TRADITIONAL	BIOREACTOR	ASH	UNIT					
Landfill Gas Treatment - Uncollected Gas, continued*									
Time Between Waste Placement and Discontinuation of 3rd Gas Collection System*	80	80	80	yr.					
Percent by Volume That is Not Collected by Landfill Gas Collection System*	12	12	12	%					
Percent Oxidation to CO_2									
Methane	15	15	15	%					
Benzene	15	15	15	%					
Toluene	15	15	15	%					
Xylenes	15	15	15	%					
Ethylbenzene	15	15	15	%					
Chloroform	0	0	0	%					
Carbon Tetrachloride	0	0	0	%					
Ethylene Dichloride	0	0	0	%					
Methylene Chloride	0	0	0	%					
Trichloroethene	0	0	0	%					
Tetrachloroethene	0	0	0	%					
Vinyl Chloride	15	15	15	%					

Table 8.5. Landfill Gas
Part 1: Production and Utilization Factors

INPUT PARAMETER, continued	TRADITIONAL	BIOREACTOR	ASH	UNIT					
Percent Use of First Landfill Gas Treatment Methods									
Vent	100	100	100	%					
Flare	0	0	0	%					
Turbine	0	0	0	%					
Direct Use	0	0	0	%					
Internal Combustion Engine	0	0	0	%					
Percent Use of Second Landfill Gas Treatment Methods*									
Vent	0	0	100	%					
Flare	100	100	0	%					
Turbine	0	0	0	%					
Direct Use	0	0	0	%					
Internal Combustion Engine	0	0	0	%					
Percent Use of Third Landfill Gas Treatment Methods*									
Vent	0	0	100	%					
Flare	100	100	0	%					
Turbine	0	0	0	%					
Direct Use	0	0	0	%					
Internal Combustion Engine	0	0	0	%					

Table 8.5. Landfill Gas
Part 2: Combustion Emission Factors

INPUT PARAMETER	FLARE	TURBINE	BOILER	INTERNAL COMBUSTION ENGINE
	(lb./mol gas)	(lb./mol gas)	(lb./mol gas)	(lb./mol gas)
Atmospheric Emissions				
Particulates (PM10)				
Particulates (Total)	1.32E-05	1.73E-05	6.50E-06	3.79E-05
Nitrogen Oxides	3.21E-05	6.83E-05	2.63E-05	1.98E-04
Hydrocarbons (non-CH_4)				
Sulfur Oxides	8.23E-06	8.23E-06	8.23E-06	8.23E-06
Carbon Monoxide	5.93E-04	1.81E-04	4.44E-06	3.70E-04
CO_2 (biomass)	1.60E-01	1.60E-01	1.60E-01	1.60E-01
CO_2 (non-biomass)				
Ammonia				
Lead				
Methane				
Hydrochloric acid	7.90E-06	8.07E-06	8.07E-06	7.49E-06
Solid Waste				
Solid Waste #1	ND	ND	ND	ND
Solid Waste #2	ND	ND	ND	ND
Solid Waste #3	ND	ND	ND	ND
Solid Waste #4	ND	ND	ND	ND
Solid Waste #5	ND	ND	ND	ND
Waterborne Emissions				
Dissolved Solids	ND	ND	ND	ND
Suspended Solids	ND	ND	ND	ND
BOD	ND	ND	ND	ND
COD	ND	ND	ND	ND
Oil	ND	ND	ND	ND
Sulfuric Acid	ND	ND	ND	ND
Iron	ND	ND	ND	ND
Ammonia	ND	ND	ND	ND
Copper	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND
Mercury	ND	ND	ND	ND
Phosphate	ND	ND	ND	ND
Selenium	ND	ND	ND	ND

Table 8.5. Landfill Gas
Part 2: Combustion Emission Factors

INPUT PARAMETER, continued	FLARE	TURBINE	BOILER	INTERNAL COMBUSTION ENGINE
	(lb./mol gas)	(lb./mol gas)	(lb./mol gas)	(lb./mol gas)
Waterborne Emissions, continued				
Chromium	ND	ND	ND	ND
Lead	ND	ND	ND	ND
Zinc	ND	ND	ND	ND
Additional Parameters				
Water Metals				
barium	ND	ND	ND	ND
silver	ND	ND	ND	ND
metals unspecified	ND	ND	ND	ND
Water Hydrocarbons				
benzene	ND	ND	ND	ND
chloroform	ND	ND	ND	ND
carbon tetrachloride	ND	ND	ND	ND
ethylene dichloride	ND	ND	ND	ND
methylene chloride	ND	ND	ND	ND
trichloroethene	ND	ND	ND	ND
tetrachloroethene	ND	ND	ND	ND
vinyl chloride	ND	ND	ND	ND
toluene	ND	ND	ND	ND
xylenes	ND	ND	ND	ND
ethylbenzene	ND	ND	ND	ND
hydrocarbons unspecified	ND	ND	ND	ND
solid waste	ND	ND	ND	ND
Raw Materials				
coal	ND	ND	ND	ND
tural gas	ND	ND	ND	ND
uranium	ND	ND	ND	ND
bauxite	ND	ND	ND	ND
sodium chloride	ND	ND	ND	ND
sand	ND	ND	ND	ND
clay	ND	ND	ND	ND
limestone	ND	ND	ND	ND

