

# WASTE SECTOR INVENTORY



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## ABBREVIATIONS AND ACRONYMS

BOD	Biochemical Oxygen Demand
CH <sub>4</sub>	Methane
CO <sub>2</sub>	Carbon dioxide
DEPC	Department of Environmental Protection and Conservation
DOCC	Department of Climate Change
DOC	Degradable Organic Carbon
DWR	Department of Water Resources
FOD	First Order Decay
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
J-PRISM	Japanese Technical Cooperation Project for Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries
MCF	Methane Correction Factor
MSW	Municipal Solid Waste
N <sub>2</sub> O	Nitrous Oxide
NMVOCs	Non-methane volatile organic compounds
OX	Oxidation Factor
PVCC	Port Vila City Council
PWD	Public Works Department
QA/QC	Quality Assurance/Quality Control
RTI	Right to Information
SWD	Solid Waste Disposal

## 4.1: WASTE OVERVIEW

### **4.1.1: CATEGORY OVERVIEW**

The waste sector in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories provides methodological guidance for estimation of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) emissions from the following waste categories (See Figure A4.1 in Annex):

- ❖ Solid Waste Disposal (SWD)
- ❖ Biological treatment for solid waste
- ❖ Incineration and open burning of waste
- ❖ Wastewater treatment and discharge

Usually, CH<sub>4</sub> emissions from Solid Waste Disposal sites (SWDS) are the largest source of greenhouse gas emissions within the waste sector. Incineration and open burning of waste having fossil carbon such as plastics are major sources of CO<sub>2</sub> emissions under the waste sector. In SWDS, wastewater treatment and burning of non-fossil waste, CO<sub>2</sub> is also produced. However, the CO<sub>2</sub> produced is of biogenic origin hence it is not recommended to be reported in this sector<sup>1</sup>. The N<sub>2</sub>O oxide is produced in most of the treatments addressed in the waste sector. It is significant in various ways depending mostly on conditions and treatment type.

Non-methane volatile organic compounds (NMVOCs) such as nitrogen oxide (NO<sub>x</sub>), carbon monoxide (CO) and ammonia (NH<sub>3</sub>) are also products from waste and wastewater treatment and discharge. Nonetheless, the waste volume does not provide specific methodologies for the estimation of emissions from these gases. In general, indirect N<sub>2</sub>O produced from NMVOCs within the waste sector is expected to be insignificant (Pipatti & Svardal, 2006).

Solid Waste Disposal on land (excluding burning of waste) and Domestic wastewater treatment and discharge occurs in Vanuatu. Hence, these are the two waste categories that will be covered in this manual.

### **4.1.2: SOLID WASTE DISPOSAL (SWD) ON LAND AND DOMESTIC WASTEWATER IN VANUATU**

The waste sector in Vanuatu encompasses of solid waste and wastewater. The main gases in this sector comprise mainly of methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) emissions estimated from the two categories, Solid waste Management and Disposal (excluding biological waste) and Domestic and Commercial wastewater (no industrial wastewater generation) (Ministry of Climate Change, 2020).

In solid waste management and disposal, the key source of methane emissions in Vanuatu is mostly from anaerobic decomposition of wastes that are discarded at Bouffa landfill sites in Port Vila,

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<sup>1</sup> CO<sub>2</sub> emissions of biogenic origin are either covered by the methodologies and reported as carbon stock change in the AFOLU Sector, or do not need to be accounted for because the corresponding CO<sub>2</sub> uptake by vegetation is not reported in the inventory (e.g., annual crops).

Luganville and Lenakel SWDs. SWD constitutes to a great amount of total greenhouse gas (GHG) emissions in Vanuatu from the waste sector itself. The GHG emission from this sector is a major concern for the country. The common practice in the country of municipal solid waste (MSW) disposal comprises of disposal on land (collected and disposes on landfills), open backyard dumpsite, and disposal on unused land. SWD in urban areas poses many hazards compared to scattered waste in rural areas. The reason being high urban population produces a higher per capita MSW where the generation of organic fraction is relatively high. On the other hand, the shallow waste depths of disposal do not induce anaerobic conditions. These allows for lower emissions of methane in the rural areas in Vanuatu (MOCC, 2021)

The domestic wastewater in Vanuatu is greatly decentralized focusing on privately managed households and commercial septic tanks for collecting human wastes. The by-product of sludge and wastewater are produced from the waste decomposition process. Over time, residual sludge is extracted by private services through tankers and is disposed at allocated waste sites or the sea. The major GHG emissions from domestic wastewater include CH<sub>4</sub> and N<sub>2</sub>O emissions. Reports have stated that though GHG emissions from wastewater may not be relevant in Vanuatu, the emissions are posing environmental hazards by increasing in time. Moreover, Tourism sector is a major contributor to the country's economy hence the waste sector may negatively impact the tourism sector in Vanuatu (Ministry of Climate Change, 2020).



## 4.2: REFERENCE MANUAL

### 4.2.1: DATA COLLECTION

#### 4.2.1.1: SOLID WASTE DISPOSAL ON LAND

The basic activity data requirements needed for First Order Decay (FOD) for Solid Waste Disposal on Land in Vanuatu comprises of:

- The **total population** and **GDP** for the period of 1950 to 2022 to estimate CH<sub>4</sub>. The activity data can be actual or modelled.
- **Waste generation per capita** (kg/cap/year). If not available, use IPCC default value for Caribbean.
- **Waste Composition** (If no country-specific data is available, break the total waste diverted to SWDs into composition with the use of default IPCC default for Oceania). If country-specific data are available, use either the *waste composition* or a *bulk waste* approach. The *waste composition* approach is a great initiative if the waste management practices changes.
- The **types of solid waste management sites** in Vanuatu with the **distribution (%)** of waste among these sites.

**Table 1: Key Parameters for Activity Data (AD) in Solid Waste Disposal on Land**

Activity Data	Key Parameters	Units
<b>Key Parameters for AD-1</b>		
General Population and Climate Data	<ul style="list-style-type: none"> <li>❖ The country's population</li> <li>❖ Total population served by waste management services</li> <li>❖ The mean average temperature</li> <li>❖ Climate Zone: Tropical Wet for Vanuatu</li> </ul>	<p>In millions In millions</p> <p>In Degree Celsius (°C)</p>
Characteristics of the solid waste disposal sites in Vanuatu, the fraction of waste managed:	<ul style="list-style-type: none"> <li>❖ Anaerobically</li> <li>❖ Semi-aerobically</li> <li>❖ Deep sites and/or high-water table</li> <li>❖ Shallow Sites</li> <li>❖ Uncategorized</li> </ul>	
<b>Key Parameters for AD-2</b>		
Information on total waste generation by population	<ul style="list-style-type: none"> <li>❖ Total MSW (municipal solid waste) generation</li> <li>❖ Does MSW include industrial waste generated? (Yes, or no?) If <i>No</i>, estimate total industrial waste generated</li> <li>❖ Is sludge deposited in SWDS? If <i>yes</i>, how much sludge was deposited?</li> </ul>	<p>(tonne/capita/yr.)</p> <p>In kilo tonnes (kt).</p> <p>In kilo tonnes (Kt)</p> <p>In kilo tonnes (kt)</p>

	<ul style="list-style-type: none"> <li>❖ Total clinical waste (generally not included in MSW)</li> <li>❖ Total hazardous waste (generally not included in MSW)</li> </ul>	In kilo tonnes (kt)
<b>Key Parameters for AD-3</b>		
Waste flows: fraction of total MSW collected (should total to 100%)	<ul style="list-style-type: none"> <li>❖ % of the amount collected that goes to solid waste disposal sites (SWDS).</li> <li>❖ % of the amount collected that fraction sent to composting.</li> <li>❖ % of the amount collected that fraction is open burned.</li> <li>❖ % of the amount collected that in incinerated</li> <li>❖ % of the amount collected that sent to recycling.</li> </ul>	
Waste flows: fraction of MSW not collected (should total up to 100%)	<ul style="list-style-type: none"> <li>❖ % of the amount not collected waste that is sent to composting.</li> <li>❖ % of the amount not collected waste that is open burned</li> <li>❖ % of the amount not collected waste that is sent to recycling.</li> </ul>	
<b>Key Parameters for AD-4</b>		
Composition of waste in Vanuatu (should total to 100%)	<ul style="list-style-type: none"> <li>❖ % Food</li> <li>❖ % Garden</li> <li>❖ % Paper/Cardboard</li> <li>❖ % Wood</li> <li>❖ % Textiles</li> <li>❖ % Rubber/leather, etc</li> </ul> <p>If data is not available, use IPCC default values for Caribbean.</p>	
Management practices at Landfills	<ul style="list-style-type: none"> <li>❖ Are you recovering landfill gas? (Yes/No) If yes, amount of landfill gas recovered)</li> <li>❖ How is landfill gas recovery estimated?</li> </ul>	Landfill gas unit in kt

#### **4.2.1.2: DOMESTIC WASTEWATER**

##### **4.2.1.2.1: METHANE (CH<sub>4</sub>) EMISSIONS IN DOMESTIC WASTEWATER**

The activity data for Domestic Wastewater in Vanuatu to estimate methane (CH<sub>4</sub>) is the total amount of organically degradable material in wastewater (TOW). To calculate TOW, the required data should be gathered:

- The country’s population
- Country-specific per capita Biological Oxygen Demand (BOD), (g/person/day). If unavailable, use default value for region “Latin America”, being the closest to Caribbean (*Refer to Annex Table A4.1*).

- 0.001 = To convert from BOD (grams) to BOD (kilograms)
- The correction factor (I) for additional industrial BOD that is discharged into sewers. (Note that for collected the default value is 1.25, for uncollected the default is 1.00).

(See 2006 IPCC Guidelines, Volume 5 Chapter 6, Wastewater treatment and Discharge, Section 6.2.2.3 for the Choice of Activity Data and Equation 6.3).

**Table 2: Additional activity data required to estimate methane (CH<sub>4</sub>) emissions in domestic water.**

ACTIVITY DATA	NOTES	UNITS
Total Organic Component removed as sludge		kg BOD/yr.
Fraction of Population in Income group (i)	Income groups in Vanuatu <ul style="list-style-type: none"> <li>• High Income Group</li> <li>• Medium Income Group</li> <li>• Low Income Group</li> </ul>	In millions
The degree of utilization of treatment/discharge pathway or system, j, for each income group fraction	Vanuatu lacks proper sewage and wastewater treatment systems. Waste is disposed via: <ul style="list-style-type: none"> <li>• Illegal stormwater connections</li> <li>• Direct discharge to poor designed/maintained septic systems that leach contaminants into coastal and freshwater system</li> </ul>	
The Emission factor	Use default for values for B <sub>o</sub> and MCF <sub>j</sub> to calculate EF from equation. $EF_j = B_o \cdot MCF_j$ (See Annex Table A4.2 & Table A4.3)	kg CH <sub>4</sub> /kg BOD
The amount of CH <sub>4</sub> recovered		kg CH <sub>4</sub> /yr.

(See 2006 IPCC Guidelines, Volume 5 Chapter 6, Wastewater treatment and Discharge, Section 6.2.2.1 for the Domestic wastewater Choice of Method and Equation 6.1).

#### 4.2.1.2.2: INDIRECT NITROUS OXIDE (N<sub>2</sub>O) EMISSIONS IN DOMESTIC WASTEWATER

At present, Vanuatu lacks treatment plants. When treatment plants are established in the future, Direct N<sub>2</sub>O emissions can be calculated utilizing the following activity data requirements:

- The total amount of nitrogen in wastewater effluent (N/yr.)
- Country's population (millions)
- Protein consumption (annual per capita protein consumption (kg/person/year.)).
- Fraction of nitrogen in protein, default = 0.16 (N/kg protein)
- Default factor for non-consumed protein added to the wastewater. (See Annex Table A4.4 for  $F_{NON-COM}$ )
- Default factor for industrial and commercial co-discharged protein into the sewer system. (See Annex Table A4.4 for  $F_{IND-COM}$ )
- Nitrogen removed with sludge (default = zero), kg N/yr.

(See 2006 IPCC Guidelines, Volume 5 Chapter 6, Wastewater treatment and Discharge, Section 6.3.1.3 for the Domestic wastewater, Choice of Activity Data and Equation 6.8).

#### **4.2.2. DATA SOURCES (DEPARTMENTS, STAKEHOLDERS)**

The country's specific data can be collected from the following departments/stakeholders/organization:

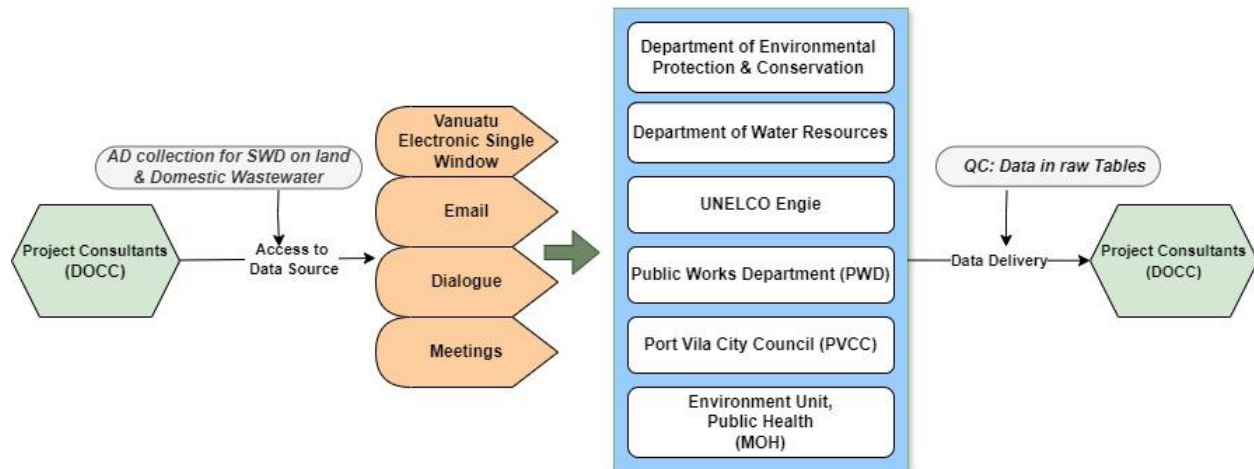
- Department of Environmental Protection and Conservation (DEPC)
- Department of Water Resources (DWR)
- Port Vila City Council (PVCC)
- Environment Unit, Public Health at the Ministry of Health
- Department of Climate Change (DOCC)
- UNELCO Engie
- Public Works Department (PWD)

Once a data set is selected, a more detailed formal specification of data should be created. A clear clarity of data requirements will allow data that is requested from the different departments/organizations to be delivered upon expectation (Goodwin, Woodfield, Ibnoaf, Koch, & Yan, 2006). The specification should include details such as:

- Definition of the data set (e.g., time series, sectors and sub-sector detail, national coverage, requirements for uncertainty data, emission factors and/or activity data units).
- The format (e.g., spreadsheet) and structure (e.g., what different tables are needed and their structure) of the data set,
- Description of any assumptions made regarding national coverage, the sectors included, representative year, technology/management level, and emission factors or uncertainty parameters.

- Identification of the routines and timescales for data collection activities (e.g., how often is the data set updated and what elements are updated).
- Reference to documentation and QA/QC procedures.
- Contact name and department/ organization.
- Date of availability.

**Flow chart 4.1: Details of access to data sources by Department of Climate Change (DOCC)**



**Table 3 Detailed Information of Collecting Data from Sources.**

Department/ Organization	Roles and Responsibility	Dates	Relevant Governing Arrangement	Contact Person	Comments
Department of Water Resources (DWR)	To provide information on measurements and analysis of BOD, COD, and activity data on Domestic wastewater operations (collection and disposal of waste) in rural areas in Vanuatu.	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided between DWR and DOCC	Department of water resources Tel: (678)22423/3343 5 Email: <a href="mailto:esteitoka@vanuatu.gov.vu">esteitoka@vanuatu.gov.vu</a>	For significant information and data collection, DOCC needs to send a prompt letter to DWR two months prior.  A follow-up email or call is crucial as well.
Department of Environmental Protection & Conservation (DEPC)	To provide relevant information on activity data and	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided	Environment Unit	For significant information and data collection, DOCC needs to

	key parameters on SWD on land.		between DEPC and DOCC	<p>Name: Ionie Bolenga (Principal Officer on Waste Management and Pollution Control) Email: <a href="mailto:ibolenga@vanuatu.gov.vu">ibolenga@vanuatu.gov.vu</a></p> <p>Name: Annabelle Alilee (Pollution Control Officer) Email: <a href="mailto:aalilee@vanuatu.gov.vu">aalilee@vanuatu.gov.vu</a></p>	<p>send a prompt letter to DEPC two months prior.</p> <p>A follow-up email or call is crucial as well.</p>
Public Works Department (PWD)	To provide relevant information and data on the operation (collection and disposal) of domestic wastewater in Urban and sub-urban areas.	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided between PWD and DOCC	<p>Public Works Department</p> <p>Email: <a href="mailto:pwdheadoffice@vanuatu.gov.vu">pwdheadoffice@vanuatu.gov.vu</a> Tel: 33460 or 22790</p>	<p>For significant information and data collection, DOCC needs to send a prompt letter to PWD two months prior.</p> <p>A follow-up email or call is crucial as well.</p>
UNELCO Engie	To provide relevant information and data on the operation (collection and disposal) of domestic wastewater in Urban and sub-urban areas.	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided between UNELCO and DOCC	<p>UNELCO ENGIE</p> <p>Email: <a href="mailto:unelco@engie.com">unelco@engie.com</a> Tel: 26000</p>	<p>For significant information and data collection, DOCC needs to send a prompt letter to UNELCO two months prior.</p> <p>A follow-up email or call is crucial as well.</p>
Port Vila City Council (PVCC)	To provide relevant information and	First week of April– First	A Memorandum of understanding or Right to		For significant information and data collection,



	data on the operation of SWD on land and domestic wastewater management within its jurisdiction.	week of May every year	Information (RTI) can be provided between PVCC and DOCC		DOCC needs to send a prompt letter to PVCC two months prior.  A follow-up email or call is crucial as well.
Department of Climate Change (DOCC)	DOCC is responsible to send a formal letter requesting relevant data and information on SWD on land and Domestic Wastewater to the Environmental Protection and Conservation, The Department of Water Resources, Public Works Department, UNELCO, Port Vila City Council, and the Environment Unit under the Ministry of Climate Change.	February – March every year	Provide a Memorandum of understanding or Right to Information (RTI) to the Environmental Protection and Conservation, The Department of Water Resources, Public Works Department, UNELCO, Port Vila City Council, and the Environment Unit under the Ministry of Climate Change	Name: Nelson Kalo Director of Climate Change Email: <a href="mailto:nekalo@vanuatu.gov.vu">nekalo@vanuatu.gov.vu</a>	DOCC is responsible for doing a follow-up to the departments or organization for the required data to be delivered upon schedule.

### 4.2.3. DATA ASSUMPTIONS

#### Solid Waste Disposal

The main considerations and assumptions made are provided for both bulk and waste composition options to estimate methane emissions on Solid waste disposal on land in Vanuatu (See 2006 IPCC Guidelines, Volume 5 Chapter 3 Solid Waste Disposal, Section 3.2.3, Choice for emission factors and parameters under Half-life).

- The default assumption for the time delay is that the reaction starts on the first of January in the year of deposition, which is equivalent to an average delay time of six months before decay to methane commences (“Delay time = 6”). It is best to assume an average delay time of six months. If a value greater than six months is chosen, evidence to support this must be provided.
- Waste composition (especially the organic component) is one of the main factors influencing both the amount and the timing of CH<sub>4</sub> production.
- Moisture content of a SWDS is an essential element for anaerobic decomposition and CH<sub>4</sub> generation. A simplified method assumes that the moisture content of a SWDS is proportional to the mean annual precipitation (MAP) in the location of the SWDS (Pelt *et al.*, 1998; U.S. EPA, 1998; Environment Canada, 2003) or to the ratio of MAP and potential evapotranspiration (PET).
- The extent to which ambient air temperatures influence the temperature of the SWDS and gas generation rates depends mainly on the degree of waste management and the depth of SWDS.
- Waste in shallow open dumps generally decomposes aerobically and produces little CH<sub>4</sub>, and the emissions decline in shorter time than the anaerobic conditions. Managed (and deep unmanaged) SWDS creates anaerobic conditions.

#### Domestic Wastewater

The emission factor for N<sub>2</sub>O emissions is based on limited field especially on specific assumptions considering the occurrence of denitrification and nitrification activities in rivers and estuaries (See 2006 IPCC Guidelines, Volume 5 Chapter 6, Wastewater treatment and Discharge, Section 6.3.1.2, Choice for emission factors and Section 6.3.4, QA/QC, Completeness, Reporting and Documentation). The assumptions provided are:

- All nitrogen is discharged with the effluent.
- N<sub>2</sub>O production in rivers and estuaries is directly related to nitrification and denitrification and, thus, to the nitrogen that is discharged into the river. (See Volume 4, Table 11.3 of Section 11.2.2 in Chapter 11, N<sub>2</sub>O Emissions from Managed Soils, and CO<sub>2</sub> Emissions from Lime and Urea Application).



- All nitrogen associated with consumption and domestic use, as well as nitrogen from co-discharged industrial wastewater, will eventually enter a waterway. As such, this estimate can be seen as a conservative estimate and covers the entire source associated with domestic wastewater use.

## 4.3. CALCULATING GREENHOUSE GAS EMISSIONS FROM WASTE SECTOR

### SOLID WASTE DISPOSAL (SWD)

#### 4.3.1 METHODOLOGY CHOICE FOR SOLID WASTE DISPOSAL(SWD)

Figure 1: Decision Tree Utilized for Method Selection in Estimating CH<sub>4</sub> Emissions from Solid Waste Disposal Sites in Vanuatu

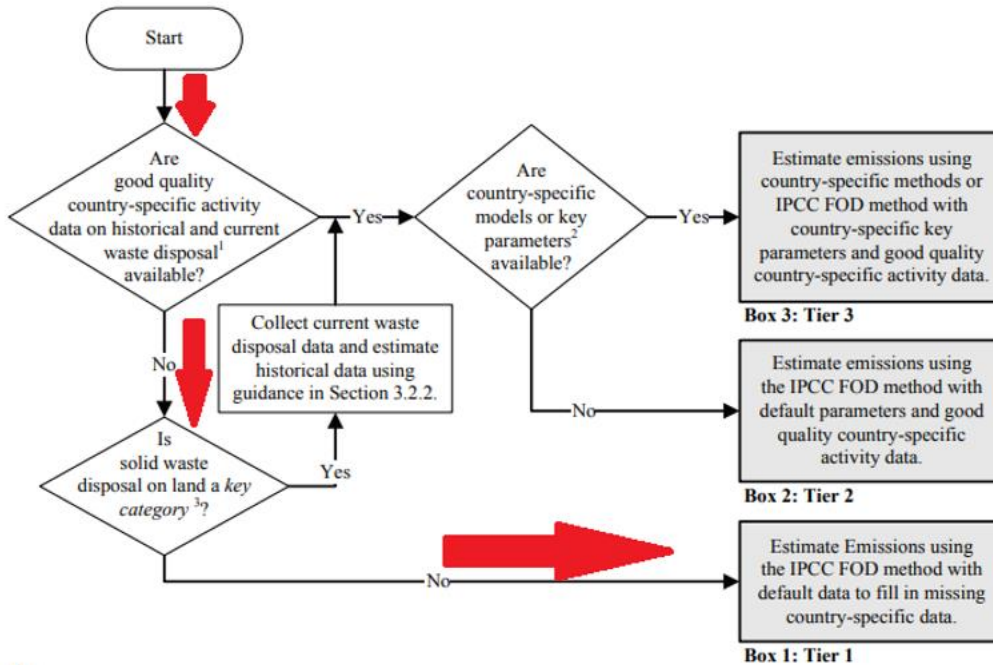


Figure 4.1: (See 2006 IPCC Guidelines, Vol.5, Figure 3.1)

Note: Due to the national circumstances (lack of resources) Vanuatu does not have yet reliable country-specific emission factors and parameters and therefore, and is therefore applying the default parameters and Tier 1 methods to estimate emissions from the category 4A – Solid Waste Disposal and its subcategories 4.A.1 Managed disposal sites, 4.A.2 Unmanaged Disposal Sites and 4.A.3 Uncategorized Waste Disposal.

## EQUATIONS USED

### 1. Determine the Amount of Decomposed DOC Deposited in the SWDs Each Year

#### Step 1: FOD (first-order decay)

##### 1.1 Estimating the mass of waste available for decomposition (DDOC<sub>m</sub>)

###### Equation 1

EQUATION 3.2  
DECOMPOSABLE DOC WASTE DISPOSAL  
$$DDOC_m = W \times DOC \times DOC_f \times MCF$$

Where:

- **W** = Amount of waste (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.2)
- **DOC** = Degradable organic carbon in the waste (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.2).
- **DOC<sub>f</sub>** = Fraction of DOC that can decompose anaerobically (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.2)
- **MCF** = Amount that will decompose anaerobically (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.2).
- **DOC<sub>f</sub>** uses a default value of 0.5 (See IPCC Guidelines, Vol.5 Pg. 27, Table 3.5).

##### 1.2 Determining the time series of waste decomposing

###### Equation 2

EQUATION 3.4  
DDOC<sub>m</sub> ACCUMULATION IN THE SWDS AT THE END OF THE YEAR T  
$$DDOC_{maT} = DDOC_{mdT} + (DDOC_{maT-1} \times e^{-k})$$

Where:

- **DDOC<sub>maT</sub>** = Mass of decomposable DOC accumulated at the end of the year. (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.4)
- **DDOC<sub>mdT</sub>** = Amount of DOC deposited in the current year (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.4)
- **(DDOC<sub>maT-1</sub> x e<sup>-k</sup>)** = Amount of degradable waste accumulated from the previous year that has not yet decomposed (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.4)

### Equation 3

#### EQUATION 3.5

$$\text{DDOC}_{\text{m decompT}} = \text{DDOC}_{\text{maT-1}} \times (1 - e^{-k})$$

Where:

- **T** = Inventory year (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.5)
- **DDOC<sub>maT</sub>** = DDOCm accumulated in the SWDS at the end of year T, Gg (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.5)
- **DDOC<sub>maT-1</sub>** = DDOCm accumulated in the SWDS at the end of the year (T-1), Gg (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.5)
- **DDOC<sub>mdT</sub>** = DDOCm deposited into the SWDS in year T, Gg (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.5)
- **DDOCm decompT** = DDOCm decomposed in the SWDS in year T, Gg (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.5)
- **k** = reaction constant,  $k = \ln(2)/t_{1/2}$  (y-1) (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.5)
- **t<sub>1/2</sub>** = half-life time (y) (See 2006 IPCC Guidelines, Vol.5, Pg. 9, EQUATION 3.5)

## **2. Determine Methane Generated as a Result of Decomposition Each Year**

### **Step 2: Converting DDOC to Methane Generated**

#### Equation 4

#### EQUATION 3.6

CH<sub>4</sub> GENERATED FROM DECAYED DDOC<sub>m</sub>

$$\text{CH}_4 \text{ generated} = \text{DDOC}_{\text{m decompT}} \times F \times 16/12,$$

Where:

- **CH<sub>4</sub> generated** = Amount of CH<sub>4</sub> generated from decomposable material (See 2006 IPCC Guidelines, Vol.5, Pg. 10, EQUATION 3.6)
- **DDOC<sub>m decompT</sub>** = DDOCm decomposed in year T, Gg (See 2006 IPCC Guidelines, Vol.5, Pg. 10, EQUATION 3.6).
- **F** = Fraction of CH<sub>4</sub>, by volume, in generated landfill gas (fraction) (See 2006 IPCC Guidelines, Vol.5, Pg. 10, EQUATION 3.6).
- **16/12** = molecular weight ratio CH<sub>4</sub>/C (ratio) (See 2006 IPCC Guidelines, Vol.5, Pg. 10, EQUATION 3.6).

