AUSTRALIAN MEAT PROCESSOR CORPORATION

NATIONAL GREENHOUSE AND ENERGY REPORTING RED MEAT PROCESSING INDUSTRY GUIDELINES

Project code:	A.ENV.0157
Prepared by:	GHD Pty Ltd
Date Submitted:	November 2013
Date Published:	November 2013
Published by:	Australian Meat Processor Corporation

Acknowledgement:

The Australian Meat Processor Corporation acknowledges the matching funds provided from the Australian Government, via Meat and Livestock Australia, to support the research and development detailed in this publication.

Disclaimer

This National Greenhouse and Energy Reporting Red Meat Processing Industry Guidelines ("Report"):

- *has been prepared by GHD Pty Ltd ("GHD") for Meat and Livestock Australia (MLA), Australian Meat Processor Corporation (AMPC) and its members as defined in section 1.1 of this report;*
- *may only be used and relied on by MLA, AMPC and its members as defined in section 1.1 of this report;*
- *must not be copied to, used by, or relied on by any person other than MLA, AMPC and its members, without the prior written consent of GHD;*
- *may only be used for the purpose of a red meat industry guide to the National Greenhouse and Energy Reporting System and must not be used for any other purpose;*
- *does not purport to provide legal advice and any conclusions or recommendations herein must not be relied upon as a substitute for such advice.*

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than MLA, AMPC and its members, arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), including (but not limited to):

- *The National Greenhouse and Energy Reporting Act 2007 ("the Act") has not been replaced or superseded by another Act or an amended version of the Act;*
- *The National Greenhouse and Energy Reporting Regulations 2008 ("the Regulations") has not been superseded by an amended version of the Regulations;*
- *The NGER (Measurement) Determination 2008 as amended (July 2012) has not been superseded by a more recent amended version of the NGER (Measurement) Determination that is relevant to the 2012/13 reporting year;*
- *The NGER (Measurement) Technical Guidelines 2012 have not been superseded by an amended version of the NGER (Measurement) Technical Guideline that is relevant to the 2012/13 reporting year; and*
- *All NGER Supplementary Guidelines, Fact Sheets or other documents prepared by the Clean Energy Regulator or the Department of Climate Change and Energy Efficiency referred to within this Report have not been superseded or replaced by another Supplementary Guideline, Fact Sheet or other document or part thereof prepared by the Clean Energy Regulator or the Department of Climate Change and Energy Efficiency.*

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on until 12 months after the date of the report, after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

Glossary

Abbreviation	Definition	Abbreviation	Definition
ABN	Australian Business Number	kt	Kilotonne
ACCU	Australian Carbon Credits Unit	kW, kWh	Kilowatt, Kilowatt-hour
ANZSIC	Australian and New Zealand Standard Industrial Classification	LEIPD	Liable entities public information database
ARENA	Australian Renewable Energy Agency	m, m^3	Metre, Cubic Metre
AMPC	Australian Meat Processor Corporation	MCF	Methane correction factor
AS	Australian Standard	mg/L	Milligrams per litre
BOD	Biochemical oxygen demand	ML	Megalitre
CEFC	Clean Energy Finance Corporation	MLA	Meat and Livestock Association
CER	Clean Energy Regulator	MW, MWh	Megawatt, Megawatt-hour
CFI	Carbon Farming Initiative	n	Number of samples
CH_4	Methane	N_2O	Nitrous oxide
COD	Chemical oxygen demand	NGA	National Greenhouse Accounts
CO_2, CO_2-e	Carbon dioxide and Carbon dioxide equivalents	NGER	National Greenhouse and Energy Reporting
CPM	Carbon Pricing Mechanism	NGERS	National Greenhouse and Energy Reporting Scheme
d	Day	OH&S	Occupational health and safety
DAF	Dissolved air flotation	PFD	Process flow diagram
DCCEE	Department of Climate Change and Energy Efficiency	RECs	Renewable Energy Certificates
EC	Energy content	s	Standard deviation
EF	Emission factor	SBR	Sequencing batch reactor
EMS	Environmental management system	SF_6	Sulfur hexafluoride
GEDO	Greenhouse and Energy Data Officer	t	Tonne
GHG	Greenhouse gas	TJ	Terajoule
GJ	Gigajoule	UASB	Upflow anaerobic sludge blanket reactor
GWP	Global warming potential	UNFCCC	United Nations Framework Convention on Climate Change
h	Hour	VS	Volatile solids
HFCs	Hydrofluorocarbons	WWTP	Wastewater treatment plant
HRT	Hydraulic retention time	y	Year
IDAL	Intermittently decanted aerated lagoons	α	Confidence interval (i.e. $\alpha = 0.05$ for 95% confidence interval)
IDEA	Intermittently decanted extended aeration		
IPCC	Intergovernmental Panel on Climate Change		
ISO	International Standards Organisation		
kg	Kilogram		
kL	Kilolitre		

