

State Inventory Tool

User Guide for Estimating Methane and Nitrous Oxide Emissions from Wastewater

SEPTEMBER 2026

ACKNOWLEDGEMENTS

The SIT was originally developed in conjunction with EPA’s state and local programs 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. The result was a user-friendly set of eleven modules that help users estimate greenhouse gas emissions and removals at the state level. CGS is supporting updates to the tool to facilitate continuity in state inventory development and improvement work at the state level.

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This section of the User Guide provides instruction on using Wastewater module of the State Inventory Tool (SIT), and describes the methodology used for estimating greenhouse gas emissions from wastewater at the state level.

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1.1 MODULE OVERVIEW

This User Guide accompanies and explains the Wastewater module of the SIT.

Because most state inventories developed today rely heavily on the SIT, User Guides have been developed for each of the SIT modules. These modules contain largely updated methodologies that are, for the most part, consistent with the Inventory of U.S. Greenhouse Gas Emissions and Sinks (EPA 2025a) and related disaggregated data by state. Users can refer to the chapters and annexes of the U.S. Inventory and the Center for Global Sustainability (CGS) FAQ page to obtain additional information not found in the SIT or in the companion User's Guides. Future updates will be consistent with the Center for Global Sustainability at University of Maryland's Greenhouse Gas Inventory and Analysis for the United States (GHGIA) (Desai et al. 2026).

In recent years, EPA also published an annual Inventory of U.S. Greenhouse Gas Emissions and Sinks by State (EPA 2024a) to make available consistent state-level GHG data for all states for use by states, researchers, and the general public. There will be differences between the latest EPA developed state-level estimates and inventory estimates developed by states using the SIT or other tools. Inventories compiled by states may differ for several reasons, and differences do not necessarily mean that one set of estimates is more accurate, or "correct". The CGS plans to continue EPA's initiative to publish an updated annual crosswalk guide to facilitate understanding methodological differences between methods in the current GHGIA, its disaggregation by state and SIT source categories, methods, and data.

The Wastewater module calculates methane (CH₄) and nitrous oxide (N₂O) emissions from the treatment of municipal and industrial wastewater. The module provides default data for most inputs, however other more state-specific data may be used if available (see Box 1 for suggestions on where to find data). If using outside data sources, or for a more thorough understanding of the tool, please refer to the Methodology section below for data requirements and methodology.

Box 1: Wastewater Data Sources

In-state sources, such as state departments of environmental protection, should be consulted first. Otherwise, default data provided by the Wastewater module may be used.

Disposal and treatment of industrial and municipal wastewater often result in CH₄ emissions. Wastewater may be treated using aerobic and/or anaerobic technologies, or if untreated, may degrade under either aerobic or anaerobic conditions. CH₄ is produced when organic material is treated in anaerobic environment and when untreated wastewater degrades anaerobically, i.e., in the absence of oxygen.

N₂O is emitted from both domestic and industrial wastewater containing nitrogen-rich organic matter. N₂O is produced through the natural processes of nitrification and denitrification. Nitrification occurs aerobically and converts ammonia into nitrate, whereas denitrification occurs anaerobically, and converts nitrate to N₂O. Human sewage is believed to constitute a significant portion of the material responsible for N₂O emissions from

1.1.1 Data Requirements

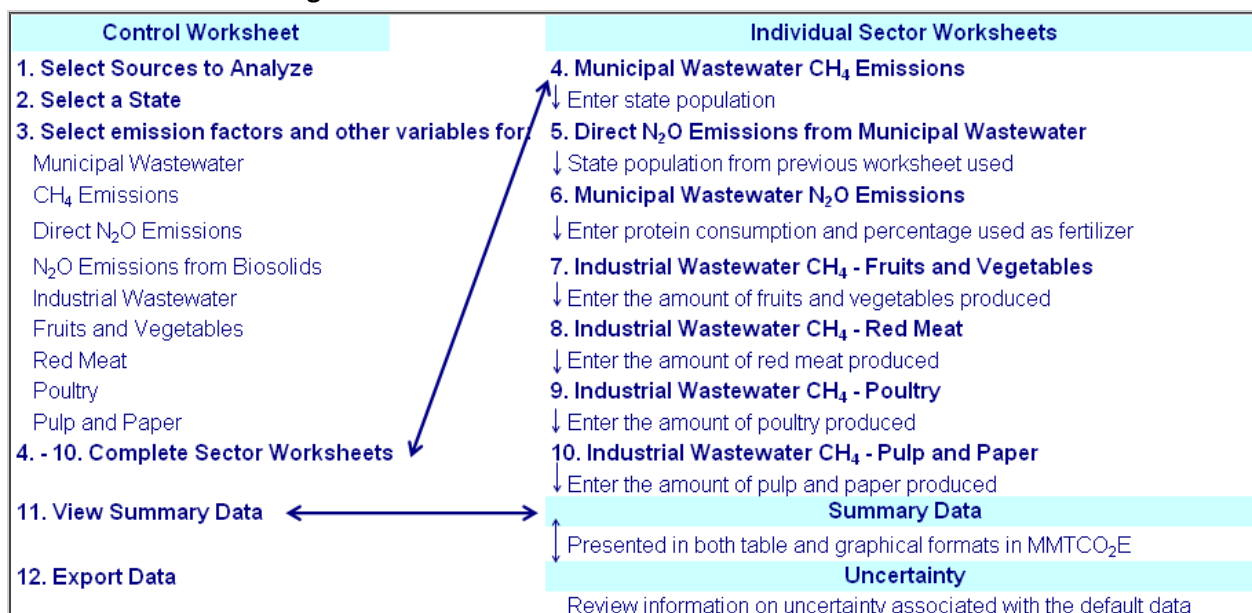
To calculate greenhouse gas emissions from wastewater, the data listed in Table 1 are required inputs (again, note that defaults are available for most of these data).