Table 8.5. Landfill Gas
Part 2: Combustion Emission Factors

INPUT PARAMETER, continued	FLARE	TURBINE	BOILER	INTERNAL COMBUSTION ENGINE
	(lb./mol gas)	(lb./mol gas)	(lb./mol gas)	(lb./mol gas)
Additional Parameters, continued				
Air Hydrocarbons				
benzene	ND	ND	ND	ND
chloroform	ND	ND	ND	ND
carbon tetrachloride	ND	ND	ND	ND
ethylene dichloride	ND	ND	ND	ND
methylene chloride	ND	ND	ND	ND
trichloroethene	ND	ND	ND	ND
tetrachloroethene	ND	ND	ND	ND
vinyl chloride	ND	ND	ND	ND
toluene	ND	ND	ND	ND
xylenes	ND	ND	ND	ND
ethylbenzene	ND	ND	ND	ND
hydrogen chloride	4.94E-06	4.94E-06	4.94E-06	4.94E-06
Energy (Btu/lb)	ND	ND	ND	ND

Table 8.5. Landfill Gas
Part 3: Efficiency of Gas Treatment (%)

	VENT	FLARE EFFICIENCY	TURBINE	DIRECT USE	INTERNAL COMBUSTION ENGINE
Gases					
Carbon Dioxide	0	0	0	0	0
Methane	0	99	99	99	99
Benzene	0	99.7	98.2	99.8	86.1
Chloroform	0	98	99.7	99.6	93.0
Carbon Tetrachloride	0	98	99.7	99.6	93.0
Ethylene Dichloride	0	98	99.7	99.6	93.0
Methylene Chloride	0	98	99.7	99.6	93.0
Trichloroethene	0	98	99.7	99.6	93.0
Tetrachloroethene	0	98	99.7	99.6	93.0
Vinyl Chloride	0	98	99.7	99.6	93.0
Toluene	0	99.7	98.2	99.8	86.1
Xylenes	0	99.7	98.2	99.8	86.1
Ethylbenzene	0	99.7	98.2	99.8	86.1

Table 8.6. Leachate Quantify, Composition, and Treatment

INPUT PARAMETER	TRADITIONAL		BIOREACTOR		ASH	
Leachate Quanity						
Time Since Waste Placement*	**start**	**finish**	**start**	**finish**	**start**	**finish**
leachate period 1	0	1.5	0	1.5	0	1.5
leachate period 2	1.5	5	1.5	3	1.5	5
leachate period 3	5	10	3	5	5	10
leachate period 4 (from the starting year until infinity)	10	Infinity	Infinity	Infinity	10	Infinity

INPUT PARAMETER	TRADITIONAL	BIOREACTOR	ASH			
Leachate Quanity, continued						
Percent of Precipitation That Becomes Leachate*						
leachate period 1	20	20	20	%		
leachate period 2	6.6	6.6	6.6	%		
leachate period 3	6.5	6.5	6.5	%		
leachate period 4 (from the starting year until infinity)	0.04	0.04	0.04	%		
Time Since Waste Placement						
time after waste placement that recirculation begins	0	0	0	yr.		
time after waste placement starts that leachate recirculation is discontinued	40	20	40	yr.		
time after refuse placement until leachate is no longer collected and treated*	40	20	40	yr.		
yearly precipitation*	35	35	35	in./yr.		
Leachate Collection Efficiency						
leachate collection efficiency	99.8	99.8	99.8	%		
Percent of Collected Leachate Sent to POTW						
after waste placement and before recirculation	0	0	0	%		
during recirculation period	100	0	100	%		
after the end of recirculation and before the end of treatment	100	100	100	%		
BOD						
BOD Concentration - Start						
BOD start period 1	8.34E-02	8.34E-02	0	lb/gal		
BOD start period 2	8.34E-02	8.34E-02	0	lb/gal		
BOD start period 3	8.34E-03	8.34E-03	0	lb/gal		

