User's Guide for Estimating Emissions from Municipal Solid Waste Using the State Inventory Tool

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This section of the User's Guide provides instruction on using the Municipal Solid Waste module of the State Inventory Tool (SIT), and describes the methodology used for estimating greenhouse gas (GHG) emissions from municipal solid waste management at the state level.

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1.1 GETTING STARTED

The Municipal Solid Waste module was developed using Microsoft® Excel 2000. While the module will operate with older versions of Excel, it functions best with Excel 2000 or later. If you are using Excel 2007 or later, instructions for opening the module will vary as outlined in the Excel basics below. Some of the Excel basics are outlined in the sections below. Before you use the Municipal Solid Waste module, make sure your computer meets the system requirements. In order to install and run the Municipal Solid Waste module, you must have:

- IBM-PC compatible computer with the Windows 95 operating system or later;

- Microsoft® Excel 1997 or later, with calculation set to automatic and macros enabled;

- Hard drive with at least 20MB free; and

- Monitor display setting of 800 x 600 or greater.

Microsoft Excel Settings

Excel 2003 and Earlier: For the SIT modules to function properly, Excel must be set to automatic calculation. To check this setting, launch Microsoft Excel before opening the Municipal Solid Waste module. Go to the Tools menu and select "Options..." Click on the "Calculations" tab and make sure that the radio button next to "Automatic" is selected, and then click on "OK" to close the window. The security settings (discussed next) can also be adjusted at this time.

Excel 2007 and Later: For the SIT modules to function properly, Excel must be set to automatic calculation. Go to the Formulas ribbon and select "Calculation Options." Make sure that the box next to the "Automatic" option is checked from the pop-up menu.

Microsoft Excel Security

Excel 2003 and Earlier: Since the SIT employs macros, you must have Excel security set to medium (recommended) or low (not recommended). To change this setting, launch Microsoft Excel before opening the Municipal Solid Waste module. Once in Excel, go to the Tools menu, click on the Macro sub-menu, and then select "Security" (see Figure 1). The Security pop-up box will appear. Click on the "Security Level" tab and select medium. When set to high, macros are automatically disabled; when set to medium, Excel will give you the choice to enable macros; when set to low, macros are always enabled.

When Excel security is set to medium, users are asked upon opening the module whether to enable macros. Macros must be enabled in order for the Municipal Solid Waste module to work. Once they are enabled, the module will open to the control worksheet. A message box will appear welcoming the user to the module. Clicking on the "x" in the upper-right-hand corner of the message box will close it.

Excel 2007 and Later: If Excel's security settings are set at the default level a Security Warning appears above the formula box in Excel when the Municipal Solid Waste module is initially opened. The Security Warning lets the user know that some active content from the spreadsheet has been disabled, meaning that Excel has prevented the macros in the spreadsheet from functioning. Since SIT needs macros in order to function properly, the user must click the "Options" button in the security message and then select, "Enable this

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content" in the pop-up box. Enabling the macro content for the SIT in this way only enables macros temporarily in Excel but does not change the macro security settings. Once macros are enabled, a message box will appear welcoming the user to module. Click on the "x" in the upper right-hand corner to close the message box.

If the Security Warning does not appear when the module is first opened, it may be necessary to change the security settings for macros. To change the setting, first exit out of the Municipal Solid Waste module and re-launch Microsoft Excel before opening the Municipal Solid Waste module. Next, click on the Microsoft Excel icon in the top left of the screen. Scroll to the bottom of the menu and select the "Excel Options" button to the right of the main menu. When the Excel Options box appears, select "Trust Center" in left hand menu of the box. Next, click the gray "Trust Center Settings" button. When the Trust Center options box appears, click "Macro Settings" in the left hand menu and select "Disable all macros with notification." Once the security level has been adjusted, open the Stationary Combustion module and enable macros in the manner described in the preceding paragraph.

Viewing and Printing Data and Results

The Municipal Solid Waste module contains some features to allow users to adjust the screen view and the appearance of the worksheets when they are printed. Once a module has been opened, you can adjust the zoom by going to the Module Options Menu, and either typing in a zoom percentage or selecting one from the drop down menu. In addition, data may not all appear on a single screen within each worksheet; if not, you may need to scroll up or down to view additional information.