Table of Contents

1. Introduction 1

1.1 Purpose of these Guidelines 1

1.2 The National Greenhouse and Energy Reporting Scheme 1

1.3 NGER Reporting Overview Checklist 3

2. Guidance on the NGER Regulations 5

2.1 Determining Participation 5

2.2 Registration 10

2.3 Reporting Obligations 10

2.4 Operational Control and Contractor's Emissions 11

2.5 Deregistration 13

3. Other Policy and Standards 14

3.1 Clean Energy Future Package 14

4. Guidance on the NGER (Measurement) Determination 19

4.1 Sources of Emission - Checklist 19

4.2 What are the methods for calculating wastewater emissions? 20

4.3 Current red meat industry data collection methods 20

4.4 Wastewater Handling – Methodology Overview 21

4.5 What is the difference between Method 1 and 2? 26

4.6 What needs to be measured? 27

4.7 How can this data be collected? 30

4.8 Selecting between Method and Method 2 – Summary 31

5. Guidance on the NGER (Audit) Determination 33

5.1 Purpose of Audits 33

5.2 What does this mean for my site? 33

5.3 What if I am going to be audited? 33

5.4 Record keeping under the NGER Act 33

5.5 Audits under the Carbon Pricing Mechanism 34

5.6 Audit Checklist 34

6. Case Studies 37

6.1 Case Study Plant A 37

6.2 Case Study Plant B 45

6.3 Case Study Summary 52

7. References 54

8. Appendix A – Operational Control Scorecard 57

9. Appendix B – Additional Guidance by Emission Source 59

9.1 Fuel Combustion 59

9.2 Fugitive Emissions from Fuels 65
9.3 Industrial Processes Emissions 65
9.4 Incidental Emissions and Energy 68
9.5 Energy Production and Consumption 69
9.6 Scope 2 Emissions 71

10. Appendix C – Additional Guidance on Emissions from Wastewater Handling 73

10.1 General Data Requirements and Calculation Approach 73
10.2 Addressing Data Gaps 81

11. Appendix D – Uncertainty 84

11.1 Assessment of Uncertainty 84

12. Appendix E – Audit checklist 88

Table Index

Table 1-1 NGER Reporting Overview Checklist 3
Table 2-1 NGER Reporting Thresholds 5
Table 2-2 Typical Emission Sources for Red Meat Processing Corporations 8
Table 4-1 Versions of the *NGER Technical Guidelines* 19
Table 4-2 Reporting Checklist – Sources of Emission 19
Table 4-3 Methane Correction Factors for Typical Wastewater Processes 25
Table 6-1 Direct Methane Emissions from Plant A (Method 1) 39
Table 6-2 Direct Methane Emissions from Plant A (Method 2) 42
Table 6-3 Direct Methane Emissions from Plant B (Method 1) 47
Table 6-4 Direct Methane Emissions from Plant B (Method 2) 50
Table 6-5 Case Study Emissions Summary and Comparison 53
Table 8-1 Template Red Meat Processing Industry Operational Control Scorecard 58
Table 9-1 Combustion of Solid Fuels 59
Table 9-2 Combustion of Gaseous Fuels 61
Table 9-3 Combustion of Liquid Fuels 64
Table 9-4 Emissions of Hydrofluorocarbons 66
Table 9-5 Emissions of Sulfur hexafluoride 67
Table 9-6 "Incidental" Emissions and Energy 68
Table 9-7 Energy Production 69
Table 9-8 Energy Consumption 70
Table 9-9 Scope 2 Emissions 72

Table 10-1 Direct Methane Emissions from WWTPs (Method 1) 73
Table 10-2 Direct Methane Emissions from WWTPs (Method 2) 76

Figure Index

Figure 1-1 NGER Legislative Framework 3
Figure 2-1 Scope 1, 2 and 3 Emissions 7
Figure 2-2 Operational Control Decision Tree (*NGER Guidelines, 2008*)...............12
Figure 3-1 Overview of the Clean Energy Future Package....................................15
Figure 4-1 Default NGERS COD Mass Balance..23
Figure 4-2 - Method 1 vs Method 2 27
Figure 4-3 Decision Tree – selecting between method 1 and method 2 32
Figure 6-1 – Plant A Process Flow Diagram...38
Figure 6-2 – Plant B Process Flow Diagram...46
Figure 6-3 Example Use of Figure 4-2 53
Figure 11-1 Types of Uncertainty ()..84

1. Introduction

1.1 Purpose of these Guidelines

The purpose of these Red Meat Procesing Industry Guidelines is to provide an industry-wide approach towards greenhouse and energy inventory calculations that is consistent with the principles of the National Greenhouse and Energy Reporting (NGER) scheme:

- Transparency
- Accuracy
- Comparability
- Completeness

Section 1.13, *NGER (Measurement) Determination 2008*

The current NGER legislative framework is necessarily generic and does not specifically relate to the unique issues of the red meat processing industry. These Guidelines aim to provide clarity around the key reporting issues that are relevant to the red meat processing industry.

This project involves the investigation of measurement, calculation and reporting methods available to the Australian red meat processing industry to meet requirements of the NGER scheme and assessment of the impact of method choice on greenhouse gas emissions calculations particularly as this relates to the calculation of wastewater emissions.

The outcomes of this project will assist organisations make informed decisions on wastewater measurement methods and compliance with audit requirements under the NGER scheme and the carbon pricing mechanism (CPM).

Commissioned by Meat and Livestock Australia (MLA) and the Australian Meat Processor Corporation (AMPC), these Red Meat Processing Industry Guidelines are written as a complement to the existing legislation and supporting documents, and where necessary, aims to fill specific gaps in the current accounting approaches. Extensive cross-referencing is provided, to avoid unnecessary duplication. Red meat processing industry examples are used throughout this document to explain complex, difficult requirements or potentially common circumstances.

These Industry Guidelines do not form part of the official suite of legislative or supporting documents for the NGER Scheme.

The development of these Red Meat Industry Guidelines was conducted under the auspices of a project working group comprising Australian Meat Processor Corporation (AMPC) delegates and member corporations.