- The **default value of (F)** = 0.5 (See 2006 IPCC Guideline, Vol.5, Pg.27, Table 3.1)

### 3. Determine Methane Emissions

#### Step 3: Converting Methane to Methane Emissions

##### Equation 5

###### EQUATION 3.1

###### CH<sub>4</sub> EMISSION FROM SWDS

$$\text{CH}_4 \text{ EMISONS} = \left[ \sum \text{CH}_4 \text{ GENERATED}_{x,T} - R \right] \times (1 - \text{OX}_T)$$

Where:

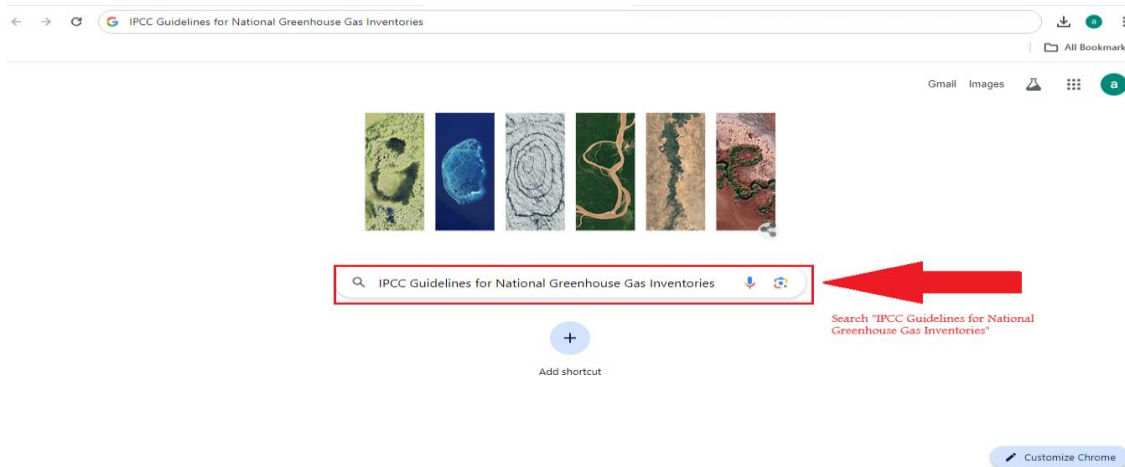
- **CH<sub>4</sub> Emissions** = CH<sub>4</sub> emitted in year T, Gg (See 2006 IPCC Guidelines, Vol.5, Pg. 8, EQUATION 3.1)
- **T** = Inventory year (See 2006 IPCC Guidelines, Vol.5, Pg. 8, EQUATION 3.1)
- **X** = Waste category or type/ material (See 2006 IPCC Guidelines, Vol.5, Pg. 8, EQUATION 3.1)
- **R<sub>T</sub>** = Recovered CH<sub>4</sub> in year T, Gg (See 2006 IPCC Guidelines, Vol.5, Pg. 8, EQUATION 3.1)
- **OX<sub>T</sub>** = Oxidation factor in year T. (fraction)
- Default **value R** = 0
- Default **OX<sub>T</sub>** = 0% (See 2006 IPCC Guideline, Vol 5, pg. 15, Table 3.2)

### 4.3.2 STEP – BY – STEP CALCULATION, DOCUMENTING RESOURCES USED

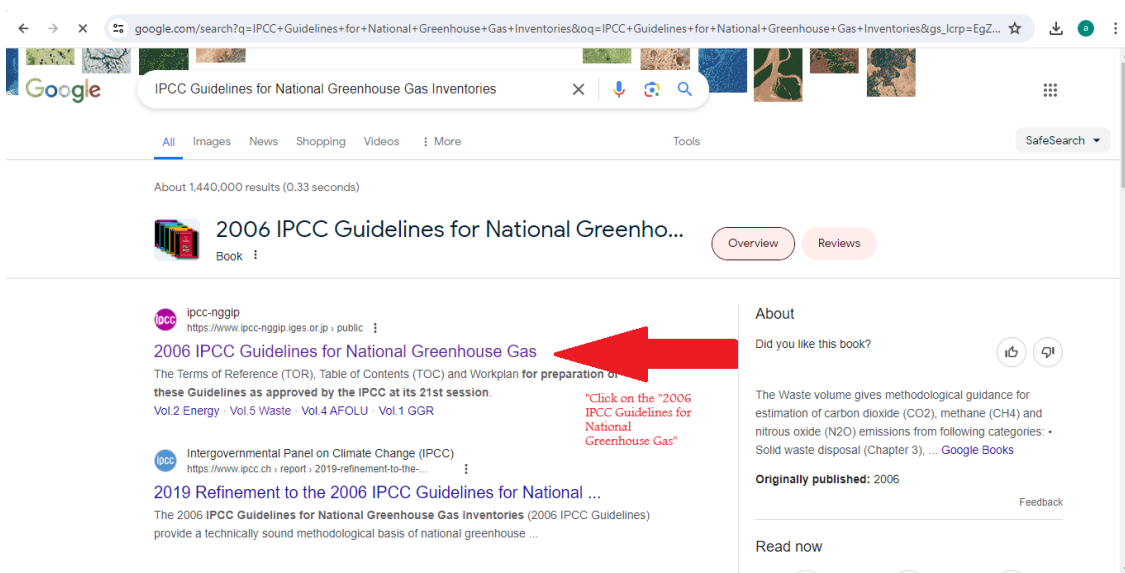
#### 1. USING THE FOD MODEL PARAMETERS:

FILE [https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5\\_Volume5/IPCC\\_Waste\\_Model.xls](https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/IPCC_Waste_Model.xls)

1.0 Open Google Browser and type in “IPCC Guidelines for National Greenhouse Gas Inventories” (See illustrations below)



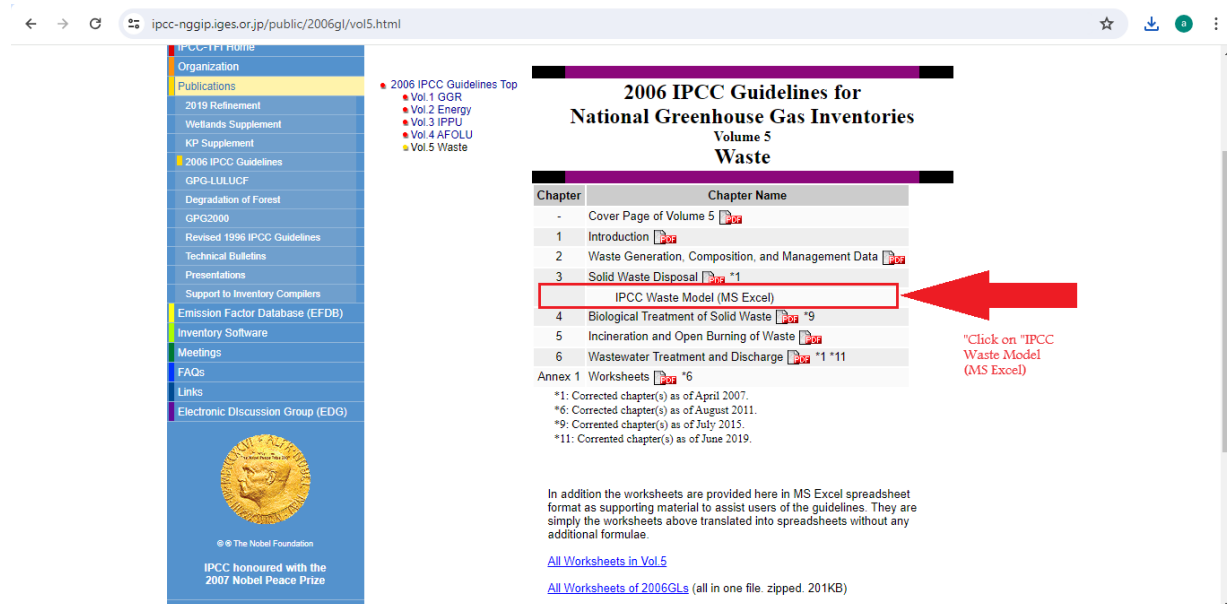
1.1 Click on the website “2006 IPCC Guidelines for National Greenhouse Gas” (See illustration below).



1.2 Click on the “Vol.5 Waste” (See illustration below)



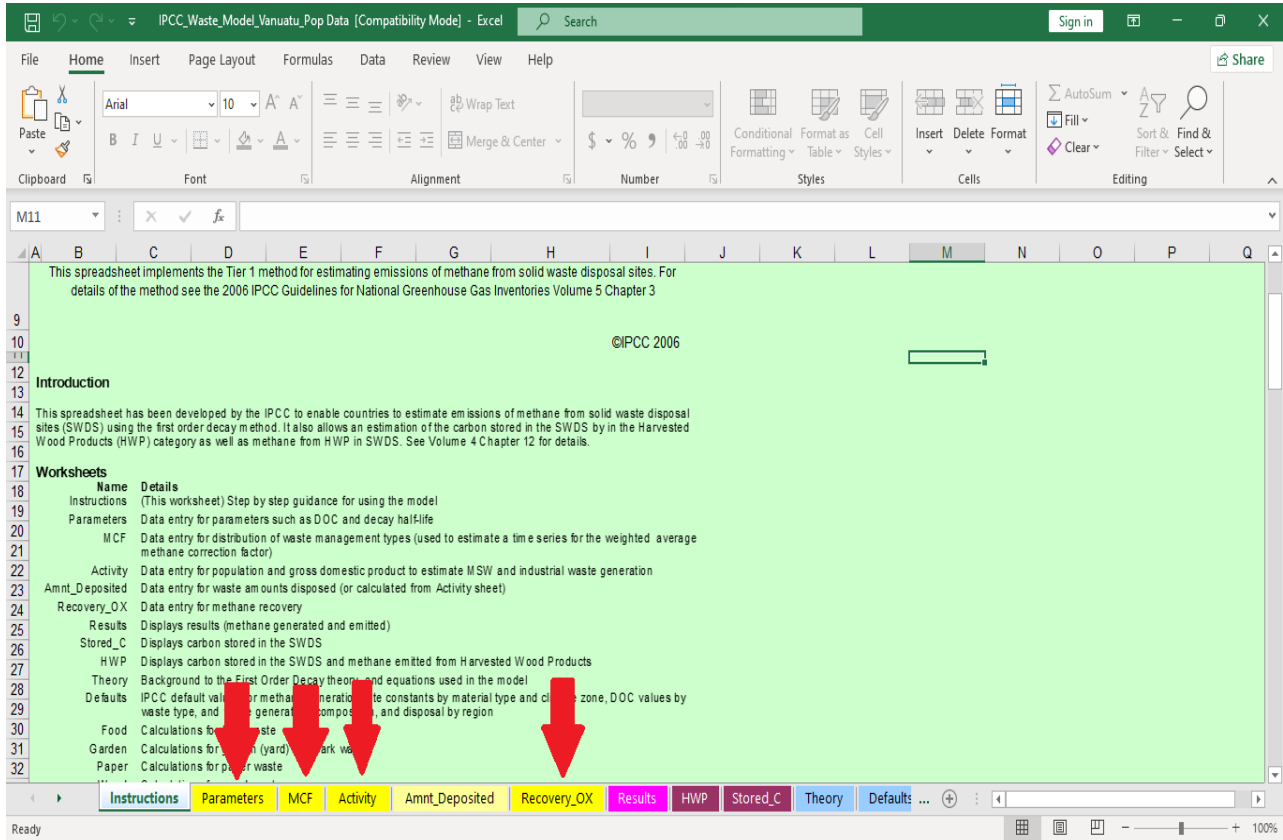
1.3 Click on the “IPCC Waste Model (MS Excel)” (See illustration below)





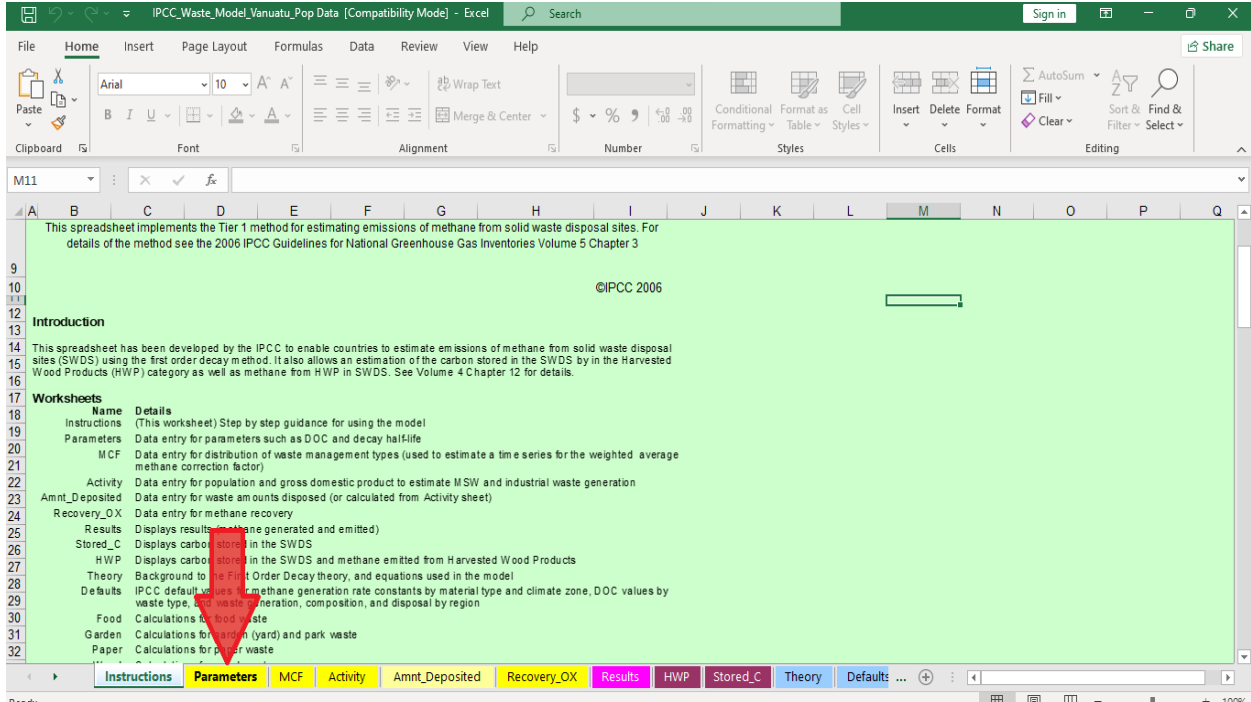
1.4 Open the file, IPCC model [https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5\\_Volume5/IPCC\\_Waste\\_Model.xls](https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/IPCC_Waste_Model.xls)

1.5 Note that the possible data entries are in tabs colored yellow (See red arrows below)

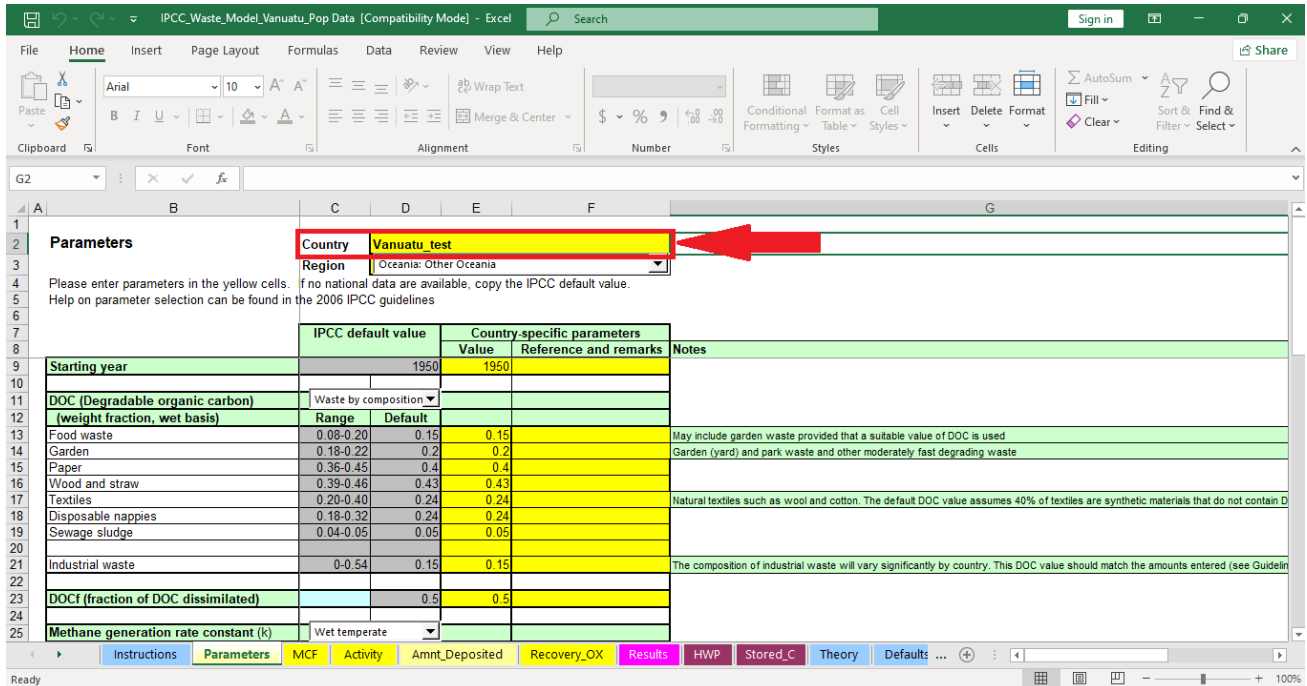




1.6 Click on the tab “Parameters” (See red arrow in illustration below)



1.7 Click on the cell Country and enter Vanuatu (See red arrow below)



1.8 Click on the “Region” tab and choose “Oceania: other Oceania” (see illustration below).

The screenshot shows the 'Parameters' worksheet in an Excel spreadsheet. The 'Country' dropdown is set to 'Vanuatu\_test'. The 'Region' dropdown is highlighted with a red box and a red arrow pointing to 'Oceania: Other Oceania'. Below this, there is a table with columns for 'IPCC default value', 'Country-specific parameters Value', 'Reference and remarks', and 'Notes'. The 'Starting year' row is highlighted in yellow, with the value '1950' entered in the 'Value' column.

	IPCC default value	Country-specific parameters		
		Value	Reference and remarks	Notes
Starting year	1950	1950		
DOC (Degradable organic carbon) (weight fraction, wet basis)	Waste by composition			
	Range	Default		
Food waste	0.08-0.20	0.15	0.15	May include garden waste provided that a suitable value of DOC is used
Garden	0.18-0.22	0.2	0.2	Garden (yard) and park waste and other moderately fast degrading waste
Paper	0.36-0.45	0.4	0.4	
Wood and straw	0.39-0.46	0.43	0.43	
Textiles	0.20-0.40	0.24	0.24	Natural textiles such as wool and cotton. The default DOC value assumes 40% of textiles are synthetic materials that do not contain D
Disposable nappies	0.18-0.32	0.24	0.24	
Sewage sludge	0.04-0.05	0.05	0.05	
Industrial waste	0-0.54	0.15	0.15	The composition of industrial waste will vary significantly by country. This DOC value should match the amounts entered (see Guidelin
DOCf (fraction of DOC dissimilated)		0.5	0.5	
Methane generation rate constant (k)	Wet temperate			

1.9 Enter the default starting year as 1950 in the “Parameters” Worksheet. (See below).

The screenshot shows the 'Parameters' worksheet in an Excel spreadsheet. The 'Starting year' row is highlighted with a red box and a red arrow pointing to the value '1950' in the 'Value' column. A red arrow also points to the 'Value' column header with the text 'Enter the Starting year'. The 'Country' dropdown is set to 'Vanuatu\_test' and the 'Region' dropdown is set to 'Oceania: Other Oceania'.

	IPCC default value	Country-specific parameters		
		Value	Reference and remarks	Notes
Starting year	1950	1950		
DOC (Degradable organic carbon) (weight fraction, wet basis)	Waste by composition			
	Range	Default		
Food waste	0.08-0.20	0.15	0.15	May include garden waste provided that a suitable value of DOC is used
Garden	0.18-0.22	0.2	0.2	Garden (yard) and park waste and other moderately fast degrading waste
Paper	0.36-0.45	0.4	0.4	
Wood and straw	0.39-0.46	0.43	0.43	
Textiles	0.20-0.40	0.24	0.24	Natural textiles such as wool and cotton. The default DOC value assumes 40% of textiles are synthetic materials that do not contain D
Disposable nappies	0.18-0.32	0.24	0.24	
Sewage sludge	0.04-0.05	0.05	0.05	
Industrial waste	0-0.54	0.15	0.15	The composition of industrial waste will vary significantly by country. This DOC value should match the amounts entered (see Guidelin
DOCf (fraction of DOC dissimilated)		0.5	0.5	
Methane generation rate constant (k)	Wet temperate			

1.10. Fill in the “DOC (Degradable Organic Carbon)” in the “Parameters” Worksheet (See the red arrow pointing to where to fill in the values for DOC and the Blue arrow indicates where the IPCC Default values are if no national data is available.)

	IPCC default value		Country-specific parameters		Notes
	Value	Reference and remarks	Value	Reference and remarks	
Starting year	1950	1950			
DOC (Degradable organic carbon) (weight fraction, wet basis)	Waste by composition				
	Range	Default			
Food waste	0.18-0.20	0.15	0.15		May include garden waste provided that a suitable value of DOC is used
Garden	0.18-0.22	0.2	0.2		Garden (yard) and park waste and other moderately fast degrading waste
Paper	0.36-0.45	0.4	0.4		
Wood and straw	0.39-0.46	0.43	0.43	Enter the values	
Textiles	0.20-0.40	0.24	0.24	If no national data is available then use the default values	Natural textiles such as wool and cotton. The default DOC value assumes 40% of textiles are synthetic materials that do not contain DOC
Disposable nappies	0.18-0.32	0.24	0.24		
Sewage sludge	0.04-0.05	0.05	0.05		
Industrial waste	0-0.54	0.15	0.15		The composition of industrial waste will vary significantly by country. This DOC value should match the amounts entered (see Guidelines)
DOCf (fraction of DOC dissimilated)		0.5	0.5		
Methane generation rate constant (k) (years <sup>-1</sup> )	Wet temperature				

1.11. Enter the DOC default value 0.5 into the yellow cell E23 (See red arrow below)

	IPCC default value		Country-specific parameters		Notes
	Value	Reference and remarks	Value	Reference and remarks	
Starting year	1950	1950			
Industrial waste	0-0.54	0.15	0.15		The composition of industrial waste will vary significantly by country. This DOC value should match the amounts entered (see Guidelines)
DOCf (fraction of DOC dissimilated)		0.5	0.5		Enter 0.5 as the default value in the yellow cell
Methane generation rate constant (k) (years <sup>-1</sup> )	Wet temperature				
	Range	Default			
Food waste	0.1-0.2	0.185	0.185		May include garden waste provided that a suitable value of DOC is used
Garden	0.06-0.1	0.1	0.1		Garden (yard) and park waste and other moderately fast degrading waste
Paper	0.05-0.07	0.06	0.06		
Wood and straw	0.02-0.04	0.03	0.03		
Textiles	0.05-0.07	0.06	0.06		Natural textiles such as wool and cotton. Synthetic textiles are assumed not to contain DOC
Disposable nappies	0.06-0.1	0.1	0.1		
Sewage sludge	0.1-0.2	0.185	0.185		
Industrial waste	0.08-0.1	0.09	0.09		The composition of industrial waste will vary significantly by country. This DOC value should match the amounts entered (see Guidelines)
Delay time (months)		6	6		

1.12. Click on the Methane drop-down menu and select Wet temperate (see illustration below)

	IPCC default value		Country-specific parameters		Notes
	Value	Reference and remarks	Value	Reference and remarks	
DOCf (fraction of DOC dissimilated)	0.5	0.5			
Methane generation rate constant (k) (years <sup>-1</sup> )					
Food waste		0.185			May include garden waste provided that a suitable value of DOC is used
Garden		0.1			Garden (yard) and park waste and other moderately fast degrading waste
Paper	0.05-0.07	0.06	0.06		
Wood and straw	0.02-0.04	0.03	0.03		
Textiles	0.05-0.07	0.06	0.06		Natural textiles such as wool and cotton. Synthetic textiles are assumed not to contain DOC
Disposable nappies	0.06-0.1	0.1	0.1		
Sewage sludge	0.1-0.2	0.185	0.185		
Industrial waste	0.08-0.1	0.09	0.09		The composition of industrial waste will vary significantly by country. This DOC value should match the amounts entered (see Guidelin
Delay time (months)		6	6		
Fraction of methane (F) in developed gas		0.5	0.5		

1.13 Enter the default values from the grey cells D27 to D35 into the yellow cells. Vanuatu does not have any Country specific values (See red arrow in the illustration below)

	IPCC default value		Country-specific parameters		Notes
	Range	Default	Value	Reference and remarks	
DOCf (fraction of DOC dissimilated)		0.5	0.5		
Methane generation rate constant (k) (years <sup>-1</sup> )					
Food waste	0.1-0.2	0.185	0.185		May include garden waste provided that a suitable value of DOC is used
Garden	0.06-0.1	0.1	0.1		Garden (yard) and park waste and other moderately fast degrading waste
Paper	0.05-0.07	0.06	0.06		
Wood and straw	0.02-0.04	0.03	0.03		
Textiles	0.05-0.07	0.06	0.06		Natural textiles such as wool and cotton. Synthetic textiles are assumed not to contain DOC
Disposable nappies	0.06-0.1	0.1	0.1		
Sewage sludge	0.1-0.2	0.185	0.185		
Industrial waste	0.08-0.1	0.09	0.09		The composition of industrial waste will vary significantly by country. This DOC value should match the amounts entered (see Guidelin
Delay time (months)		6	6		
Fraction of methane (F) in developed gas		0.5	0.5		

1.14 Enter the default values from the grey cells into the yellow cells:

- Delay time: 6
- Fraction of Methane: 0.5
- Oxidation Factor (OX): 0
- % Paper in industrial waste: 0%
- % Wood in industrial waste: 0%

(See the red outline in the figure below)

	IPCC default value	Country-specific parameters		Notes
		Value	Reference and remarks	
Industrial waste	0.08-0.1	0.09	0.09	The composition of industrial waste will vary significantly by country. This DOC value should match the amounts entered (see Guidelin
Delay time (months)		6	6	
Fraction of methane (F) in developed gas		0.5	0.5	
Conversion factor, C to CH <sub>4</sub>		1.33	1.33	
Oxidation factor (OX)		0	0	
<b>Parameters for carbon storage</b>				
% paper in industrial waste		0%	0%	
% wood in industrial waste		0%	0%	

1.15 Click on the “MFC” tab (see red arrow below)

1.16 Enter the IPCC default values from grey cells 12C to 12M into the yellow cells 13C to 13M. Vanuatu has no country-specific value hence the IPCC default value will be used.