You may also adjust the print margins of the worksheets to ensure that desired portions of the Municipal Solid Waste module are printed. To do so, go to the File menu, and then select "Print Preview." Click on "Page Break Preview" and drag the blue lines to the desired positions (see Figure 2). To print this view, go to the File menu, and click "Print." To return to the normal view, go to the File menu, click "Print Preview," and then click "Normal View."

**Figure 1. Changing Security Settings**
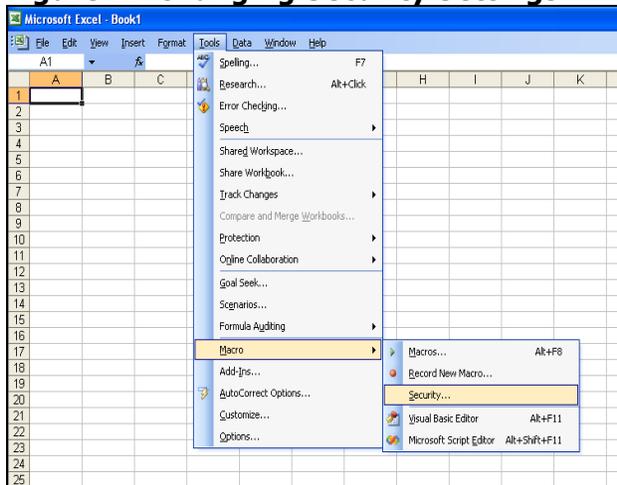
Figure 2. Adjusting Print Margins

1.2 MODULE OVERVIEW

This User's Guide accompanies and explains the Municipal Solid Waste module of the SIT. The SIT was developed in conjunction with EPA's Emissions Inventory Improvement Program (EIIP). Prior to the development of the SIT, EPA developed the States Workbook for estimating greenhouse gas emissions. In 1998, EPA revisited the States Workbook and expanded it to follow the format of EIIP guidance documents for criteria air pollutants. The result was a comprehensive, stepwise approach to estimating greenhouse gas emissions at the state level. This detailed methodology was appreciated by states with the capacity to devote considerable time and resources to the development of emission inventories. For other states, the EIIP guidance was overwhelming and impractical for them to follow from scratch. EPA recognized the resource constraints facing the states and developed the SIT. The ten modules of the SIT corresponded to the EIIP chapters and attempted to automate the steps states would need to take in developing their own emission estimates in a manner that was consistent with prevailing national and state guidelines.

Since most state inventories developed today rely heavily on the tools, User's Guides have been developed for each of the SIT modules. These User's Guides contain the most up-to-date methodologies that are, for the most part, consistent with the Inventory of U.S. Greenhouse Gas Emissions and Sinks. Volume VIII of the EIIP guidance is a historical document that was last updated in August 2004, and while these documents can be a valuable reference, they contain outdated emissions factors and in some cases outdated methodologies. States can refer to Volume VIII of the EIIP guidance documents if they are interested in obtaining additional information not found in the SIT or the companion User's Guide.

The Municipal Solid Waste module calculates methane (CH_4) emissions from landfilling of municipal solid waste (MSW) and carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions from the combustion of MSW. While the module provides

> **Box 1: State Solid Waste Data Sources**
>
> In-state sources, such as state departments of environmental protection, should be consulted first. Otherwise, default data provided by the Municipal Solid Waste module may be used.

default data for most inputs, if you have access to more comprehensive data sources, they should be used in place of the default data (see Box 1 for suggestions of possible data sources). If using outside data sources, or for a more thorough understanding of the tool, please refer to the following Methodology section for data requirements and methodology.

In landfills, CH_4 and CO_2 are produced from anaerobic decomposition of organic matter by methanogenic bacteria. Organic waste first decomposes aerobically (in the presence of oxygen) and is then decomposed by anaerobic non-methanogenic bacteria, which convert organic material to simpler forms like cellulose, amino acids, sugars, and fats. These simple substances are further broken down to gases and short-chain organic compounds (H_2, CO_2, CH_3COOH, $HCOOH$, and CH_3OH), which support the growth of methanogenic bacteria. The bacteria further metabolize these fermentation products into stabilized organic materials and "biogas," which consists of approximately 50 percent CO_2 and 50 percent CH_4 by volume. Additionally, some landfills flare recovered landfill gas, which converts the CH_4 portion of the gas to CO_2. There are also some landfills that collect and burn landfill gas for electricity production or other energy uses (known as landfill-gas-to-energy projects, or LFGTE), which are treated similarly to landfills that flare their gas.