Table 1. Required Data Inputs for the Wastewater Module

Wastewater Sectors	Input Data
Municipal Wastewater: CH ₄ Emissions	Per capita 5-day biochemical oxygen demand (BOD ₅) (kg/day) Fraction of wastewater BOD ₅ anaerobically digested Emission factor (Gg CH ₄ /Gg BOD ₅) State population
Municipal Wastewater: Direct N ₂ O Emissions	Factor for non-consumption nitrogen Fraction of population not on septic Direct wastewater treatment plant emissions (g N ₂ O/person/year)
Municipal Wastewater: N ₂ O Emissions from Biosolids	Emission factor (kg N ₂ O-N/kg sewage N produced) Fraction of nitrogen in protein (Frac _{NPR}) Protein content (kg/person/year) Biosolids used as fertilizer (percentage)
Industrial Wastewater: Fruits and Vegetables	Wastewater Outflow (m ³ /metric ton) WW organic content - chemical oxygen demand (COD) (g/L)
Industrial Wastewater: Red Meat	Fraction of COD anaerobically degraded
Industrial Wastewater: Poultry	Emission factor (g CH ₄ /g COD) Production processed (metric tons)
Industrial Wastewater: Pulp and Paper	Wastewater Outflow (m ³ /metric ton) WW organic content - chemical oxygen demand (COD) (g/L) Fraction of COD anaerobically degraded Emission factor (g CH ₄ /g COD) Production processed of woodpulp and paper & paperboard (metric tons)

1.1.2 Tool Layout

Because the methodology for estimating emissions from Wastewater treatment is complex, it is important to understand the module's overall design. The layout of the Wastewater module and the purpose of its worksheets are presented in Figure 1.

Figure 1. Flow of Information in the Wastewater Module

1.2 METHODOLOGY

This section provides a guide to using the Wastewater module of the SIT to estimate greenhouse gas emissions from municipal and industrial wastewater treatment. The methods used in this module are taken from the report by the Intergovernmental Panel on Climate Change (IPCC) entitled *IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006) and are presented as used in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (U.S. EPA 2025).

The Wastewater module follows the general methodology from the National Inventory Report (NIR) GHG Inventory by U.S. State. However, SIT default data are not available for all sources (e.g., fruits and vegetables, poultry, pulp & paper, ethanol refineries, breweries, and petroleum refineries).

There are twelve general steps involved in estimating emissions using the Wastewater module: (1) select industrial wastewater sources; (2) select a state; (3) select emission factors and other variables used throughout the module; (4) complete municipal wastewater worksheet; (5) review direct N₂O emissions from municipal wastewater treatment worksheet; (6) complete municipal wastewater N₂O emissions worksheet; (7) complete industrial wastewater CH₄ - fruits and vegetables worksheet; (8) complete industrial wastewater CH₄ – red meat worksheet; (9) complete industrial wastewater CH₄ – poultry worksheet; (10) complete industrial wastewater CH₄ – pulp and paper worksheet; and (11) review summary information. The Wastewater 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 data for most sectors.

Step (1) Select Industrial Wastewater Sources

To begin, select the industrial wastewater sources you would like to analyze in step 1 of the control worksheet. Check the box to the left of the following industrial wastewater sectors you would like to analyze: fruits and vegetables, red meat, poultry, and pulp and paper.

Step (2) Select a State

Next, 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. Figure 2 shows an example of the control worksheet.

Figure 2. Example of the Control Worksheet in the Wastewater Module

State Inventory Tool - Wastewater Module
Version 2025.1

This module provides default activity data, emission factors, and other relevant metrics for 1990-2022. Emission factors are proxied for 2023-2025.

1. Select those sources you wish to analyze.

☒ CH₄ from industrial wastewater

- ☒ - Fruits and Vegetables
- ☒ - Red Meat
- ☒ - Poultry
- ☒ - Pulp and Paper

2. Choose a State: Florida

3. Fill in the variables used throughout this module:

Municipal Wastewater CH₄ Emissions

	Default Values	Values Used	Use the Default? (Check for Yes)
Per capita 5-day Biochemical Oxygen Demand (BOD ₅) (kg/day)	0.09	0.09	☒
Fraction of wastewater BOD ₅ anaerobically digested	12.38%	12.38%	☒
Emission Factor (Gg CH ₄ /Gg BOD ₅)	0.6	0.6	☒

Municipal Wastewater Direct N₂O Emissions

	Default Values	Values Used	Use the Default? (Check for Yes)
Factor non-consumption nitrogen	1.75	1.75	☒
Fraction of population not on septic	84%	84%	☒
Direct wastewater treatment plant emissions (g N ₂ O/person/year)	4.0	4.0	☒