(MCF)

ed average MCF from the estimated distribution of site types  
national values into the yellow MCF cells in row 12  
tion of waste disposals (by mass) between site types in the columns below.  
100% (see "distribution check" values)

Calculated values for MCF

Default values to be used, since Vanuatu has no country specific values

Enter values into the yellow cells

Waste Management Type	Distribution of Waste by Waste Management Type								
	Managed, semi-aerobic	Uncategorised	Distribution Check	Un-managed, shallow	Un-managed, deep	Managed	Managed, semi-aerobic	Uncategorised	Distribution Check
IPCC default	0.5	0.6		0.4	0.8	1	0.5	0.6	
Country-specific value	0.5	0.6		0.4	0.8	1	0.5	0.6	
Year	%	%	Total (100%)	%	%	%	%	%	Total (100%)
1950	5%	15%	100%	20%	30%	25%	5%	20%	100%
1951	5%	15%	100%	20%	30%	25%	5%	20%	100%
1952	5%	15%	100%	20%	30%	25%	5%	20%	100%
1953	5%	15%	100%	20%	30%	25%	5%	20%	100%
1954	5%	15%	100%	20%	30%	25%	5%	20%	100%
1955	5%	15%	100%	20%	30%	25%	5%	20%	100%

1.17 Enter the % waste for MSW and Industrial see the tables below for the values. An illustration is also provided after the tables (see figure below, after the tables)

**Table 4: Percentage values for each of the different MSW site types**

The yellow cells on the excel file where the values are to be entered. These percentages should total to 100%.

MSW	% of waste	Cell
Unmanaged Shallow	25	C16
Unmanaged Deep	30	D16
Managed	25	E16
Managed Semi-aerobic	5	F16
Uncategorized	15	G16
<b>Total =</b>	<b>100%</b>	

**Table 5: Percentage values for each of the different Industrial site types**

The yellow cells where the values are to be entered. These percentages have to equal to 100%.

Industrial	% of waste	Cell
Unmanaged Shallow	25	I16
Unmanaged Deep	30	J16
Managed	25	K16



Managed Semi-aerobic	5	L16
Uncategorized	15	M16
<b>Total =</b>	<b>100%</b>	

**Methane Correction Factor (MCF)**

This worksheet calculates a weighted average MCF from the estimated distribution of site types  
 Enter either IPCC default values or national values into the yellow MCF cells in row 12  
 Then enter the approximate distribution of waste disposals (by mass) between site types in the columns below.  
 Totals on each row must add up to 100% (see "distribution check" values)

Calculated val

	MSW						Industrial						References / remarks
	Un-managed, shallow	Un-managed, deep	Managed	Managed, semi-aerobic	Uncate-gorised	Distri-bution Check	Un-managed, shallow	Un-managed, deep	Managed	Managed, semi-aerobic	Uncate-gorised	Distri-bution Check	
IPCC default	0.4	0.8	1	0.5	0.6		0.4	0.8	1	0.5	0.6		
Country-specific value		0.8	1	0.5	0.6			0.8	1	0.5	0.6		
Distribution of Waste by Waste Management Type						Distribution of Waste by Waste Management Type							
"Fixed" Country-specific value	25%	30%	25%	5%	15%	Total	20%	30%	25%	5%	20%	Total	
Year	%	%	%	%	%	(100%)	%	%	%	%	%	(100%)	
1957	25%	30%	25%	5%	15%	100%	20%	30%	25%	5%	20%	100%	
1958	25%	30%	25%	5%	15%	100%	20%	30%	25%	5%	20%	100%	
1959	25%	30%	25%	5%	15%	100%	20%	30%	25%	5%	20%	100%	
1960	25%	30%	25%	5%	15%	100%	20%	30%	25%	5%	20%	100%	
1961	25%	30%	25%	5%	15%	100%	20%	30%	25%	5%	20%	100%	

MSW
Weighted average MCF for MSW
wt. fraction
0.71
0.71
0.71
0.71
0.71

1.18 Click on the "Activity" tab at the bottom of the page (see red arrow in illustration)

1.19 Enter population data in yellow cell C12 to Yellow cell C84 (See red figure below).

**MSW activity data**  
Enter the population data up to year 2023  
Enter population, waste per capita and MSW waste composition into the yellow cells.  
Help and default regional values are given in the 2006 IPCC Guidelines.  
Industrial waste activity data must be entered separately starting in Column Q.

**IPCC Regional defaults**  
690

Composition of waste going to solid waste disposal sites												
Year	Population	Waste per capita	Total MSW	% to SWDS	Food	Garden	Paper	Wood	Textile	Nappies	Plastics, other inert	Total
	millions	kg/cap/yr	Gg	%	%	%	%	%	%	%	%	(=100%)
2020	0.29855931	690	206.0059	85%	68%	0%	6%	3%	0%	0%	24%	100%
2021	0.30027304	690	207.1884	85%	68%	0%	6%	3%	0%	0%	24%	100%
2022		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2023		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2024		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2025		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%

**Industrial waste activity**  
Enter GDP, waste generation rate  
Help and default regional values

Year	GDP	ge
	\$ millions	
2020	946.44	
2021	956	
2022		
2023		
2024		
2025		

1.20 Enter in the IPCC Regional default value of 690 for waste per capita in yellow cell D12 (See illustration below)

**MSW activity data**  
Enter this IPCC Regional default value into cell D12  
Enter population, waste per capita and MSW waste composition into the yellow cells.  
Help and default regional values are given in the 2006 IPCC Guidelines.  
Industrial waste activity data must be entered separately starting in Column Q.

**IPCC Regional defaults**  
690

Composition of waste going to solid waste disposal sites												
Year	Population	Waste per capita	Total MSW	% to SWDS	Food	Garden	Paper	Wood	Textile	Nappies	Plastics, other inert	Total
	millions	kg/cap/yr	Gg	%	%	%	%	%	%	%	%	(=100%)
1950	0.2	690	138	85%	68%	0%	6%	3%	0%	0%	24%	100%
1951	0.201148	690	138.7921	85%	68%	0%	6%	3%	0%	0%	24%	100%
1952	0.20230259	690	139.5888	85%	68%	0%	6%	3%	0%	0%	24%	100%
1953	0.20346381	690	140.39	85%	68%	0%	6%	3%	0%	0%	24%	100%
1954	0.20463169	690	141.1959	85%	68%	0%	6%	3%	0%	0%	24%	100%
1955	0.20580627	690	142.0063	85%	68%	0%	6%	3%	0%	0%	24%	100%

**Industrial waste activity**  
Enter GDP, waste generation rate  
Help and default regional values

Year	GDP	ge
	\$ millions	
1950	468.335101	
1951	473.065759	
1952	477.844201	
1953	482.67091	
1954	487.546373	
1955	492.471084	



1.21 Enter in yellow Cell F12 Enter the default value of 85% from the grey cell F8.

MSW activity data

Enter population, waste per capita and MSW waste composition into the yellow cells. Help and default regional values are given in the 2006 IPCC Guidelines. Industrial waste activity data must be entered separately starting in Column Q.

IPCC Regional defaults

690	85%	68%	0%	6%	3%	0%	0%	24%	100%
-----	-----	-----	----	----	----	----	----	-----	------

Composition of waste going to solid waste disposal sites

Year	Population	Waste per capita	Total MSW	% to SWDS	Food	Garden	Paper	Wood	Textile	Nappies	Plastics, other inert	Total
	millions	kg/cap/yr	Gg	%	%	%	%	%	%	%	%	(=100%)
2020	0.29855931	690	206.0059	85%	68%	0%	6%	3%	0%	0%	24%	100%
2021	0.30027304	690	207.1884	85%	68%	0%	6%	3%	0%	0%	24%	100%
2022		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2023		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2024		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2025		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%

Industrial waste activity

Enter GDP, waste generation rate and default regional values

Year	GDP	waste generation rate
	\$ millions	kg/cap/yr
2020	946.44	
2021	956	
2022		
2023		
2024		
2025		

1.22 Enter the IPCC Regional default values for the Different Compositions of waste going to the Solid Waste Disposal Site (SWDS) into yellow cells G12 to M12 using the values from the grey cells in G8 to M8 (See figure below). Note that the total percentage should add up to 100%.

MSW activity data

Enter population, waste per capita and MSW waste composition into the yellow cells. Help and default regional values are given in the 2006 IPCC Guidelines. Industrial waste activity data must be entered separately starting in Column Q.

IPCC Regional defaults

690	85%	68%	0%	6%	3%	0%	0%	24%	100%
-----	-----	-----	----	----	----	----	----	-----	------

Composition of waste going to solid waste disposal sites

Year	Population	Waste per capita	Total MSW	% to SWDS	Food	Garden	Paper	Wood	Textile	Nappies	Plastics, other inert	Total
	millions	kg/cap/yr	Gg	%	%	%	%	%	%	%	%	(=100%)
2020	0.29855931	690	206.0059	85%	68%	0%	6%	3%	0%	0%	24%	100%
2021	0.30027304	690	207.1884	85%	68%	0%	6%	3%	0%	0%	24%	100%
2022		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2023		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2024		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%
2025		690	0	85%	68%	0%	6%	3%	0%	0%	24%	100%

Industrial waste activity

Enter GDP, waste generation rate and default regional values

Year	GDP	waste generation rate
	\$ millions	kg/cap/yr
2020	946.44	
2021	956	
2022		
2023		
2024		
2025		

1.23 Enter the collected data on GDP for years 1950 to 2023 into the yellow cell R12 to R85 (See figure below).

**Industrial waste activity data**

Enter GDP, waste generation rate, % to SWDS and distribution of waste between site types into the yellow cells. Help and default regional values are given in the 2006 IPCC Guidelines.

Enter the GDP from collected data in yellow cell R12 till you reach year 2023.

Year	GDP	Waste generation rate	Total industrial waste	% to SWDS	Total to SWDS
	\$ millions	Gg/\$m GDP/yr	Gg	%	Gg
1950	468.335101	5	2341.6755	100%	2341.676
1951	473.065759	5	2365.3288	100%	2365.329
1952	477.844201	5	2389.221	100%	2389.221
1953	482.67091	1.5	724.00636	100%	724.0064
1954	487.546373	1.5	731.31956	100%	731.3196
1955	492.471084	1.5	738.70663	100%	738.7066

1.24 Enter the data for waste generation rate for the years 1950 to 2023 into yellow cells S12 to S85 (see figure below)

**Industrial waste activity data**

Enter GDP, waste generation rate, % to SWDS and distribution of waste between site types into the yellow cells. Help and default regional values are given in the 2006 IPCC Guidelines.

Enter the values for Waste Generation Rate from year 1950 to 2023

Year	GDP	Waste generation rate	Total industrial waste	% to SWDS	Total to SWDS
	\$ millions	Gg/\$m GDP/yr	Gg	%	Gg
1950	468.335101	5	2341.6755	100%	2341.676
1951	473.065759	5	2365.3288	100%	2365.329
1952	477.844201	5	2389.221	100%	2389.221
1953	482.67091	1.5	724.00636	100%	724.0064
1954	487.546373	1.5	731.31956	100%	731.3196
1955	492.471084	1.5	738.70663	100%	738.7066

1.25 Enter 100% for all of the years in yellow cells U12 to U85 under the “% to SWDS” column.

**Industrial waste activity data**

Enter GDP, waste generation rate, % to SWDS and distribution of waste between site types into the yellow cells. Help and default regional values are given in the 2006 IPCC Guidelines.

Year	GDP	Waste generation rate	Total industrial waste	% to SWDS	Total to SWDS
	\$ millions	Gg/\$m GDP/yr	Gg	%	Gg
1950	468.335101	5	2341.6755	100%	2341.676
1951	473.065759	5	2365.3288	100%	2365.329
1952	477.844201	5	2389.221	100%	2389.221
1953	482.67091	1.5	724.00636	100%	724.0064
1954	487.546373	1.5	731.31956	100%	731.3196
1955	492.471084	1.5	738.70663	100%	738.7066

## 2. ALTERNATIVE METHOD TO CALCULATING CH<sub>4</sub> EMISSIONS FROM THE SWDS USING THE IPCC SOFTWARE.

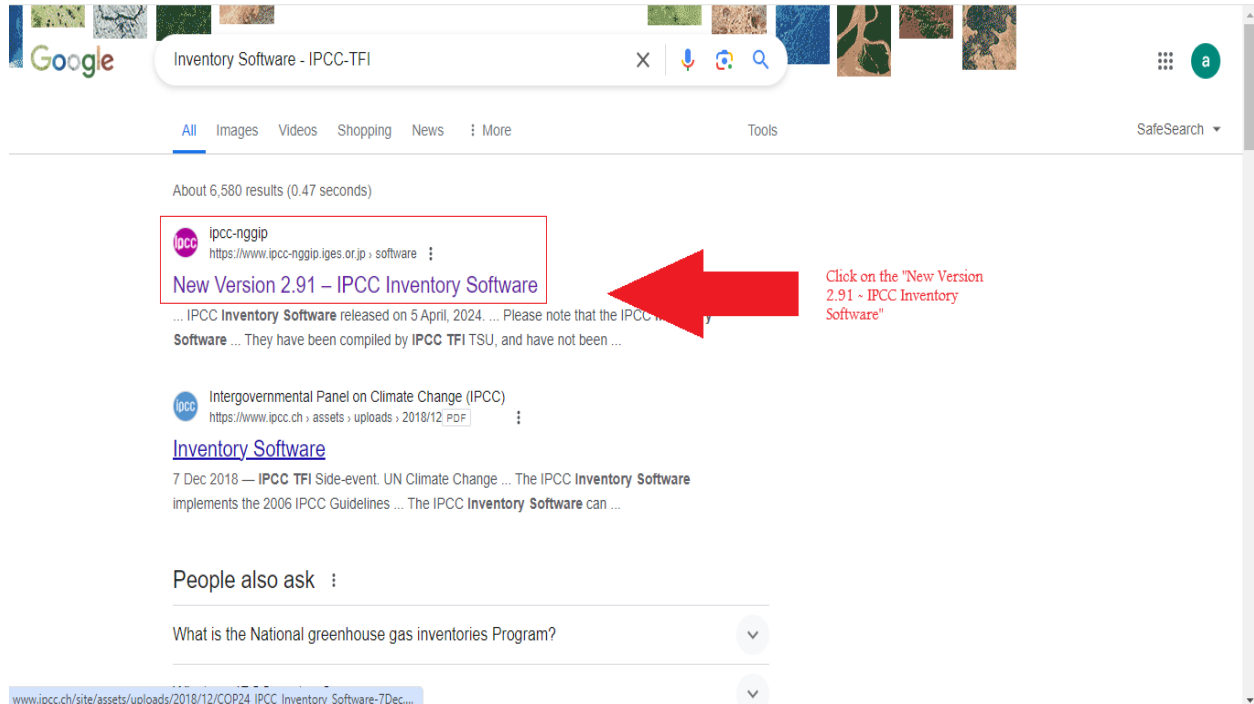
1.0 Open Google chrome and search “Inventory Software – IPCC-TFI” (See illustration below)

Search Google or type a URL

Inventory Software - IPCC-TFI

Search 'Inventory Software - IPCC-TFI'

### 1.2 Click on the “New Version 2.91 – IPCC Inventory Software (See illustration below)”



### 1.3 Click on the “ver 2.91 IPCC inventory Software – 32bit” (See illustration below).



- 1.4 Launch the Ver. 2.901 IPCC Inventory Software - 32bit and install to your PC.
- 1.5 Create your password and username.
- 1.6 Type in the year of your choosing or the current inventory year.
- 1.7 Locate the bar labeled "IPCC categories" on the left side of the page (See Illustration below)

The screenshot shows the IPCC Inventory Software interface. On the left, the '2006 IPCC Categories' list is visible, with a red arrow pointing to the '2.F.1.a - Refrigeration and Stationary Air Conditioning' category. The main window displays a data table for 'HFC-134a (CH2FCF3)' emissions from 2019 to 2023. The table includes columns for Production, Exports, Imports, Total new agent, Agent in retired equipment, Destruction of agent, Release of agent, Bank, and Emissions. A bar chart at the bottom right shows the emissions trend from 1990 to 2025.

Year	Production (tonnes)	Exports (tonnes)	Imports (tonnes)	Total new agent to domestic market (tonnes)	Agent in retired equipment (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions (tonnes)
2019	0	0	16.4	16.4	0.57828	0	0.57828	82.33718	12.92886
2020	0	0	17.11	17.11	0.6307	0	0.6307	86.46591	13.60058
2021	0	0	17.83	17.83	0.68398	0	0.68398	90.64204	14.28029
2022	0	0	18.55	18.55	0.73814	0	0.73814	94.85759	14.96678
2023	0	0	19.27	19.27	0.7923	0	0.7923	99.10665	15.6583

- 1.8 Scroll Down the category list till you get to 4 – Waste, then select 4 A – Solid Waste Disposal (See red arrow in figure below)

The screenshot shows the IPCC Inventory Software interface with the '2006 IPCC Categories' list on the left. A red arrow points to the '4.A - Solid Waste Disposal' category. The main window displays the 'Parameters' tab for '4.A - Solid Waste Disposal'. The parameters include Country/Territory (Vanuatu), Region (Oceania - Australia & New Zeland), Subdivision (Unspecified), and Climate Zone (Boreal and temperate dry). The 'Main parameters and Waste Types for selected Subdivision' section shows values for 'Year' (1950), 'Residence time (months)' (6), and 'Fraction of methane (F) in developed gas' (0.500). The 'Parameters for HWP (Bulk MSW)' section shows values for '% garden in municipal waste', '% paper in municipal waste', and '% wood in municipal waste' (all 0.00%). The 'Parameters for HWP (Bulk Industrial Waste)' section shows values for '% paper in industrial waste' and '% wood in industrial waste' (all 0.00%).

1.9 Click on the “Region” drop-down tab and select “Oceania – Other Oceania (See illustration below)

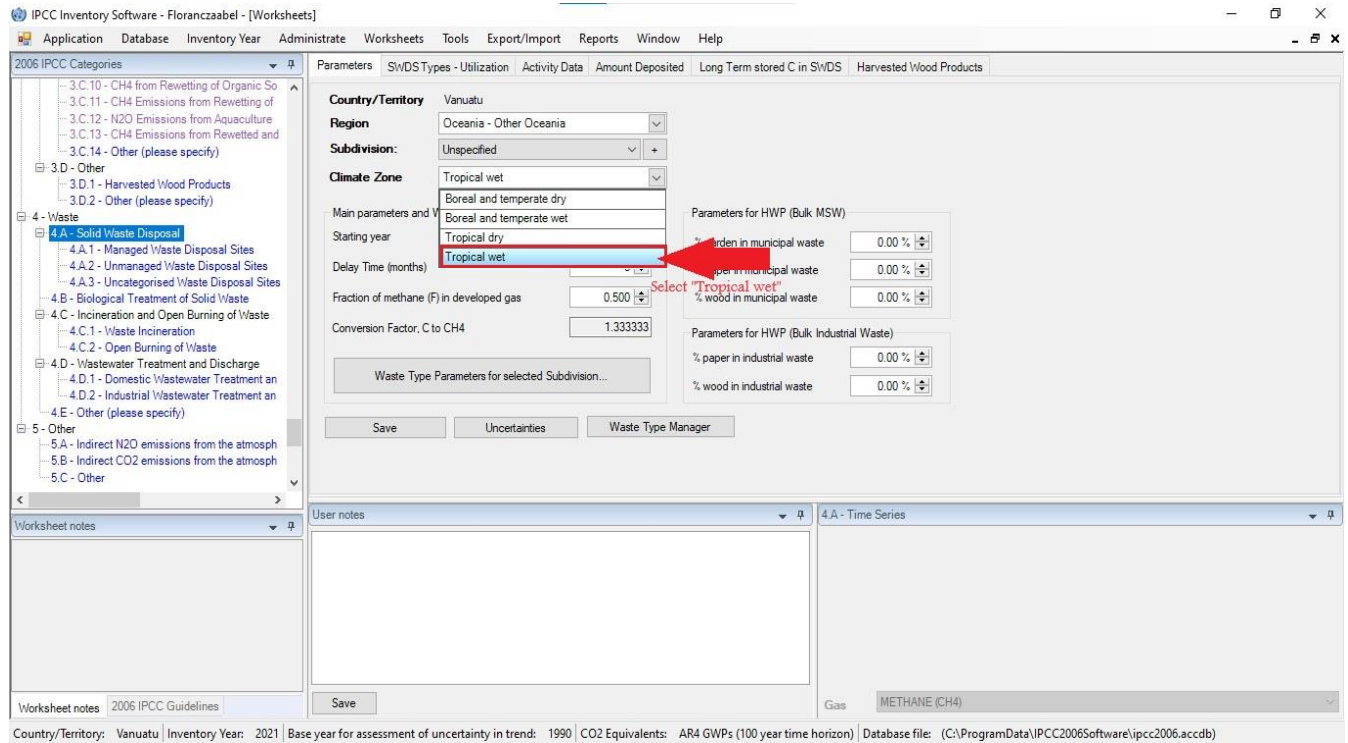
The screenshot shows the 'Parameters' tab of the software. The 'Country/Territory' is set to 'Vanuatu'. The 'Region' dropdown menu is open, and 'Oceania - Other Oceania' is selected and highlighted with a red circle. A red arrow points to this selection with the text: 'Click on the "Region" Drop down tab and Select "Oceania - Other Oceania"'. Other dropdowns for 'Subdivision' and 'Climate Zone' are also visible. The main parameters section includes fields for 'Starting year' (1950), 'Delay Time (months)' (6), 'Fraction of methane (F) in developed gas' (0.500), and 'Conversion Factor, C to CH4' (1.333333). There are also sections for 'Parameters for HWP (Bulk MSW)' and 'Parameters for HWP (Bulk Industrial Waste)'. At the bottom, there are buttons for 'Save', 'Uncertainties', and 'Waste Type Manager'.

1.10 Click the Subdivision drop-down tab and select “Unspecified” (see illustration below)

The screenshot shows the 'Parameters' tab of the software. The 'Country/Territory' is 'Vanuatu' and the 'Region' is 'Oceania - Australia & New Zealand'. The 'Subdivision' dropdown menu is open, and 'Unspecified' is selected and highlighted with a red circle. A red arrow points to this selection with the text: 'Click the Subdivision drop down tab and Select "Unspecified"'. The 'Climate Zone' dropdown is also visible. The main parameters section is the same as in the previous screenshot. At the bottom, there are buttons for 'Save', 'Uncertainties', and 'Waste Type Manager'.



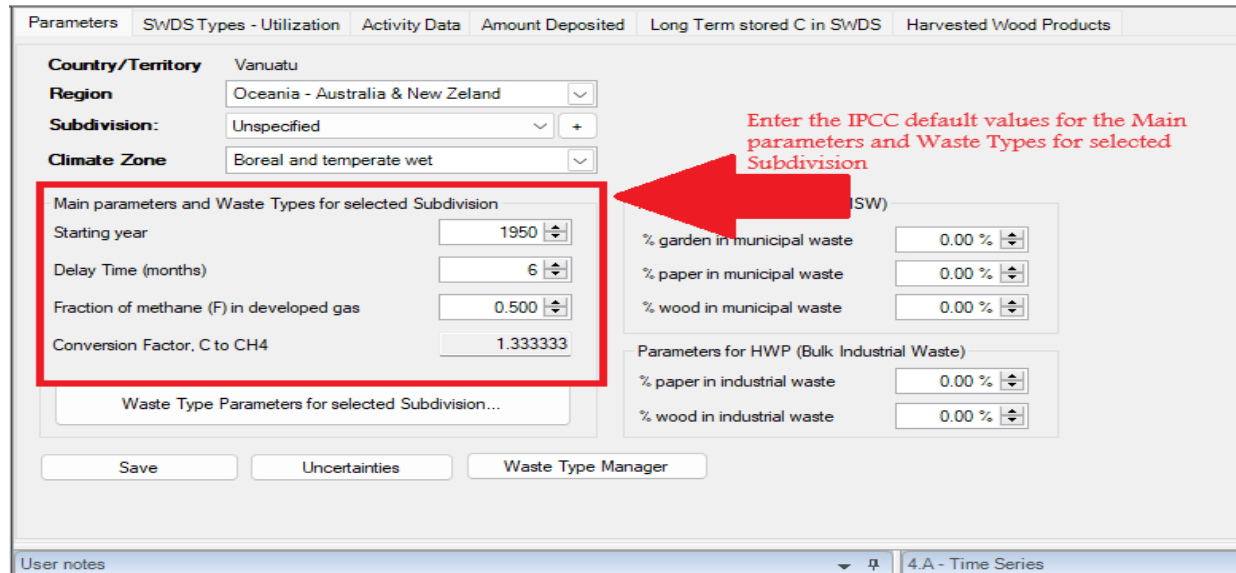
1.11 Select the “Climate zone” drop-down bar and Select “Tropical Wet”



1.12 Enter the following default values into the “Main Parameters and waste types for Selected Subdivision (See illustration below)

Default Value:

- Starting year:1950
- Delay Time (months): 6
- Fraction of methane (F) in developed gas: 0.5



1.13 Click the “Waste Type Parameters for Selected Subdivision” tab (See illustration below)

The screenshot shows a software interface with a tree view on the left and a main panel on the right. The tree view is expanded to '4 - Waste' > '4.A - Solid Waste Disposal'. The main panel has several tabs: 'Parameters', 'SWDSTypes - Utilization', 'Activity Data', 'Amount Deposited', 'Long Term stored C in SWDS', and 'Harvested Wood Products'. The 'Parameters' tab is active, showing fields for Country/Territory (Vanuatu), Region (Oceania - Australia & New Zeland), Subdivision (Unspecified), and Climate Zone (Boreal and temperate wet). Below these are input fields for 'Main parameters and Waste Types for selected Subdivision' (Starting year: 1950, Delay Time: 6, Fraction of methane: 0.500, Conversion Factor: 1.333333) and 'Parameters for HWP (Bulk MSW)' and 'Parameters for HWP (Bulk Industrial Waste)'. A red arrow points to a button labeled 'Waste Type Parameters for selected Subdivision...'. A red text box next to it says 'Select the "Waste Type Parameters for selected Subdivisions" tab'. At the bottom, there are buttons for 'Save', 'Uncertainties', and 'Waste Type Manager'. A 'User notes' section is visible at the bottom left, and a '4.A - Time Series' section is at the bottom right.