1.2 The National Greenhouse and Energy Reporting Scheme

The Federal *National Greenhouse and Energy Reporting Act 2007* (the Act) was designed to provide a single, streamlined national framework for the reporting and dissemination of information related to greenhouse gas emissions, energy consumption and energy production of corporations. Specifically, it has five key objectives:

1. Underpin the introduction of an emissions trading scheme;
2. Inform government policy formulation and the Australian public;
3. Meet Australia's international reporting obligations;
4. Assist Commonwealth, State and Territory government programs and activities; and
5. Avoid the duplication of similar reporting requirements in the States and Territories.

The CER is an independent statutory authority established on 2 April 2012 by the *Clean Energy Regulator Act 2011*. The CER has responsibility for the functions previously held by the Office of the Renewable Energy Regulator, the Carbon Farming Initiative Administrator and the Greenhouse and Energy Data Officer (GEDO). Among these responsibilities, the CER administers the NGER scheme. The DCCEE has retained formal oversight of the NGER Scheme and responsibility for tracking progress against Australia's target under the Kyoto Protocol.

In July 2012 the *NGER Act* was amended to take into account consequential matters arising from the enactment of the *Clean Energy Act 2011*. Details on the Government's Clean Energy Future Package are included in section 3.1 of these guidelines.

There are a number of supporting legislative instruments under the Act. The supporting legislation provides greater detail about corporations' obligations and includes:

1. NGER Regulations 2008

The Regulations provide detailed requirements for reporting under the Act including definitions of operational control, facilities, the requirements for registration and the types of greenhouse gas emissions and energy consumption/ production that have to be reported.

2. NGER (Measurement) Determination 2008

The Measurement Determination provides methods and criteria for calculating greenhouse gas emissions and energy data under the Act. The Measurement Determination was amended in July 2012 and is relevant to the 2012/13 reporting year.

The *NGER (Measurement) Technical Guidelines 2012* assist corporations understand and apply the Measurement Determination and are derived from it. In cases where there is a perceived conflict, the Measurement Determination takes precedence. The Technical Guidelines are updated annually.

3. NGER (Audit) Determination 2009

The Audit Determination sets out the requirements for greenhouse and energy auditors to follow when preparing for, conducting and reporting on audits.

The NGER legislative framework is illustrated in Figure 1-1. These documents are publicly available via the CER website (and associated links):

http://www.cleanenergyregulator.gov.au/National-Greenhouse-and-Energy-Reporting/Legislation-and-regulations/Pages/default.aspx

There are several other documents and standards, which could provide additional guidance and contextual information for corporations developing greenhouse gas and energy inventories, such as:

- *National Greenhouse Accounts (NGA) Factors*, July 2012, DCCEE.
- *AS/ISO 14064.1 – 2006*, Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals, Standards Australia.
- IPCC, 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*, prepared by the National Greenhouse Gas Inventories Program, Intergovernmental Panel on Climate Change.
- *The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard*, April 2004, World Business Council for Sustainable Development and World Resources Institute (GHG Protocol); and
- *GHG Protocol Guidance on uncertainty assessment in GHG inventories and calculating statistical parameter uncertainty* (2003), and calculation worksheets, World Business Council for Sustainable Development and World Resources Institute.

However, it must be noted that none of these supporting documents have any legislative standing within NGER, including the *NGA Factors* and the *NGER Technical Guidelines*.

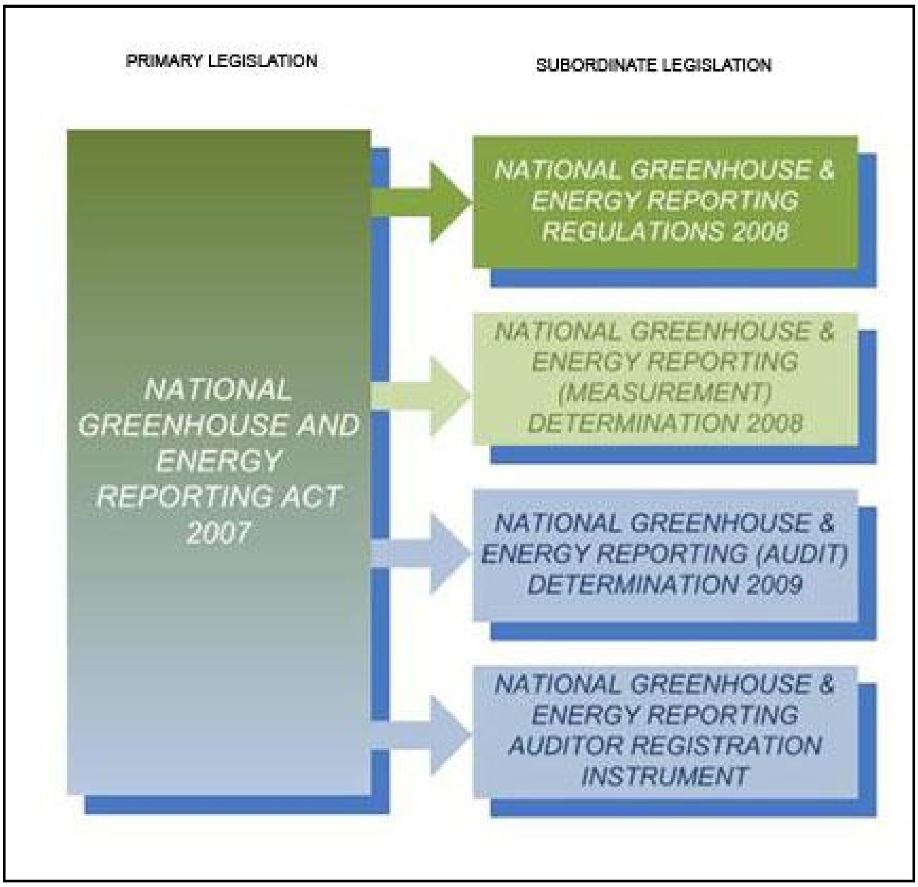


Figure 1-1 NGER Legislative Framework

1.3 NGER Reporting Overview Checklist

Table 1-1 below provides an overview checklist of steps that red meat processing corporations should undertake to assess how NGER reporting applies to their operations.