Municipal Wastewater N₂O Emissions from Biosolids

	Default Values	Values Used	Use the Default? (Check for Yes)
Emission Factor (kg N ₂ O-N/kg sewage N-produced)	0.005	0.005	☒
Fraction of nitrogen in protein (Frac _{protein})	16%	16%	☒

Step (3) Select Emission Factors and Other Variables Used Throughout the Module

The next part of the control worksheet involves selecting default variables or entering state specific variables in the yellow cells on the control worksheet, as seen in Figure 4. The required inputs for each sector are discussed further in following steps. Box 2 explains terminology used throughout the module. Default factors for all parameters are provided in the control worksheet and may be selected by clicking the gray "Clear / Select All Defaults" at the top of the worksheet. These factors are drawn from the

Inventory of U.S. Greenhouse Gas Emissions and Sinks (U.S. EPA 2025) and are used to estimate emissions from industrial wastewater. 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.

Box 2: Wastewater Terminology

In highly organic wastewater streams, e.g., streams from food processing plants or pulp and paper plants, the available oxygen in the water is rapidly depleted as the organic matter decomposes. The organic content (sometimes known as “loading”) of these wastewater streams is expressed in terms of biochemical oxygen demand, or BOD. BOD represents the amount of oxygen taken up by the organic matter in the wastewater during decomposition. Alternatively, the chemical oxygen demand (COD) is often used to characterize industrial wastewater. COD refers to the amount of oxygen consumed during the oxidation of both organic matter and oxidizable *inorganic* matter. Under the same conditions, wastewater with a higher BOD or COD will produce more CH₄ than wastewater with a lower BOD/COD.

CH₄ from Municipal Wastewater

In the yellow cells for this sector on the control worksheet, enter total biochemical oxygen demand (BOD₅)¹ produced, the fraction of wastewater BOD₅ anaerobically digested, and the CH₄ emission factor for municipal wastewater emissions.

Direct N₂O from Municipal Wastewater

In the yellow cells for this sector on the control worksheet, enter the factor for non-consumption nitrogen², the fraction of your state population not on septic systems, and the direct wastewater treatment plant emissions per person per year.

N₂O from Biosolids

In the yellow cells for this sector on the control worksheet, enter the N₂O emission factor for biosolids (the solid portion of human sewage) and the fraction of nitrogen in protein (FRAC_{NPR}).

¹ BOD represents the amount of oxygen that would be required to completely consume the organic matter contained in the wastewater through aerobic decomposition processes (U.S. EPA 2025). A standardized measurement of BOD is the “5-day test” denoted as BOD₅.

² This factor represents the nitrogen loading occurring from wastewater going directly into the waste stream from residences (i.e. bathwater, laundry, and use of garbage disposals) as well as industrial wastewater that is not included in the four industries analyzed in this module.

Industrial Wastewater: Fruits and Vegetables, Red Meat, Poultry, and Pulp and Paper

In the yellow cells for these sectors on the control worksheet, enter the wastewater outflow of the particular industrial facility, the organic content of the wastewater, the fraction of COD anaerobically degraded, and the CH₄ emission factor.

Step (4) Complete Municipal Wastewater Worksheet

Click on the gray navigational arrow in step 4 of the control worksheet to complete sector worksheets and continue to the CH₄ from Municipal Wastewater worksheet. On this worksheet, the annual state population is entered into the blue cells as seen in Figure 3. Default data from U.S. Census (2023) is provided, if the “Select Default Data” button is selected.

Figure 3. Example of the Municipal Wastewater CH₄ Emissions Worksheet

Click here to find where these data are available.

To calculate methane emissions from municipal wastewater treatment, the total annual BOD₅ production in metric tons is multiplied by the fraction that is treated anaerobically and by the CH₄ produced per metric ton of BOD₅, converted to million metric tons carbon dioxide equivalent (MMTCo₂E). The methodology and factors used for these calculations are discussed in detail in the Wastewater Chapter of the User's Guide.

