



Iowa Department of Natural Resources

**Greenhouse Gas Model
for
Solid Waste Management Organizations**

User Guide

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ACRONYMS AND ABBREVIATIONS

CH ₄	methane
CO ₂	carbon dioxide
DNR	Department of Natural Resources
EMS	Environmental Management System
GHG	greenhouse gas
LGOP	Local Governments Operations Protocol
N ₂ O	nitrous oxide
OWC	Organic Waste Composting
SWAP	Solid Waste Alternatives Program
SWMO	Solid Waste Management Organizations
tCO ₂ e	carbon dioxide equivalent in tons
USEPA	United States Environmental Protection Agency
WRI	World Resources Institute
WBCSD	World Business Council on Sustainable Development

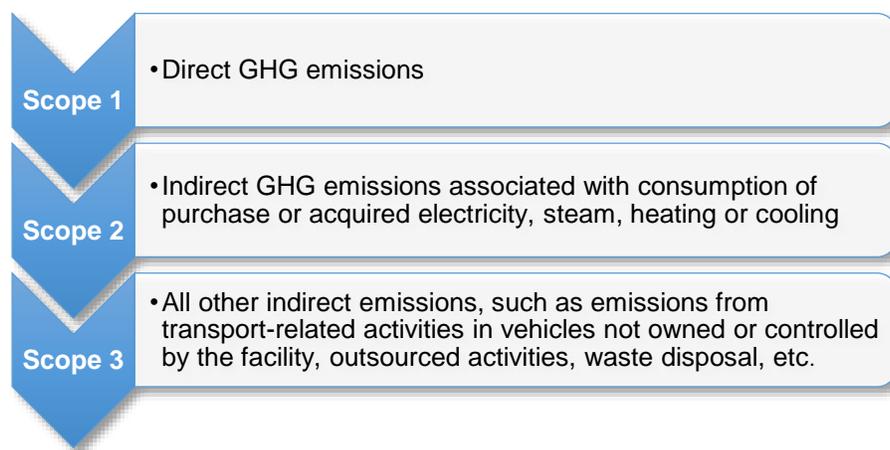
1.0 INTRODUCTION

The Greenhouse Gas (GHG) Model for Solid Waste Management Organizations (SWMO) has been developed for the Iowa Department of Natural Resources (DNR) Solid Waste Environmental Management System (EMS) Program. Wenck Associates developed the first version of the model in 2009 and Gresham, Smith and Partners (GS&P) revised and updated it in 2015. The model is intended for use by SWMOs of all sizes and complexities across the state of Iowa to assist in assessing GHG emissions associated with their facilities and operations.

The model was developed following the Local Government Operations Protocol¹ (LGOP), which was developed cooperatively by the Climate Registry; the California Air Resources Board; ICLEI USA - Local Governments for Sustainability; and the California Climate Action Registry. It is based on the principles outlined in the World Resources Institute/World Business Council on Sustainable Development (WRI/WBCSD) *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Protocol*.

1.1 Model Overview

The GHG Model is used to calculate emissions data from a variety of sources including fuel, electricity, and refrigerant consumption as well as emissions from solid waste sources such as composting and landfills. The model focuses primarily on Scope 1 and Scope 2 emissions, although it does allow for certain Scope 3 emissions, including hauling and third-party facility operations where data is readily available from the third-party.



Greenhouse gases included in the model are carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). All gases are converted to tons of carbon dioxide equivalent (tCO₂e) using the global warming potential factors from Table B.1 in the General Reporting Protocol.

¹ http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

1.2 Model Structure

The model consists of a series of calculation and results summary worksheets along with a reference worksheet. An image from the model is shown below followed by a brief description of each of the worksheets.



Year Summary – This worksheet summarizes and presents the calculated total GHG emissions by year and scope. A graphic comparison of calculated emissions is provided on this worksheet.

Facility Summary - This worksheet summarizes and presents the calculated total organizational GHG emissions by facility, scope, and year. The source of the Facility Summary data are each of the individual facility worksheets that contain detailed emissions broken down by source and scope.

Facility – This worksheet is generated when a new facility is added through either the “Year Summary” or “Facility Summary” worksheet. An individual facility worksheet for each year is then populated from inputs entered in the “Add Source Data” command button located at the top of each facility worksheet.

Emission Factors – This worksheet is a reference sheet with GHG emission factors, unit conversions, and citation information. The emission factors have been updated as noted based on available published information.

1.3 Workflow

The GHG Model is intended to allow users to build an inventory based on their specific operations. Users will be able to add facilities based on predefined categories. After a facility is added, users will be able to add GHG emission sources as needed on the facility worksheet. Once all of the sources are added, the model can be run to calculate the emissions, which can then be viewed by facility and year.