Neither the CO_2 emitted directly as biogas nor the CO_2 emitted from combusting CH_4 at flares is counted as an anthropogenic greenhouse gas (GHG) emission. The source of the CO_2 is primarily the decomposition of organic materials derived from biomass sources (e.g., crops, forests), and in the United States these sources are grown and harvested on a sustainable basis. Sustainable harvesting implies that photosynthesis (which removes CO_2 from the atmosphere) is equal to decomposition (which adds CO_2 to the atmosphere).

Waste combustion emits both CO_2 and N_2O. CO_2 is produced from the oxidation of organic materials in waste, such as paper, food scraps, yard trimmings, and plastic. As with CO_2 from biogas and oxidation of CH_4, CO_2 emissions from biogenic sources (e.g., paper and food scraps) are not counted in GHG inventories because they simply return CO_2 that plants previously absorbed through photosynthesis to the atmosphere. However, some CO_2 is from nonbiogenic sources (e.g., plastic and rubber made from petroleum), and is thus counted in GHG emission inventories. N_2O is produced at the high temperature found in waste combustors by the combination of nitrogen (both nitrogen contained in the waste and nitrogen gas in the air) and oxygen gas in the air.

Users should also note that an additional waste-related greenhouse gas sink, carbon storage from landfilled yard trimmings and food scraps, is accounted for in the Land-Use Change and Forestry module of the SIT.

1.2.1 Data Requirements

To calculate GHG emissions from municipal solid waste management, the data listed in Table 1 are required inputs (again, note that defaults are available for most of these data).

Table 1. Required Data Inputs for the Municipal Solid Waste Module

Solid Waste Sectors	Input Data
Landfills	Amount of **MSW landfilled** in state from 1960 through the present OR from 1990 through the present (short tons)
	State population data, 1960 through the present
	Amount of CH$_4$ flared/recovered at landfills (short tons)
	Industrial landfill CH$_4$ emissions, as a percent of MSW landfill emissions
	Percent of landfill CH$_4$ oxidized at the landfill surface (oxidation factor)
Waste Combustion	Fraction of plastics, synthetic rubber, and synthetic fiber that is oxidized in a combustion facility
	Amount of MSW combusted for 1990 through the present (short tons)
Plastic Combustion	Polyethylene terephthalate (PET) as a proportion of all MSW discards
	High-density polyethylene (HDPE) as a proportion of all MSW discards
	Polyvinyl chloride (PVC) as a proportion of all MSW discards
	Low-density/linear low-density polyethylene (LDPE/LLDPE) as a proportion of all MSW discards
	Polypropylene (PP) as a proportion of all MSW discards
	Polystyrene (PS) as a proportion of all MSW discards
	Other plastic as a proportion of all MSW discards
Synthetic Rubber Combustion	Synthetic rubber durables as a proportion of all MSW discards
	Synthetic rubber clothing and footwear as a proportion of all MSW discards
	Other synthetic rubber non-durables as a proportion of all MSW discards
	Synthetic rubber containers and packaging as a proportion of all MSW discards
Synthetic Fiber Combustion	Synthetic fiber as a proportion of all MSW discards

1.2.2 Tool Layout

Since the methodology of the Municipal Solid Waste module is complex, it is important to have an understanding of the module's overall design. The layout of the Municipal Solid Waste module and the purpose of its worksheets are presented in Figure 3.