Table 8.6. Leachate Quantify, Composition, and Treatment

INPUT PARAMETER, continued	TRADITIONAL	BIOREACTOR	ASH	UNIT		
BOD, continued						
BOD Year - Start						
start period 1	0	0	1	yr.		
start period 2	1.5	1.5	1.5	yr.		
start period 3	10	10	10	yr.		
BOD Concentration - Finish						
BOD finish period 1	8.34E-02	8.34E-02	0.00E+00	lb/gal		
BOD finish period 2	8.34E-03	8.34E-03	0.00E+00	lb/gal		
BOD finish period 3	0.00E+00	0.00E+00	0.00E+00	lb/gal		
BOD Year - Finish						
finish period 1	1.5	1	0	yr.		
finish period 2	10	3	0	yr.		
finish period 3	50	10	0	yr.		
COD						
COD Concentration - Start						
COD start period 1	1.04E-01	1.04E-01		lb/gal		
COD start period 2	1.04E-01	1.04E-01		lb/gal		
COD start period 3	8.34E-03	8.34E-03		lb/gal		
COD start period 4	8.34E-04	8.34E-04		lb/gal		
COD Year - Start						
start period 1	0	0		yr.		
start period 2	1.5	1.5		yr.		
start period 3	10	10		yr.		
start period 4	100	100		yr.		
COD Concentration - Finish						
COD finish period 1	1.04E-01	1.04E-01		lb/gal		
COD finish period 2	2.78E-02	2.78E-02		lb/gal		
COD finish period 3	8.34E-04	8.34E-04		lb/gal		
COD finish period 4	8.34E-04	8.34E-04		lb/gal		
COD Year - Finish						
finish period 1	1.5	1		yr.		
finish period 2	10	3		yr.		
finish period 3	50	10		yr.		
finish period 4	Infinity	Infinity		yr.		
Other Organics						
TSS	4.75E-04	4.75E-04	0.00E+00	lb/gal		
NH_3	2.86E-03	2.86E-03	1.00E-04	lb/gal		
PO_4	8.34E-05	8.34E-05	9.17E-07	lb/gal		

Table 8.6. Leachate Quantify, Composition, and Treatment

INPUT PARAMETER, continued	TRADITIONAL	BIOREACTOR	ASH	UNIT		
Trace Organics						
Benzene	5.84E-08	5.84E-08	0.00E+00	lb/gal		
Chloroform	8.34E-08	8.34E-08	0.00E+00	lb/gal		
Carbon Tetrachloride	0.00E+00	0.00E+00	0.00E+00	lb/gal		
Ethylene Dichloride	1.25E-08	1.25E-08	0.00E+00	lb/gal		
Methylene Chloride	1.49E-06	1.49E-06	0.00E+00	lb/gal		
Trichloroethene	6.68E-08	6.68E-08	0.00E+00	lb/gal		
Tetrachloroethene	8.09E-08	8.09E-08	0.00E+00	lb/gal		
Vinyl Chloride	8.34E-08	8.34E-08	0.00E+00	lb/gal		
Toluene	1.34E-06	1.34E-06	0.00E+00	lb/gal		
Xylenes	4.67E-07	4.67E-07	0.00E+00	lb/gal		
Ethylbenzene	1.51E-07	1.51E-07	0.00E+00	lb/gal		
Metals						
Arsenic	2.50E-07	2.50E-07	1.63E-06	lb/gal		
Barium	7.10E-06	7.10E-06	3.41E-05	lb/gal		
Cadmium	5.80E-08	5.80E-08	1.58E-08	lb/gal		
Chromium	7.10E-07	7.10E-07	2.17E-08	lb/gal		
Lead	1.10E-07	1.10E-07	1.67E-07	lb/gal		
Mercury	3.50E-09	3.50E-09	0.00E+00	lb/gal		
Selenium	8.10E-08	8.10E-08	1.37E-06	lb/gal		
Silver	5.50E-07	5.50E-07	0.00E+00	lb/gal		
copper			6.99E-08	lb/gal		
iron			2.29E-05	lb/gal		
zinc			4.80E-07	lb/gal		
Transport of Leachate to POTW						
Distance	25	25	25	mi.		
Heavy Truck Specific Consumption	6.4	6.4	6.4	mi./gal.		
Heavy Truck Actual Load	6.62E+04	6.62E+04	6.62E+04	lb.		
Heavy Truck Maximum Load	6.62E+04	6.62E+04	6.62E+04	lb.		
Empty Return	1	1	1			
Percent of Leachate Transported to POTW	100	100	100			
Leachate Treatment Efficiency - Percent Removal						
BOD	92.1	92.1		%		
COD	80	80	80	%		
NH_3	21.6	21.6	21.6	%		
PO_4	21.6	21.6	21.6	%		
TSS	96	96	96	%		
metals	85	85	85	%		
trace organics	100	100		%		