Continue to the Next Sheet

Select Default Data

Clear All Data

	State Population	Per Capita BOD ₅ (kg/day)	Days per Year	Unit Conversion (metric tons/kg)	Emission Factor (g CH ₄ /Gg BOD ₅)	WW BOD ₅ anaerobically digested (percent)	Emissions (metric tons CH ₄)	CH ₄ GWP (CO ₂ Eq.)	Unit Conversion (MMT/MT)	C/CO ₂	Emissions (MMTCE)	Emissions (MMTCo ₂ E)
1990	453,890	0.0900	365	0.001	0.60	12.78%	1,142.5	25	0.000001	0.27	0.008	0.030
1991	459,260	0.0900	365	0.001	0.60	12.78%	1,156.5	25	0.000001	0.27	0.008	0.031
1992	466,251	0.0900	365	0.001	0.60	12.78%	1,174.1	25	0.000001	0.27	0.008	0.031
1993	473,081	0.0900	365	0.001	0.60	12.78%	1,191.3	25	0.000001	0.27	0.008	0.031
1994	480,283	0.0900	365	0.001	0.60	12.78%	1,209.4	25	0.000001	0.27	0.008	0.031
1995	485,160	0.0900	365	0.001	0.60	12.78%	1,221.7	25	0.000001	0.27	0.008	0.031
1996	488,167	0.0900	365	0.001	0.60	12.78%	1,229.3	25	0.000001	0.27	0.008	0.031
1997	489,451	0.0900	365	0.001	0.60	12.78%	1,232.5	25	0.000001	0.27	0.008	0.031
1998	490,787	0.0900	365	0.001	0.60	12.78%	1,235.9	25	0.000001	0.27	0.008	0.031
1999	491,780	0.0900	365	0.001	0.60	12.78%	1,238.4	25	0.000001	0.27	0.008	0.031
2000	494,300	0.0900	365	0.001	0.60	12.78%	1,244.7	25	0.000001	0.27	0.008	0.031
2001	494,657	0.0900	365	0.001	0.60	12.78%	1,245.6	25	0.000001	0.27	0.008	0.031
2002	500,017	0.0900	365	0.001	0.60	12.78%	1,259.1	25	0.000001	0.27	0.009	0.031
2003	503,453	0.0900	365	0.001	0.60	12.78%	1,267.8	25	0.000001	0.27	0.009	0.032
2004	509,106	0.0900	365	0.001	0.60	12.78%	1,282.0	25	0.000001	0.27	0.009	0.032

Control Dataframe Dataframe Sum Municipal WW, CH₄ Municipal WW, N₂O, direct Municipal WW, N₂O, effluent Ind WW Fruit Ind WW Meat Ind WW Poi

The CH₄ emissions from municipal wastewater treatment are calculated by multiplying the state population by the total annual BOD₅ production in metric tons, by the fraction that is treated anaerobically, and by the CH₄ produced per metric ton of BOD₅ (i.e. the emission factor); the total is then converted to million metric tons carbon dioxide equivalent (MMTCo₂E). This calculation is shown in Equation 1.

Equation 1. CH₄ Emissions from Municipal Wastewater Treatment

$$\begin{aligned} \text{CH}_4 \text{ Emissions (MMTCO}_2\text{E)} = & \\ & \text{State Population} \times \text{BOD}_5 \text{ Production (kg/day)} \times 365 \text{ days/year} \times \\ & 0.001 \text{ (metric ton/kg)} \times \text{Fraction Treated Anaerobically} \times \text{Emission Factor (Gg CH}_4\text{/Gg BOD}_5\text{)} \times 10^{-6} \\ & \text{(MMT/metric ton)} \times 28 \text{ (GWP)} \end{aligned}$$

Click on the gray navigational arrow to estimate direct N₂O emissions from municipal wastewater treatment.

Step (5) Review Direct N₂O Emissions from Municipal Wastewater Treatment Worksheet

There is no required data for this worksheet because the annual state population was entered in Step (4). Direct N₂O emissions from municipal wastewater treatment are calculated by multiplying total population served, by the fraction of the population not using septic systems, by an N₂O emission factor per person per year, and then converting to MMTCO₂E as seen in Equation 2.

Equation 2. Direct N₂O Emissions from Municipal Wastewater Treatment

$$\begin{aligned} \text{Direct N}_2\text{O Emissions (MMTCO}_2\text{E)} = & \\ & \text{State Population} \times \text{Fraction of Population not on Septic (\%)} \times \\ & \text{Emission Factor (g N}_2\text{O/person/year)} \times 10^{-6} \text{ (metric ton/g)} \times \\ & 10^{-6} \text{ (MMT/metric ton)} \times 265 \text{ (GWP)} \end{aligned}$$

Click on the gray navigational arrow to estimate direct N₂O emissions from biosolids in municipal wastewater treatment.

Step (6) Complete Municipal Wastewater N₂O Emissions Worksheet

Municipal wastewater N₂O emissions from biosolids are calculated by multiplying the state population by the total annual protein consumption, by the nitrogen content of protein and fraction of nitrogen not consumed, and by an N₂O emission factor per metric ton of nitrogen treated, then subtracting direct emissions as well as the percentage of biosolids used as fertilizer, and finally converting to MMTCO₂E. Direct and biosolids N₂O emissions are then added to produce an estimate of total municipal wastewater treatment N₂O emissions. This calculation is shown below in Equation 3. Data on annual per capita protein consumption for the United States have been published by the United States EPA in Table A-251 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks (U.S. EPA 2025).

Equation 3. N₂O Emissions from Biosolids Municipal Wastewater Treatment

$$\begin{aligned} \text{N}_2\text{O Emissions (MMTCO}_2\text{E)} = & \\ & [\text{State Population} \times \text{Protein Consumption (kg/person/year)} \times \\ & \text{FRAC}_{\text{NPR}} \text{ (kg N/kg protein)} \times \text{Fraction of Nitrogen not Consumed} \\ & \text{0.001 (metric ton/kg)} - \text{Direct N Emissions (metric tons)}] \times \\ & [1 - \text{Percentage of Biosolids used as Fertilizer (\%)}] \times \\ & \text{Emission Factor (kg N}_2\text{O-N/kg sewage N produced)} \times \\ & 44/28 \text{ (kg N}_2\text{O /kg N)} \times 10^{-6} \text{ (MMT/metric ton)} \times 265 \text{ (GWP)} + \\ & \text{Direct N}_2\text{O Emissions} \end{aligned}$$