Figure 3. Flow of Information in the Municipal Solid Waste Module
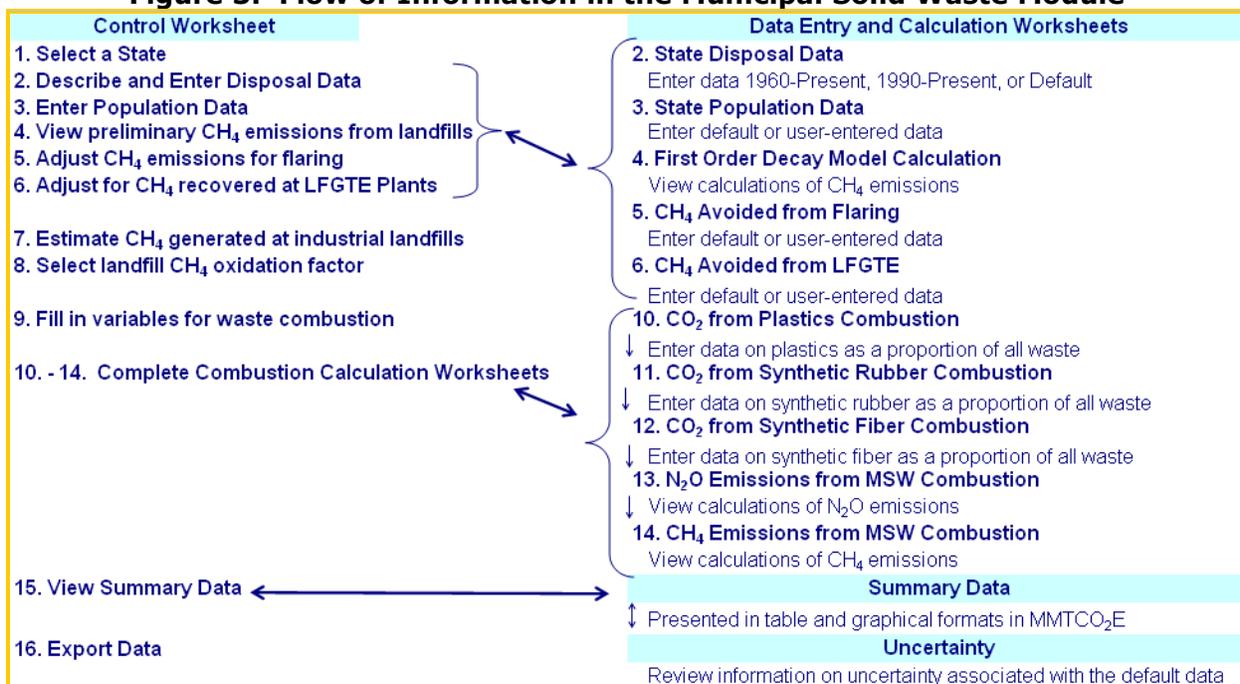
1.3 METHODOLOGY

This section provides a guide to using the Municipal Solid Waste module of the SIT to estimate GHG emissions from municipal solid waste management. The two sectors within the Municipal Solid Waste module, landfills and combustion, are treated separately. Steps 4 through 8 address the estimation of landfill CH_4, while Step 9 deals with combustion.

The following steps are involved in estimating emissions using the Municipal Solid Waste module: (1) select a state; (2) describe and enter state disposal information; (3) enter population data; (4) view preliminary CH_4 emissions from landfills; (5) adjust CH_4 emissions for the amount that is flared; (6) adjust for the amount of CH_4 recovered at landfill-gas-to-energy plants; (7) estimate CH_4 generated at industrial landfills; (8) select landfill CH_4 oxidation factor; (9) fill in the variables used for waste combustion; (10) complete the CO_2 from synthetic rubber combustion worksheet; (11) complete the CO_2 from synthetic fiber combustion worksheet; (12) complete the CO_2 from the combustion of synthetic fibers worksheet; (13) review estimates on the N_2O from MSW combustion worksheet; (14) review estimates on the CH_4 from MSW combustion worksheet; (15) review summary information; and (16) export data. Most of these steps take place on the control worksheet. The Municipal Solid Waste module will automatically calculate emissions after you make choices on the control worksheet and enter the required data on the individual sector worksheets. The tool provides default sector data for most sectors.

Step (1)   Select a State

To begin, select the state you are interested in evaluating. By selecting a state, the rest of the tool will automatically reset to reflect the appropriate state default data and assumptions for use in subsequent steps of the tool.

Step (2)   Describe and Enter State Disposal Information

On the control worksheet, select the radio button that corresponds to the data you would like to use as shown in Figure 4. There are three data options for entering waste disposal data:

> Option 1: If you have state-specific information on waste disposal from 1960 to the present, then no further disposal or population (see Step (3)) data are needed.

> Option 2: If you have state data on waste disposal for 1990 through the present, but not dating back to 1960, the module will estimate waste disposal using historical population data and national per capita landfilling rates.

> Option 3: If do not have state-specific disposal data, you may use the default disposal data already loaded into the module. Default disposal data were estimated by allocating national waste disposal data (U.S. EPA 2018a) to the state level on the basis of a state's historical population (U.S. Census 2019).

Clicking either of the first two user-entered data options will take you directly to a disposal data entry worksheet where you will enter annual state disposal into the yellow input cells. If you choose to use the available default disposal data provided in the module, you may navigate to the data-entry worksheet using the gray "View / Enter Data" arrow to the right of the selection buttons.