2.0 PREPARING TO USE THE TOOL

Before getting started with the model, it is a useful exercise to identify the SWMO's GHG emission inventory fence line and determine how to organize the inventory prior to proceeding. This section provides guidance on establishing the fence line and identifies the information to acquire for input into the GHG Model.

2.1 Defining Operations by "Facility"

The first step in developing an inventory is to define the specific facilities and operations within the GHG emission inventory fence line. The GHG Model is designed to allow the user to organize operations by "facility." The user can define specifically what a facility might be, whether a specific geographic location or the entire SWMO's operations. For example, a landfill and recycling center may be entered as separate facilities or combined into one facility. Combining them may be simpler for data entry purposes, but separating them may provide more detail on independent sources of GHG emissions. For each identified facility, the specific GHG emission sources will be identified and quantified.

2.2 Defining Analysis Years

When first starting an inventory, it is important to choose a baseline year for each facility. This can be any year that an organization would like to compare against current and future years. It might make sense to choose a recent year that is representative of current operations. The key is to make sure there are complete data records for the chosen year.

Within the GHG Model each facility will have its own worksheet by year and will appear on the "Facility Summary" tab. The analysis year for each facility will appear on the "Year Summary" tab and the facility data will be represented on the worksheet based on the analysis year specified by the user.

2.3 Gathering the Data

Once the operations and the time period of the analysis have been defined, the user must collect consumption data for input into the GHG Model. Sources of the data (and associated units of measure) will vary by the emission source type, but could include:

- Electricity bills (e.g., kilowatt hours)
- Natural gas bills (e.g., therms)
- Fuel dispenser gauge readings or "fuel key" log (e.g., gallons)
- Vehicle mileage logs (e.g., miles)
- Equipment hours logs (e.g., hours)
- Propane invoices (e.g., gallons)
- Compost (yard waste) records (e.g., cubic yards or tons)
- Landfill gas collection readings (e.g., standard cubic feet)

3.0 USING THE TOOL

This section details the specific steps to take in entering inventory data into the GHG Model and running the calculations. The GHG Model was developed utilizing Microsoft Excel with macros. Prior to using the model, the user should ensure that macros are enabled for the program.

3.1 Adding Facilities and Years

To add a facility to the workbook, click on the “Add Facility/Year” button at the top of either the “Year Summary” or “Facility Summary” worksheet.



This will open a data entry form requiring the user to input information detailed below.

- **Facility Name-Year** – Enter the name of the facility. If the facility name is more than 31 characters, the facility name will be truncated to include the first 24 characters of this field. It is recommended that the analysis year is placed at the end of the facility name to ensure that an error does not occur from two worksheets being labeled with the same facility name, should the same facility have emissions analyzed for two different years. Special characters (e.g., “/”, “?” or “>”) are not allowed.
- **Facility Type** – Select the facility type from the dropdown menu. Possible options include the following:
 - General;
 - Landfill;
 - Fueling Station;
 - Vehicles;
 - Composting;
 - Third Party Hauling; or
 - Demanufacturing.

If a facility type is not in the list, simply select “General.”

A screenshot of a dialog box titled "Add Facility Information". It contains four input fields: "Facility Name-Year:" (a text box), "Facility Type:" (a dropdown menu), "Analysis Year:" (a text box), and "Copy From a Previous Sheet:" (a dropdown menu). At the bottom of the dialog box are "OK" and "Cancel" buttons.

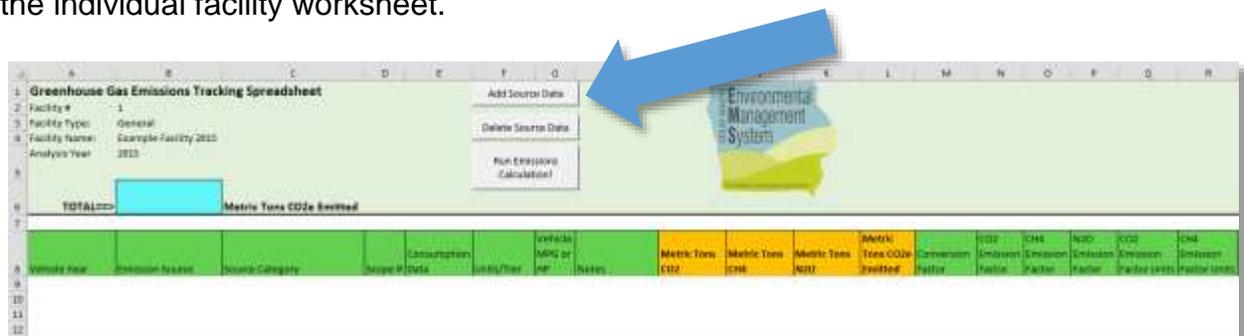
- **Analysis Year** – Provide the year of the data to be entered and analyzed.
- **Copy From a Previous Sheet** – This is an optional feature to copy data from a previously completed sheet. An existing sheet can be selected from the dropdown menu. This feature can save the user time by copying the list of emissions sources from a prior Facility/Year. The user can then simply enter the new consumption data on the new worksheet.