Figure 4. Example of the Municipal Wastewater N₂O Emissions Worksheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
6. Wyoming Municipal Wastewater Nitrous Oxide Emissions (formerly Human Sewage)																						
		Click here to find where these data are available. Municipal wastewater N₂O emissions from biosolids are calculated by multiplying the total annual protein consumption by the nitrogen content of protein and fraction of nitrogen not consumed, an N₂O emission factor per metric ton of nitrogen treated, subtracting direct emissions, converted to million metric tons carbon equivalent (MMTCE), and converted to million metric tons carbon dioxide equivalent (MMTCE). Direct and biosolids N₂O emissions are then added to produce an estimate of total municipal wastewater treatment N₂O emissions. The methodology and factors used for these calculations are discussed in detail in the Wastewater Chapter of the User's Guide. Sewage sludge is often applied to agricultural fields as fertilizer. Emissions from this use should be accounted under Agricultural Soil Management. The Agriculture Module of the SIT is designed to calculate emissions from sewage sludge applied to land, but to be consistent, users should enter the percentage of sewage sludge applied to agricultural soils in Column S so that emissions are not double-counted. Currently, there are no default data for this percentage. Continue to the Next Sheet Select Default Data Clear All Data																				
	State Population	Protein (kg/ person/ year)	Fraction N/kg protein	Fraction Non-Consumption N	Unit Conversion (metric tons/kg)	N in Domestic Wastewater (metric tons)	Direct N Emissions from Domestic Wastewater (metric tons)	Biosolids Available N (metric tons)	Percentage of Biosolids Used as Fertilizer	Emission Factor (kg N ₂ O-N/ kg sewage N-produced)												
1990	453,690	43.1	16%	1.75	0.001	5,475	1	5,474	x (1 -)	0.01												
1991	459,260	43.5	16%	1.75	0.001	5,589	1	5,588	x (1 -)	0.01												
1992	466,251	43.8	16%	1.75	0.001	5,806	1	5,805	x (1 -)	0.01												
1993	473,081	43.8	16%	1.75	0.001	5,806	1	5,805	x (1 -)	0.01												
1994	480,283	44.6	16%	1.75	0.001	5,992	1	5,991	x (1 -)	0.01												
1995	485,160	44.2	16%	1.75	0.001	6,004	1	6,003	x (1 -)	0.01												
1996	488,167	44.6	16%	1.75	0.001	6,091	1	6,090	x (1 -)	0.01												
1997	489,451	44.2	16%	1.75	0.001	6,057	1	6,056	x (1 -)	0.01												
1998	490,787	44.6	16%	1.75	0.001	6,122	1	6,122	x (1 -)	0.01												
1999	491,780	45.3	16%	1.75	0.001	6,235	1	6,235	x (1 -)	0.01												
2000	494,300	45.3	16%	1.75	0.001	6,268	1	6,267	x (1 -)	0.01												
2001	494,657	44.6	16%	1.75	0.001	6,172	1	6,171	x (1 -)	0.01												
2002	500,017	44.9	16%	1.75	0.001	6,290	1	6,289	x (1 -)	0.01												
2003	503,453	45.3	16%	1.75	0.001	6,385	1	6,383	x (1 -)	0.01												
2004	509,106	45.7	16%	1.75	0.001	6,508	1	6,507	x (1 -)	0.01												
2005	514,157	44.9	16%	1.75	0.001	6,468	1	6,467	x (1 -)	0.01												
	Control	Dataframe	Dataframe_Sum	Municipal WW, CH ₄	Municipal WW, N ₂ O, direct	Municipal WW, N ₂ O, effluent																

Sewage sludge is often applied to agricultural fields as fertilizer. Emissions from this use should be accounted for under Agricultural Soil Management. The Agriculture module of the SIT is designed to calculate emissions from sewage sludge applied to land, but to be consistent, users need to enter the percentage of sewage sludge applied to agricultural soils in the second column of orange cells in order to not double-count emissions, as shown in Figure 4. At this time, there is no default data for the percentage of biosolids used as fertilizer.

Click on the gray navigational arrow to estimate CH₄ emissions from the industrial wastewater sectors selected on the control worksheet.

Step (7) Complete Industrial Wastewater CH₄ – Fruits and Vegetables Worksheet

This worksheet calculates emissions from wastewater used for fruits and vegetables. Please enter the amount of fruits and vegetables processed in metric tons in the yellow cells, as shown in Figure 5.

Figure 5. Example of Industrial Wastewater CH₄ – Fruits and Vegetables Worksheet

7. Wyoming Industrial Wastewater Methane - Fruits and Vegetables

Click here to find where these data are available.

Emissions from treatment of industrial wastewater from fruit and vegetables is based annual metric tons produced and factored by the volume of wastewater produced per unit production, the average organic matter content of wastewater from those processes, a CH₄ emission factor, the percent treated anaerobically, converted to million metric tons carbon equivalent (MMTCE), and converted to million metric tons carbon dioxide equivalent (MMTCE₂E). The methodology and factors used for these calculations are discussed in detail in the Wastewater Chapter of the User's Guide.