Table 1-1 NGER Reporting Overview Checklist

Step	Description	Relevant section of this Industry Guideline
Step 1	Does my corporation need to report under NGER?	Section 2
Step 2	How should I structure my corporate entity?	Section 2
Step 3	Which emissions and energy sources are relevant to my facility?	Section 4
Step 4	What data do I need to estimate my emissions, energy production and energy consumption?	Section 4, Appendix B, C
Step 5	What methods should I use to estimate my emissions, energy production and energy consumption?	Section 4, Appendix B, C
Step 6	How do I satisfy audit requirements?	Section 5
Step 7	How do I report my NGER data?	Section 2

2. Guidance on the NGER Regulations

2.1 Determining Participation

2.1.1 Reporting Thresholds

Applicable sections in *NGER Regulations 2008*	Applicable Supplementary *Guideline/ Fact Sheet*
• Part 4, Division 4.2	• Reporting under the NGER Act 2007

The thresholds for NGER reporting are shown in Table 2-1.

Table 2-1 NGER Reporting Thresholds

Entity	NGER Reporting Threshold (t CO_2-e)	NGER Reporting Threshold (TJ)
Facilty	25 kt	100 TJ
Corporate Group	50 kt	200 TJ

Organisations that are constitutional corporations and exceed any of these thresholds are obliged to apply for registration and report their greenhouse gas emissions, energy production and energy consumption.

Note:

- A corporation that exceeds the corporation threshold must report for all facilities under its operational control; and
- A corporation that does not exceed the corporation threshold, but does exceed the facility threshold for one or more of their facilities, needs only report on those facilities.

Corporations required to register must apply by **31 August** after the reporting year in which they first meet a threshold. Corporations must register through the following web link:

http://www.cleanenergyregulator.gov.au/National-Greenhouse-and-Energy-Reporting/NGER-reporters/How-to-register/Pages/default.aspx

Reporting by registered corporations needs to be completed on or before the **31 October** in the year following the end of the reporting year being considered.

If your corporation meets or exceeds one or more of the thresholds for a reporting year, you must register and report for the first year you reached a threshold. You must then report for each year your corporation remains registered (even if thresholds for emissions, energy consumption or energy production are not reached[1]). For example:

- if an organisation has introduced energy efficiency measures so that the corporate group energy consumption is less than 200 TJ and emissions are less than 50 kt CO_2-e for all its facilities/sites combined, it would still need to report until it is deregistered;
- if an organisation has energy consumption less than 200 TJ and emissions are more than 50 kt CO_2-e, it would need to continue to report; and

[1] In such a circumstance, the report must include a statement that the corporation's group did not meet any of the thresholds in section 13 of the Act for the reporting year (refer to Division 4.6 of the *NGER Regulations*).

- if a facility has introduced energy efficiency measures so that energy consumption is less than 100 TJ and emissions are less than 25 kt CO_2-e, it would still need to report until it is deregistered.

Guidance on deregistration is included in Section 2.5of this report.

2.1.2 Organisational Status

Applicable sections in *NGER Act 2007*	Applicable Supplementary Guideline/ Fact Sheet
• 1, Division 2, section 7	• N/A

Prior to the enactment of the *Clean Energy Act 2011*, only "constitutional corporations" were required to report under the *NGER Act*. A substantial body of case law and corporations' legislation surrounds the definition of a constitutional corporation and the functions of "trading".

Following the enactment of the *Clean Energy Act 2011* and the associated *Clean Energy (Consequential Amendments) Act 2011*, the coverage of the *NGER Act* has been extended to include any 'person' who is a liable entity under the *Clean Energy Act*. A person includes any of the following:

– An individual;

– A body corporate;

– A trust;

– A corporation sole;

– A body politic; and

– A local governing body.

2.1.3 Facility Definition

Applicable sections in *NGER Regulations 2008*	Applicable Supplementary Guideline/ Fact Sheet
• Part 2, subdivision 2.4.2 • Schedule 2 (item 192)	• Defining Facilities

Under section 9(1) of the *NGER Act*, a facility "*is an activity, or a series of activities (including ancillary activities), that involve the production of greenhouse gas emissions, the production of energy or the consumption of energy and that:*

(a) form a single undertaking or enterprise and meet the requirements of the regulations; or

(b) are declared by the Greenhouse and Energy Data Officer to be a facility under section 54."

Corporations are encouraged to refer to the supplementary guideline on Defining Facilities for further guidance on how to define the corporate structure for NGER reporting.

2.1.4 Reporting Scopes

Applicable sections in *NGER Regulations 2008*	Applicable Supplementary Guideline/ Fact Sheet
• Part 2, division 2.5	• N/A

The *NGER Regulations 2008* and the *GHG Protocol* define three Scopes of greenhouse gas emissions into which total emissions should be separated:

- **Scope 1:** Direct emissions from sources within the boundaries of an organisation as a result of its activities.