Table 8.6. Leachate Quantify, Composition, and Treatment

INPUT PARAMETER, continued	TRADITIONAL	BIOREACTOR	ASH	UNIT		
Bioreactor Operations						
Fuel Consumption for a Water Truck	0	0.75		gal./hr		
Horizontal Subsurface Introduction						
Distance Between Recirculation System and Side Slopes		20		ft		
Average Length of Trench		2394		ft		
Influence Distance Between Trenches	100	25	100	ft		
Distance Between Bottom Liner and First Horizontal Trench		10		ft		
Distance Between Top of Landfill and Horizontal Trench		10		ft		
Materials in Horizontal Trenches						
Volume of PVC per Unit Length		2.22E-02		ft^3/ft		
Vertical Injection Wells						
Area of Influence per Well		1		ac		
Materials in Vertical Injection Wells						
Solid Concrete Base						
volume of concrete base per well		32		ft^3		
Solid Concrete Section						
volume of solid concrete per well		2.31E+02		ft^3		
Perforated Concrete Section						
length of perforated concrete well		65		ft		
volume of perforated concrete per unit length		2.63E+02		ft^3		
PVC Pipe						
pipe length in each well		65		ft		
volume of PVC per unit length		1.66E-02		ft^3		
Emissions Due to Leachate Treatment						
Electric Energy Consumption	4.54E-01	4.54E-01	4.54E-01	kWh/lb. BOD removed		

Table 8.6. Leachate Quantify, Composition, and Treatment

INPUT PARAMETER, continued	TRADITIONAL	BIOREACTOR	ASH	UNIT		
Sludge Generation						
lb. Sludge Generated per lb. BOD Removed	0.5	0.5	0.5	lb. sludge/lb. BOD		
Air Emissions						
lb. CO_2 (biomass) Generated per lb. BOD Removed	3.6	3.6	3.6	lb. $C0_2$/lb. BOD		

Table 8.7. Metals, Ammonia, and Phosphate Allocation for Traditional and Bioreactor Landfills

MSW COMPONENT	PERCENT CONTRIBUTION OF METALS IN LEACHATE FOR EACH WASTE COMPONENT*									
	ARSENIC	BARIUM	CADMIUM	CHROMIUM	MERCURY	LEAD	SELENIUM	SILVER	AMMONIA	PHOSPHATE
Yard Trimmings, Leaves	2.10E-01	1.37E+01	1.11E+01	1.45E+01	1.52E+01	1.40E+01	1.19E-01	2.57E-08	9.37E-01	1.02E+01
Yard Trimmings, Grass	6.28E-02	4.09E+00	3.32E+00	4.34E+00	4.54E+00	4.18E+00	3.56E-02	2.57E-08	4.60E+01	8.78E+01
Yard Trimmings, Branches	7.38E-03	1.59E+00	5.80E-01	9.84E-01	1.24E+00	1.61E+00	1.94E-02	2.57E-08	1.00E+00	1.05E+00
Old Newsprint	1.04E-02	1.03E+00	9.80E-02	4.02E+00	1.21E+01	3.13E-01	9.06E-02	2.57E-08	3.11E-02	1.08E-01
Old Corrugated Cardboard	2.19E-03	8.22E-02	2.34E-02	3.27E-02	1.37E-01	4.38E-02	8.61E-03	2.57E-08	7.43E-03	2.58E-02
Office Paper	3.21E-03	6.81E-02	1.59E-02	4.18E-02	2.79E-01	3.52E-02	3.65E-02	2.57E-08	5.04E-03	1.75E-02
Phone Books	4.86E-04	2.02E-02	3.90E-03	3.93E-03	6.87E-02	4.61E-03	3.95E-03	2.57E-08	1.24E-03	4.30E-03
Books	4.37E-04	2.45E-01	2.81E-02	4.73E-02	8.24E-02	1.73E-05	8.40E-03	2.57E-08	2.23E-03	7.74E-03
Old Magazines	3.22E-03	2.43E-01	2.07E-02	1.28E-01	2.54E-01	2.15E-02	1.38E-02	2.57E-08	4.58E-03	1.59E-02
Third Class Mail	4.35E-03	1.86E-01	3.96E-01	5.95E-01	5.47E-01	2.63E+00	6.42E-03	2.57E-08	7.39E-03	2.57E-02
Paper - Other #1	4.49E-03	3.74E-01	1.19E-01	3.93E-01	9.76E-01	5.53E-01	3.16E-02	2.57E-08	0.00E+00	0.00E+00
Paper - Other #2	3.77E-03	3.14E-01	9.98E-02	3.29E-01	8.18E-01	4.64E-01	2.65E-02	2.57E-08	0.00E+00	0.00E+00
Paper - Other #3	2.52E-03	2.10E-01	6.68E-02	2.21E-01	5.48E-01	3.11E-01	1.78E-02	2.57E-08	0.00E+00	0.00E+00
Paper - Other #4	1.86E-04	1.55E-02	4.91E-03	1.62E-02	4.03E-02	2.28E-02	1.31E-03	2.57E-08	0.00E+00	0.00E+00
Paper - Other #5	1.86E-04	1.55E-02	4.91E-03	1.62E-02	4.03E-02	2.28E-02	1.31E-03	2.57E-08	0.00E+00	0.00E+00
CCCR - Other (user defines)*	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
Mixed Paper (average of newsprint, office paper, corrugated cardboard, and magazines)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
HDPE - Translucent	1.44E-03	8.59E-01	5.36E-01	2.15E-01	2.17E-01	5.51E-01	8.49E-03	2.57E-08	0.00E+00	0.00E+00
HDPE - Pigmented	5.67E-04	3.39E-01	2.11E-01	8.47E-02	8.55E-02	2.17E-01	3.35E-03	2.57E-08	0.00E+00	0.00E+00
PET (used PET)	7.29E-04	2.61E-02	3.10E-01	7.57E-02	6.87E-02	1.77E-01	2.69E-03	2.57E-08	0.00E+00	0.00E+00
Plastic - Other # 1	5.25E-03	1.83E+00	2.08E+00	6.78E-01	6.60E-01	1.69E+00	2.58E-02	2.57E-08	0.00E+00	0.00E+00
Plastic - Other # 2	3.85E-03	1.34E+00	1.53E+00	4.97E-01	4.84E-01	1.24E+00	1.90E-02	2.57E-08	0.00E+00	0.00E+00