The uncertainty associated with the three state disposal options varies. The range of uncertainty represented by these three options is highly variable. Option 1 is preferable, if the state-specific data entered into the module is well-documented and comprehensive. Option 2 attempts to leverage near-term historical data and to scale national information on per capita disposal, state population, and national population information to back cast waste disposal estimates. This approach draws on several assumptions, namely that per capita generation in the state is the same as per capita generation at the national level. Option 3 has the least reliance on state information, making it the easiest, but potentially the least certain of the three options.

The module uses a statistical model, known as a first order decay (FOD) model, to calculate landfill emissions. In the FOD model, the CH_4 emission rate is a function of the quantity of waste deposited in landfills (in short tons) over the previous 30 years.

Figure 4. Example of Steps 1 through 4 on the Control Worksheet

Step (3)   Enter Population Data

Unless you have entered disposal data for 1960 through the present, state population data will be required to calculate emissions. The module automatically uses the default population data (from U.S. Census). If you want to use population data from another source, click on the radio button indicating you would like to use your own data. This action will automatically take you to the population data entry worksheet; you may also navigate to this worksheet using the gray arrow ("View / Enter Data") to the right of the selection buttons, as shown in Figure 4.

Landfills

Step (4)   View Preliminary CH$_4$ Emissions from Landfills

Once you have made your selections and entered data for the previous three steps, you may view preliminary calculations of CH$_4$ emissions from MSW landfills in your state by clicking on the gray arrow that says "Go to the Calculations Sheet." This worksheet shows the preliminary results of the FOD model calculations for MSW. These calculations are considered preliminary because CH$_4$ emissions for the amount collected and burned and the amount oxidized at the surface of the landfill is taken into account in later steps. The FOD model estimates the potential CH$_4$ emissions that occur during the inventory year, but which are associated with the waste landfilled over the past thirty years, using Equation 1.

Equation 1. First Order Decay Model Equation

$$Q_{Tx} = A \times k \times R_x \times L_o \times e^{-k(T - x)}$$

Where, Q_{Tx} = Amount of CH_4 generated in year T by the waste R_x,
T = Current year
x = Year of waste input
A = Normalization factor $(1-e-k)/k$
k = CH_4 generation rate (yr^{-1})
R_x = Amount of waste landfilled in year x
L_o = CH_4 generation potential

As the equation shows, emissions vary not only by the amount of waste present in the landfill, but also by the CH_4 generation rate (k). The CH_4 generation rate varies according to several factors pertaining to the climate in which the landfill is located and is automatically chosen based on the selected state from Step (1). Figure 5 shows the worksheet where the FOD model is applied. It is not necessary to enter any information on this worksheet, as its purpose is to clarify how the FOD model is applied to the previously entered data.

Figure 5. Example of the First Order Decay Model Calculations Worksheet

Step (5)   Adjust CH₄ Emissions for Amount of CH₄ Flared

The control worksheet offers three options for adjusting the module to reflect the amount of CH_4 that is flared:

> Option 1: If you have state-specific data on short tons of CH_4 flared, you may enter these data by clicking on the corresponding radio button, as shown in Figure 6, and then entering your data on the Flaring worksheet;

> Option 2: If you would like to use available default data provided in the module, select to use the default amount of CH_4 flared, which is based on U.S. EPA (2018c) data; or

> Option 3: If you do not want to account for flaring of landfill gas in your state, you may choose to omit this section.

Figure 6. Example of Steps 5 through 8 on the Control Worksheet

Gas collection systems have been put in place at many landfills. At some landfills the CH_4 collected by these systems is flared. As explained in the Module Overview, the CO_2 produced by flaring is not counted as anthropogenic GHG emissions under the accounting system used in the module, so the quantity of CH_4 collected and flared may be subtracted from the total amount of MSW landfill CH_4 produced, as shown in Equation 2. Likewise, CH_4 that is collected and used to create electricity may also be subtracted, as discussed in Step (6) below.

Equation 2. Net CH₄ Emissions from Landfills

Preliminary Net CH₄ Emissions =

Total CH₄ Generated – CH₄ Flared or Recovered for Energy – CH₄ Oxidized in Landfill

Step (6)   Adjust For Amount of CH₄ Recovered at Landfill-Gas-to-Energy Plants

As mentioned in Step (5), some landfills collect and burn landfill gas to produce energy. Such operations are known as landfill gas to energy (LFGTE) plants. The CH₄ collected and burned as part of that landfill gas should be subtracted from the total CH₄ generation, as shown in Equation 2.