Continue to the Next Sheet

Clear All Data

	Production Processed (metric tons)	WW Outflow (m ³ /metric ton)	Unit Conversion (L/m ³)	COD (g COD/L)	Emission Factor (g CH ₄ /g COD)	COD Degraded (percent)	Emissions (g CH ₄)	Unit Conversion (g/Tg)	Emissions (Tg or MMT CH ₄)	CH ₄ GWP (CO ₂ Eq)	C/CO ₂	Emissions (MMTCE)	Emissions (MMTCE ₂ E)
1990		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
1991		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
1992		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
1993		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
1994		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
1995		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
1996		5.6					-	1E-12	-	25	0.27	0.000	0.000
1997		5.6					-	1E-12	-	25	0.27	0.000	0.000
1998		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
1999		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
2000		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
2001		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
2002		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
2003		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
2004		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000
2005		5.6	1,000	5	0.25	5%	-	1E-12	-	25	0.27	0.000	0.000

Enter Production Processed

Control Dataframe Dataframe_Sum Municipal WW, CH₄ Municipal WW, N₂O, direct Municipal WW, N₂O, effluent Ind WW Fruit Ind WW Meat Ind WW Poultry ... (+)

Emissions from treatment of industrial wastewater from processing fruits and vegetables are based on annual production in metric tons, multiplied by the volume of wastewater produced per unit production, the average organic matter content of wastewater from those processes, the CH₄ emission factor, the percent treated anaerobically, and then converted to MMTCE₂E as shown in Equation 4.

Equation 4. CH₄ Emissions from Industrial Wastewater for Fruits and Vegetables

$$\begin{aligned} \text{CH}_4 \text{ Emissions (MMTCE}_2\text{E)} = & \\ & \text{Production Processed (Metric Tons)} \times \text{Wastewater Produced (m}^3\text{/metric ton)} \times 1,000 \text{ (L/m}^3\text{)} \times \\ & \text{Organic Matter Content (g COD/L)} \times \\ & \text{Emission Factor (g CH}_4\text{/g COD)} \times \text{Percent Treated Anaerobically (\%)} \times \\ & 10^{-12} \text{ (MMT/g)} \times 28 \text{ (GWP)} \end{aligned}$$

Step (8) Complete Industrial Wastewater CH₄ – Red Meat Worksheet

This worksheet calculates emissions from wastewater from red meat processing. In the pink cells, enter the amount of red meat processed in metric tons, as shown in Figure 6.

Figure 6. Example of Industrial Wastewater CH₄ – Red Meat Worksheet

8. Wyoming Industrial Wastewater Methane - Red Meat																								
Emissions from treatment of industrial wastewater from red meat is based annual metric tons produced and factored by the volume of wastewater produced per unit production, the average organic matter content of wastewater from those processes, a CH ₄ emission factor, the percent treated anaerobically, converted to million metric tons carbon equivalent (MMTCE), and converted to million metric tons carbon dioxide equivalent (MMTCE). The methodology and factors used for these calculations are discussed in detail in the Wastewater Chapter of the User's Guide. USDA default data are unavailable for the following states: CT, DC, ME, MA, NH, RI, and VT.																								
Production Processed (metric tons)	WW Outflow (m ³ /metric ton)	Unit Conversion (L/m ³)	COD (g COD/L)	Emission Factor (g CH ₄ /g COD)	COD Degraded (percent)	Emissions (g CH ₄)	Unit Conversion (g/Tg)	Emissions (Tg or MMT CH ₄)	CH ₄ GWP (CO ₂ Eq.)	C/CO ₂	Emissions (MMTCE)													
1990	2,041.20	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	5,454,444	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1991	1,814.40	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	4,848,394	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1992	1,950.48	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	5,212,024	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1993	2,086.56	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	5,575,653	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1994	2,222.64	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	5,939,283	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1995	2,540.16	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	6,787,752	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1996	2,494.80	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	6,666,542	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1997	2,268.00	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	6,060,493	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1998	2,449.44	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	6,545,332	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
1999	2,540.16	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	6,787,752	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
2000	2,268.00	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	6,060,493	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
2001	2,086.56	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	5,575,653	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
2002	2,585.52	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	6,908,962	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
2003	2,993.76	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	7,999,851	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
2004	3,129.84	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	8,363,480	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=
2005	2,948.40	x	8	x	1,000	x	4.1	x	0.25	x	33%	=	7,878,641	x	1E-12	=	0.00	x	25	x	0.27	=	0.000	=

Control Dataframe Dataframe_Sum Municipal WW, CH₄ Municipal WW, N₂O, direct Municipal WW, N₂O, effluent Ind WW Fruit Ind WW Meat

Emissions from treatment of industrial wastewater from red meat are based on annual production in metric tons, multiplied by the volume of wastewater produced per unit production, the average organic matter content of wastewater from those processes, the CH₄ emission factor, the percent treated anaerobically, and then converted to MMTCE as shown in Equation 5. Default data on red meat production are available from USDA (2026).