Table 8.7. Metals, Ammonia, and Phosphate Allocation for Traditional and Bioreactor Landfills

MSW COMPONENT, continued	PERCENT CONTRIBUTION OF METALS IN LEACHATE FOR EACH WASTE COMPONENT*									
	ARSENIC	BARIUM	CADMIUM	CHROMIUM	MERCURY	LEAD	SELENIUM	SILVER	AMMONIA	PHOSPHATE
Plastic - Other # 3	2.55E-03	8.88E-01	1.01E+00	3.29E-01	3.21E-01	8.19E-01	1.26E-02	2.57E-08	0.00E+00	0.00E+00
Plastic - Other # 4	4.13E-04	1.44E-01	1.64E-01	5.33E-02	5.19E-02	1.33E-01	2.03E-03	2.57E-08	0.00E+00	0.00E+00
Plastic - Other # 5	1.22E-04	4.23E-02	4.82E-02	1.57E-02	1.53E-02	3.90E-02	5.98E-04	2.57E-08	0.00E+00	0.00E+00
Mixed Plastic (average of translucent HDPE, pigmented HDPE, and PET)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
CCNR - Other (user defines)*	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
Ferrous Cans	2.34E-02	5.31E-02	9.36E+00	3.21E+00	9.53E+00	3.49E+00	8.02E-03	2.57E-08	0.00E+00	0.00E+00
Ferrous Metal - Other	7.86E+01	3.79E+01	1.99E+01	1.87E+01	3.14E+01	2.28E+01	1.01E+01	2.57E-08	0.00E+00	0.00E+00
Aluminum Cans	5.87E-04	7.99E-01	5.66E-01	8.30E-01	2.48E-01	2.66E-01	1.08E-03	2.57E-08	0.00E+00	0.00E+00
Aluminum - Other #1 (used aluminum cans)	3.73E-04	4.50E-02	1.53E+00	3.11E-01	1.40E-01	5.89E-06	2.75E-04	2.57E-08	0.00E+00	0.00E+00
Aluminum - Other #2 (used aluminum cans)	1.67E+00	1.70E-01	9.50E-01	3.89E+00	1.42E-01	2.45E-01	3.62E-01	2.57E-08	0.00E+00	0.00E+00
Glass - Clear	5.83E-03	7.11E+00	1.80E+00	8.13E-01	4.40E-01	2.02E+00	2.65E-01	2.57E-08	0.00E+00	0.00E+00
Glass - Brown	4.16E-02	4.12E+00	6.59E-01	1.39E+00	1.36E+00	1.97E+00	1.71E-01	2.57E-08	0.00E+00	0.00E+00
Glass - Green	2.00E-02	3.56E+00	3.94E-02	9.60E+00	7.71E-02	1.29E-01	7.25E-03	2.57E-08	0.00E+00	0.00E+00
Mixed Glass (average of clear, brown, and green)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
CNNR - Other (user defines)*	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
Paper - Nonrecyclable	1.33E-02	5.69E-01	1.21E+00	1.83E+00	1.68E+00	8.07E+00	1.97E-02	2.57E-08	0.00E+00	0.00E+00
Food Waste	2.30E-02	1.19E+00	2.46E+00	2.15E+00	2.16E+00	4.36E+00	5.65E-02	2.57E-08	5.20E+01	8.13E-01