Once the fields are completed, click “OK.” When the facility is added, a new worksheet is added to the workbook for the new facility. The new worksheet will have column headings, but the data beginning at Row 9 will initially be blank.

The user should repeat this process for each facility and year.

3.2 Data Entry (Inventory Development)

Emission sources can be added using the “Add Source Data” command button when in the individual facility worksheet.



A data entry form will appear requiring the user to input emission source data detailed below.

- **Emission Sources** – Select the emission source from the list of possible options provided within the GHG Model that include the following:
 - Natural Gas/Propane/Other Gas Consumption;
 - Electricity Usage;
 - Boilers;
 - Combustion Engines (Non-Highway);
 - Landfill Gas;
 - Composting;
 - Transportation (by weight class of vehicle);
 - Light Vehicles
 - Heavy Vehicles
 - Off-Road Equipment;
 - Welding;
 - Refrigerants; or
 - Miscellaneous (to be entered as tCO₂e).

The image shows a dialog box titled 'Add Source Data'. It contains several input fields: 'Vehicle Year' (text box), 'Emission Source' (dropdown menu), 'Source Specification' (dropdown menu), 'Units/Tier' (dropdown menu), 'Consumption Data' (text box), 'Vehicle MPG or HP (If Applicable)' (text box), and 'Notes' (text box). At the bottom, there are 'Add Source' and 'Cancel' buttons. A note at the bottom of the dialog box states: 'Bold Categories Designate Required Information'.

- **Source Specification** – This field requires additional input on the specific type of emission source. For example, under the Combustion Engines emission source, the user can specify that the source uses gasoline. The more specific the information the user provides within the GHG Model, the more precise the resulting inventory.
- **Units/Tier** - Consumption data are sometimes provided in different units. This field allows users to change the unit value for a row using the drop down list.
- **Consumption Data** – Enter the available consumption data into this field. The data entered for each emission source depends on the level of detail and units of the available data reported.
- **Vehicle MPG or HP** – If applicable, specify a vehicle’s fuel economy identified as miles per gallon (mpg). If a fuel economy value is not specified in this field, a default value will be assigned to the vehicle based on the weight class of the vehicle (i.e., light or heavy), vehicle fuel type (i.e., gasoline, diesel, ethanol, etc.), and vehicle model year. If the total gallons of a specific fuel type is known for a fleet of vehicles the total diesel fuel consumed can be entered in the “Consumption Data” text box. Separately, if each vehicle in the fleet has available fuel consumption data, each vehicle can be entered in as a separate emission source.

Once data has been entered into the required fields, select the “Add Source” command button to populate Columns B-H with the specified values.

The user should repeat this process for each source at the facility.

3.3 Modifying Source Data

Within the rows populated with source data, cells highlighted in yellow (Columns D through H) allow the user to change the input data, such as modifications of designated scope, reported values, units or vehicle fuel efficiency. This is helpful to correct typos when adding source data or to fill-in blank cells.

The screenshot shows a spreadsheet interface. Row 1 is the title 'Greenhouse Gas Emissions Tracking Spreadsheet'. Rows 2-5 contain facility information: Facility # 1, Facility Type: General, Facility Name: Example Facility 2015, and Analysis Year 2015. Row 6 shows a total of 0.65 Metric Tons CO2e Emitted. A blue arrow points to the data table below. The table has columns for Vehicle Year, Emission Source, Source Category, Scope #, Consumption Data, Units/Tier, Vehicle MPG or HP, and Notes. The first data row (row 9) has yellow highlights under Scope # (1), Consumption Data (100), Units/Tier (gallons), and Notes.