- **Scope 2**: Indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation
- **Scope 3:** All other indirect emissions that arise as a consequence of an organisation's activities, but occur outside its boundaries, from sources that it does not own or control.

Reporting of Scope 3 emissions, and some Scope 1 emissions, is not required under NGERS.

Coverage of emission sources under NGER includes fuel combustion, fugitive emissions from fuels, industrial processes emissions and waste emissions (including wastewater handling). It does not include emissions from "agriculture" or "land use, land use change and forestry".

Though Scope 3 emissions are not reportable under NGERS, an organisation may choose to estimate some of their Scope 3 emissions as part of carbon neutral accreditation or for supporting government funding applications (such as AusIndustry assistance).

A diagram illustrating Scope 1, Scope 2 and Scope 3 sources is presented in Figure 2-1 [2]. Typical emission sources for red meat processing corporations are shown in Table 2-2 below. This includes separation of sources reportable under NGERS versus non-reportable sources.

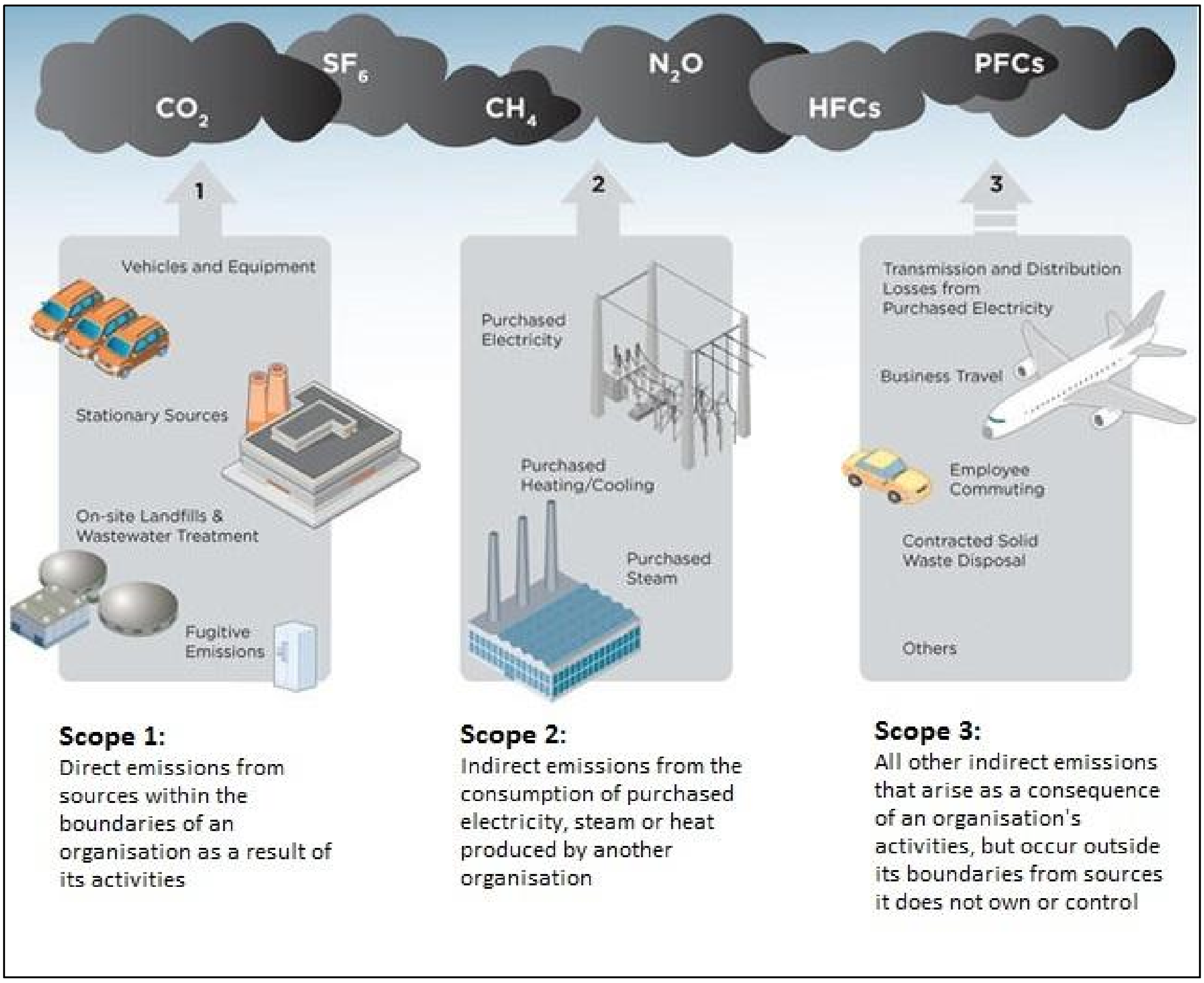


Figure 2-1 Scope 1, 2 and 3 Emissions

[2] Adapted from CoolClimate Network, University of Berkeley (http://coolclimate.berkeley.edu/node/405)