Equation 5. CH₄ Emissions from Industrial Wastewater for Red Meat

$$\begin{aligned}
 \text{CH}_4 \text{ Emissions (MMTCE)} = & \\
 & \text{Production Processed (Metric Tons)} \times \text{Wastewater Produced (m}^3\text{/metric ton)} \times 1,000 \text{ (L/m}^3\text{)} \times \\
 & \text{Organic Matter Content (g COD/L)} \times \\
 & \text{Emission Factor (g CH}_4\text{/g COD)} \times \text{Percent Treated Anaerobically (\%)} \times \\
 & 10^{-12} \text{ (MMT/g)} \times 28 \text{ (GWP)}
 \end{aligned}$$

Step (9) Complete Industrial Wastewater CH₄ – Poultry Worksheet

This worksheet calculates emissions from wastewater used for poultry. The required input is amount of production processed in metric tons in the purple cells, as shown in Figure 7.

Figure 7. Example of Industrial Wastewater CH₄ - Poultry Worksheet

9. Wyoming Industrial Wastewater Methane - Poultry

Click here to find where these data are available.

Emissions from treatment of industrial wastewater from poultry is based annual metric tons produced and factored by the volume of wastewater produced per unit production, the average organic matter content of wastewater from those processes, a CH₄ emission factor, the percent treated anaerobically, converted to million metric tons carbon equivalent (MMTCE), and converted to million metric tons carbon dioxide equivalent (MMTCE_{2E}). The methodology and factors used for these calculations are discussed in detail in the Wastewater Chapter of the User's Guide.

Continue to the Next Sheet

Clear All Data

	Production Processed (metric tons)	WW Outflow (m ³ /metric ton)	Unit Conversion (L/m ³)	COD (g COD/L)	Emission Factor (g CH ₄ /g COD)	COD Degraded (percent)	Emissions (g CH ₄)	Unit Conversion (g/Tg)	Emissions (Tg or MMT CH ₄)	CH ₄ GWP (CO ₂ Eq.)	C/CO ₂	Emissions (MMTCE)	Emissions (MMTCE _{2E})
1990		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
1991		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
1992		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
1993		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
1994		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
1995		17					-	1E-12	-	25	0.27	0.000	0.000
1996		17					-	1E-12	-	25	0.27	0.000	0.000
1997		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
1998		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
1999		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
2000		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
2001		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
2002		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
2003		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
2004		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000
2005		17	1,000	4.1	0.25	25.0%	-	1E-12	-	25	0.27	0.000	0.000

Enter Production Processed

... Dataframe Dataframe_Sum Municipal WW, CH4 Municipal WW, N2O, direct Municipal WW, N2O, effluent Ind WW Fruit Ind WW Meat Ind WW Poultry

Equation 6 shows that emissions from treatment of industrial wastewater from poultry are based on annual production in metric tons, multiplied by the volume of wastewater produced per unit production, the average organic matter content of wastewater from those processes, the CH₄ emission factor, the percent treated anaerobically, with the total then converted to MMTCE_{2E}.

Equation 6. CH₄ Emissions from Industrial Wastewater for Poultry

$$\begin{aligned}
 \text{CH}_4 \text{ Emissions (MMTCE)} = & \\
 & \text{Production Processed (Metric Tons)} \times \text{Wastewater Produced (m}^3\text{/metric ton)} \times 1,000 \text{ (L/m}^3\text{)} \times \\
 & \text{Organic Matter Content (g COD/L)} \times \\
 & \text{Emission Factor (g CH}_4\text{/g COD)} \times \text{Percent Treated Anaerobically (\%)} \times \\
 & 10^{-12} \text{ (MMT/g)} \times 28 \text{ (GWP)}
 \end{aligned}$$

Step (10) Complete Industrial Wastewater CH₄ – Pulp and Paper Worksheet

This worksheet calculates emissions from wastewater used for pulp and paper. The required data (in the green cells) is the amount in metric tons of (1) woodpulp (marketed) and (2) paper and paperboard processed, as shown in Figure 8.

Figure 8. Example of Industrial Wastewater CH₄ - Pulp and Paper Worksheet

10. Wyoming Industrial Wastewater Methane – Pulp & Paper

Click here to find where these data are available.

Emissions from treatment of industrial wastewater from pulp and paper production is based annual metric tons produced and factored by the volume of wastewater produced per unit production, the average organic matter content of wastewater from those processes, a CH₄ emission factor, the percent treated anaerobically, converted to million metric tons carbon equivalent (MMTCE), and converted to million metric tons carbon dioxide equivalent (MMTCE₂E). The methodology and factors used for these calculations are detailed in the Wastewater Chapter of the User's Guide.

Continue to the Next Sheet

Clear All Data

Year	Production Processed (metric tons)	WW Outflow (m ³ /metric ton)	Unit Conversion (L/m ³)	BOD Degraded (g BOD / L)	Emission Factor (g CH ₄ /g BOD)	TA (percent)	Emissions (g CH ₄)	Unit Conversion (g/Tg)	Emissions (Tg or MMT CH ₄)	CH ₄ GWP (CO ₂ Eq)	C/CO ₂	Emissions (MMTCE)
1990	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1991	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1992	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1993	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1994	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1995	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1996	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1997	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1998	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
1999	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
2000	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
2001	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
2002	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
2003	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
2004	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0
2005	() + ()	85	1,000	0.4	0.6	10.3%	-	1E-12	-	25	0.27	0.0

Enter Production Processed

... Dataframe_Sum Municipal WW, CH₄ Municipal WW, N₂O, direct Municipal WW, N₂O, effluent Ind WW Fruit Ind WW Meat Ind WW Poultry Ind WW P&P Summ ...