Table 8.7. Metals, Ammonia, and Phosphate Allocation for Traditional and Bioreactor Landfills

MSW COMPONENT, continued	PERCENT CONTRIBUTION OF METALS IN LEACHATE FOR EACH WASTE COMPONENT*									
	ARSENIC	BARIUM	CADMIUM	CHROMIUM	MERCURY	LEAD	SELENIUM	SILVER	AMMONIA	PHOSPHATE
CCCN - Other (user defines)*	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
Plastic - Nonrecyclable	9.34E-04	5.78E-01	3.13E+00	1.19E+00	1.23E-01	1.56E+00	4.54E-03	2.57E-08	0.00E+00	0.00E+00
Misc. (CNNN)	1.57E+01	1.22E+01	3.51E+01	2.55E+01	1.24E+01	2.45E+01	8.80E+01	2.57E-08	0.00E+00	0.00E+00
CCNN - Other (user defines)*	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
Ferrous - Nonrecyclable	3.28E+00	1.58E+00	8.31E-01	7.81E-01	1.31E+00	9.50E-01	4.21E-01	2.57E-08	0.00E+00	0.00E+00
Aluminum - Nonrecyclable	3.64E-01	3.70E-02	2.07E-01	8.49E-01	3.10E-02	5.36E-02	7.90E-02	2.57E-08	0.00E+00	0.00E+00
Glass - Nonrecyclable (used glass - clear)	5.37E-03	2.52E+00	5.07E-01	1.40E+00	1.73E-01	6.19E-01	7.59E-02	2.57E-08	0.00E+00	0.00E+00
Misc. (user defines)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00
CNNN - Other*	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-08	0.00E+00	0.00E+00

9. RDF AND PRF Process Models

Overview

The objective of the Refuse Derived Fuel (RDF) and Processed Refuse Fuel (PRF) model is to calculate the cost and life-cycle inventory (LCI) parameters for converting MSW into fuel that is combusted in on-site combustors. The user can choose to use either the PRF design or the RDF design in the design of their integrated solid waste management system. Costs and LCI parameters are calculated on the basis of user input and default design information. Based on the cost and LCI design information, coefficients are calculated in the process model to represent the cost and environmental burdens associated with a PRF or RDF facility. The coefficients take into account both the quantity and composition of the waste input to a PRF and RDF facility and are used in the solid waste management model to calculate the total system cost and LCI parameters for solid waste management alternatives that involve the PRF and RDF processes.

The mathematical equations used for model development are presented in the combustion process model document. Mass balance equations used to estimate the quantity and composition waste moving through the PRF or RDF process designs are presented in this document. The cost and LCI allocation methodologies are identical to the combustion process model, and are not presented in this document.

Conceptual Designs for RDF and PRF

Two designs for fuel processed from mixed waste are presented in this document. The differences between the PRF and RDF lie in steps in the process flow design preceding combustion of fuel. The following sections present descriptions of the processes involved in a Processed Refuse Fuel facility and a Refuse Derived Fuel facility.

Processed Refuse Fuel Facility

Figure 1 shows the steps in the process flow of the PRF facility. MSW is conveyed directly into a shredder to provide a maximum particle size of 6 inches, with most of the materials being less than 2 inches in size. The shredded material is then passed under a magnet for removal of approximately 40% to 50% of the ferrous metal. The remaining shredded material now termed PRF, is blown into specifically designed boilers at a point approximately 2 meters above a traveling grate. Lighter materials burn in midair while heavier portions of the fuel including non-combustibles, drop to the rear of the grate. The grate moves from the back to the front of the furnace to allow for complete burnout of any combustible material at an ash bed depth of 12-20 centimeters. The heat liberated by the combustion of the PRF is recovered to produce superheated steam for the generation of electricity. By forcing most of the combustion air through the grate, grate temperatures are maintained below the melting point of glass and most metals, thereby eliminating slagging and producing a granular bottom ash from which marketable materials can be recovered. From the bottom ash, a substitute for natural aggregate can also be produced. Bottom ash and fly ash are collected separately in a dry state, allowing for recovery of ferrous and nonferrous metals and the production of aggregate from the bottom ash and isolation of the fly ash for conditioning and disposal by landfilling and for future beneficial reuse.