The following three options for adjusting CH₄ emissions for the amount recovered at LFGTE plants are provided on the control worksheet:

> Option 1: If you have state-specific data on short tons of CH₄ burned in LFGTE facilities, you may enter those data by clicking on the corresponding radio button, as shown in Figure 6, and then entering your data on the LFGTE worksheet;

> Option 2: If you would like to use default data provided in the module, select to use the default amount of CH₄ recovered at LFGTE plants, which is based on U.S. EPA (2018c) data; or

> Option 3: If you do not account for CH₄ recovered at LFGTE plants, you may choose to omit this section and not account for LFGTE operations.

Step (7)   Estimate CH₄ Generated at Industrial Landfills

Up to this point, all information entered in the module refers to CH₄ generated from MSW landfills. However, CH₄ is also generated from waste deposited in non-hazardous industrial landfills. Although CH₄ generation from non-hazardous industrial landfills is believed to be small relative to that from MSW landfills, industrial landfill CH₄ generation is still a significant source of CH₄ emissions. CH₄ generation from industrial landfills does not include CH₄ generation from industrial waste disposed of into MSW landfills, as these emissions have already been accounted for in the module.

The quantity of waste in industrial landfills and the quantity of CH₄ that it generates must be estimated due to a lack of data. Based on estimates of the quantity of waste in place at industrial landfills and on the estimated organic content of industrial landfills compared to MSW landfills, U.S. EPA (1993) estimated that CH₄ generation from industrial landfills in the United States is approximately 7 percent of CH₄ generation from MSW landfills in the United States, prior to adjusting for flaring and recovery or oxidation. If you have outside information, you may adjust this percent in the yellow box, as shown in Figure 6.

Step (8)   Select Landfill CH₄ Oxidation Factor

The default assumption in Step (8) of the control worksheet is that 10 percent of the CH_4 generated that is not flared or recovered is oxidized in the soil (this holds for industrial landfills also). To use the default percent, click on the check box. To use your own oxidation factor, enter it in the yellow box as shown in Figure 6. If the user-specific inputs do not match the default data in the control worksheet (i.e., the default value is overwritten), the text will appear red.

Regardless of whether a landfill gas recovery system is in place, uncollected CH_4 will pass upward through the landfill cover or surrounding soils, where it may be oxidized (Whalen, Reeburgh and Sandbeck 1990). The amount of oxidation that occurs is uncertain and depends on latitude (affecting surface soil temperature), soil characteristics, and other factors.

Waste Combustion

Step (9)   Fill in the Variables Used for Waste Combustion

As described in the Module Overview, combustion of fossil-fuel derived materials in MSW results in emissions of anthropogenic CO_2, N_2O, and CH_4. To develop an estimate of CO_2 emissions, the module calculates combustion of the fossil-derived carbon in MSW for three waste categories: plastics, synthetic fibers (e.g. textiles), and synthetic rubber (U.S. EPA 2018a). The defaults in the Municipal Solid Waste module use information on the typical composition of discards in the U.S. solid waste stream to estimate the mass of each of these waste types that is combusted, and estimates the proportion of each material that comprises fossil carbon. The module defaults also assume that 98 percent of the fossil carbon is converted to CO_2 in the combustion process (with the balance remaining in the ash).

Some of the data inputs required to complete estimates of GHG emissions from waste combustion are entered on the control worksheet as shown in Figure 7, and the remaining data inputs are entered on individual calculation worksheets for each type of material, as well as for N_2O and CH_4 emissions.

Fraction of Waste Oxidized

Enter the fraction of carbon that is oxidized for each material type in the yellow boxes on the control worksheet as shown in Figure 7. To use the default percent oxidized (98 percent); use the check boxes to the right of the yellow cells. If the user-specific inputs do not match the default data in the control worksheet (i.e., the default value is overwritten), the text will appear red.

Figure 7. Example of Steps 9 through 11 on the Control Worksheet

Default or User-Entered Data

The module allows you to enter your own data on short tons of waste combusted in-state for the years 1990 through the present, or to use the default data, which is based on BioCycle (1991-2008). Choose the appropriate radio button; if you choose to enter your own data, this action will take you to the data entry worksheet. You may also navigate to this sheet using the gray "View / Enter / Edit Data" arrow to the right of the buttons. After completing this section of the control worksheet, go on to the combustion sector calculation worksheets.