Table 2-2 Typical Emission Sources for Red Meat Processing Corporations

Scope	Reportable Sources of Emission under NGERS:	Non-Reportable Sources
Scope 1	• Combustion of fuels (stationary and transportation) • Methane (CH_4) from wastewater treatment, sludge treatment and sludge drying (e.g. lagoons, anaerobic digesters) • CH_4 and nitrous oxide (N_2O) from biogas, biosolids and solid waste combustion (e.g. burning organic waste in a boiler) • Emissions from leakage of sulfur hexafluoride (SF_6) gas from insulated switchgear and circuit breakers • Emissions from leakage of refrigerants (i.e. hydrofluorocarbons, HFCs)	• Direct livestock emissions (1) • Nitrous oxide (N_2O) and carbon dioxide (CO_2) from wastewater treatment, sludge treatment, sludge drying and effluent disposal (2) • CH_4 and N_2O from biological treatment of waste solids (e.g. composting of paunch waste or primary sludge) (5) • CH_4 and N_2O from biosolids reuse on agricultural land (owned by the corporation) (1)
Scope 2	• Electricity consumption from a third party electricity generator - emissions physically produced by the burning of fuels (coal, natural gas, etc.) at the power station (3) arising from electricity consumed at the red meat processing plant	

Scope	Reportable Sources of Emission under NGERS:	Non-Reportable Sources
Scope 3 (4)	None	• Indirect electricity emissions attributable to electricity lost in delivery in the transmission and distribution network from a third party electricity generator and indirect emissions from the extraction, production and transport of fuel burned at generation) (3) • Fuels production • Chemicals production and transport • Fuel combustion and production for salary packaged vehicles (if they are used primarily for private commuting etc.) • Commuting for employees • Business travel in third party vehicles (e.g. flights, taxis) • Office consumables (e.g. paper) • Embodied emissions in new infrastructure (built during the reporting year) • Biosolids and solid waste disposal to landfill • Biosolids disposal to agricultural land (owned by others)

Notes:

(1) Not currently reportable under NGER, due to these activities being conducted in the Agricultural sector.

(2) Nitrous oxide emissions from industrial wastewater handling are not considered in the accounting of greenhouse gas emissions from industrial wastewater systems under NGER because it is assumed that there is no nitrification and denitrification occurring at these wastewater systems.
Carbon dioxide emissions from wastewater handling are not considered in the accounting of greenhouse gas emissions from wastewater systems under NGER because these are assumed to be of biogenic origin and part of the natural short-term carbon cycle.

(3) *NGA Factors* (July 2012), p.8.

(4) Scope 3 emissions are not reportable under NGER. Corporations may wish to refer to Section 4.2.3 of the National Carbon Offset Standard which includes a list of Scope 3 emission sources that an organisation should, at a minimum, consider as a result of its activities.

(5) As the *NGER (Measurement) Determination* refers to "biological treatment of solid waste at the landfill", composting emissions that do not occur at a landfill are not required to be reported. For further information Refer to *NGER (Measurement) Determination*, Division 5.2.1 section 5.2 (2).

2.2 Registration

Applicable sections in *NGER Regulations 2008*	Applicable Supplementary Guideline/ Fact Sheet
• Part 3	• Reporting under the NGER Act 2007 • NGER Registration Application Tool – User Guide

Section 14 of the *NGER Act* includes the provision for a corporation to voluntarily register and report its greenhouse gas emissions and energy data to the CER if it or a member of its group is involved in or proposes to be involved in a greenhouse gas project. A greenhouse gas project is defined in the *NGER Act* as follows:

> Greenhouse gas project means an activity or series of activities:
>
> (a) designed to remove or reduce the emission of greenhouse gases; and
>
> (b) which meet the requirements specified in the regulations
>
> *NGER Act 2007*, Part 1 ,Division 2, section 7

2.3 Reporting Obligations

Applicable sections in *NGER Regulations 2008*	Applicable Supplementary Guideline/ Fact Sheet
• Part 4	• Reporting under the NGER Act 2007

The Supplemetary Guideline: *Reporting under the NGER Act 2007* provides four useful checklists for organisations to determine their reporting obligations:

- Do I need to report?;
- Preparing and submitting reports;
- What information does my corporation need to report?; and
- How do I submit the report?

2.3.1 Contextual Data

In addition to mandatory reporting obligations, corporations may also voluntarily report "contextual data". Corporations may also voluntarily report GreenPower™ purchases, voluntarily surrendered renewable energy certificates (RECs) and the associated Offset Scope 2 totals. Offset Scope 2 totals are calculated by deducting electricity that the corporation has purchased using either GreenPower™ and/or RECs from its total electricity consumption. This net electricity consumption figure is then used to calculate an offset total for the corporation's total Scope 2 emissions.

Such data will be published by the CER, along with the Scope 2 gross total (i.e. before subtracting voluntary actions) and other mandatory reporting results [(3)].

The CER website provides further guidance on reporting voluntary actions, including instructions on how to report this information.

[3] GreenPower, RECs and Offset Scope 2 totals voluntarily surrendered by Australian corporations are publically available on the CER website, via the following link: http://www.cleanenergyregulator.gov.au/National-Greenhouse-and-Energy-Reporting/Publication-of-NGER-data/GreenPower-and-RECs/Pages/default.aspx

2.4 Operational Control and Contractor's Emissions

Applicable sections in *NGER Regulations 2008*	Applicable Supplementary Guideline/ Fact Sheet
• Part 2, Division 2.4, • Part 4, Divisions 4.3	• Operational Control

A corporation is considered to have *overall* control in relation to an activity (or series of activities), or o*perational* control over a facility, if the corporation has the authority to *introduce and implement* operating, health and safety, and environmental policies for the activity or facility.

For most red meat processing corporations and facilities, this definition is relatively uncomplicated. In some circumstances however, the boundaries of operational control can become difficult to define, such as for:

- Contractors' and subcontractors' activities (particularly maintenance contracts and capital works projects); and
- Joint venture and alliance projects.