In the PRF process model design used in the DST, it is assumed that there is no revenue associated with the sale of building aggregate material or coins and other metals that may be recovered from the bottom ash. The combustion stoichiometry and emissions allocation are exactly the same as in the combustion process model. Refer to the combustion process model documentation for more information.

Refuse Derived Fuel Facility

In the RDF facility, refuse that is received either unconfined or in bags, is loaded onto a conveyor system and enters a flail mill. The flail mill opens any unopened bags and reduces the sizes of some of the breakable materials in the refuse. From the flail mill, the refuse passes under a magnet that recovers ferrous materials which are a source of revenue. The remainder then continues into a trommel for removal of material less than 2 inches in diameter. The trommel removes materials like broken glass, grit, sand, etc. From the trommel, the refuse is shredded in a shredder to reduce the size of components of the waste. The shredded waste then passes through an air classifier that separates the "lights," considered to have the high BTU content, from the "heavies," which have a relatively low BTU content. The "lights" then flow to an eddy current separator for aluminum removal. The material remaining after aluminum removal is combusted and the heat energy liberated is converted to electricity.

The combustion stoichiometry and emissions allocation in the RDF process model are exactly the same as in the combustion process model.

Cost Methodology

Costs for the PRF and RDF facility designs are divided into six components: capital cost, operation and maintenance cost, revenue from electricity generation and revenue from ferrous recovery, and revenue from aluminum recovery. The cost equations for the PRF and RDF facilities are exactly the same as those in the combustion process model.

LCI Methodology

The environmental equations for the PRF and RDF facility are exactly the same as for the combustion process model.

Table 9.1. RDF and PRF Economic Input Parameters

DESCRIPTION Economic Data	PRF	RDF	Units
Lifetime	20	20	years
Capacity Factor	1	1	unitless
Heat Rate	18000.0	18000.0	BTU/kWh
Unit Capital Cost	288.6	288.6	$/(design ton/year)
Unit O&M Cost	60.5036	60.5036	$/year/(design ton/year)

Note that all other data inputs for RDF PRF are the same as the WTE process model.

10. Compost Process Model

Overview

The composting process model includes both mixed municipal and yard waste composting operations. Composting using the windrow turner method is used for both types of facilities, instead of aerated static pile designs and in-vessel systems. The windrow turner design was selected because it is used by a majority of compost facilities in the United States.

Conceptual Designs for Composting

The three composting facility designs included in the system are summarized as follows:

COMP 1: MSW compost facility, low quality compost. Processes mixed MSW is collected and preprocessed at a MRF to remove any recyclable or non-compostable materials. This facility produces low quality compost that is used for landfill cover or is landfilled.

COMP 2: MSW compost facility, high quality compost. Processes mixed MSW is collected and preprocessed at a MRF to remove any recyclable or non-compostable materials. This facility produces high quality that is used for soil amendment.

COMP 3: Yard waste compost facility. Processes yard wastes (e.g., branches, grass, leaves) is collected and delivered to the compost facility by residents or a yard waste transfer station. Only one type of yard waste facility is designed; it is the same general design as the high quality MSW compost facility design.

In the general compost facility design, waste is collected at curbside and transported to a MRF where recyclables and non-compostable materials are removed. The residual mixed waste is transported to a compost facility. At the compost facility, waste is deposited onto a tipping floor, where large items (if any) are removed manually. A front-end loading introduces the waste to a preprocessing trommel screen. The finer fraction is directed to the composting pad or hammermill for shredding and then to the composting pad. The oversized fraction is sent to a landfill for disposal. Moisture is added to the compost to achieve an optimal moisture content. Turning, mixing, and aeration of the windrows takes place once or twice a week (a user input value) using self-propelled windrow turner. Curing takes place without any turning of the curing piles in an uncovered area, while cured compost is distributed for use as cover or sold as soil amendment. The compost facility is designed to handle MSW tonnage rates from 10 to 10,000 tons per day.

Note that there are some minor differences in the process flows of the different compost facility designs depending on the type of material being processed and desired quality of the final product. Refer to Appendix H for complete documentation describing the alternative compost facility designs.

Cost Methodology for Composting

The cost of a compost facility depends on the type of facility, the quantity and type of material processed, and user input data. Costs are divided into capital costs, O&M costs, and revenue from the sale of compost.

Capital Cost

The capital cost component for composting consists of construction, land acquisition, engineering, and equipment cost that can be expressed in annual terms using a given capital recovery factor that is dependent upon a book lifetime and discount rate.