1.14 and click on the “methane generation rate constant” drop-down tab to select the default values as illustrated below. Click OK.

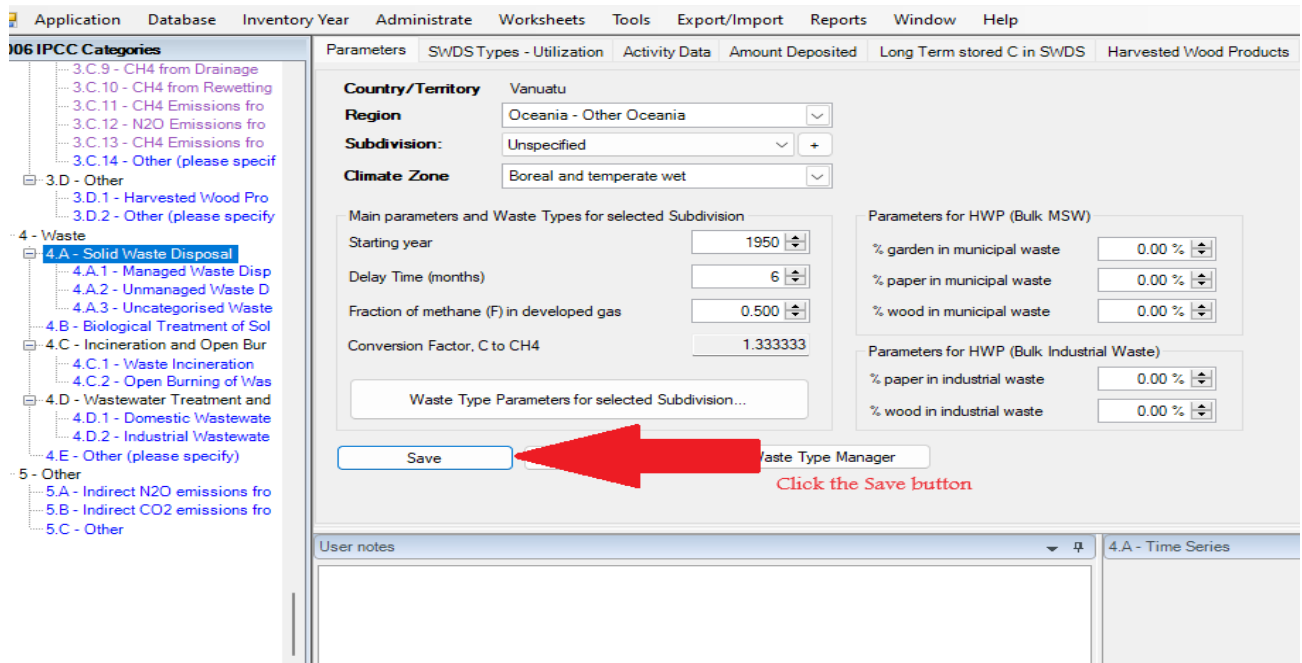
Waste Type Parameters

Waste Category	Waste Type / Industry Type			Degradable organic carbon	Degradable organic carbon which decomposes in SWDS	Methane generation rate constant (k)
	Class of decomposability	Type	Use in calculations	DOC (Fraction of wet weight)	DOCF (Fraction)	k
Industrial Waste	Bulk waste	Bulk Industrial Waste	<input checked="" type="checkbox"/>	0.15	0.5	0.17
	Highly decomposable waste	Food, beverages and tobacco	<input checked="" type="checkbox"/>	0.15	0.7	
	Less decomposable waste	Construction and demolition	<input checked="" type="checkbox"/>	0.04	0.5	
		Wood and wood products	<input checked="" type="checkbox"/>	0.43	0.5	
	Moderately decomposable w...	Pulp and paper	<input checked="" type="checkbox"/>	0.4	0.5	
Municipal Waste	Bulk waste	Bulk Municipal Waste	<input checked="" type="checkbox"/>	0.18	0.5	0.17
	Highly decomposable waste	Food waste	<input checked="" type="checkbox"/>	0.15	0.7	0.4
		Garden and park	<input checked="" type="checkbox"/>	0.2	0.7	0.17
	Less decomposable waste	Wood	<input checked="" type="checkbox"/>	0.43	0.5	0.035
	Moderately decomposable w...	Disposable nappies	<input checked="" type="checkbox"/>	0.24	0.5	0.17
Other waste		Paper and cardboard	<input checked="" type="checkbox"/>	0.4	0.5	0.07
		Textile	<input checked="" type="checkbox"/>	0.24	0.5	0.07
	Bulk waste	Clinical waste	<input checked="" type="checkbox"/>	0.15	0.5	
Sludge		Hazardous waste	<input checked="" type="checkbox"/>		0.5	
	Highly decomposable waste	Industrial sewage sludge	<input checked="" type="checkbox"/>	0.09	0.5	
		Municipal sewage sludge	<input checked="" type="checkbox"/>	0.05	0.5	0.4

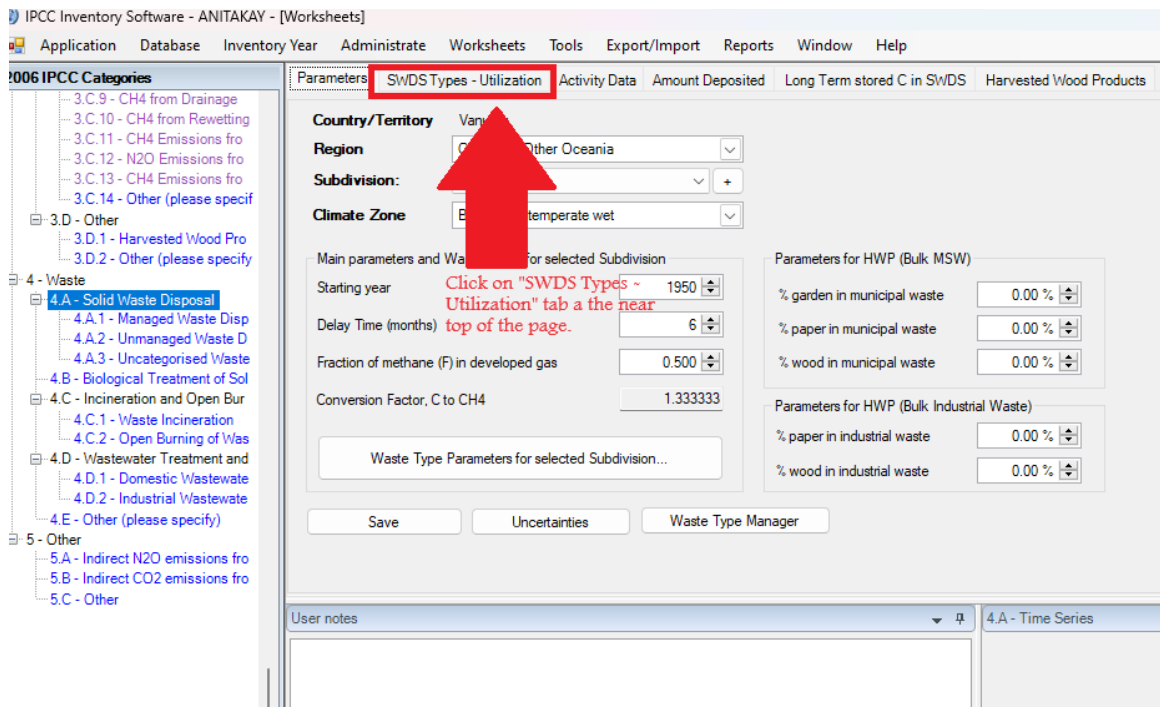
Cancel OK



1.15 Click on the save button (see Illustration below)



1.16 Click on the “SWDS Type – Utilization” tab at the near top of the page (see illustration below)



1.17 Click on the drop-down tab under the “Unmanaged shallow (%)” tab and select the Default factor 25.

IPCC Inventory Software - ANITAKAY - [Worksheets]

Parameters: SWDSTypes - Utilization | Activity Data | Amount Deposited | Long Term stored C in SWDS | Harvested Wood Products

Worksheet: Waste | 2016

Sector: Waste  
 Category: Methane emissions from Solid Waste Disposal Sites  
 Subcategory: 4.A - Solid Waste Disposal  
 Sheet: SWDSTypes - Utilization

Data: Subdivision: Unspecified | Waste Category: Municipal Waste

Year	Unmanaged		Managed				Uncategorised SWDS (%)	Total (%)	Distribution Check
	shallow (%)	deep (%)	anaerobic (%)	poorly - semi-aerobic (%)	well - semi-aerobic (%)	poorly - active aeration (%)			
1950	25	30	25		5		15	100	
1951	Default Value 25	30	25		5		15	100	
1952	25	30	25		5		15	100	
1953	25	30	25		5		15	100	
1954	25	30	25		5		15	100	
1955	25	30	25		5		15	100	
1956	25	30	25		5		15	100	
1957	25	30	25		5		15	100	
1958	25	30	25		5		15	100	
1959	25	30	25		5		15	100	
1960	25	30	25		5		15	100	

User notes: 4.A - Time Series

METHANE (CH4) Emissions (Gq CO2 Equivalents)

\* Base year for assessment of uncertainty in trend: 1990

1.18 click on the blue arrow beside the drop-down sign under the Unmanaged- Shallow to update all the years starting from 1950 to 2025. (%) (See illustration below).

IPCC Inventory Software - ANITAKAY - [Worksheets]

Parameters: SWDSTypes - Utilization | Activity Data | Amount Deposited | Long Term stored C in SWDS | Harvested Wood Products

Worksheet: Waste | 2016

Sector: Waste  
 Category: Methane emissions from Solid Waste Disposal Sites  
 Subcategory: 4.A - Solid Waste Disposal  
 Sheet: SWDSTypes - Utilization

Data: Subdivision: Unspecified | Waste Category: Municipal Waste

Year	Unmanaged		Managed				Uncategorised SWDS (%)	Total (%)	Distribution Check
	shallow (%)	deep (%)	anaerobic (%)	poorly - semi-aerobic (%)	well - semi-aerobic (%)	poorly - active aeration (%)			
1950	25	30	25		5		15	100	
1951	25	30	25		5		15	100	
1952	25	30	25		5		15	100	
1953	25	30	25		5		15	100	
1954	25	30	25		5		15	100	
1955	25	30	25		5		15	100	
1956	25	30	25		5		15	100	
1957	25	30	25		5		15	100	
1958	25	30	25		5		15	100	
1959	25	30	25		5		15	100	
1960	25	30	25		5		15	100	

User notes: 4.A - Time Series

METHANE (CH4) Emissions (Gq CO2 Equivalents)

\* Base year for assessment of uncertainty in trend: 1990

1.19 Replicate steps 2.5 and 2.6 using the IPCC default values for the following tabs (see illustration below):

**Table 6: Default values for each of the different types of sites.**  
They should all give a total of 100%.

Unmanaged		Managed		Uncategorized	Distribution Check
Unmanaged - Shallow %	Unmanaged- Deep %	Managed- Anaerobic	Managed well – semi-aerobic %	Uncategorized SWDS %	Total (%)
25	30	25	5	15	<b>100%</b>

Parameters SWDSTypes - Utilization Activity Data Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A - Solid Waste Disposal

Sheet: SWDS Types - Utilization

2016

Data

Subdivision Unspecified Waste Category Municipal Waste

Year	Unmanaged		Managed				Uncategorised	Distribution	Check	
	Unmanaged – shallow (%)	Unmanaged – deep (%)	Managed – anaerobic (%)	Managed poorly – semi-aerobic (%)	Managed well – semi-aerobic (%)	Managed poorly – active aeration (%)	Managed well – active aeration (%)	Uncategorised SWDS (%)	Total (%)	
1950	25	30	25		5			15	100	
1951	25	30	25		5			15	100	
1952	25	30	25		5			15	100	
1953	25	30	25		5			15	100	
1954	25	30	25		5			15	100	
1955	25	30	25		5			15	100	
1956	25	30	25		5			15	100	
1957	25	30	25		5			15	100	
1958	25	30	25		5			15	100	
1959	25	30	25		5			15	100	
1960	25	30	25		5			15	100	

User notes

Time Series

METHANE (CH4) Emissions (Gg CO<sub>2</sub> equivalents)

\* Base year for assessment of uncertainty in trend: 1990

Select the default values from the drop down tabs for each of the different sites indicated by the red arrows

1.20 Select "Activity Data" at the near top of the page (See illustration below)

Parameters SWDSTypes - Utilization **Activity Data** Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet  
**Sector:** Waste  
**Category:** Methane emissions from Solid Waste Disposal Sites  
**Subcategory:** 4.A - Solid Waste Disposal  
**Sheet:** Activity Data

*Select the "Activity Data" at the near top of the page*

Data  
**Subdivision** Unspecified **Waste Category** Municipal Waste **Total Waste** Calculated from Population **Waste Type Amounts** % of Total Waste going to SWDS

Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	Total
	A	B	C = A * B * 10 <sup>-6</sup>	D	E = C * (D/100)	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%
1950														0
1951														0
1952														0
1953														0
1954														0
1955														0
1956														0
1957														0
1958														0

User notes  
 4.A - Time Series  
 METHANE (CH4) Emissions (Gg CO2 Equivalents)

\* Base year for assessment of uncertainty in trend: 1990

1.21 Click on the "subdivision" tab and select "Unspecified" (see illustration below).

Parameters SWDSTypes - Utilization **Activity Data** Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet  
**Sector:** Waste  
**Category:** Methane emissions from Solid Waste Disposal Sites  
**Subcategory:** 4.A - Solid Waste Disposal  
**Sheet:** Activity Data

*Click on the "Subdivision" tab and select "Unspecified"*

Data  
**Subdivision** Unspecified **Waste Category** Municipal Waste **Total Waste** Calculated from Population **Waste Type Amounts** % of Total Waste going to SWDS

Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	Total
	A	B	C = A * B * 10 <sup>-6</sup>	D	E = C * (D/100)	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%
1950														0
1951														0
1952														0
1953														0
1954														0
1955														0
1956														0
1957														0
1958														0

User notes  
 4.A - Time Series  
 METHANE (CH4) Emissions (Gg CO2 Equivalents)

1.22 Click on the Waste Sector tab and select “Municipal Waste”, see illustration below.

Parameters SWDSTypes - Utilization **Activity Data** Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste 2016

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A - Solid Waste Disposal

Sheet: Activity Data

Data

Subdivision: Unspecified **Waste Category: Municipal Waste** Total Waste: Calculated from Population Waste Type Amounts: % of Total Waste going to SWDS

Composition of waste going to solid waste disposal sites.														
Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	Total
	A	B	$C = A * B * 10^{-6}$	D	$E = C * (D/100)$	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%
1950														0
1951														0
1952														0
1953														0
1954														0
1955														0
1956														0
1957														0
1958														0

User notes

4.A - Time Series

METHANE (CH4) Emissions (Gg CO2 Equivalents)

1.23 Click on the Total Waste drop-down tab and select “Calculated from the population”

Parameters SWDSTypes - Utilization **Activity Data** Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste 2016

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A - Solid Waste Disposal

Sheet: Activity Data

Data

Subdivision: Unspecified **Waste Category: Municipal Waste** **Total Waste: Calculated from Population** Waste Type Amounts: % of Total Waste going to SWDS

Composition of waste going to solid waste disposal sites.														
Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	Total
	A	B	$C = A * B * 10^{-6}$	D	$E = C * (D/100)$	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%
1950														0
1951														0
1952														0
1953														0
1954														0
1955														0
1956														0
1957														0
1958														0

User notes

4.A - Time Series

1.24 Click on the “Waste Type Amounts” drop-down tab and select “% of Total Waste going to SWDS”.

Parameters SWDSTypes - Utilization Activity Data Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A - Solid Waste Disposal

Sheet: Activity Data

Data

Subdivision Unspecified Waste Category Municipal Waste Total Waste Calculated from Population Waste Type Amounts % of Total Waste going to SWDS

Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Composition of waste going to solid waste disposal sites.										Total	%		
						Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	% of E	% of E				
	A	B	$C = A * B * 10^{-6}$	D	$E = C * (D/100)$	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%			
1950																0			
1951																0			
1952																0			
1953																0			
1954																0			
1955																0			
1956																0			
1957																0			
1958																0			

User notes 4.A - Time Series

1.25 Enter the data for the population under the “Population n (Capita)” tab for the years 1950 to 2023 (see Illustration below).

Parameters SWDSTypes - Utilization Activity Data Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A - Solid Waste Disposal

Sheet: Activity Data

Data

Subdivision Unspecified Waste Category Municipal Waste Total Waste Calculated from Population Waste Type Amounts % of Total Waste going to SWDS

Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Composition of waste going to solid waste disposal sites.										Total	%		
						Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	% of E	% of E				
	A	B	$C = A * B * 10^{-6}$	D	$E = C * (D/100)$	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%				
1950																0			
1951																0			
1952																0			
1953																0			
1954																0			
1955																0			
1956																0			
1957																0			
1958																0			

User notes 4.A - Time Series



1.26 Under the “Waste per Capita (Kg/cap/yr.)” tab, enter 690 as the Regional Default value. Enter national data if available. See illustration below. (See 2006 IPCC Guideline, Vol.5, pg. 19, Table 2A.1).

Parameters SWDSTypes - Utilization Activity Data Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste 2016

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A - Solid Waste Disposal

Sheet: Activity Data

Data

Subdivision: Unspecified Waste Category: Municipal Waste Total Waste: Calculated from Population Waste Type Amounts: % of Total Waste going to SWDS

Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Composition of waste going to solid waste disposal sites.									
						Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	Total	
	A	B	$C = A * B * 10^{-6}$	D	$E = C * (D/100)$	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%	
1950		690													
1951		690													
1952		690													
1953		690													
1954		690													
1955		690													
1956		690													
1957		690													
1958		690													

Enter the Regional Default Value for years 1950 to 2023

1.27 Click on the green cell below “Total Waste (Gg)” to generate the value (see illustration below).

Worksheet

Sector: Waste 2016

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A - Solid Waste Disposal

Sheet: Activity Data

Data

Subdivision: Unspecified Waste Category: Municipal Waste Total Waste: Calculated from Population Waste Type Amounts: % of Total Waste going to SWDS

Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Composition of waste going to solid waste disposal sites.									
						Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	Total	
	A	B	$C = A * B * 10^{-6}$	D	$E = C * (D/100)$	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%	
1950	230	690	0.1587												
1951		690													
1952		690													
1953		690													
1954		690													
1955		690													
1956		690													
1957		690													
1958		690													

Click on the green cells to generate the value of " Total waste (Gg).

1.28 Under the “% to SWDS (%)”, enter 85 for all years starting from 1950 to 2023 (see illustration below).

Parameters SWDSTypes - Utilization Activity Data Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste  
 Category: Methane emissions from Solid Waste Disposal Sites  
 Subcategory: 4.A - Solid Waste Disposal  
 Sheet: Activity Data

2016

Data

Subdivision: Unspecified Waste Category: Municipal Waste Total Waste: Calculated from Population Waste Type Amounts: % of Total Waste going to SWDS

Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Composition of waste going to solid waste disposal sites.									
						Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	Total	
	A	B	$C = A * B * 10^{-6}$	D	$E = C * (D/100)$	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%	
1950	230	690	0.1587	85	0.1349									0	
1951		690		85										0	
1952		690		85										0	
1953		690		85										0	
1954		690		85										0	
1955		690		85										0	
1956		690		85										0	
1957		690		85										0	
1958		690		85										0	

User notes 4.A - Time Series

1.29 Click the green cell under the “Total to SWDS) to generate the value.

1.30 For each of the following waste compositions going to a solid waste disposal facility, enter the default values by clicking on the drop-down button and choosing the default value (See Illustration below). (See 2006 IPCC guidelines, Vol.5, page12, Table 2.3). Enter national data if available.

Parameters SWDSTypes - Utilization Activity Data Amount Deposited Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste  
 Category: Methane emissions from Solid Waste Disposal Sites  
 Subcategory: 4.A - Solid Waste Disposal  
 Sheet: Activity Data

2016

Data

Subdivision: Unspecified Waste Category: Municipal Waste Total Waste: Calculated from Population Waste Type Amounts: % of Total Waste going to SWDS

Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Composition of waste going to solid waste disposal sites.									
						Food waste	Garden and park	Disposable nappies	Paper and cardboard	Textile	Wood	Bulk Municipal Waste	Inert	Total	
	A	B	$C = A * B * 10^{-6}$	D	$E = C * (D/100)$	% of E	% of E	% of E	% of E	% of E	% of E	% of E	% of E	%	
1950	230	690	0.1587	85	0.1349	67.5			6		2.5		24	100	
1951		690		85										0	
1952		690		85										0	
1953		690		85										0	
1954		690		85										0	
1955		690		85										0	
1956		690		85										0	
1957		690		85										0	
1958		690		85										0	

User notes 4.A - Time Series

1.31 Click on the Green cell under the “Total” tab, it should total up to 100%.

1.32 Go to the “2006 IPCC categories” tab and select “4.A.1 – Managed Waste Disposal Sites” (See illustration below).

The screenshot shows the '2006 IPCC Categories' interface. On the left, a tree view shows the hierarchy: 4 - Waste > 4.A - Solid Waste Disposal > 4.A.1 - Managed Waste Disposal Sites. A red arrow points to this category. The main area displays a table for 'SWDS' types. The table has a header row with four main categories: 'Managed - anaerobic', 'Managed poorly - semi-aerobic', 'Managed well - semi-aerobic', and 'Managed well - active aeration'. Each of these has two sub-columns: 'MCF (Fraction)' and 'OX (Fraction)'. The rows represent years from 1950 to 1960. A red arrow points to the cell for 'Managed - anaerobic' in the year 1950, with the text 'Click on the Category 4.A.1' next to it. Below the table, there is a 'Time Series' chart titled 'METHANE (CH4) Emissions (Gg CO2 Equivalents)' with a grid for years from 1990 to 2025.

1.33 Enter the following default values from the table below for the Managed – anaerobic and Managed Well- semi-aerobic into the cells for the years 1950 to 2023. For the other SWDS enter 0. (See illustration below).

**Table 7: Default value for MCF (fraction) and OX for the 2 types of SWDS**

	Managed - anaerobic		Managed well- Semi aerobic	
Year	MCF (fraction)	OX (fraction)	MCF	OX (fraction)
1950 - 2023	1	0	0.5	0

( See 2006 IPCC Guidelines, Vol.5, pg 14, Table 3.1)

SWDS Types - MCF and OX Methane Generated Methane Emissions

Worksheet  
Sector: Waste  
Category: Methane emissions from Solid Waste Disposal Sites  
Subcategory: 4.A.1 - Managed Waste Disposal Sites  
Sheet: SWDS Types - Methane Correction Factors and Oxidation Factors  
Date: 1950 to 2023  
Subdivision: Unspecified

2016

Year	Managed - anaerobic		Managed poorly - semi-aerobic		Managed well - semi-aerobic		Managed poorly - active aeration		Managed well - active aeration	
	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)
1950	1	0	0	0	0.5	0	0	0	0	0
1951	1	0	0	0	0.5	0	0	0	0	0
1952	1	0	0	0	0.5	0	0	0	0	0
1953	1	0	0	0	0.5	0	0	0	0	0
1954	1	0	0	0	0.5	0	0	0	0	0
1955	1	0	0	0	0.5	0	0	0	0	0
1956	1	0	0	0	0.5	0	0	0	0	0
1957	1	0	0	0	0.5	0	0	0	0	0
1958	1	0	0	0	0.5	0	0	0	0	0
1959	1	0	0	0	0.5	0	0	0	0	0

User notes 4.A.1 - Time Series

1.34 Click on “Methane Generated” tab at the upper corner of the page (see illustration below).

SWDS Types - MCF and OX Methane Generated Methane Emissions

Worksheet  
Sector: Waste  
Category: Methane emissions from Solid Waste Disposal Sites  
Subcategory: 4.A.1 - Managed Waste Disposal Sites  
Sheet: SWDS Types - Methane Correction Factors and Oxidation Factors  
Date: 1950 to 2023  
Subdivision: Unspecified

Year	Managed - anaerobic		Managed poorly - semi-aerobic		Managed well - semi-aerobic		Managed poorly - active aeration		Managed well - active aeration	
	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)
1950	1	0	0	0	0.5	0	0	0	0	0
1951	1	0	0	0	0.5	0	0	0	0	0
1952	1	0	0	0	0.5	0	0	0	0	0
1953	1	0	0	0	0.5	0	0	0	0	0
1954	1	0	0	0	0.5	0	0	0	0	0
1955	1	0	0	0	0.5	0	0	0	0	0
1956	1	0	0	0	0.5	0	0	0	0	0
1957	1	0	0	0	0.5	0	0	0	0	0
1958	1	0	0	0	0.5	0	0	0	0	0
1959	1	0	0	0	0.5	0	0	0	0	0
1960	1	0	0	0	0.5	0	0	0	0	0
1961	1	0	0	0	0.5	0	0	0	0	0
1962	1	0	0	0	0.5	0	0	0	0	0

User notes 4.A.1 - Time Series

1.35 Click on the “SWDS Type” and select “Managed – anaerobic” (see illustration below).

Worksheet: 2016  
 Sector: Waste  
 Category: Methane emissions from Solid Waste Disposal Sites  
 Subcategory: 4.A.1 - Managed Waste Disposal Sites  
 Sheet: Methane Generated across SWDS Types and Waste Types

Data  
 Subdivision: Unspecified  
**SWDS Type: Managed - anaerobic**  
 Waste Category: Municipal Waste  
 Waste Type: Food waste  
 DOC

k 0.4 Half-life time (h=ln(2)/k) 1.7328679513e exp1=exp(-k) 0.67032004603e Month of reaction start (M) 13 exp2=exp(-k\*((13-M)/12)) 1

Year	Amount deposited (Gg)	MCF (Fraction)	Decomposable DOC (DDOCm) deposited (Gg)	DDOCm not reacted in deposition year (Gg)	DDOCm decomposed in deposition year (Gg)	DDOCm accumulated in SWDS at the end of year (Gg)	DDOCm decomposed (Gg)	CH4 generated (Gg)
Year	W	MCF	$D = W * DOC * DOC^k / MCF$	$B = D * exp2$	$C = D * (1-exp2)$	$H = B + (H(y-1) * exp1)$	$E = C + H(y-1) * (1-exp1)$	$Q = E * 16/12 * F$
1950	5.10378	1	0.5359	0.5359	0	0.5359	0	0
1951	5.18929	1	0.54488	0.54488	0	0.9041	0.17667	0.11778
1952	5.28124	1	0.55453	0.55453	0	1.16057	0.29806	0.19871
1953	5.38516	1	0.56544	0.56544	0	1.34339	0.38262	0.25508
1954	5.49769	1	0.57726	0.57726	0	1.47776	0.44289	0.29526
1955	5.61863	1	0.58996	0.58996	0	1.58053	0.48719	0.32479
1956	5.7474	1	0.60348	0.60348	0	1.66294	0.52107	0.34738
1957	5.8917	1	0.61863	0.61863	0	1.73333	0.54824	0.36549
1958	6.05114	1	0.63537	0.63537	0	1.79725	0.57144	0.38096
1959	6.2185	1	0.65294	0.65294	0	1.85768	0.59252	0.39501

1.36 The green cell under the “CH4 generated (Gg)” will give the amount of methane generated for each year (see illustration below).