Step (10)   Complete the CO₂ from Plastics Combustion Calculation Worksheet

There are separate worksheets for each of the three types of fossil-derived MSW (plastics, synthetic rubber, and synthetic fiber) and each of the worksheets is similar in layout. An example of the plastics combustion worksheet is shown in Figure 8. Emissions are calculated using the following equation:

Equation 3. CO₂ Emissions from Combustion

$$\text{CO}_2 \text{ Emissions (MTCO}_2\text{E)} =$$
$$\text{Material as Proportion of all Discards (\%)} \times \text{Total MSW Combusted (short tons)} \times \text{Carbon Content (\%)} \times \text{Fraction Oxidized (\%)} \times 44/12 \text{ (CO}_2 \text{ to C ratio)} \times 0.9072 \text{ (short tons to metric tons conversion)}$$

On the plastics combustion worksheet, enter the proportion of each type of plastic (PET, HDPE, PVC, LDPE/LLDPE, PP, PS, and other) as a percent of total discards in the blue cells. The default data are from U.S. EPA (2018a), and may be selected by clicking the check box for each year, as shown in Figure 8, or by clicking the box "Select All Defaults." Total tons of waste combusted are drawn from the data you entered in Step (9); default carbon contents are provided for each type of plastic. Once you have entered data for each year, you may proceed to the synthetic rubber combustion worksheet by clicking on the gray arrow at the top of the page.

Figure 8. Example of Plastics Combustion Calculation Worksheet
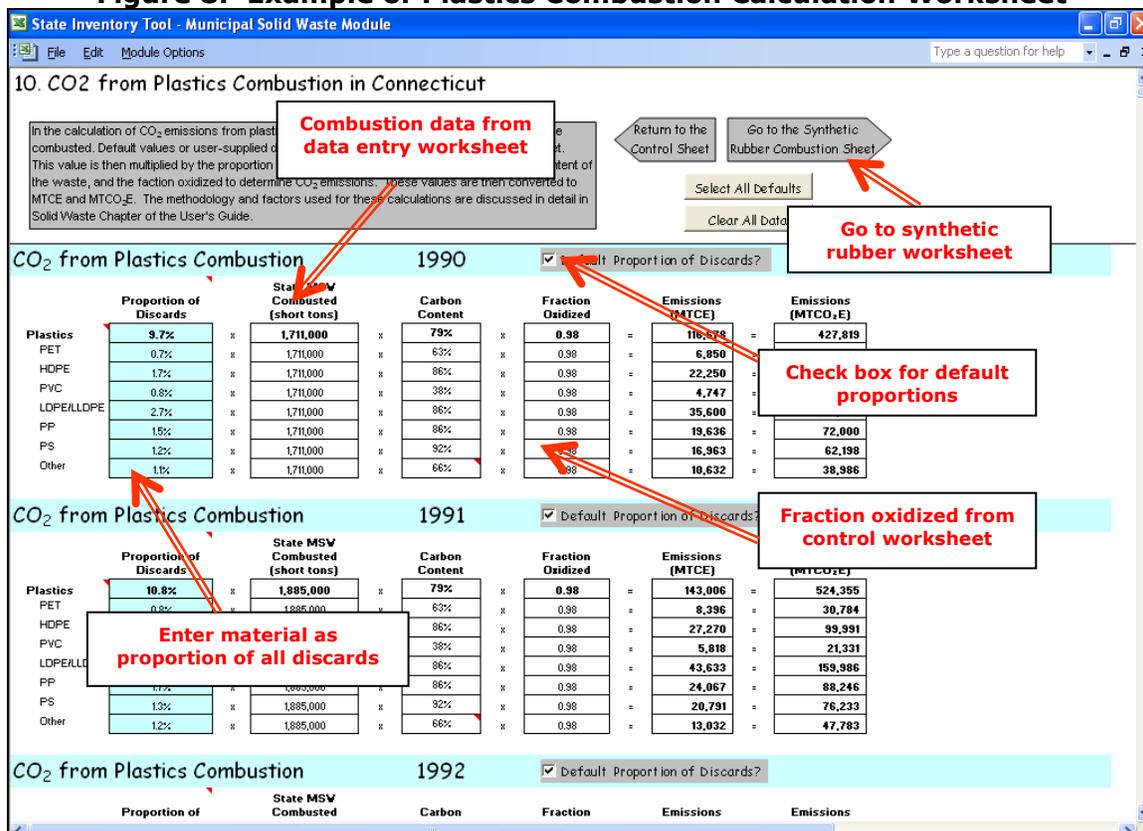
Step (11)   Complete the CO_2 from Synthetic Rubber Combustion Calculation Worksheet