Vehicle Year	Emission Source	Source Category	Scope #	Consumption Data	Units/Tier	Vehicle MPG or HP	Notes
2009	Transportation (Light Vehicles)	Gasoline (Light Truck)	1	100	gallons		

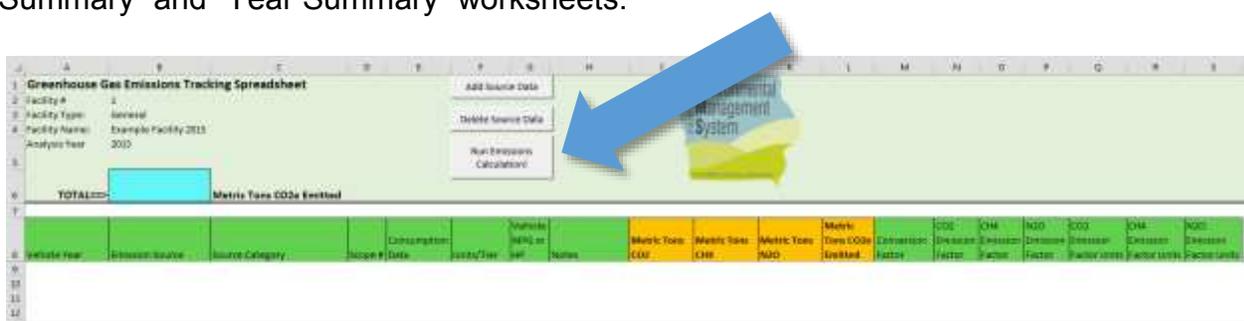
*Iowa Department of Natural Resources
Greenhouse Gas Emissions Model User Guide*

An entire row of emission source data can also be deleted by selecting the “Delete Source Data” command button. A data entry form will appear requiring the user to specify the row number corresponding to the emission source data to be removed from the worksheet. Once the “OK” command button is selected, the identified row will be removed in its entirety from the worksheet.



3.4 Emissions Calculations

After data is entered, selecting the “Run Emissions Calculation!” button runs the model, thereby calculating the GHG emissions, populating the results for each specific source on the facility worksheet and populating the summarized results on the “Facility Summary” and “Year Summary” worksheets.



4.0 EMISSION SOURCE SPECIFICS

For several sources, there may be alternate ways of calculating emissions, depending on the data available. The following section details methods for calculating emissions from landfills, composting facilities, vehicles and vehicle fleets, and Scope 3 emissions.

4.1 Landfills

Landfill emissions can be calculated in multiple ways:

- 1) If landfill emissions are already calculated for other purposes (e.g., the USEPA Greenhouse Gas Mandatory Reporting Rule, LandGEM model runs, etc.), the results from those calculations can be input directly into the model. The emissions are added in units of tCO₂e by selecting “Miscellaneous (as tCO₂e)” from the “Emission Source” drop down menu. Then the user adds the tCO₂e provided from an external source in the “Consumption Data” field.
- 2) If the landfill has a gas collection system and the volume of gas captured is monitored, emissions can be estimated using the Landfill Gas Calculator on the Emission Factors reference worksheet of the GHG Model and specifying variables listed in cells C201 through C207. The calculator has two columns. The first column uses LGOP values; these default values are not highlighted. The second column is editable, as noted by the yellow highlighting, and allows for user defined variables. Emissions can be calculated using either column.

Once the data for “LFG Collected (MMSCF)” is added to the facility worksheet by selecting the “Add Source Data” command button and selecting inputs corresponding to landfill gas, the result is calculated in Column O of the corresponding facility worksheet by selecting the “Run Emissions Calculation!” command button. The user defined variables are referenced when the emissions calculations are executed.

Variables in the calculator with corresponding default values include:

- Amount of gas captured (MMSCF)
- Fraction of Methane (0.5)
- Destruction efficiency (0.99)
- Collection efficiency (0.75)
- Oxidation Factor (0.10)

4.2 Composting Facilities

The LGOP refers to the Climate Action Reserve’s Organic Waste Composting (OWC) project protocol to calculate emissions from composting. As a result, the GHG Model uses the calculation method in the OWC protocol as an estimate of emissions from composting facilities. Input parameters for this calculation are:

- Weight of organic waste coming into the composting facility (if mixed stream, the amount of organics must be estimated and used as the input to the model)
- Composting Category (this will determine the emissions factor):
 - Turned Systems
 - No Cover

- 15 cm of cover for three weeks
- Forced Aeration Systems
 - No Cover
 - Synthetic Cover
 - Positive Aeration
 - Negative Aeration

After selecting the “Add Source Data” command button from the facility worksheet, select “composting” from the drop down list under “Emission Source.” Then specify the value in the “Source Specification” drop down that aligns with the corresponding composting practice at the facility. Selecting the appropriate composting type will determine the emission factor used.

4.3 Vehicles and Vehicle Fleets

Vehicles can be entered by individual vehicle or in bulk if multiple vehicles have the same model year, fuel type used, and weight class. Users will be able to enter fuel type (e.g., gasoline, diesel, compressed natural gas, etc.), MPG and miles travelled or amount of fuel consumed and vehicle type.

4.4 Scope 3 Emissions

The primary Scope 3 emissions will be specified by the user in Column E.