Worksheet: 2016  
 Sector: Waste  
 Category: Methane emissions from Solid Waste Disposal Sites  
 Subcategory: 4.A.1 - Managed Waste Disposal Sites  
 Sheet: Methane Generated across SWDS Types and Waste Types

Data  
 Subdivision: Unspecified  
**SWDS Type: Managed - anaerobic**  
 Waste Category: Municipal Waste  
 Waste Type: Food waste  
 DOC

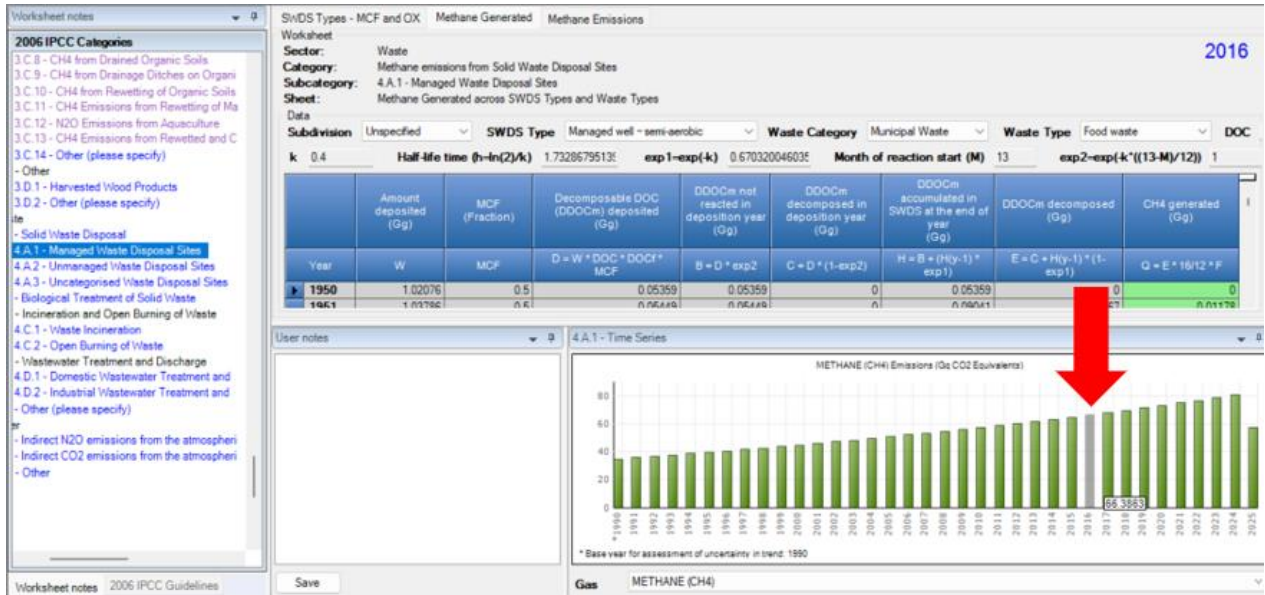
k 0.4 Half-life time (h=ln(2)/k) 1.7328679513e exp1=exp(-k) 0.67032004603e Month of reaction start (M) 13 exp2=exp(-k\*((13-M)/12)) 1

Year	Amount deposited (Gg)	MCF (Fraction)	Decomposable DOC (DDOCm) deposited (Gg)	DDOCm not reacted in deposition year (Gg)	DDOCm decomposed in deposition year (Gg)	DDOCm accumulated in SWDS at the end of year (Gg)	DDOCm decomposed (Gg)	CH4 generated (Gg)
Year	W	MCF	$D = W * DOC * DOC^k / MCF$	$B = D * exp2$	$C = D * (1-exp2)$	$H = B + (H(y-1) * exp1)$	$E = C + H(y-1) * (1-exp1)$	$Q = E * 16/12 * F$
1950	5.10378	1	0.5359	0.5359	0	0.5359	0	0
1951	5.18929	1	0.54488	0.54488	0	0.9041	0.17667	0.11778
1952	5.28124	1	0.55453	0.55453	0	1.16057	0.29806	0.19871
1953	5.38516	1	0.56544	0.56544	0	1.34339	0.38262	0.25508
1954	5.49769	1	0.57726	0.57726	0	1.47776	0.44289	0.29526
1955	5.61863	1	0.58996	0.58996	0	1.58053	0.48719	0.32479
1956	5.7474	1	0.60348	0.60348	0	1.66294	0.52107	0.34738
1957	5.8917	1	0.61863	0.61863	0	1.73333	0.54824	0.36549
1958	6.05114	1	0.63537	0.63537	0	1.79725	0.57144	0.38096
1959	6.2185	1	0.65294	0.65294	0	1.85768	0.59252	0.39501

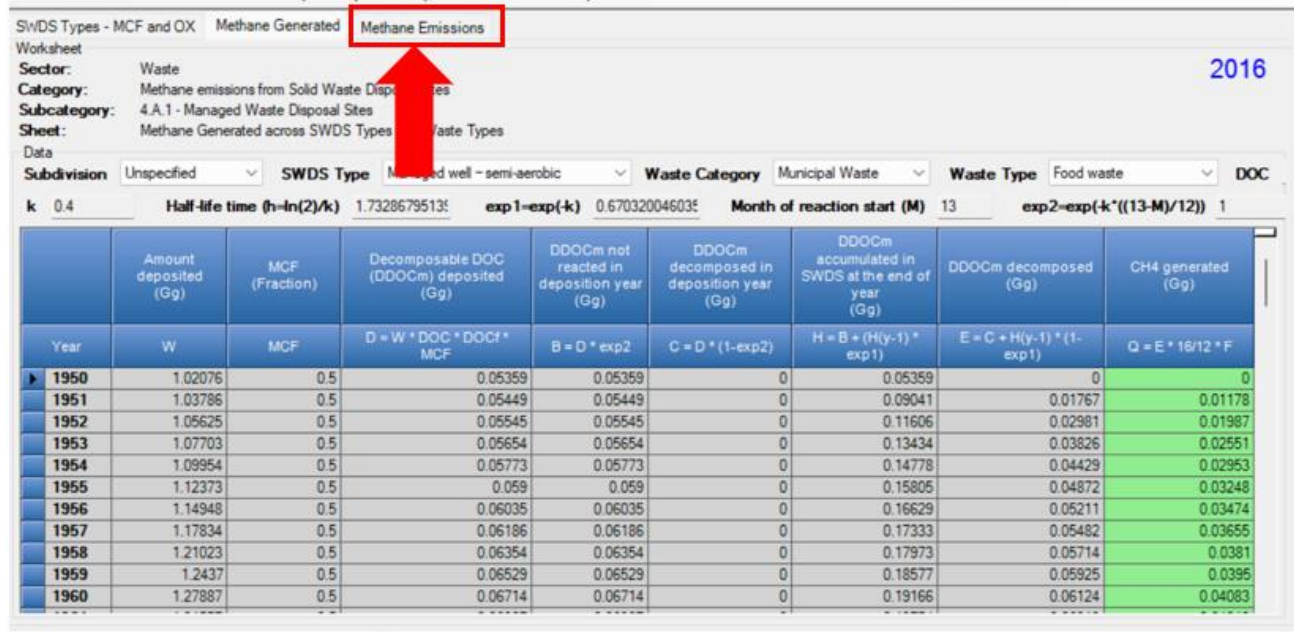
1.37 Repeat steps 1.35 and 1.36 by selecting “Managed well- semi aerobic” from the “SWDS Type”.



1.38 Run the Cursor over the graph below to give the CH<sub>4</sub> Emissions (Gg CO<sub>2</sub> Equivalent) (see illustration below).



1.39 Click on the tab “Methane Emissions” at the top-hand corner of the page (see illustration below)





1.40 Green cells under the "Methane Emissions" tab display the total methane emission for a given year for the designated SWDS type (see illustration below).

Worksheet: SwDS Types - MCF and OX Methane Generated Methane Emissions

Sector: Waste  
 Category: Methane emissions from Solid Waste Disposal Sites  
 Subcategory: 4.A.1 - Managed Waste Disposal Sites  
 Sheet: Methane Emissions

Data  
 Subdivision: Unspecified SWDS Type: Managed - anaerobic

2016

Year	Methane generated				Total methane generated (Gg)	Methane recovered		Methane oxidised		Methane Emissions
	Municipal Waste (Gg)	Industrial Waste (Gg)	Sludge (Gg)	Other waste (Gg)		Flaring (Gg)	Energy use (Gg)	OX (Fraction)	Methane oxidised (Gg)	Methane Emissions (Gg)
	A	B	C	D	E = A + B + C + D	F	G	H	I = (E - F - G) * H	J = E - F - G - I
1953	0.26949	0	0	0	0.26949			0	0	0.26949
1954	0.31409	0	0	0	0.31409			0	0	0.31409
1955	0.34788	0	0	0	0.34788			0	0	0.34788
1956	0.37458	0	0	0	0.37458			0	0	0.37458
1957	0.39669	0	0	0	0.39669			0	0	0.39669
1958	0.41605	0	0	0	0.41605			0	0	0.41605
1959	0.43392	0	0	0	0.43392			0	0	0.43392
1960	0.45095	0	0	0	0.45095			0	0	0.45095
1961	0.46761	0	0	0	0.46761			0	0	0.46761
1962	0.4842	0	0	0	0.4842			0	0	0.4842
1963	0.50089	0	0	0	0.50089			0	0	0.50089
1964	0.51785	0	0	0	0.51785			0	0	0.51785

Uncertainties

User notes: 4.A.1 - Time Series

1.41 Click on the 4.A.2 – “Unmanaged Waste Disposal” under the “2006 IPCC categories” tab (see illustration below)

Worksheet notes: 2006 IPCC Categories

- 3.C.8 - CH4 from Drained Organic
- 3.C.9 - CH4 from Drainage Ditches
- 3.C.10 - CH4 from Rewetting of Org
- 3.C.11 - CH4 Emissions from Rewe
- 3.C.12 - N2O Emissions from Aqua
- 3.C.13 - CH4 Emissions from Rewe
- 3.C.14 - Other (please specify)
- 3.D - Other
  - 3.D.1 - Harvested Wood Products
  - 3.D.2 - Other (please specify)
- 4 - Waste
  - 4.A - Solid Waste Disposal
    - 4.A.1 - Managed Waste Disposal Sites
    - 4.A.2 - Unmanaged Waste Disposal**
    - 4.A.3 - Unincinerated Waste Dispo
  - 4.B - Biological Treatment of Solid Was
  - 4.C - Incineration and Open Burning of
    - 4.C.1 - Waste Incineration
    - 4.C.2 - Open Burning of Waste
  - 4.D - Wastewater Treatment and Disch
    - 4.D.1 - Domestic Wastewater Treat
    - 4.D.2 - Industrial Wastewater Treat
  - 4.E - Other (please specify)
- 5 - Other
  - 5.A - Indirect N2O emissions from the a
  - 5.B - Indirect CO2 emissions from the a
  - 5.C - Other

Worksheet: SwDS Types - MCF and OX Methane Generated Methane Emissions

Sector: Waste  
 Category: Methane emissions from Solid Waste Disposal Sites  
 Subcategory: 4.A.2 - Unmanaged Waste Disposal Sites  
 Sheet: SWDS Types - Methane Correction Factors and Oxidation Factors

Data  
 Subdivision: Unspecified

2016

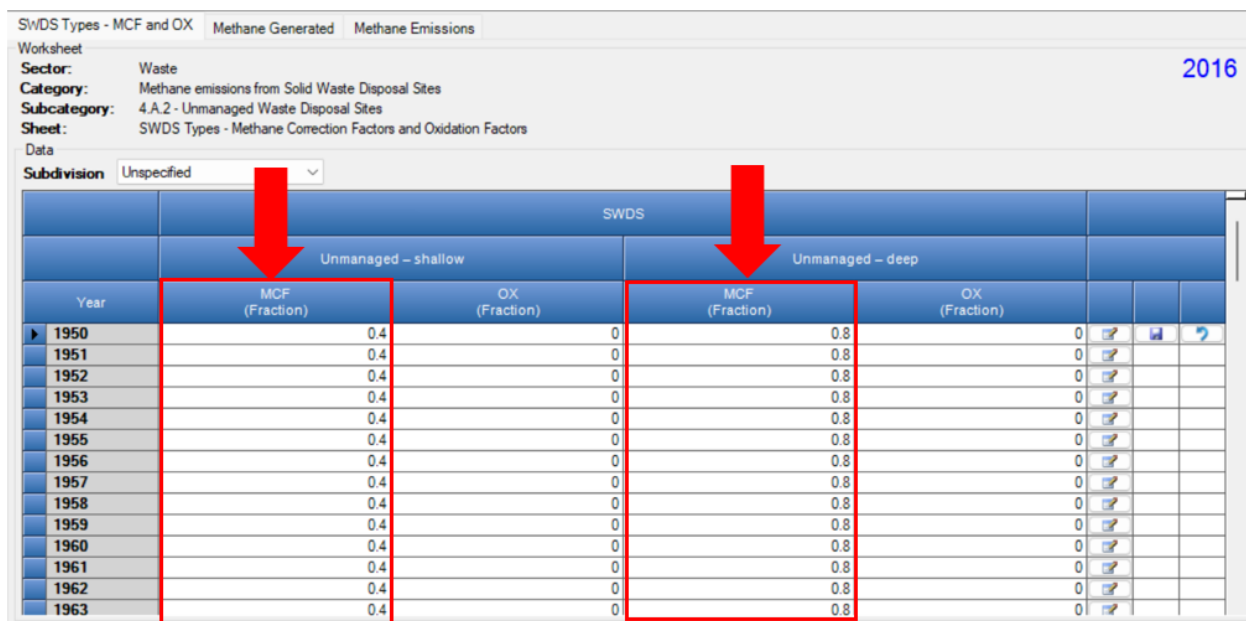
Year	SWDS			
	Unmanaged - shallow		Unmanaged - deep	
	MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)
1952	0.4	0	0.8	0
1953	0.4	0	0.8	0
1954	0.4	0	0.8	0
1955	0.4	0	0.8	0
1956	0.4	0	0.8	0
1957	0.4	0	0.8	0
1958	0.4	0	0.8	0
1959	0.4	0	0.8	0
1960	0.4	0	0.8	0
1961	0.4	0	0.8	0
1962	0.4	0	0.8	0
1963	0.4	0	0.8	0

1.42 Under “SWDS Types – MCF and OX” tab, enter the following default value from the table below into the cells accordingly for all years 1950 to 2023 (see illustration below).

**Table 8: Default values for MCF and OX under the Unmanaged Waste Disposal Sites**

SWDS			
Unmanaged Shallow		Unmanaged Deep	
MCF (Fraction)	OX (Fraction)	MCF (Fraction)	OX (Fraction)
0.4	0	0.8	0

(See 2006 IPCC Guidelines, Vol.5, pg 14, Table 3.1)



1.43 Run the cursor over the graph to give the CH<sub>4</sub> Emissions (Gg Co<sub>2</sub> Equivalent) (see illustration in step 4.0).

1.44 Repeat steps 1.34 to 1.40 for category “4.A.2 – Unmanaged Waste Disposal”.

1.45 Click on the category “4.A.3-Uncategorised Waste Disposal” under the “2006 IPCC categories” (see illustration below).

IPCC Inventory Software - ANITAKAY - [Worksheets]

Application Database Inventory Year Administrate Worksheets Tools Export/Import Reports Wind

**2006 IPCC Categories**

- 3.C.9 - CH4 from Drainage
- 3.C.10 - CH4 from Rewetting
- 3.C.11 - CH4 Emissions from
- 3.C.12 - N2O Emissions from
- 3.C.13 - CH4 Emissions from
- 3.C.14 - Other (please specify)
- 3.D - Other
  - 3.D.1 - Harvested Wood Pro
  - 3.D.2 - Other (please specify)
- 4 - Waste
  - 4.A - Solid Waste Disposal
    - 4.A.1 - Managed Waste Disp
    - 4.A.2 - Unmanaged Waste D
    - 4.A.3 - Uncategorised Waste**
  - 4.B - Biological Treatment of Sol
  - 4.C - Incineration and Open Bur
    - 4.C.1 - Waste Incineration
    - 4.C.2 - Open Burning of Was
  - 4.D - Wastewater Treatment and
    - 4.D.1 - Domestic Wastewater
    - 4.D.2 - Industrial Wastewater
  - 4.E - Other (please specify)
- 5 - Other
  - 5.A - Indirect N2O emissions fro
  - 5.B - Indirect CO2 emissions fro
  - 5.C - Other

SWDS Types - MCF and OX Methane Generated Methane Emissions

Worksheet

Sector: Waste

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A.3 - Uncategorised Waste Disposal Sites

Sheet: SWDS Types - Methane Correction Factors and Oxidation Factors

Data

Subdivision: Unspecified

Year	MCF (Fraction)
1951	
1952	
1953	
1954	
1955	
1956	
1957	
1958	
1959	

User notes

1.46 under the “SWDS Types -MCF and OX” tab, enter the IPCC default value for MCF = 0.6 and OX = 0 (see illustration below)

SWDS Types - MCF and OX Methane Generated Methane Emissions

Worksheet

Sector: Waste

Category: Methane emissions from Solid Waste Disposal Sites

Subcategory: 4.A.3 - Uncategorised Waste Disposal Sites

Sheet: SWDS Types - Methane Correction Factors and Oxidation Factors

Data

Subdivision: Unspecified

2016

Enter 0.6

Enter 0

Year	MCF (Fraction)	OX (Fraction)
1950	0.6	0
1951	0.6	0
1952	0.6	0
1953	0.6	0
1954	0.6	0
1955	0.6	0
1956	0.6	0
1957	0.6	0
1958	0.6	0
1959	0.6	0
1960	0.6	0

User notes

4.A.3 - Time Series

METHANE (CH4) Emissions (Gg CO2 Equivalents)

0.08  
0.06  
0.04  
0.02  
0

1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

\* Base year for assessment of uncertainty in trend: 1990

1.47 Run the Cursor over the graph below to give the CH<sub>4</sub> Emissions (Gg Co<sub>2</sub> Equivalent) (see illustration in step 1.38)

1.48 Repeat steps 1.34 to 1.40 for the category “4.A.3-Uncategorised Waste Disposal”.

### **4.3.3 TIME SERIES**

According to the report produced by The Republic of Vanuatu Third National Communication to the United Nations Framework Convention on Climate Change (2020), the key source of emission from solid waste managed and disposed of included emissions from anaerobic decomposition of waste management of aerobic decomposition at the Bouffa landfill site<sup>2</sup>.

Tier 1 method – IPCC First Order Decay (FOD) was used in the Third National Inventory report (2020) which covered the years 2008 to 2015. The method mainly consisted of the usage of Default value, default activity data, and default parameters <sup>1</sup>.

Estimates of MSW generation in Vanuatu are based on the urban populations of Port Vila, Luganville, and Lenakel in the lack of activity statistics. The majority of data is gathered from urban regions rather than rural ones because those locations are typically dispersed and fail to identify many hazards. An average figure of 1-1.5 kg/person/day was extracted from a 2015 study in which the J-PRISM team was involved <sup>1</sup>.

The Director General of the Ministry of Climate Change used office notifications to notify relevant ministries and departments, specified organizations, the public-private sector, and other institutions to collect data for this inventory period. The Department of Climate Change is responsible for maintaining the gathered data, database repository, and archives <sup>1</sup>.

Following the 2006 IPCC Guidelines, Vol. 5, Figure 3.1, the Tier 1 Method Approach specifically IPCC First Order Decay (FOD) will be used for this inventory. Estimated Emissions will be calculated using historical data and present up-to-date data.

To collect information, the Project Coordinator and the Consultants will notify Offices relevant to ministries and stakeholders such as the:

- Department of Environmental Protection and Conservation (DEPC)
- Department of Water Resources (DWR)
- Port Vila City Council (PVCC)
- Environment Unit, Public Health at the Ministry of Health
- Department of Climate Change (DOCC)
- UNELCO Engie
- Public Works Department (PWD)

The channels for requesting activity data meetings are the Electronic Single Window, emails, dialogues, and interviews. Consultants may ask the Prime Minister's Office for a Confidential Agreement or Right to Information (RTI) in specific situations where data is unavailable.

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<sup>2</sup> *The Republic of Vanuatu Third National Communication to the United Nations Framework Convention on Climate Change | Vanuatu Environment Data Portal (2020)*

**Table 9: Annual emissions data from the base year of 1994 through 2023, including the emissions values, their units, the emission factors, and the methods used to estimate the emissions.**

Year	Emissions	Units	EF	Methods
1994	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
1995	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
1996	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
1997	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
1998	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
1999	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2000	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2001	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2002	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2003	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2004	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2005	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2006	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2007	22.44	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2008	23.3	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2009	24.1	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2010	24.9	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2011	25.8	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2012	26.7	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2013	27.7	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2014	28.6	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2015	29.6	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2016	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2017	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2018	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2019	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2020	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2021	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2022	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1
2023	NE	kt CO <sub>2</sub> -e	0.15Kg CH <sub>4</sub> / kg DOC	Tier 1

Where:

NE = Not Estimated

In improving this, the sector concern should strengthen the monitoring and reporting system for past years that are missing to satisfy the inventory process in moving forward.



The base year for MSW begins in 1994, and the collection of data will begin from 1994 to 2023. The emissions were calculated using the Tier 1 methodology approach with the default IPCC parameters and EF. The values in the Emissions need to be updated therefore no information has been placed in the table for years 1994 to 2006 and from 2016 to 2023.

Identifying Trends, Big Variations, And Outliers with A Transparent Explanation

As may be observed from the graph below, which was taken from the Third National Inventory (2020), when it comes to identifying trends and outliers The graph below shows that between 2007 and 2017, there was an increase in Gg CH<sub>4</sub> emissions (MSW). The growing population is the cause of the increase in emissions.

Certain trends in data can be caused by a variety of factors, including changes in underlying conditions, external influences, or anomalies such as outliers.

1. Inadequate data management system
2. The majority of the data was erased from the government system following a hack, even after it was restored.

**Figure 2: Emissions of CH<sub>4</sub> and N<sub>2</sub>O (in Gg) from Solid Waste Disposal and Wastewater, 2007–2015**

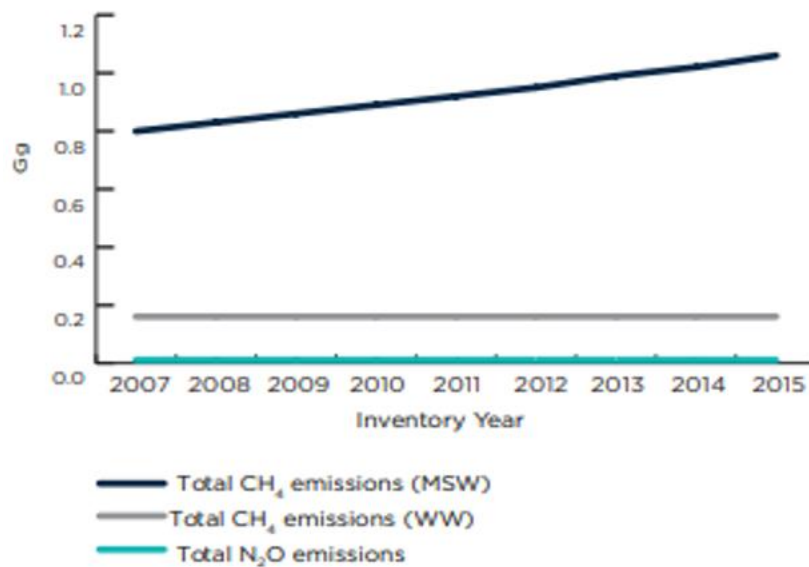


Figure 4.2: Source: Vanuatu’s Third National Inventory (2020).

The figure depicts an increase in the CH<sub>4</sub> (g) emissions across the years of 2007 to 2015 compared to the other categories of Waste such as Wastewater in grey and blue in the graph above.

#### 4.3.4. QUALITY CONTROL/ QUALITY CHECK

##### QUALITY CONTROL (QC) METHOD

**Table 10: QC activities and procedures that will be followed**

The three consultants will handle the QC and Procedures based on the color in the table, Anita Kay-Pink, Floranca- Green, and Zechariah Bani- Blue.

QUALITY CONTROL CHECK	PROCEDURES	TIME TAKEN TO COMPLETE PROCEDURE (DAYS)	COMMENTS
Check the Assumptions and criteria for the selection of activity data, emissions factor, and other estimation parameters	<ul style="list-style-type: none"> <li>• Confirm that estimates are reported for all categories and all years from the appropriate base year to the period of the current inventory.</li> </ul>		
	<ul style="list-style-type: none"> <li>• For subcategories, confirm that the entire category is being covered.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Provide a clear definition of ‘Other’ type categories.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate concerning total emissions (e.g., subcategories classified as ‘not estimated’, see Chapter 8, Reporting Guidance and Tables).</li> </ul>		
Check for transcriptions Errors in the data input and references	<ul style="list-style-type: none"> <li>• Confirm that bibliographical data references are properly cited in the internal documentation.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Cross-check a sample of input data from each category (either measurements or</li> </ul>		

	parameters used in calculations) for transcription errors.		
Check that emissions and removals are calculated correctly	<ul style="list-style-type: none"> <li>• Reproduce a set of emissions and removal calculations.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Use a simple approximation method that gives similar results to the original and more complex calculation to ensure that there is no data input error or calculation error.</li> </ul>		
Check that parameters and units are correctly recorded and that appropriate conversion factors are used.	<ul style="list-style-type: none"> <li>• Check that units are properly labeled in calculation sheets.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that units are correctly carried through from beginning to end of calculations.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that conversion factors are correct.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that temporal and spatial adjustment factors are used correctly.</li> </ul>		
Check the integrity of database files	<ul style="list-style-type: none"> <li>• Examine the included intrinsic documentation (see also Box 6.4) to:</li> </ul>		
	1. Confirm that the appropriate data processing steps are correctly represented in the database.		
	2. Confirm that data relationships are correctly represented in the database.		
	3. Ensure that data fields are properly labeled and have the correct design specifications.		
	4. Ensure that adequate documentation of database and model structure and operation are archived.		