The synthetic rubber combustion worksheet is identical to the plastic combustion worksheet, except that it calculates emissions for durable goods, non-durable goods (clothing and footwear, and other non-durables), and packaging and containers made of synthetic rubber. Enter the proportion of each type of rubber in the green cells as a percent of total discards, or select the default data (U.S. EPA 2018a). Once you have entered data for each year, you may proceed to the synthetic fiber combustion worksheet by clicking on the gray arrow at the top of the page.

Step (12)   Complete the CO_2 from Synthetic Fiber Combustion Calculation Worksheet

Again, this worksheet is identical to the worksheets for plastic and synthetic rubber combustion. Enter synthetic fiber as a proportion of all discards, in the orange cells, or

choose the default proportions. The carbon content provided is a weighted average of the carbon contents of the major synthetic fibers used in the United States. Once you have entered data for each year, you may proceed to the N_2O from MSW combustion worksheet by clicking on the gray arrow at the top of the page.

Step (13)   Review Estimates on the N_2O from MSW Combustion Calculation Worksheet

This worksheet does not require any data inputs; it presents an example of how the emissions are calculated based on the following equation (the emission factor is from U.S. EPA 2018b):

Equation 4. N_2O Emissions from Combustion

> **N_2O Emissions (MTCO$_2$E) =**
> **MSW Combusted (short tons) × 0.00005 (emission factor in tons N_2O/ton MSW) × 298 (N_2O GWP) × 0.9072 (short tons to metric tons conversion)**

Step (14)   Review Estimates on the CH_4 from MSW Combustion Calculation Worksheet

This worksheet does not require any data inputs; it presents an example of how the emissions are calculated based on the following equation (the emission factor is from U.S. EPA 2018b):

Equation 5. CH_4 Emissions from Combustion

> **CH_4 Emissions (MTCO$_2$E) =**
> **MSW Combusted (short tons) × 0.00002 (emission factor in tons N_2O/ton MSW) × 25 (CH_4 GWP) × 0.9072 (short tons to metric tons conversion)**

Step (15)   Review Summary Information

The steps above provide estimates of total emissions and reductions from municipal solid waste management. The information from the control worksheet and data entry worksheets is collected on the summary worksheet, which displays results in million metric tons of carbon dioxide equivalent (MMTCO$_2$E). Figure 9 shows the summary worksheet that sums the emissions from all sectors in the Municipal Solid Waste module. In addition, the results are displayed in graphical format at the bottom of the summary worksheets.

Figure 9. Example of the Emissions Summary Worksheet in the Municipal Solid Waste Module

Step (16)   Export Data

The final step is to export the summary data. Exporting data allows the estimates from each module to be combined later by the Synthesis Module to produce a comprehensive GHG inventory for the state.

To access the "Export Data" button, return to the control worksheet and scroll down to the bottom (15). Click on the "Export Data" button and a message box will open that reminds the user to make sure all sections of the module have been completed. If you make any changes to the Municipal Solid Waste module later, you will then need to re-export the results.

> **Note: the resulting export file should not be modified.** The export file contains a summary worksheet that allows users to view the results, as well as a separate data worksheet with an unformatted version of the results. The second worksheet, the data worksheet, contains the information that is exported to the Synthesis Tool. Users may not modify that worksheet. Adding/removing rows, moving data, or making other modifications jeopardize the ability of the Synthesis Module to accurately analyze the data.

Clicking "OK" prompts you to save the file. The file is already named, so you only need to choose a convenient place to save the file. After the file is saved, a message box will appear indicating that the data was successfully exported.

While completing the modules, you are encouraged to save each completed module; doing so will enable you to easily make changes without re-running the entire module.

Following data export, the module may be reset and run for another state. Alternatively, you may run the remaining modules of the State Inventory Tool to obtain a comprehensive profile of emissions for your state.

1.4 UNCERTAINTY

In the upper right-hand corner of the summary worksheet is a button: "Review discussion of uncertainty associated with these results." By clicking on this button, you are taken to a worksheet that discusses the uncertainty surrounding the activity data and emission factors, and how the uncertainty estimates for this source category affect the uncertainty of the emission estimates for your state.

1.5 REFERENCES

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