As shown in Equation 7, emissions from treatment of industrial wastewater from pulp and paper are based on annual woodpulp (marketed), paper, and paperboard produced in metric tons, multiplied by the volume of wastewater produced per unit production, the average organic matter content of wastewater from those processes, the CH₄ emission factor, and the percent treated anaerobically. The total emissions are then converted to MMTCE₂E.

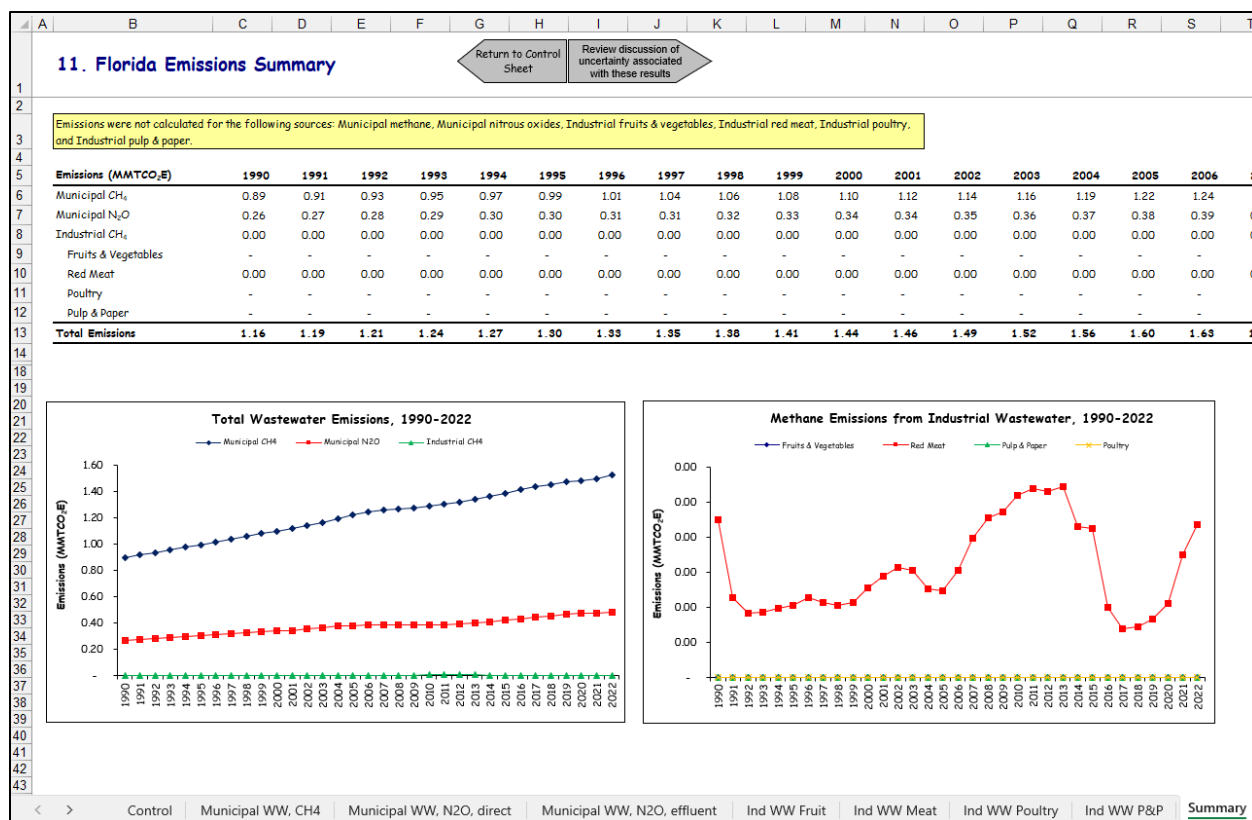
Equation 7. CH₄ Emissions from Industrial Wastewater for Pulp and Paper

$$\begin{aligned}
 \text{CH}_4 \text{ Emissions (MMTCE}_2\text{E)} = & \\
 & [\text{Production Processed (Marketed) Woodpulp (Metric Tons) + Production Processed Paper \& Paperboard (Metric Tons)}] \times \text{Wastewater Produced (m}^3\text{/metric ton)} \times 1,000 \text{ (L/m}^3\text{)} \times \text{Organic Matter} \\
 & \text{Content (g BOD/L)} \times \\
 & \text{Emission Factor (g CH}_4\text{/g BOD)} \times \text{Percent Treated Anaerobically (\%)} \times \\
 & 10^{-12} \text{ (MMT/g)} \times 28 \text{ (GWP)}
 \end{aligned}$$

Step (11) Review Summary Information

The steps above provide estimates of total emissions from wastewater. The information from the control worksheet and data entry worksheets is collected on the summary worksheet, which displays results in MMTCE₂E. Figure 9 shows the summary worksheet that sums the emissions from all sectors in the Wastewater module. In addition, the results are displayed in graphical format at the bottom of the summary worksheet.

Figure 9. Example of the Emissions Summary Worksheet in the Wastewater Module



1.3 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.

1.4 REFERENCES

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