<p>Check for consistency in data between categories.</p>	<p>Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emission/removal calculations.</p>		
<p>Check that the movement of inventory data among processing steps is correct.</p>	<ul style="list-style-type: none"> <li>• Check that emissions and removal data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries.</li> <li>• Check that emissions and removal data are correctly transcribed between different intermediate products.</li> </ul>		
<p>Check that uncertainties in emissions and removals are estimated and calculated correctly.</p>	<ul style="list-style-type: none"> <li>• Check that the qualifications of individuals providing expert judgment for uncertainty estimates are appropriate.</li> <li>• Check that qualifications, assumptions, and expert judgments are recorded.</li> <li>• Check that calculated uncertainties are complete and calculated correctly.</li> <li>• If necessary, duplicate uncertainty calculations on a small sample of the probability distributions used by Monte Carlo analyses (for example, using uncertainty calculations according to Approach 1).</li> </ul>		
<p>Check time series consistency.</p>	<ul style="list-style-type: none"> <li>• Check for temporal consistency in time series input data for each category.</li> <li>• Check for consistency in the algorithm/method used for calculations throughout the time series.</li> <li>• Check methodological and data changes resulting in recalculations.</li> </ul>		

	<ul style="list-style-type: none"> <li>• Check that the effects of mitigation activities have been appropriately reflected in time series calculations.</li> </ul>		
Check Completeness	<ul style="list-style-type: none"> <li>• Confirm that estimates are reported for all categories and all years from the appropriate base year to the period of the current inventory.</li> </ul>		
	For subcategories, confirm that the entire category is being covered.		
	<ul style="list-style-type: none"> <li>• Provide a clear definition of ‘Other’ type categories.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate concerning total emissions (e.g., subcategories classified as ‘not estimated’, see Chapter 8, Reporting Guidance and Tables)</li> </ul>		

Trend Check	<ul style="list-style-type: none"> <li>• Confirm that estimates are reported for all categories and all years from the appropriate base year to the period of the current inventory.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check the value of implied emission factors (aggregate emissions divided by activity data) across time series.</li> </ul>		
	1. Do any of the year’s show outliers that are not explained?		
	2. If they remain static across time series, are changes in emissions or removals being captured?		
	<ul style="list-style-type: none"> <li>• Check if there are any unusual and unexplained trends noticed for activity data or other parameters across the time series.</li> </ul>		

<p>Review of internal documentation and archiving.</p>	<ul style="list-style-type: none"> <li>• Check that there is detailed internal documentation to support the estimates and enable the reproduction of the emission, removal, and uncertainty estimates.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that the archive is closed and retained in a secure place following completion of the inventory.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check the integrity of any data archiving arrangements of outside organizations involved in inventory preparation</li> </ul>		

(Table 6.1 GENERAL INVENTORY QC PROCEDURES, volume 1, 2006 IPCC Guidelines for National Greenhouse Gas Inventories).



**Table 11: Responsibilities assigned to each party**

Displayed are the corresponding timelines indicating the duration required for each party to complete their respective tasks

Quality Control Method	Responsibilities	Timeline (Time for completion)
GHG Inventory Team Members (Consultant)	1. Implement QA/QC at all levels of transparency	2 Months
	2. Collect data, Inventory Preparation and Reporting	
	3. Conduct Checks on the consistency of data and information provided by the different stakeholders to ensure data integrity, correctness, and completeness	
TWGS (Technical Working Groups) Specific group consisting of Experts and Professionals	1. Technical Review of sub-category activity data, Emission Factor, Estimation Parameters, and Calculation method	2 - 3 Weeks
	2. Final Check of the Report	
Municipal	According to the United Nations Development Programme (UNDP) and the Government of Vanuatu, municipalities are responsible for managing solid waste in the country. This includes the collection, transportation, disposal, and sometimes treatment of solid waste. To effectively manage waste and allocate resources, accurate data on waste generation is essential.	2 Weeks upon request
Environment Department	The Department of Environmental Protection and Conservation oversees environmental protection and regulation. The department may have information on the generation of MSW	2 Weeks upon request

### **4.3.5 UNCERTAINTIES**

#### **Uncertainty in the method**

As stated by the 2006 IPCC guidelines the following are the reasons behind uncertainty in the method <sup>3</sup>.

A first-order decay reaction may not always be followed in the complex chemical reactions that convert carbon molecules to CH<sub>4</sub>. Reaction rates will fluctuate depending on the circumstances at the particular SWDS, and higher-order reactions might be involved. Restrictions on water access and regional differences in bacterial populations may limit reactions <sup>2</sup>.

- There are variations in SWDS. Even within a single site, conditions like temperature, moisture content, waste composition, and compaction can fluctuate significantly, and even more between sites within a country. It is challenging to choose "average" parameter values that are typical for an entire nation <sup>2</sup>.
- Using the FOD approach adds to the ambiguity around past waste disposal amounts and degradation rates (half-lives). Neither of these has been studied or understood in great detail <sup>2</sup>.
- Using the FOD approach adds to the ambiguity around past waste disposal amounts and degradation rates (half-lives). Neither of these has been studied or understood in great detail (2006 IPCC Guidelines, Vol. 5) <sup>2</sup>.

#### **Uncertainty Associated with Data Uncertainty**

Using the FOD approach adds to the ambiguity around past waste disposal amounts and degradation rates (half-lives). Neither of these has been studied or understood in great detail (2006 IPCC Guidelines, Vol. 5) <sup>2</sup>.

The degree of uncertainty in waste disposal data varies depending on how the data is obtained; it can be reduced when the amounts of waste in the SWDS are weighed; it will be higher if the estimates are based on waste delivery vehicle capacity or visual estimation; and it can be highest for estimates based on default activity data. The quality of CH<sub>4</sub> emission estimates is directly related to the quality and availability of the waste generation, composition, and management data used to derive these estimates (2006 IPCC Guidelines, Vol. 5) <sup>2</sup>.

The activity data in the waste sector includes the total municipal solid waste, total industrial waste, waste composition, and the fraction of solid waste sent to solid waste disposal sites. Waste scavenging at the SWDS must be considered while analyzing the waste disposal data; otherwise, the data's level of uncertainty will rise <sup>2</sup>.

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<sup>3</sup> [nggip.iges.or.jp/public/2006gl/pdf/5\\_Volume5/V5\\_3\\_Ch3\\_SWDS.pdf](http://nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf)

Scavenging will also raise speculations about the composition of the waste that ends up in the SWDS and, in turn, about how much DOC is in the trash generally. Uncertainty estimates for the default model parameters are given in Table 4.12. The estimations are based on expert assessment. waste creation can be estimated using population (or urban population) and per-capita waste generation rates. Uncertainty may be introduced if the population does not match the population from which waste is collected. In many countries, waste is usually collected only from city dwellers. An urban area's population may fluctuate daily or seasonally due to labor force mobility<sup>2</sup>.

### **Uncertainty Associated with Parameters**

The following Uncertainties have been extracted straight from the (2006 IPCC Guidelines, Vol. 5, Pg. 26).

Methane correction factor (MCF) There are two sources of uncertainty in the MCF.

- Uncertainty in the value of the MCF for each type of site (managed-anaerobic, managed-semi-aerobic, unmanaged deep and/or high-water table, unmanaged shallow): These MCF values are based on one experimental study and expert judgment and not on measured data<sup>2</sup>.

- Uncertainty in the classification of sites into the different site types: For example, the distinction between deep and shallow sites (5 m depth of waste) is based on expert opinion. Inevitably, few, if any, countries will be able to classify their unmanaged waste disposal sites into deep and shallow based on measured data. It can also be difficult to determine the sites that meet the IPCC criteria for managed sites. Degradable organic carbon (DOC)

- Uncertainty in setting the DOC for different types of waste types/materials (paper, food, etc.): There are few studies of DOC, and different types of paper, food, wood, and textiles can have very different DOC values. The water content of the waste also has an influence. DOC for industrial waste is very poorly known. Degradable organic carbon (DOC) There are two sources of uncertainty in DOC values<sup>2</sup>.

- Uncertainty in the waste composition affects estimates of total DOC in the SWDS: Waste composition varies widely even within countries (for example, between urban and rural populations, between households on different incomes, and between seasons) as well as between countries<sup>2</sup>.

### **Fraction Of Degradable Organic Carbon Which Decomposes (DOC<sub>f</sub>)**

The uncertainty in DOC<sub>f</sub> is very high. There have been few studies, and it is difficult to replicate real SWDS conditions in experimental studies<sup>2</sup>.

### **Fraction Of CH<sub>4</sub> In Landfill Gas (*F*)**

The CH<sub>4</sub> fraction of generated landfill gas, *F*, is usually taken to be 0.5 but can vary between 0.5 and 0.55, depending on several factors (see Section 3.2.3). The uncertainty in this figure is

relatively low, as  $F$  depends largely on the stoichiometry of the chemical reaction producing  $\text{CH}_4$ . The concentration of  $\text{CH}_4$  in recovered landfill gas may be lower than the actual value because of potential dilution by air, so  $F$  values estimated in this way will not necessarily be representative <sup>2</sup>.

### **Methane recovery (R)**

$\text{CH}_4$  recovery is the amount of  $\text{CH}_4$  generated at SWDS that is recovered and burned in a flare or energy recovery device. The uncertainty depends on the method used to estimate recovered  $\text{CH}_4$ . The uncertainty is likely to be relatively small compared to other uncertainties if metering is used. If other methods are used, for example by estimating the efficiency of  $\text{CH}_4$  recovery equipment, the uncertainty will be larger <sup>2</sup>. (See Section 3.2.3.).

### **Oxidation Factor (OX)**

The oxidation factor is very uncertain because it is difficult to measure, and varies considerably with the thickness and nature of the cover material, atmospheric conditions and climate, the flux of methane, and the escape of methane through cracks/fissures in the cover material. Field and laboratory studies that determine oxidation of  $\text{CH}_4$  only through uniform and homogeneous soil layers may lead to overestimations of oxidation in landfill-cover soils <sup>2</sup>.

### **The Half-Life**

There is high uncertainty in the estimates of half-life because it is difficult to measure decay rates under conditions equivalent to those prevailing in real SWDS. Also, since there is considerable variation in half-life with waste composition, climate, and site type, it is difficult to select values representative of a whole country <sup>2</sup>.

Uncertainty estimates for  $\text{MSW}_T$  (total MSW generated) and  $\text{MSW}_F$  (fraction of  $\text{MSW}_T$  disposed at SWDS) and the default model parameters are given in Table 4.12.

**Table 12: Estimates of uncertainties associated with the default activity data and parameters in the FOD method for CH<sub>4</sub> emissions from SWDs**

Activity data and Emission Factors	Uncertainty Range
Total Municipal Solid Waste (MSWT)	Country-specific: 30% is a typical value for countries that collect waste generation data regularly. ±10% for countries with high-quality data (e.g., weighing at all SWDS and other treatment facilities). For countries with poor quality data: more than a factor of two.
A fraction of MSWT sent to SWDS (MSWF)	±10% for countries with high-quality data (e.g., weighing at all SWDS). ±30% for countries collecting data on disposal at SWDS. For countries with poor quality data: more than a factor of two.
The total uncertainty of Waste composition	±10% for countries with high-quality data (e.g., regular sampling at representative SWDS). ±30% for countries with country-specific data based on studies including periodic sampling. For countries with poor quality data: more than a factor of two.
Degradable Organic Carbon (DOC) <sup>7</sup>	For IPCC default values: ±20% For country-specific values: Based on representative sampling and analyses: ±10%
Fraction of Degradable Organic Carbon Decomposed (DOC <sub>f</sub> )	For IPCC default value (0.5): ± 20% For country-specific value ± 10% for countries based on the experimental data over longer periods.
Methane Correction Factor (MCF) = 1.0 = 0.8 = 0.5 = 0.4 = 0.6	For IPCC default value : -10%, +0% ±20% ±20% ±30% -50%, +60%
Fraction of CH <sub>4</sub> in generated Landfill Gas (F) = 0.5	For IPCC default value: ±5%
Methane Recovery (R)	The uncertainty range will depend on how the amounts of CH <sub>4</sub> recovered and flared or utilized are estimated: ± 10% if metering is in place. ± 50% if metering is not in place.

Oxidation Factor (OX)	Include OX in the uncertainty analysis if a value other than zero has been used for OX itself. In this case, the justification for a non-zero value should include consideration of uncertainties.
half-life (t1/2)	Ranges for the IPCC default values are provided in Annex Table A4.5. Country-specific values should include consideration of uncertainties.
Source: Expert judgment by Lead Authors of the Chapter.	



**DOMESTIC WASTEWATER**

**4.3.6 METHODOLOGY CHOICE FOR DOMESTIC WASTEWATER**

The decisions implemented during this operation are indicated by the red arrows.

**Figure 3: Decision Tree for Method Selection in Estimating Actual Emissions from Sub-Category 4.D.1 Domestic Wastewater Treatment and Discharge**

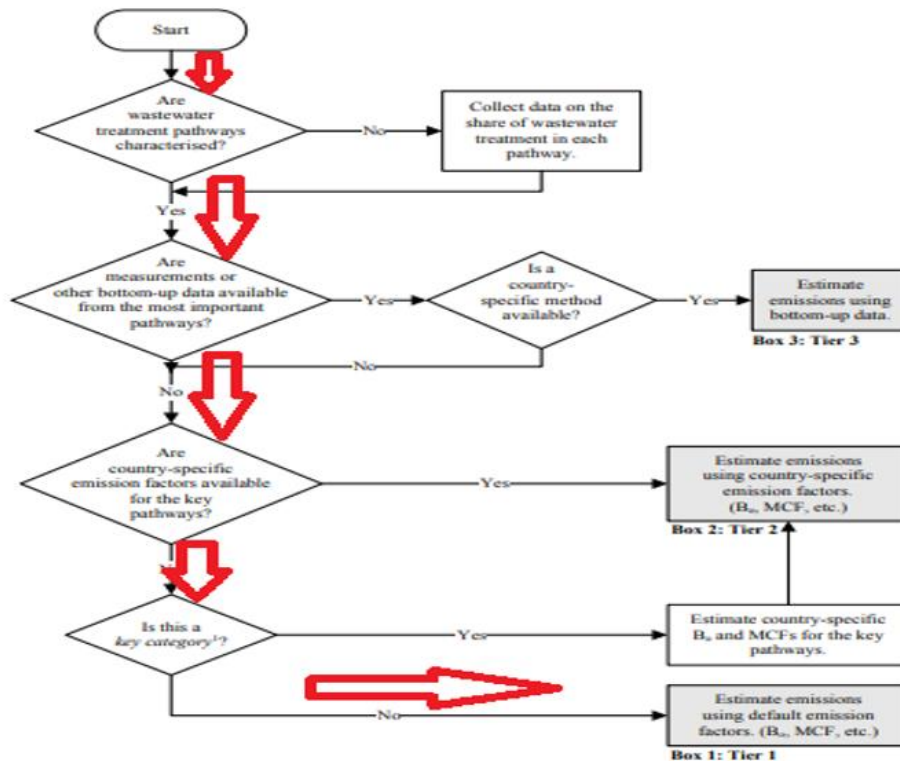


Figure 4.3 (See 2006 IPCC Guidelines, Vol. 5, Figure 6.2)

Note: Due to the national circumstances (lack of resources) Vanuatu does not have yet reliable country-specific emission factors and parameters and therefore, is applying the default parameters and Tier 1 methods to estimate emissions from the 4.D.1 Sub-Category.

## EQUATIONS USED

### Equation 1

EQUATION 6.3

Total Organically Degradable Material in Domestic Wastewater

$$TOW = P \cdot BOD \cdot 0.001 \cdot I \cdot 365$$

Where:

- **TOW**: total organics in wastewater in inventory year, kg BOD/yr. (Biochemical Oxygen Demand (BOD) is the amount of carbon that is aerobically biodegradable) (See 2006 IPCC Guidelines, Vol.5, Pg. 13, Equation 6.3)
- **P**: country population in inventory year, number of people (See 2006 IPCC Guidelines, Vol.5, Pg. 13, Equation 6.3).
- **BOD**: country-specific per capita BOD in inventory year, g/person/day (Biochemical Oxygen Demand) (See 2006 IPCC Guidelines, Vol.5, Pg. 13, Equation 6.3)
  - conversion from grams BOD to kg BOD (See 2006 IPCC Guidelines, Vol.5, Pg. 13, Equation 6.3)
- **I**: correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00). In some countries, information from industrial discharge permits may be available to improve this parameter (See 2006 IPCC Guidelines, Vol.5, Pg. 13, Equation 6.3)

### Equation 2:

EQUATION 6.1

Total CH<sub>4</sub> Emissions From Domestic Wastewater

$$N_2O \text{ EMISSIONS} = [\sum (U_i \times T_{i,j} \times EF)](TOW - S) - R$$

Where:

- **TOW**: total organics in wastewater in inventory year, kg BOD/yr. (See 2006 IPCC Guidelines, Vol.5, Pg. 1, Equation 6.1)
- **S**: organic component removed as sludge in inventory year, kg BOD/yr. (See 2006 IPCC Guidelines, Vol.5, Pg. 1, Equation 6.1)

- $U_i$ : fraction of population in income group I in inventory year (these are rural population and high/low-income urban population) (See 2006 IPCC Guidelines, Vol.5, Pg. 1, Equation 6.1).
- $T_{i,j}$ : degree of utilization of treatment/discharge pathway or system, j, for each income group fraction I in inventory year (See 2006 IPCC Guidelines, Vol.5, Pg. 1, Equation 6.1).
- **I**: income group: rural, urban high income, and urban low income (See 2006 IPCC Guidelines, Vol.5, Pg. 1, Equation 6.1)
- **j**: each treatment/discharge pathway or system (See 2006 IPCC Guidelines, Vol.5, Pg. 1, Equation 6.1)
- $EF_j$ : emission factor, kg CH<sub>4</sub> / kg BOD (See 2006 IPCC Guidelines, Vol.5, Pg. 1, Equation 6.1)
- **R**: amount of CH<sub>4</sub> recovered in inventory year, kg CH<sub>4</sub> /yr (See 2006 IPCC Guidelines, Vol.5, Pg. 1, Equation 6.1)

Equation 3:

EQUATION 6.7

Domestic wastewater: N<sub>2</sub>O emissions

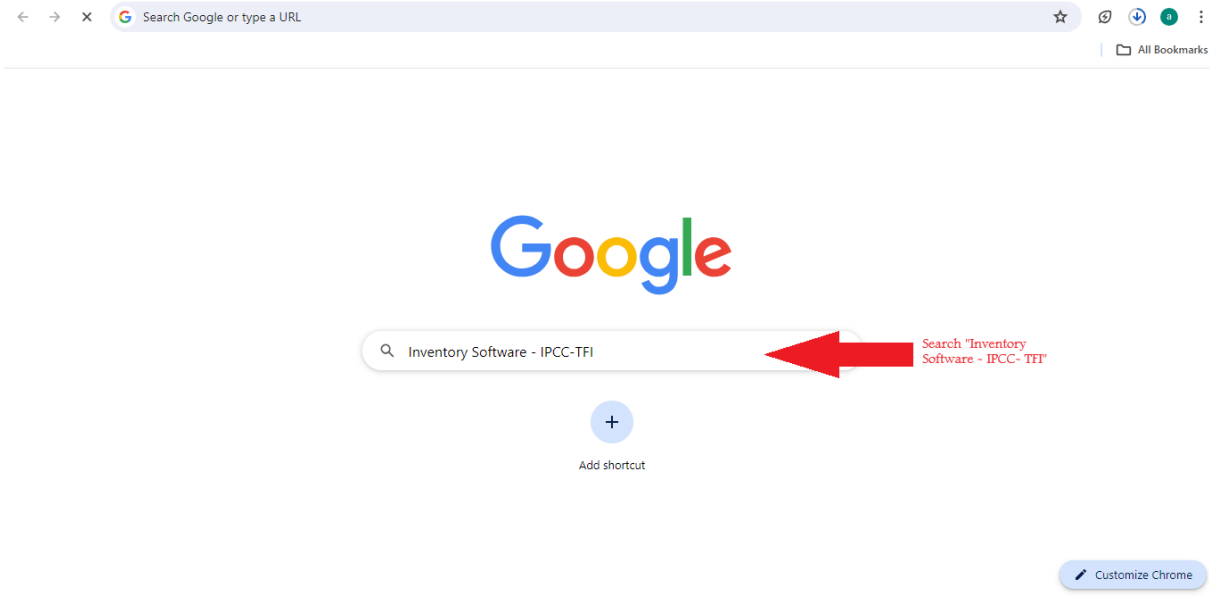
$$N_2O \text{ EMISSIONS} = N_{\text{EFFLUENT}} \cdot EF_{\text{EFFLUENT}} \cdot 44/28$$

Where:

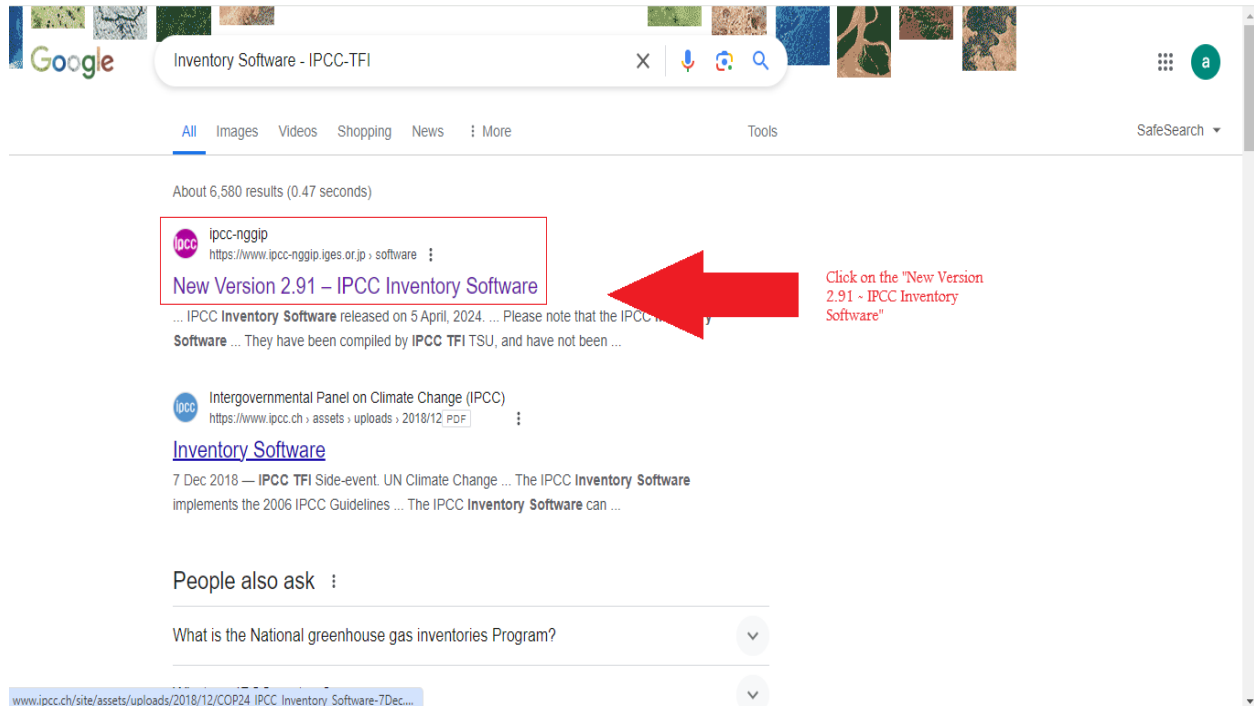
- **N<sub>2</sub>O emissions** = N<sub>2</sub>O emissions in inventory year, kg N<sub>2</sub>O/yr (2006 IPCC Guidelines, Vol. 5, Pg. 25, Equation 6.7)
- **N<sub>EFFLUENT</sub>** = Nitrogen in the effluent discharged to aquatic environments, kg N/yr (2006 IPCC Guidelines, Vol. 5, Pg. 25, Equation 6.7)
- **EF<sub>EFFLUENT</sub>** = Emission factor for N<sub>2</sub>O emissions from discharged to wastewater, kg N<sub>2</sub>O-N/kg N (2006 IPCC Guidelines, Vol. 5, Pg. 25, Equation 6.7)
- The factor 44/28 is the conversion of kg N<sub>2</sub>O-N into kg N<sub>2</sub>O (2006 IPCC Guidelines, Vol. 5, Pg. 25, Equation 6.7).

### 4.3.7 STEP – BY – STEP CALCULATION, DOCUMENTING RESOURCES USED

1.0 Open Google chrome and search “Inventory Software – IPCC-TFI” (See illustration below)



1.1: Click on the “New Version 2.91 – IPCC Inventory Software (See illustration below)



1.2: Click on the “ver 2.91 IPCC inventory Software – 32bit” and download the software (See illustration below).



1.3: Launch the Ver. 2.901 IPCC Inventory Software - 32bit and follow the installation steps to install to your PC.

1.4: Create your password and username. If you have an existing account, type in your username and password.

1.5: Type in the year of your choosing or the current inventory year.

1.6: Scroll down the “2006 IPCC Category” tab on the left-hand side of the page till you reach 4.D “Waste Water Treatment and Discharge”.

IPCC Inventory Software - ANITAKAY - [Worksheets]

Application Database Inventory Year Administrate Worksheets Tools Export/Import Reports Window Help

2006 IPCC Categories

- 3.C.12 - N2O Emissions from...
- 3.C.13 - CH4 Emissions from...
- 3.C.14 - Other (please specify)
- 3.D - Other
  - 3.D.1 - Harvested Wood Pro...
  - 3.D.2 - Other (please specify)
- 4 - Waste
  - 4.A - Solid Waste Disposal
    - 4.A.1 - Managed Waste Disp...
    - 4.A.2 - Unmanaged Waste D...
    - 4.A.3 - Uncategorised Waste
  - 4.B - Biological Treatment of Sol...
  - 4.C - Incineration and Open Bur...
  - 4.C.1 - Waste Incineration
  - 4.C.2 - Open Burning of Was...
  - 4.D - Wastewater Treatment and...
  - 4.D.1 - Domestic Wastewater
  - 4.D.2 - Industrial Wastewater
  - 4.E - Other (please specify)
- 5 - Other
  - 5.A - Indirect N2O emissions fro...
  - 5.B - Indirect CO2 emissions fro...
  - 5.C - Other

2006 IPCC category\* tab

Sector: Waste  
 Category: Wastewater Treatment and Discharge  
 Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge  
 Sheet: CH4 Emissions from Domestic Wastewater

Equation 6.1, 6.3

Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)		Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers		Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)		CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)
	WEF	P			BOD	I			F	R		
Unspecified	Specified	300	900	60	Specified	80	Calculated	1576800	909	0	0	47
Total								1576800	0	0	47	

4.D.1 - Time Series

METHANE (CH4) Emissions (Gg CO2 Equivale)

\* Base year for assessment of uncertainty in trend: 1990

1.7: Click on the subcategory 4.D.1 “Domestic Wastewater Treatment and Discharge”.