The *NGER Guidelines* provide the following advice for scenarios where more than one corporation has the authority to introduce or implement operating, health and safety, and environmental policies:

> If there is uncertainty about which corporation has operational control over a facility, the corporation deemed to have operational control will be the one with the greatest authority to introduce and implement operating and environmental policies.
>
> The decision rule consists of two parts — authority to introduce policies and authority to implement policies. In determining 'greatest authority', where there is uncertainty, the decision rule is limited to operational and environmental policies: it does not include health and safety policies.
>
> *NGER Guidelines (2008)*, section 1.4.1

The *NGER Guidelines* provide a step-by-step decision tree to assist corporations in identifying operational control (included as Figure 2-2 below). The Clean Energy Regulator website also provides further guidance on establishing operational control (Supplementary Guideline - Operational Control). For activities involving more than one corporation, a round table discussion with all parties is recommended at the commencement of a contract, in order to:

- Establish and agree which parties have the ability to introduce and implement facility policies; and
- Identify and agree which party has the greatest authority to introduce and implement facility policies.

> If there is any uncertainty or disagreement about who has operational control of a facility, corporations are encouraged to seek legal advice. Corporations should record all decisions and the reasons for them when determining who has operational control of a facility.
>
> Under section 55 of the NGER Act, the CER may declare that a controlling corporation or another member of the corporation's group has operational control of a facility. The CER may make such a declaration on the initiative of the CER or in response to an application by a controlling corporation.
>
> *NGER Supplementary Guideline – Operational Control*

An operational control scorecard may be used to assist in identifying which party has the greatest authority to introduce and implement facility policies. The scorecard should be developed and completed by all parties on a case by case basis. A template operational control scorecard has been developed for the red meat processing industry as part of these Guidelines. The template scorecard outlines common policies and default weightings applicable to typical red meat processing facilities. The template scorecard is included in Appendix A and should be revised on a case by case basis in accordance with relevant policies for each facility.

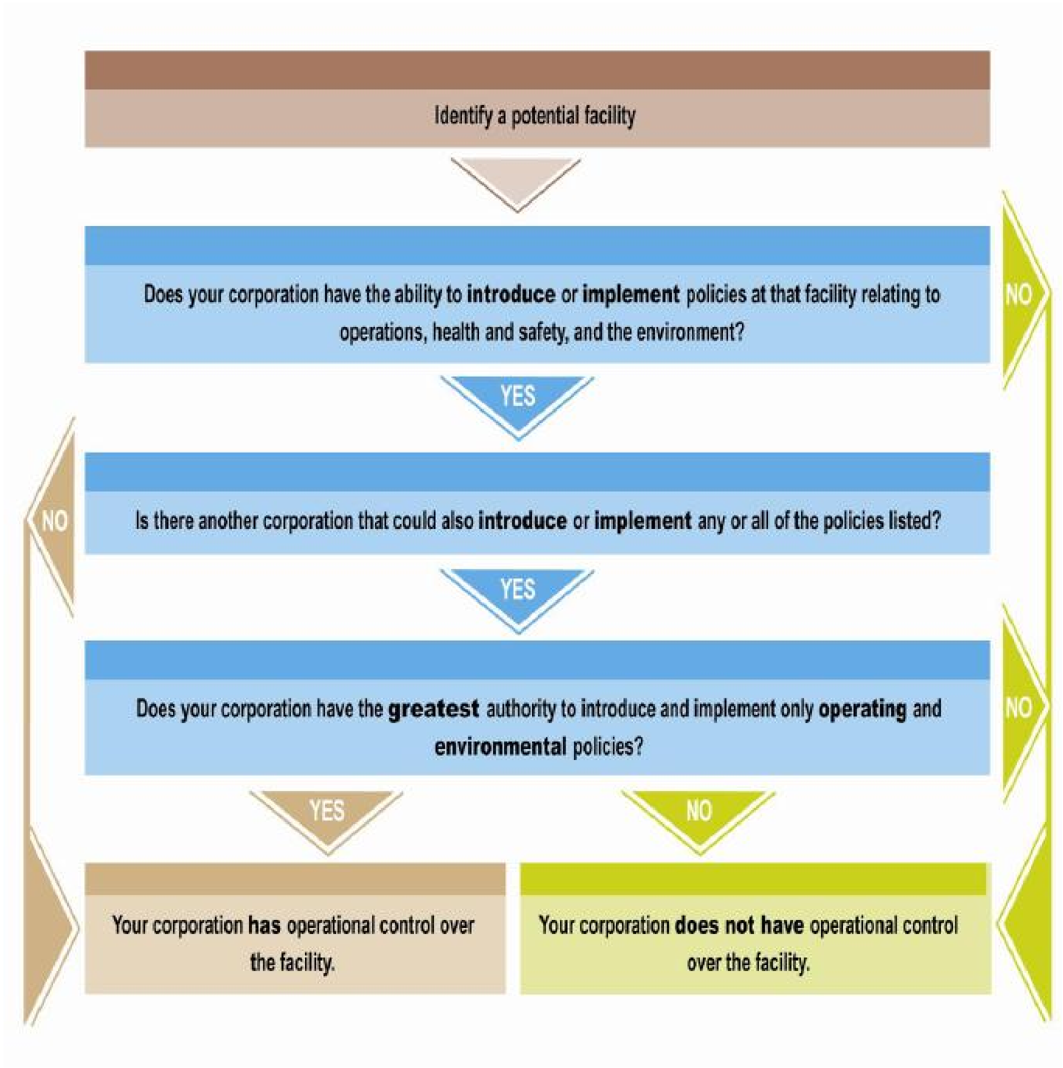


Figure 2-2 Operational Control Decision Tree (*NGER Guidelines, 2008*)

2.4.1 Contractors' Emissions

Corporations are obliged to report greenhouse gas emissions, energy production and energy consumption from contractors' activities that are within the corporation's operational control (refer to NGER Fact Sheet – Contracts and Leasing). Emissions should be identified as Scope 1 or Scope 2 emissions, if the contractors' activities are within the corporation's operational control. Contractors' emissions should be identified as Scope 3 emissions if the contractors' activities are not within the corporation's operational control.