- Construction cost includes the cost of the structure, access roads, fencing, landscaping, etc. The cost of the structure includes support facilities such as office space, a weigh station, and the loading conveyer. Construction cost is obtained by multiplying the floor area of the compost facility by the construction cost rate. Total area for the facility includes area for the structure, access roads, fencing, weigh station, landscaping, etc. Total area multiplied by a cost rate gives the land acquisition cost.

- Engineering cost consists of fees paid for consulting and technical services for the compost facility planning and construction, and is estimated to be a fraction of the construction cost.

- Equipment cost consists of the capital and installation cost of equipment.

Operating and Maintenance Cost

The O&M cost for the compost facility includes wages, overhead, equipment and building maintenance, and utilities.

- Labor required for the compost facility consists of management, drivers and equipment operators. In estimating the labor wages, it is assumed that part-time services can be hired. Management includes managers, supervisors, and secretaries. The wages paid for management are assumed to be a fraction of the wages paid to drivers and equipment operators.

- Overhead costs for labor are calculated as a fraction of labor wages. Overhead includes overtime, office supplies, insurance, social security, vacation, sick leave, and other services.

- The cost of utilities, assumed to be electricity, fuel, oil, etc., is assumed to be proportional to the weight of incoming MSW or yard waste.

- The cost of maintenance of equipment and structure is assumed to be proportional to the weight of incoming MSW or yard waste.

High quality compost that is produced by the high quality MSW compost facility or yard waste compost facility may be sold as soil amendment and thus provide revenue to help offset the costs of the compost facility. The user can enter the value of compost.

LCI Methodology for Composting

The LCI methodology calculates energy consumption or production, and environmental releases from the compost facility and allocates these LCI parameters to individual components of the waste stream.

Energy

The composting process model accounts for two types of energy consumption: fuel and electricity. The energy calculations include:

1. Combustion energy: the energy used in rolling stock, lighting and heating, and equipment, and
2. Precombustion energy: the energy required to manufacture the fuel or electricity from feed stock.

For electricity, the source of energy depends on the regional energy grid used. Default data on the energy required to produce a unit of electricity, including its precombustion energy, are included in the electric energy process model documentation. The composting process model uses default or user-supplied data on fuel consumed by rolling stock, for heating and lighting purposes, and for processing equipment to calculate the total quantity of energy consumed per ton of material processed.

Air Emissions

The composting process model accounts for airborne releases from two sources: (1) the pollutants released when fuel is combusted in a vehicle (combustion releases), and (2) the pollutants emitted from the biodegradation of organic material. Data for fuel production and electricity generation, and associated air emissions, are included in the common process model. Data for air emissions resulting from the biodegradation of organic material are being developed through a laboratory experiment being conduct at the University of Wisconsin-Madison. In this experiment, food, mixed paper, yard waste, and inorganics are biodegraded in lab-scale vessels. Emissions from the vessels are captured and analyzed and will ultimately be used to develop air emission factors for all waste components.

Water Releases

The compost process model accounts for waterborne pollutants associated production of energy (electricity and fuel) consumed at the compost facility. There are no process related water releases. Default values for water releases from energy production are provided in the common process model.

Solid Waste Releases

The compost process model uses the fuel consumed and energy consumed by equipment and for heating and lighting the compost facility to calculate the solid waste generated. Solid waste generation is expressed in terms of pounds of pollutant per ton of material processed. Note that the solid waste referred to in this section pertains to the waste generated when energy is produced. Default values for solid wastes generated due to energy production are provided in the common process model. Solid waste remaining after non-compostables are removed (residue) is routed to a treatment or disposal facility. The LCI of residue is accounted for in these treatment and disposal facilities.

Table 10.1 Compost Design Options

OPERATION TYPE	Yardwaste Composting	MSW Composting Design 1	MSW Composting Design 2	
Windrow Composting	1	1	1	Enter 1 for selecting design type
Aerated Static pile Composting	0	0	0	
OPERATING TIMES				
Number of operating hours	8	8	8	hours/day
Number of days / week	5	5	5	days/week
Operating days per year	262	262	262	days/year
Number of operating hours for blowers	1.58	1.58	1.58	hours/day

	Yardwaste Composting		**MSW Composting Design 1**		**MSW Composting Design 2**		
PILE OPERATION							
Composting Pad	**Windrow**	**Aerated Static Pile**	**Windrow**	**Aerated Static Pile**	**Windrow**	**Aerated Static Pile**	
Compost residence time	168	51	30	51	60	51	days
Compost pile turning frequency	0		1		3		lbs/week
Curing Stage							
Curing stage residense time	0		0		30		days
Density of reject storage piles	450		450		450		lb/yd3