IPCC Inventory Software - ANITAKAY - [Worksheets]

Application Database Inventory Year Administrate Worksheets Tools Export/Import Reports Window Help

2006 IPCC Categories

- 3.C.12 - N2O Emissions from...
- 3.C.13 - CH4 Emissions from...
- 3.C.14 - Other (please specify)
- 3.D - Other
  - 3.D.1 - Harvested Wood Pro...
  - 3.D.2 - Other (please specify)
- 4 - Waste
  - 4.A - Solid Waste Disposal
    - 4.A.1 - Managed Waste Disp...
    - 4.A.2 - Unmanaged Waste D...
    - 4.A.3 - Uncategorised Waste
  - 4.B - Biological Treatment of Sol...
  - 4.C - Incineration and Open Bur...
  - 4.C.1 - Waste Incineration
  - 4.C.2 - Open Burning of Was...
  - 4.D - Wastewater Treatment and...
  - 4.D.1 - Domestic Wastewater
  - 4.D.2 - Industrial Wastewater
  - 4.E - Other (please specify)
- 5 - Other
  - 5.A - Indirect N2O emissions fro...
  - 5.B - Indirect CO2 emissions fro...
  - 5.C - Other

CH4 Emissions

Worksheet

Sector: Waste  
 Category: Wastewater Treatment and Discharge  
 Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge  
 Sheet: CH4 Emissions from Domestic Wastewater

2016

Equation 6.1, 6.3

Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)		Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers		Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)		CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)
	WEF	P			BOD	I			F	R		
Unspecified	Specified	300	900	60	Specified	80	Calculated	1576800	909	0	0	4727673
Total								1576800	0	0	4727673	4727673

4.D.1 - Time Series



1.8: Under the “CH<sub>4</sub> Emission” tab, the table under the “Subdivision (Region, City, etc.)” tab, click on the drop-down tab and select “Unspecified” (see illustration below)

The screenshot shows the 'CH4 Emissions' worksheet for the year 2016. The table is titled 'Equation 6.1, 6.3' and has columns for Subdivision, Weighted Emission Factor (kg CH<sub>4</sub>/kg BOD), Population (Capita), Degradable organic component (g/cap/day), Correction factor for industrial BOD discharged in sewers, Organically degradable material in wastewater (kg BOD/yr), Sludge removed (kg BOD/yr), Methane recovered (kg CH<sub>4</sub>), CH<sub>4</sub> Emissions (kg CH<sub>4</sub>), and CH<sub>4</sub> Emissions (Gg CH<sub>4</sub>). The 'Subdivision' column has a drop-down menu with 'Unspecified' selected. A red arrow points to this menu. The 'Total' row shows a value of 0 for CH<sub>4</sub> Emissions (kg CH<sub>4</sub>) and 0 for CH<sub>4</sub> Emissions (Gg CH<sub>4</sub>).

1.9: Select the drop-down tab under the “Weight Emission Factor (KgCH<sub>4</sub> BOD)” in the table and select “Specified” (see illustration below)

The screenshot shows the 'CH4 Emissions' worksheet for the year 2016. The table is titled 'Equation 6.1, 6.3' and has columns for Subdivision, Weighted Emission Factor (kg CH<sub>4</sub>/kg BOD), Population (Capita), Degradable organic component (g/cap/day), Correction factor for industrial BOD discharged in sewers, Organically degradable material in wastewater (kg BOD/yr), Sludge removed (kg BOD/yr), Methane recovered (kg CH<sub>4</sub>), CH<sub>4</sub> Emissions (kg CH<sub>4</sub>), and CH<sub>4</sub> Emissions (Gg CH<sub>4</sub>). The 'Weighted Emission Factor' column has a drop-down menu with 'Specified' selected. A red arrow points to this menu. The 'Total' row shows a value of 0 for CH<sub>4</sub> Emissions (kg CH<sub>4</sub>) and 0 for CH<sub>4</sub> Emissions (Gg CH<sub>4</sub>).

1.10: Under the same tab “Weight Emission Factor (KgCH<sub>4</sub> BOD)” within the table, Enter the value for the WEF (See Illustration below). Use default if national data is unavailable.

The screenshot shows the IPCC Inventory Software interface for the year 2016. The left sidebar lists categories, with '4-D.1 - Domestic Wastewater' selected. The main table, titled 'Equation 6.1, 6.3', has columns for 'Subdivision', 'Weighted Emission Factor (kg CH<sub>4</sub>/kg BOD)', 'Population (Capita)', 'Degradable organic component (g/cap/day)', 'Correction factor for industrial BOD discharged in sewers', 'Organically degradable material in wastewater (kg BOD/yr)', 'Sludge removed (kg BOD/yr)', 'Methane recovered (kg CH<sub>4</sub>)', 'CH<sub>4</sub> Emissions (kg CH<sub>4</sub>)', and 'CH<sub>4</sub> Emissions (Gg CH<sub>4</sub>)'. The 'Weighted Emission Factor' column is highlighted with a red box, and a red arrow points to it with the text 'Enter Value for WEF into the cell'. The 'Population' column is also highlighted with a red box. The 'Total' row shows values of 0 for several columns.

1.11: Under the “Population” column in the table, enter the Population of the chosen inventory year into the Cell. (See illustration below)

The screenshot shows the IPCC Inventory Software interface for the year 2016, similar to the previous one. The 'Population (Capita)' column in the table is highlighted with a red box, and a red arrow points to it with the text 'Enter the Population into cell'. The 'Weighted Emission Factor' column is also highlighted with a red box. The 'Total' row shows values of 0 for several columns.

1.12: Click on the drop-down tab under the “Degradable Organic Component (g/cap/day)” select the default value “60” (see Illustration below)

The screenshot shows the software interface for CH4 Emissions from Domestic Wastewater. The 'Degradable Organic Component (g/cap/day)' dropdown menu is open, showing a list of values: Unspecified, Specified, 60, and Specified. The value '60' is highlighted, and a red arrow points to it with the text 'Select the default value "60"'. The table below shows the 'Correction factor for industrial BOD discharged in sewers' column with a dropdown menu set to 'Specified'.

Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)	Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers	Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)	CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)
Unspecified	Specified		60	Specified	Calculated		0	0	0
			Default Value	Range	references				
			60	50 - 70	Doom and Liles (1999).				
Total						0	0	0	0

1.13: Under the first column in the tab “Correction factor for industrial BOD discharge in sewers” in the table click on the drop-down tab and select “Specified” (see illustration below).

The screenshot shows the software interface for CH4 Emissions from Domestic Wastewater. The 'Correction factor for industrial BOD discharged in sewers' dropdown menu is open, showing a list of values: Unspecified, Specified, and Specified. The value 'Specified' is highlighted, and a red arrow points to it with the text 'Click on drop down tab and select "Specified"'. The table below shows the 'Degradable Organic Component' column with a dropdown menu set to '60'.

Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)	Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers	Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)	CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)
Unspecified	Specified		60	Specified	Calculated		0	0	0
			Default Value	Range	references				
			60	50 - 70	Doom and Liles (1999).				
Total						0	0	0	0

1.14: Enter the Correction factor (I) into the cell under the tab “Correction factor for industrial BOD discharge in sewers”. Use default value of 1.25 if national data is unavailable. (See illustration below).

The screenshot shows the '2006 IPCC Categories' sidebar on the left, with '4 - Waste' expanded to '4.D.1 - Domestic Wastewater'. The main window displays 'CH4 Emissions from Domestic Wastewater' for the year 2016. A table titled 'Equation 6.1, 6.3' contains the following columns: Subdivision, Weighted Emission Factor (kg CH4/kg BOD), Population (Capita), Degradable organic component (g/cap/day), Correction factor for industrial BOD discharged in sewers (I), Organically degradable material in wastewater (kg BOD/yr), Sludge removed (kg BOD/yr), Methane recovered (kg CH4), CH4 Emissions (kg CH4), and CH4 Emissions (Gg CH4). The 'Correction factor for industrial BOD discharged in sewers' column has a red box around the cell containing 'I', with a red arrow pointing to it and the text 'Enter the Correction factor into the Cell'.

1.15: Click on the drop-down tab under the “Organically degradable material in wastewater (Kg BOD/yr.)” in the table and select “Calculated” (See illustration below).

The screenshot shows the same software interface as above, but with the 'Organically degradable material in wastewater (kg BOD/yr)' column selected. A red circle highlights the 'Calculated' option in the drop-down menu, with a red arrow pointing to it and the text 'Click on the drop-down tab and select "Calculated"'. The table data shows a value of 70 in the 'Organically degradable material in wastewater' column.

1.16: Under the same tab “Organically degradable material in wastewater (Kg BOD/yr)”, click on the green cell to generate the value for the “TOW”.

CH4 Emissions CH4 Emissions from Constructed Wetlands Direct N2O Emissions from Treatment Plants Indirect N2O Emissions Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: CH4 Emissions from Domestic Wastewater

Data

Equation 6.1, 6.3													
Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)		Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers		Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)		CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)	
Δ ▾	WEF		P	BOD		I	TOW = P * BOD * 0.001 * I * 365 or specified	S	Flaring F	Energy use R	E = WEF * (TOW - S) - F - R	E / 1000000	
Unspecified	Specified			60	Specified		Calculated		70	0	0	0	0
Total									0	0	0	0	

Enter Value into green cell

Uncertainties Time Series data entry...

1.17: Under the tab “Sludge removed (kg BOD /year)”, enter the data value 0 into the cell since sludge is not removed in Vanuatu. (See illustration below).

CH4 Emissions CH4 Emissions from Constructed Wetlands Direct N2O Emissions from Treatment Plants Indirect N2O Emissions Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: CH4 Emissions from Domestic Wastewater

Data

Equation 6.1, 6.3													
Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)		Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers		Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)		CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)	
Δ ▾	WEF		P	BOD		I	TOW = P * BOD * 0.001 * I * 365 or specified	S	Flaring F	Energy use R	E = WEF * (TOW - S) - F - R	E / 1000000	
Unspecified	Specified			60	Specified		Calculated		70	0	0	0	0
Total									0	0	0	0	

Enter Value into cell

Uncertainties Time Series data entry...

1.18: Methane is not recovered in Vanuatu, therefore Enter 0 for both “Flaring” and “Energy use R” under the tab “Methane Recovered” (See Illustration below).

CH4 Emissions CH4 Emissions from Constructed Wetlands Direct N2O Emissions from Treatment Plants Indirect N2O Emissions Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: CH4 Emissions from Domestic Wastewater

Data

Equation 6.1, 6.3															
Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)			Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers			Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)		CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)	
	Δ▽	WEF				P	BOD	I							
Unspecified	Specified				60	Specified			Calculated			0	0	0	0
Total												0	0	0	

Enter 0      Enter 0

1.19: Click on the green cells under CH4 Emissions (kg CH4) and CH4 Emissions (Gg CH4) to generate values (see Illustration below).

CH4 Emissions CH4 Emissions from Constructed Wetlands Direct N2O Emissions from Treatment Plants Indirect N2O Emissions Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: CH4 Emissions from Domestic Wastewater

Data

Equation 6.1, 6.3															
Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)			Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers			Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)		CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)	
	Δ▽	WEF				P	BOD	I					TOW = P * BOD * 0.001 * I * 365 or specified	S	
Unspecified	Specified				60	Specified			Calculated			0	0	0	0
Total												0	0	0	

Click on green cells



1.20: Within the same Subcategory 4.D.1, click on the Indirect N<sub>2</sub>O Emissions from the top-hand corner of the IPCC software page (see Illustration below).

Worksheet: Waste  
 Category: Wastewater Treatment and Discharge  
 Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge  
 Sheet: CH4 Emissions from Domestic Wastewater

Equation 6.1, 6.2

Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)	Population (Capita)	Degradable organic component (g/cap/day)	Correction factor for industrial BOD discharged in sewers	Organically degradable material in wastewater (kg BOD/yr)	Sludge removed (kg BOD/yr)	Methane recovered (kg CH4)	CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)
Δ ▾	WEF	P	BOD	I	$TOW = P * BOD * 0.001 * I * 365$ or specified	S	Flaring F Energy use R	$E = WEF * (TOW - S) - F - R$	$E / 1000000$
Unspecified	Specified			60	Specified	Calculated	0	0	0
<b>Total</b>									0

Gas: METHANE (CH4)

1.21: Under the “Subdivision” tab click on the drop-down bar and select “Unspecified”.

Worksheet: Waste  
 Category: Wastewater Treatment and Discharge  
 Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge  
 Sheet: Indirect N2O Emissions from Wastewater

Equation 6.7, 6.8

Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)
Δ ▾	A	B	C	D	E	F	$G = (A * B * C * D * E) - F$	H	I	$J = (G - H) * I * 44/28$	$K = J / 10^6$
Unspecified			0.16	1.1	1.25				0.005		
<b>Total</b>										0	0

Gas: METHANE (CH4)

1.22: Enter the population for the selected Inventory year under the “Population (P) (People)” (see illustration below).

Worksheet: CH4 Emissions | CH4 Emissions from Constructed Wetlands | Direct N2O Emissions from Treatment Plants | **Indirect N2O Emissions** | Direct N2O Emissions from Constructed Wetlands

Sector: Waste 2016  
 Category: Wastewater Treatment and Discharge  
 Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge  
 Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8												
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)	
Δ ∇	A	B	C	D	E	F	G = (A*B*C*D*E)-F	H	I	J = (G - H) * 1.44/28	K = J / 10^6	
Unspecified	+	+	0.16	1.1	1.25	+			0.005			
Total							0			0	0	

↑  
Enter Population for the Inventory year

Uncertainties Time Series data entry...

1.23: Enter the value for the “Per capita protein consumption (protein) (Kg/person/year)” (See illustration below).

Worksheet: CH4 Emissions | CH4 Emissions from Constructed Wetlands | Direct N2O Emissions from Treatment Plants | **Indirect N2O Emissions** | Direct N2O Emissions from Constructed Wetlands

Sector: Waste 2016  
 Category: Wastewater Treatment and Discharge  
 Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge  
 Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8												
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)	
Δ ∇	A	B	C	D	E	F	G = (A*B*C*D*E)-F	H	I	J = (G - H) * 1.44/28	K = J / 10^6	
Unspecified	+	+	0.16	1.1	1.25	+			0.005			
Total							0			0	0	

↑  
Enter Value into cell for "Per capita protein consumption (protein) (kg/person/year)

Uncertainties Time Series data entry...

1.24: Click on the drop-down bar under the “Fraction of Nitrogen in Protein (Fnpr) (Kg N/ Kg protein)” and select the default value of 0.16 (see illustration below).

CH4 Emissions | CH4 Emissions from Constructed Wetlands | Direct N2O Emissions from Treatment Plants | Indirect N2O Emissions | Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8												
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)	
Δ▽	A	B	C	D	E	F	G = (A*B*C*D*E)-F	H	I	J = (G - H) * I * 44/28	K = J / 10 <sup>6</sup>	
Unspecified			0.16	1.1	1.25				0.005			
			<b>Fnpr</b>	Fraction of nitrogen in protein (kg N/kg protein)		0.16	0.15 - 0.17				0	0

Click on the drop-down bar under the “Fraction of Nitrogen in Protein (Fnpr) (Kg N/ Kg protein)” and select the default value of 0.16.

Select the IPCC Default Value "0.16"

Uncertainties Time Series data entry...

User notes 4.D.1 - Time Series

1.25: Click on the drop-down bar under the “Fraction of non-consumption protein (Fnon-con) (-)” and select the default value of 1.1 (see Illustration below).

CH4 Emissions | CH4 Emissions from Constructed Wetlands | Direct N2O Emissions from Treatment Plants | Indirect N2O Emissions | Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8												
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)	
Δ▽	A	B	C	D	E	F	G = (A*B*C*D*E)-F	H	I	J = (G - H) * I * 44/28	K = J / 10 <sup>6</sup>	
Unspecified			0.16	1.1	1.25				0.005			
			<b>Fnon-con1</b>	Factor to adjust for non-consumed protein - for countries with no garbage disposals		1.1	1.0 - 1.5				0	0
			<b>Fnon-con2</b>	Factor to adjust for non-consumed protein - for countries with garbage disposals		1.4	1.0 - 1.5					

Click on drop-down bar under the “Fraction of non-consumption protein (Fnon-con) (-)” and select the default value of 1.1.

Select value "1.1"

Uncertainties Time Series data entry...

User notes 4.D.1 - Time Series

1.26: Click on the tab under the “Fraction of industrial and Commercial co-discharge protein (Find-com) and select the default value of 1.25 (see Illustration below).

CH4 Emissions | CH4 Emissions from Constructed Wetlands | Direct N2O Emissions from Treatment Plants | Indirect N2O Emissions | Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8																	
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Y ear)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)						
$\Delta \nabla$	A	B	C	D	E	F	G = (A*B*C*D*E)-F)	H	I	J = (G - H) * I * 44/28	K = J / 10^6						
Unspecified			0.16	1.1	1.25				0.005								
<table border="1"> <thead> <tr> <th>Name</th> <th>Definition</th> <th>Value</th> <th>Range</th> </tr> </thead> <tbody> <tr> <td>Find-com</td> <td>Factor to allow for co-discharge of industrial nitrogen into sewers. For countries with significant fish processing plants, this factor may be higher. Expert judgment is recommended.</td> <td>1.25</td> <td>1.0 - 1.5</td> </tr> </tbody> </table>						Name	Definition	Value	Range	Find-com	Factor to allow for co-discharge of industrial nitrogen into sewers. For countries with significant fish processing plants, this factor may be higher. Expert judgment is recommended.	1.25	1.0 - 1.5	Uncertainties		Time Series data entry...	
Name	Definition	Value	Range														
Find-com	Factor to allow for co-discharge of industrial nitrogen into sewers. For countries with significant fish processing plants, this factor may be higher. Expert judgment is recommended.	1.25	1.0 - 1.5														

User notes | 4.D.1 - Time Series

Select drop-down bar

Select the value "1.25"

1.27: Enter the value in the cell under the “Nitrogen removed with Sludge (Nsludge)(kg)”. Vanuatu do not remove Nitrogen in sludges therefore enter 0 under F. (See illustration below).

CH4 Emissions | CH4 Emissions from Constructed Wetlands | Direct N2O Emissions from Treatment Plants | Indirect N2O Emissions | Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8											
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Y ear)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)
$\Delta \nabla$	A	B	C	D	E	F	G = (A*B*C*D*E)-F)	H	I	J = (G - H) * I * 44/28	K = J / 10^6
Unspecified			0.16	1.1	1.25	0			0.005		
Total							0			0	0

Uncertainties | Time Series data entry...

Enter Value into the cell

1.28: Click on the green cell under the tab “Total Nitrogen in Effluent (Effluent (Kg N/yr.))” to generate the value (see illustration below).

CH4 Emissions CH4 Emissions from Constructed Wetlands Direct N2O Emissions from Treatment Plants Indirect N2O Emissions Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8												
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)	
Δ ▾	A	B	C	D	E	F	$G = (A*B*C*D*E) - F$	H	I	$J = (G - H) * 1 + 44/28$	$K = J / 10^6$	
Unspecified			0.16	1.1	1.25				0.005			
Total										0	0	

Click on green cell to generate value

Uncertainties Time Series data entry...

1.29: Click on the drop-down tab under the tab “Emission factor (Kg N<sub>2</sub>O – N/Kg N)” and select the default value 0.005 (see Illustration below).

CH4 Emissions CH4 Emissions from Constructed Wetlands Direct N2O Emissions from Treatment Plants Indirect N2O Emissions Direct N2O Emissions from Constructed Wetlands

Worksheet

Sector: Waste 2016

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8												
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (Fnpr) (kg N/kg Protein)	Fraction of non-consumption protein (Fnon-con) (-)	Fraction of industrial and commercial co-discharged protein (Find-com)	Nitrogen removed with sludge (Nsludge) (kg)	Total nitrogen in effluent (Neffluent) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)	
Δ ▾	A	B	C	D	E	F	$G = (A*B*C*D*E) - F$	H	I	$J = (G - H) * 1 + 44/28$	$K = J / 10^6$	
Unspecified			0.16	1.1	1.25				0.005			
Total										0	0	

Name	Definition	Value	Range
EFeffluent	Emission factor, (kg N2O-N/kg N)	0.005	0.0005 - 0.25

Click on drop-down tab

Select the IPCC default value "0.005"

Uncertainties Time Series data entry...

User notes 4.D.1 - Time Series

1.30: Click on the green cells under the tabs “N<sub>2</sub>O Emissions (Kg N<sub>2</sub>O / yr.)” and “(N<sub>2</sub>O Emissions (Gg N<sub>2</sub>O/ yr.) to generate the Emissions value for N<sub>2</sub>O (see illustration below).

CH4 Emissions | CH4 Emissions from Constructed Wetlands | Direct N2O Emissions from Treatment Plants | Indirect N2O Emissions | Direct N2O Emissions from Constructed Wetlands

Worksheet: Waste 2016  
 Category: Wastewater Treatment and Discharge  
 Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge  
 Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8											
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (F <sub>npr</sub> ) (kg N/kg Protein)	Fraction of non-consumption protein (F <sub>non-con</sub> ) (-)	Fraction of industrial and commercial co-discharged protein (F <sub>ind-com</sub> )	Nitrogen removed with sludge (N <sub>sludge</sub> ) (kg)	Total nitrogen in effluent (N <sub>effluent</sub> ) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)
Δ▽	A	B	C	D	E	F	G = (A*B*C*D*E)-F	H	I	J = (G - H) * I * 44/28	K = J / 10 <sup>6</sup>
Unspecified			0.16	1.1	1.25				0.005		
Total							0				0

Click on the two green cells to generate the values

Uncertainties | Time Series data entry...

User notes | 4.D.1 - Time Series

1.31: Place the cursor on the bar in the graph below entitled “Nitrous Oxide (N<sub>2</sub>O) Emissions (Gg CO<sub>2</sub> Equivalent)” to find the Global Warming Potential (GWP) (See illustration below).

CH4 Emissions | CH4 Emissions from Constructed Wetlands | Direct N2O Emissions from Treatment Plants | Indirect N2O Emissions | Direct N2O Emissions from Constructed Wetlands

Worksheet: Waste 2016  
 Category: Wastewater Treatment and Discharge  
 Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge  
 Sheet: Indirect N2O Emissions from Wastewater

Data

Equation 6.7, 6.8											
Subdivision (Region, city, etc.)	Population (P) (people)	Per capita protein consumption (Protein) (kg/person/Year)	Fraction of nitrogen in protein (F <sub>npr</sub> ) (kg N/kg Protein)	Fraction of non-consumption protein (F <sub>non-con</sub> ) (-)	Fraction of industrial and commercial co-discharged protein (F <sub>ind-com</sub> )	Nitrogen removed with sludge (N <sub>sludge</sub> ) (kg)	Total nitrogen in effluent (N <sub>effluent</sub> ) (kg N/yr)	Nitrogen from Wastewater plants (kg N/yr)	Emission Factor (kg N2O-N/kg N)	N2O Emissions (kg N2O/yr)	N2O Emissions (Gg N2O/yr)
Δ▽	A	B	C	D	E	F	G = (A*B*C*D*E)-F	H	I	J = (G - H) * I * 44/28	K = J / 10 <sup>6</sup>
Unspecified	90000	600	0.16	1.1	1.25	70	11879930		0.005	93342.30714	0.09334
Total							11879930			93342.30714	0.09334

Uncertainties | Time Series data entry...

User notes | 4.D.1 - Time Series

NITROUS OXIDE (N<sub>2</sub>O) Emissions (Gg CO<sub>2</sub> Equivalent)

Place cursor on the bar to give the (Gg CO<sub>2</sub> Equivalent) value.

Gas: NITROUS OXIDE (N<sub>2</sub>O)



### 4.3.8. QUALITY CONTROL/ QUALITY CHECK

**Table 13: The QC activities and procedures that will be followed**

It is indicated in the table below. The Three consultants will handle the QC and Procedures based on the color in the table, Kay – pink, Florenza Abel – Green, and Zacky Bani – Blue.

QUALITY CONTROL CHECK	PROCEDURES	TIME TAKEN TO COMPLETE PROCEDURE (DAYS)	COMMENTS
Check the Assumptions and criteria for the selection of activity data, emissions factor, and other estimation parameters	<ul style="list-style-type: none"> <li>• Confirm that estimates are reported for all categories and all years from the appropriate base year to the period of the current inventory.</li> </ul>		
	<ul style="list-style-type: none"> <li>• For subcategories, confirm that the entire category is being covered.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Provide a clear definition of ‘Other’ type categories.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate concerning total emissions (e.g., subcategories classified as ‘not estimated’, see Chapter 8, Reporting Guidance and Tables).</li> </ul>		
Check for transcriptions Errors in the data input and references	<ul style="list-style-type: none"> <li>• Confirm that bibliographical data references are properly cited in the internal documentation.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Cross-check a sample of input data from each category (either measurements or parameters used in calculations) for transcription errors.</li> </ul>		
Check that emissions and removals are calculated correctly	<ul style="list-style-type: none"> <li>• Reproduce a set of emissions and removal calculations.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Use a simple approximation method that gives similar results to the original and more complex calculation to ensure that there is no data input error or calculation error.</li> </ul>		
Check that parameters and units are correctly	<ul style="list-style-type: none"> <li>• Check that units are properly labeled in calculation sheets.</li> </ul>		

<p>recorded and that appropriate conversion factors are used.</p>	<ul style="list-style-type: none"> <li>• Check that units are correctly carried through from beginning to end of calculations.</li> <li>• Check that conversion factors are correct.</li> <li>• Check that temporal and spatial adjustment factors are used correctly.</li> </ul>		
<p>Check the integrity of database files</p>	<ul style="list-style-type: none"> <li>• Examine the included intrinsic documentation (see also Box 6.4) to:             <ol style="list-style-type: none"> <li>1. Confirm that the appropriate data processing steps are correctly represented in the database.</li> <li>2. Confirm that data relationships are correctly represented in the database.</li> <li>3. Ensure that data fields are properly labeled and have the correct design specifications.</li> <li>4. Ensure that adequate documentation of database and model structure and operation are archived.</li> </ol> </li> </ul>		
<p>Check for consistency in data between categories.</p>	<p>Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emission/removal calculations.</p>		
<p>Check that the movement of inventory data among processing steps is correct.</p>	<ul style="list-style-type: none"> <li>• Check that emissions and removal data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries.</li> <li>• Check that emissions and removal data are correctly transcribed between different intermediate products.</li> </ul>		
<p>Check that uncertainties in emissions and removals are estimated and calculated correctly.</p>	<ul style="list-style-type: none"> <li>• Check that the qualifications of individuals providing expert judgment for uncertainty estimates are appropriate.</li> <li>• Check that qualifications, assumptions, and expert judgments are recorded.</li> <li>• Check that calculated uncertainties are complete and calculated correctly.</li> <li>• If necessary, duplicate uncertainty calculations on a small sample of the probability distributions used by Monte Carlo analyses (for example, using</li> </ul>		

	uncertainty calculations according to Approach 1).		
Check time series consistency.	• Check for temporal consistency in time series input data for each category.		
	• Check for consistency in the algorithm/method used for calculations throughout the time series.		
	• Check methodological and data changes resulting in recalculations.		
	• Check that the effects of mitigation activities have been appropriately reflected in time series calculations.		
Check Completeness	• Confirm that estimates are reported for all categories and all years from the appropriate base year to the period of the current inventory.		
	For subcategories, confirm that the entire category is being covered.		
	• Provide a clear definition of ‘Other’ type categories.		
	• Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate concerning total emissions (e.g., subcategories classified as ‘not estimated’, see Chapter 8, Reporting Guidance and Tables)		

Trend Check	• Confirm that estimates are reported for all categories and all years from the appropriate base year to the period of the current inventory.		
	• Check the value of implied emission factors (aggregate emissions divided by activity data) across time series.		
	1. Do any year’s show outliers that are not explained?		
	2. If they remain static across time series, are changes in emissions or removals being captured?		
	• Check if there are any unusual and unexplained trends noticed for activity data or other parameters across the time series.		

Review of internal documentation and archiving.	<ul style="list-style-type: none"> <li>• Check that there is detailed internal documentation to support the estimates and enable the reproduction of the emission, removal, and uncertainty estimates.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check that the archive is closed and retained in a secure place following completion of the inventory.</li> </ul>		
	<ul style="list-style-type: none"> <li>• Check the integrity of any data archiving arrangements of outside organizations involved in inventory preparation</li> </ul>		

(Table 6.1 GENERAL INVENTORY QC PROCEDURES, Volume 1, 2006 IPCC Guidelines for National Greenhouse Gas Inventories).

### **4.3.9 TIME SERIES**

Tier 1 method was used in the last National Inventory report. The method mainly consisted of the usage of Default value, default activity data, and default parameters <sup>1</sup>.

The Director General of the Ministry of Climate Change used office notifications to notify relevant ministries and departments, specified organizations, the public-private sector, and other institutions to collect data for this inventory period. The Department of Climate Change is responsible for maintaining the gathered data, database repository, and archives <sup>4</sup>

Following the 2006 IPCC Guidelines, Vol. 5, figure 6.2, the Tier 1 Method Approach specifically will be used for this inventory. Estimated Emissions will be calculated using historical data and present up-to-date data.

To collect information, the Project Coordinator and the Consultants will notify Offices relevant to ministries and stakeholders such as the:

- Department of Environmental Protection and Conservation (DEPC)
- Department of Water Resources (DWR)
- Port Vila City Council (PVCC)
- Environment Unit, Public Health at the Ministry of Health
- Department of Climate Change (DOCC)
- UNELCO Engie
- Public Works Department (PWD)

The channels for requesting activity data meetings are the Electronic Single Window, emails, dialogues, and interviews. Consultants may ask the Prime Minister's Office for a Confidential Agreement or Right to Information (RTI) in specific situations where data is unavailable.

**Table 14: Annual emissions of CH<sub>4</sub> and N<sub>2</sub>O from the base year of 1994 to 2023, including the emissions values, emission factors, and the methods used to estimate these emissions.**

Year	CH <sub>4</sub> Emission (Gg)	Emission Factor (Kg N <sub>2</sub> O - N/Kg N)	N <sub>2</sub> O Emission (Gg)	Weighted Emission Factor (Kg CH <sub>4</sub> / Kg BOD)	Total CO <sub>2</sub> e Emission (Gg)	Method
1994	NE	0.05	NE	0.6	NE	TIER 1
1995	NE	0.05	NE	0.6	NE	TIER 1
1996	NE	0.05	NE	0.6	NE	TIER 1
1997	NE	0.05	NE	0.6	NE	TIER 1
1998	NE	0.05	NE	0.6	NE	TIER 1

<sup>4</sup> *The Republic of Vanuatu Third National Communication to the the United Nations Framework Convention on Climate Change / Vanuatu Environment Data Portal (2020)*

1999	NE	0.05	NE	0.6	NE	TIER 1
2000	NE	0.05	NE	0.6	NE	TIER 1
2001	NE	0.05	NE	0.6	NE	TIER 1
2002	NE	0.05	NE	0.6	NE	TIER 1
2003	NE	0.05	NE	0.6	NE	TIER 1
2004	NE	0.05	NE	0.6	NE	TIER 1
2005	NE	0.05	NE	0.6	NE	TIER 1
2006	NE	0.05	NE	0.6	NE	TIER 1
2007	0.157	0.05	0.0102	0.6	7.11	TIER 1
2008	0.157	0.05	0.0105	0.6	7.174	TIER 1
2009	0.157	0.05	0.0107	0.6	7.239	TIER 1
2010	0.157	0.05	0.011	0.6	7.304	TIER 1
2011	0.157	0.05	0.0112	0.6	7.371	TIER 1
2012	0.157	0.05	0.0115	0.6	7.439	TIER 1
2013	0.157	0.05	0.0117	0.6	7.509	TIER 1
2014	0.157	0.05	0.012	0.6	7.581	TIER 1
2015	0.157	0.05	0.0123	0.6	7.654	TIER 1
2016	NE	0.05	NE	0.6	NE	TIER 1
2017	NE	0.05	NE	0.6	NE	TIER 1
2018	NE	0.05	NE	0.6	NE	TIER 1
2019	NE	0.05	NE	0.6	NE	TIER 1
2020	NE	0.05	NE	0.6	NE	TIER 1
2021	NE	0.05	NE	0.6	NE	TIER 1
2022	NE	0.05	NE	0.6	NE	TIER 1
2023	NE	0.05	NE	0.6	NE	TIER 1

Where:

NE: Not estimated



### **4.3.10 UNCERTAINTY**

The list of the uncertainty below was extracted from the (2006 IPCC guidelines, Vol.5, pg. 16)

#### **Uncertainty Within the CH<sub>4</sub> Default Parameters**

Chapter 3, Uncertainties, in Volume 1 provides advice on quantifying uncertainties in practice. It includes guidance on eliciting and using expert judgments that, combined with empirical data can provide overall uncertainty estimates. Table 6.7 provides default uncertainty ranges for emission factor and activity data of domestic wastewater. The following parameters are believed to be very uncertain (2006 IPCC guidelines, Vol.5, pg. 16):

- The degrees to which wastewater in developing countries is treated in latrines, septic tanks, or removed by sewer, for urban high, urban low-income groups, and rural populations (Ti, j) (2006 IPCC guidelines, Vol.5, pg. 16).
- The fraction of sewers that are ‘open’, as well as the degree to which open sewers in developing countries are anaerobic and will emit CH<sub>4</sub>. This will depend on retention time, temperature, and other factors including the presence of a facultative layer and possibly toxic components to anaerobic bacteria (e.g., certain industrial wastewater discharges) (2006 IPCC guidelines, Vol.5, pg. 16).
- The amount of industrial TOW that is discharged into open or closed domestic sewers for each country is very difficult to quantify (2006 IPCC guidelines, Vol.5, pg. 16).

Table 4.15 illustrates the default uncertainty ranges for domestic wastewater this includes the Parameter, Emission Factor, Activity Data, and their Uncertainty.

**Table 15: Default uncertainty ranges for Domestic Wastewater**

Parameter	Uncertainty Range
<b>Emission Factor</b>	
Maximum CH <sub>4</sub> producing capacity (B <sub>0</sub> )	± 30%
Fraction treated anaerobically (MCF)	<p>The MCF is technology dependent. See Table 6.3. Thus, the uncertainty range is also technology dependent. The uncertainty range should be determined by expert judgement, bearing in mind that MCF is a fraction and must be between 0 and 1. Suggested ranges are provided below.</p> <p>Untreated systems and latrines, ± 50%</p> <p>Lagoons, poorly managed treatment plants ± 30%</p> <p>Centralized well managed plant, digester, reactor, ± 10%</p>
<b>Activity Data</b>	
Human population (P)	± 5%
BOD per person	± 30%
Fraction of population income group (U)	Good data on urbanization are available, however, the distinction between urban high income and urban low income may have to be based on expert judgment. ± 15%
Degree of utilization of treatment/ discharge pathway or system for each income group (T <sub>i,j</sub> )	Can be as low as ± 3% for countries that have good records and only one or two systems. Can be ± 50% for an individual method/pathway. Verify that total T <sub>i,j</sub> = 100%
Correction factor for additional industrial BOD discharged into sewers (I)	For uncollected, the uncertainty is zero %. For collected the uncertainty is ± 20%
Source: Judgement by Expert Group (Authors of this section).	

(2006 IPCC Guidelines, Vol.5, pg. 16, Table 6.7)

## Uncertainty Within the N<sub>2</sub>O Default Parameters

The IPCC default factors contain a significant level of uncertainty. Very little effort has been made to improve the Default factor values in the category as of yet (2006 IPCC guideline). Table 6.11 (See 2006 IPCC Guidelines, Vol.5, Table 6.11) below includes uncertainty ranges based on expert judgment (2006 IPCC Guidelines, Vol.5, pg26).

**Table 16: N<sub>2</sub>O Methodology Default Emission factor and Activity data**

	Definition	Default Value	Range
<b>Emission Factor</b>			
EF <sub>EFFLUENT</sub>	Emission factor, (kg N <sub>2</sub> O-N/kg –N)	0.005	0.0005 – 0.25
EF <sub>PLANTS</sub>	Emission factor, (g N <sub>2</sub> O/person/year)	3.2	2 – 8
<b>Activity Data</b>			
P	Number of people in country	Country-specific	± 10 %
Protein	Annual per capita protein consumption	Country-specific	± 10 %
FNPR	Fraction of nitrogen in protein (kg N/kg protein)	0.16	0.15 – 0.17
T <sub>plant</sub>	Degree of utilization of large WWT plants	Country-specific	± 20 %
F <sub>NON-CON</sub>	Factor to adjust for non-consumed protein	1.1 for countries with no garbage disposals, 1.4 for countries with garbage disposals	1.0 – 1.5
F <sub>IND-COM</sub>	Factor to allow for co-discharge of industrial nitrogen into sewers. For countries with significant fish processing plants, this factor may be higher. Expert judgment is recommended.	1.25	1.0 – 1.5

(2006, IPCC Guidelines, Vol.5, Pg 27, Table 6.11)

## 4.4. IMPROVEMENT PLAN

### 4.4.1 VANUATU’S CURRENT INVENTORY PROCESS

The national Greenhouse Gas (GHG) inventory of anthropogenic (human- caused) GHG emissions and removals were estimated for the Republic of Vanuatu under the first, second, and third (draft) National Communications for 1994, 2000, and 2015 (Srikanth Subbarao, Subbarao Consulting Services, Naveen Pawar, Subbarao Consulting Services, 2020). However, the waste sector of Vanuatu comprises mainly solid waste and wastewater (Ministry of Climate Change, 2020). For first National Communications 1994, emissions for the waste sector were not estimated due to lack of resources. However, for the second and third National communications, emissions were estimated from the waste sector for the national greenhouse gas inventory 2007-2015.

Table 3.4.1.a Different Categories of Waste that is Relevant to Vanuatu. <sup>5</sup>

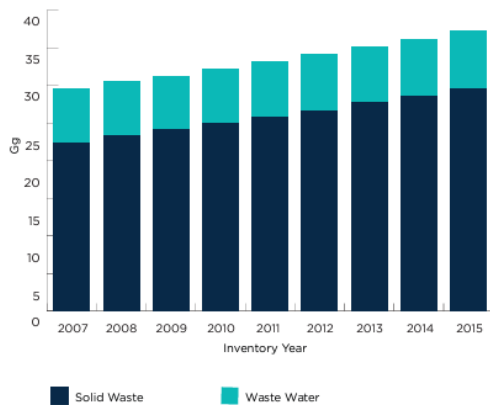
Categories	Remarks
4 - Waste	
4.A - Solid Waste Disposal	Estimated
4.B - Biological Treatment of Solid Waste	Not Occurring
4.C - Incineration and Open Burning of Waste	Not Estimated
4.D - Wastewater Treatment and Discharge	Estimated
4.E - Other (please specify)	Not Occurring

*Source: Vanuatu’s Third National Inventory (2020).*

As mentioned above, this sector focuses mainly on two key categories, which is, solid waste management and disposal (excluding biological waste), and domestic and commercial wastewater handling (no industrial waste water generation). Therefore, emissions estimated is mostly methane (CH<sub>4</sub>) and Nitrous Oxide (N<sub>2</sub>O) from these categories.

<sup>5</sup> <https://unfccc.int/sites/default/files/resource/Vanuatu%20Third%20National%20Communication%20Report.pdf>

Figure 3.4.1 Waste Sector Emissions Gg CO2e: 2007-2015<sup>6</sup>



*This is a representation of methane emissions for solid waste & wastewater. The graph shows an increase in methane emissions from 2007-2015.*

Source: Vanuatu’s Third National Inventory (2020).

#### **4.4.2 AREAS IDENTIFIED FOR IMPROVEMENT AND IDENTIFIED GAPS**

The improvement gap will be the waste sector data: The waste (Solid waste and waste water) activity data monitoring and reporting has been initiated in urban Centre’s, therefore higher tier method (Tier 2) will be applied for the future inventory period (Ministry of Climate Change, 2020). There is also potential development of open burning estimates.

#### **4.4.3: PROPOSED IMPROVEMENT ACTIONS**

These are the outlined improvement actions the consultant needs to take into consideration while conducting the GHG inventory. This table shows detailed information on the data sources, how to access it, who is responsible and the relevant time it needs to collect data sets, thus, will result in accurate GHG inventory.

Department/ Organization	Roles and Responsibility	Dates	Relevant Governing Arrangement	Contact Person	Comments
Department of Water Resources (DWR)	To provide information on measurements and analysis of BOD, COD, and activity data on Domestic	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided between DWR and DOCC	Department of water resources Tel: (678)22423/33435	For significant information and data collection, DOCC needs to send a prompt letter to DWR two

<sup>6</sup> <https://unfccc.int/sites/default/files/resource/Vanuatu%20Third%20National%20Communication%20Report.pdf>

	wastewater operations (collection and disposal of waste) in rural areas in Vanuatu.			Email: <a href="mailto:esteitoka@vanuatu.gov.vu">esteitoka@vanuatu.gov.vu</a>	months prior.  A follow-up email or call is crucial as well.
Department of Environmental Protection & Conservation (DEPC)	To provide relevant information on activity data and key parameters on SWD on land.	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided between DEPC and DOCC	Environment Unit  Name: Ionie Bolenga ( <i>Principal Officer on Waste Management and Pollution Control</i> ) Email: <a href="mailto:ibolenga@vanuatu.gov.vu">ibolenga@vanuatu.gov.vu</a>  Name: Annabelle Alilee (Pollution Control Officer) Email: <a href="mailto:aalilee@vanuatu.gov.vu">aalilee@vanuatu.gov.vu</a>	For significant information and data collection, DOCC needs to send a prompt letter to DEPC two months prior.  A follow-up email or call is crucial as well.
Public Works Department (PWD)	To provide relevant information and data on the operation (collection and disposal) of domestic wastewater in Urban and sub-urban areas.	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided between PWD and DOCC	Public Works Department  Email: <a href="mailto:pwdheadoffice@vanuatu.gov.vu">pwdheadoffice@vanuatu.gov.vu</a> Tel: 33460 or 22790	For significant information and data collection, DOCC needs to send a prompt letter to PWD two months prior.  A follow-up email or call is crucial as well.
UNELCO Engie	To provide relevant information and data on the operation	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided	UNELCO ENGIE Email: <a href="mailto:unelco@engie.com">unelco@engie.com</a>	For significant information and data collection, DOCC needs to send a prompt



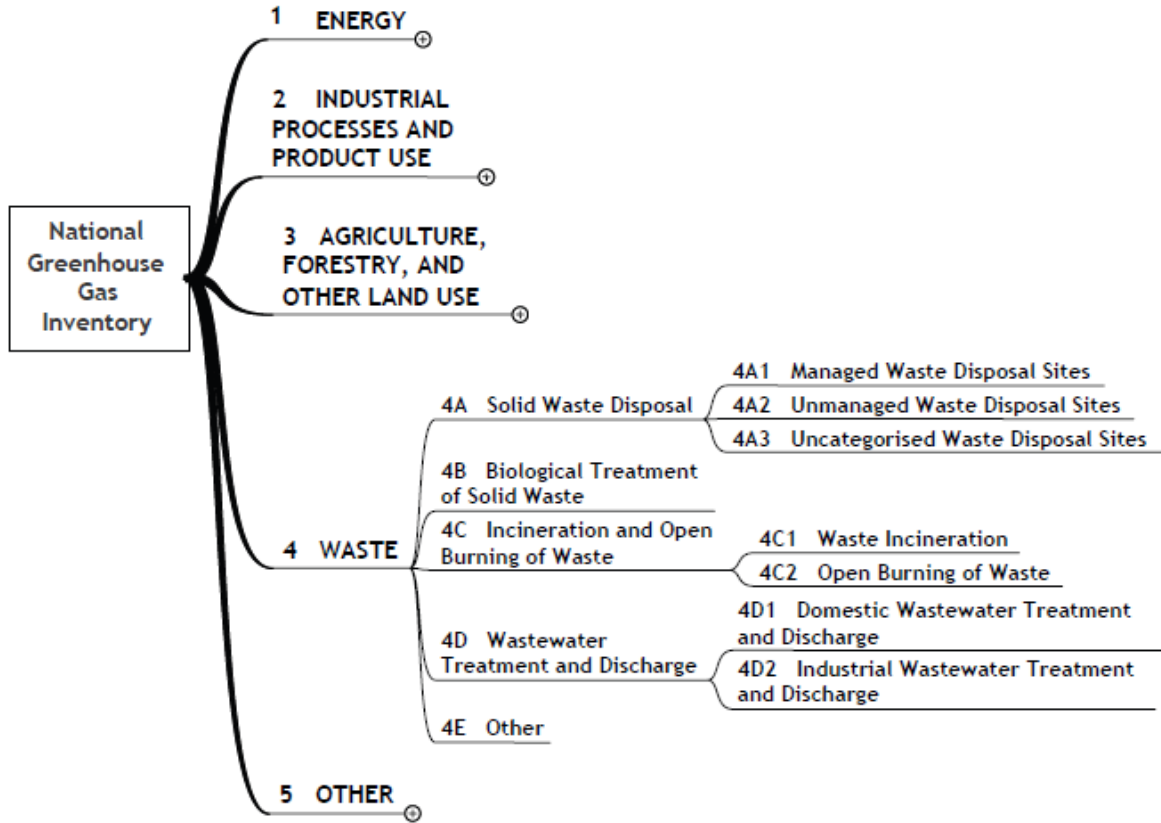
	(collection and disposal) of domestic wastewater in Urban and sub-urban areas.		between UNELCO and DOCC	Tel: 26000	letter to UNELCO two months prior.  A follow-up email or call is crucial as well.
Port Vila City Council (PVCC)	To provide relevant information and data on the operation of SWD on land and domestic wastewater management within its jurisdiction.	First week of April– First week of May every year	A Memorandum of understanding or Right to Information (RTI) can be provided between PVCC and DOCC		For significant information and data collection, DOCC needs to send a prompt letter to PVCC two months prior.  A follow-up email or call is crucial as well.
Department of Climate Change (DOCC)	DOCC is responsible to send a formal letter requesting relevant data and information on SWD on land and Domestic Wastewater to the Environmental Protection and Conservation, The Department of Water Resources, Public Works Department, UNELCO, Port Vila City Council, and the Environment Unit under the Ministry of Climate Change.	February – March every year	Provide a Memorandum of understanding or Right to Information (RTI) to the Environmental Protection and Conservation, The Department of Water Resources, Public Works Department, UNELCO, Port Vila City Council, and the Environment Unit under the Ministry of Climate Change	Name: Nelson Kalo Director of Climate Change Email: <a href="mailto:nekalo@vanuatu.gov.vu">nekalo@vanuatu.gov.vu</a>	DOCC is responsible for doing a follow-up to the departments or organization for the required data to be delivered upon schedule.

## 4.5 REFERENCES

- Goodwin, J., Woodfield, M., Ibnoaf, M., Koch, M., & Yan, H. (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 2: Approaches to Data Collection*. Institute for Global Environmental Strategies (IGES).
- Ministry of Climate Change. (2020). *The Republic of Vanuatu, Third National Communication*. Port Vila.
- Ministry of Climate Change, M. (2020). *The Republic of Vanuatu Third National Communication to the The United Nations Framework Convention on Climate Change*. Port Vila: Ministry of Climate Change.
- MOCC. (2021). *The Republic of Vanuatu First Biennial Update Report, UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)*. Port Vila: The Ministry of Climate Change Adaptation, Meteorology and Geo- Hazards, Energy, Environment and National Disaster Management Government of Vanuatu.
- Pipatti, R., & Svardal, P. (2006). *SOLID WASTE DISPOSAL*. 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

## 4.6 ANNEX

Figure A4.1 Structure of Waste Sector



(See 2006 IPCC Guidelines, Volume 5 Chapter 1, Introduction, Figure 1.1)

**TABLE A4.1: ESTIMATED BOD<sub>5</sub> VALUES IN DOMESTIC WASTEWATER FOR SELECTED REGIONS AND COUNTRIES**

<b>ESTIMATED BOD<sub>5</sub> VALUES IN DOMESTIC WASTEWATER FOR SELECTED REGIONS AND COUNTRIES</b>			
<b>Country/Region</b>	<b>BOD<sub>5</sub> (g/person/day)</b>	<b>Range</b>	<b>Reference</b>
Africa	37	35 – 45	1
Egypt	34	27 – 41	1
Asia, Middle East, Latin America	40	35 – 45	1
India	34	27 – 41	1
West Bank and Gaza Strip (Palestine)	50	32 – 68	1
Japan	42	40 – 45	1
Brazil	50	45 – 55	2
Canada, Europe, Russia, Oceania	60	50 – 70	1
Denmark	62	55 – 68	1
Germany	62	55 – 68	1
Greece	57	55 – 60	1
Italy	60	49 – 60	3
Sweden	75	68 – 82	1
Turkey	38	27 – 50	1
United States	85	50 – 120	4

Note: These values are based on an assessment of the literature. Please use national values, if available.

Reference:

1. Doorn and Liles (1999).
2. Feachem *et al.* (1983).
3. Masotti (1996).
4. Metcalf and Eddy (2003).

(See 2006 IPCC Guidelines, Volume 5 Chapter 6, Wastewater treatment and Discharge, Table 6.4)

**TABLE A4.2: DEFAULT MAXIMUM CH<sub>4</sub> PRODUCING CAPACITY (B<sub>0</sub>) FOR DOMESTIC WASTEWATER**

DEFAULT MAXIMUM CH <sub>4</sub> PRODUCING CAPACITY (B <sub>0</sub> ) FOR DOMESTIC WASTEWATER
0.6 kg CH <sub>4</sub> /kg BOD
0.25 kg CH <sub>4</sub> /kg COD
Based on expert judgment by lead authors and on Doorn <i>et al.</i> , (1997)

(See 2006 IPCC Guidelines, Volume 5 Chapter 6, Wastewater treatment and Discharge, Table 6.2)

**TABLE A4.3: DEFAULT MCF VALUES FOR DOMESTIC WASTEWATER**

DEFAULT MCF VALUES FOR DOMESTIC WASTEWATER			
Type of treatment and discharge pathway or system	Comments	MCF <sup>1</sup>	Range
<b>Untreated system</b>			
Sea, river and lake discharge	Rivers with high organics loadings can turn anaerobic.	0.1	0 – 0.2
Stagnant sewer	Open and warm	0.5	0.4 – 0.8
Flowing sewer (open or closed)	Fast moving, clean. (Insignificant amounts of CH <sub>4</sub> from pump stations, etc.)	0	0
<b>Treated system</b>			
Centralized, aerobic treatment plant	Must be well managed. Some CH <sub>4</sub> can be emitted from settling basins and other pockets.	0	0 – 0.1
Centralized, aerobic treatment plant	Not well managed. Overloaded.	0.3	0.2 – 0.4
Anaerobic digester for sludge	CH <sub>4</sub> recovery is not considered here.	0.8	0.8 – 1.0

Anaerobic reactor	CH <sub>4</sub> recovery is not considered here.	0.8	0.8 – 1.0
Anaerobic shallow lagoon	Depth less than 2 meters, use expert judgment.	0.2	0 – 0.3
Anaerobic deep lagoon	Depth more than 2 meters	0.8	0.8 – 1.0
Septic system	Half of BOD settles in anaerobic tank.	0.5	0.5
Latrine	Dry climate, ground water table lower than latrine, small family (3-5 persons)	0.1	0.05 – 0.15
Latrine	Dry climate, ground water table lower than latrine, communal (many users)	0.5	0.4 – 0.6
Latrine	Wet climate/flush water use, ground water table higher than latrine	0.7	0.7 – 1.0
Latrine	Regular sediment removal for fertilizer	0.1	0.1
1 Based on expert judgment by lead authors of this section.			

(See 2006 IPCC Guideline, Vol.5, Chapt.6 Wastewater, Section 6.2.2.2, Table 6.3)

**TABLE A4.4: N<sub>2</sub>O METHODOLOGY DEFAULT DATA**

N <sub>2</sub> O METHODOLOGY DEFAULT DATA			
	Definition	Default Value	Range
<b>Emission Factor</b>			
E <sub>EFFLUENT</sub>	Emission factor, (kg N <sub>2</sub> O-N/kg –N)	0.005	0.0005 – 0.25
E <sub>PLANTS</sub>	Emission factor, (g N <sub>2</sub> O/person/year)	3.2	2 – 8
<b>Activity Data</b>			
P	Number of people in country	Country-specific	± 10 %
Protein	Annual per capita protein consumption	Country-specific	± 10 %
F <sub>NPR</sub>	Fraction of nitrogen in protein (kg N/kg protein)	0.16	0.15 – 0.17
T <sub>plant</sub>	Degree of utilization of large WWT plants	Country-specific	± 20 %



FNON-COM	Factor to adjust for non-consumed protein	1.1 for countries with no garbage disposals, 1.4 for countries with garbage disposals	1.0 – 1.5
FIND-COM	Factor to allow for co-discharge of industrial nitrogen into sewers. For countries with significant fish processing plants, this factor may be higher. Expert judgment is recommended.	1.25	1.0 – 1.5

(See 2006 IPCC Guidelines, Volume 5 Chapter 6, Wastewater treatment and Discharge, Table 6.11)

**TABLE A4.5: RECOMMENDED DEFAULT HALF-LIFE (t1/2) VALUES (YR) UNDER TIER 1**

Type of Waste		Climate Zone*							
		Boreal and Temperate (MAT ≤ 20°C)				Tropical <sup>1</sup> (MAT > 20°C)			
		Dry (MAP/PET < 1)		Wet (MAP/PET > 1)		Dry (MAP < 1000 mm)		Moist and Wet (MAP ≥ 1000 mm)	
		Default	Range <sup>2</sup>	Default	Range <sup>2</sup>	Default	Range <sup>2</sup>	Default	Range <sup>2</sup>
Slowly degrading waste	Paper/textiles waste	17	14 <sup>3,5</sup> – 23 <sup>3,4</sup>	12	10 – 14 <sup>3,5</sup>	15	12 – 17	10	8 – 12
	Wood/ straw waste	35	23 <sup>3,4</sup> – 69 <sup>6,7</sup>	23	17 – 35	28	17 – 35	20	14 – 23
Moderately degrading waste	Other (non – food) organic putrescible/ Garden and park waste	14	12 – 17	7	6 – 9 <sup>8</sup>	11	9 – 14	4	3 – 5
Rapidly degrading waste	Food waste/Sewage sludge	12	9 – 14	4 <sup>4</sup>	3 <sup>3,4</sup> – 6 <sup>9</sup>	8	6 – 10	2	1 <sup>10</sup> – 4
Bulk Waste		14	12 – 17	7	6 – 9 <sup>8</sup>	11	9 – 14	4	3 – 5 <sup>11</sup>

(See 2006 IPCC Guidelines, Volume 5 Chapter 3, Solid Waste Disposal, Table 3.4)