2.5 Deregistration

Applicable sections in *NGER Regulations 2008*	Applicable Supplementary Guideline/ Fact Sheet
• Part 3 Division 3.4	• N/A

No specific issues for the industry related to deregistration from NGER have been identified.

A corporation may apply to be deregistered providing that it meets the conditions set out in the *NGER Act* and *NGER Regulations*. Information on deregistration is included in Division 3.4 of the *NGER Regulations*.

An application form for deregistration can be found on the CER website.

3. Other Policy and Standards

3.1 Clean Energy Future Package

3.1.1 Overview

The Clean Energy Future Package has been established to reduce Australia's carbon emissions and increase the use of clean energy. Administered by the Clean Energy Regulator, the scheme is designed to have an economy wide impact to reduce Australia's overall greenhouse gas emissions to a target of 5 percent below 2000 emission levels by the year 2020. The scheme came into effect on 1 July 2012.

The Clean Energy Future Package comprises four distinct initiatives:

- The Carbon Pricing Mechanism;
- Energy Efficiency (Grants and Programs);
- Renewable Energy (Grants and Funding); and
- Land Based Carbon Credits (Carbon Farming Initiative).

The *Clean Energy Act 2011* establishes the carbon pricing mechanism and includes detail about assistance for emissions-intensive trade-exposed industries and the coal-fired electricity generation sector. It also contains rules about coverage by the carbon pricing mechanism, what sources of carbon pollution are included, the surrender of emissions units, caps on the amount of carbon pollution from 1 July 2015, international linking, monitoring, enforcement, and appeal and review provisions.

The *Clean Energy (Consequential Amendments) Act 2011* makes amendments to other laws to ensure that the carbon pricing mechanism is integrated with existing regulatory schemes and processes. This includes the National Greenhouse and Energy Reporting Scheme, the Carbon Farming Initiative, the Australian National Registry of Emissions Units, the regulation of financial services and competition and consumer laws.

An overview of the main components of the legislative package is provided in the following sections.

3.1.2 Carbon Pricing Mechanism

From 1 July 2012 Australia's largest greenhouse gas emitters are liable to pay a price on carbon of $23 per tonne CO_2-e through purchase of carbon permits equal to their emissions.

Liable entities under the carbon pricing mechansm either operate facilities that meet an emissions threshold of at least 25,000 tonnes of CO_2-e of direct emissions or supply or use large amounts of natural gas. The mechanism covers approximately 60 percent of Australia's carbon emissions and includes emissions from electricity generation, stationary energy, landfills, wastewater, industrial processes and fugitive emissions.

Relevant to the red meat processing industry, sources of emission that are covered under the carbon pricing mechanism include direct emissions from wastewater handling, emissions from the combustion of fuels for stationary energy[4] (with the exception of biomass, biofuel and biogas) and emissions from the use of petroleum based oils and greases and acetylene.

Sources of emission that are not covered under the carbon pricing mechanism include emissions from transport fuels and also the emissions of synthetic greenhouse gases (hydrofluorcarons, perfluorocarbons and sulfur hexafluoride).

[4] If duty under the Customs Tariff Act or Excise Tariff Act has been applied to the fuel, then emissions from the fuel are exempt (Clean Energy Act section 30(2)(e & f))

The full list of emission sources that are covered (or not covered) under the carbon pricing mechanism is itemised on the CER website.

It is important to note that the coverage of the *Clean Energy Act* extends beyond constitutional corporations (refer to section 2.1.2).

The CER's *Guide to Carbon Price Liability* provides further information to assist entities understand their obligations under the *Clean Energy Act* and the *NGER Act*. A corporation is encouraged to obtain legal advice if it is not clear whether it is a liable entity under the *Clean Energy Act*.

The Clean Energy Regulator must keep a database known as the Liable Entities Public Information Database (LEPID). Legal persons will be included in the LEPID if the Clean Energy Regulator has reasonable grounds to believe the person is, or is likely to be, a liable entity for the eligible financial year. The LEPID is accessible via the CER website.

The carbon pricing mechanism will operate for the first three years as a fixed price scheme (tax) and in 2015 transfer to a market based system (emission trading scheme - ETS), with a floating price, a regulated ceiling price and linkage to the European Union Trading Scheme. Each year under an ETS, the Government will reduce Australia's emissions cap and reduce the number of permits for sale.

Liable entities must report under the NGER scheme on the extent of their emissions and satisfy their liability for each tonne of CO_2-e they emit, either by surrendering emissions units or paying a unit shortfall charge. Liable entities who are required to purchase permits (or carbon credits) will likely pass the cost on to businesses and households. It is intended that the market will work to achieve the lowest cost of abatement with a progressive transition to a low carbon economy.

The diagram below explains the different interactions within the scheme.

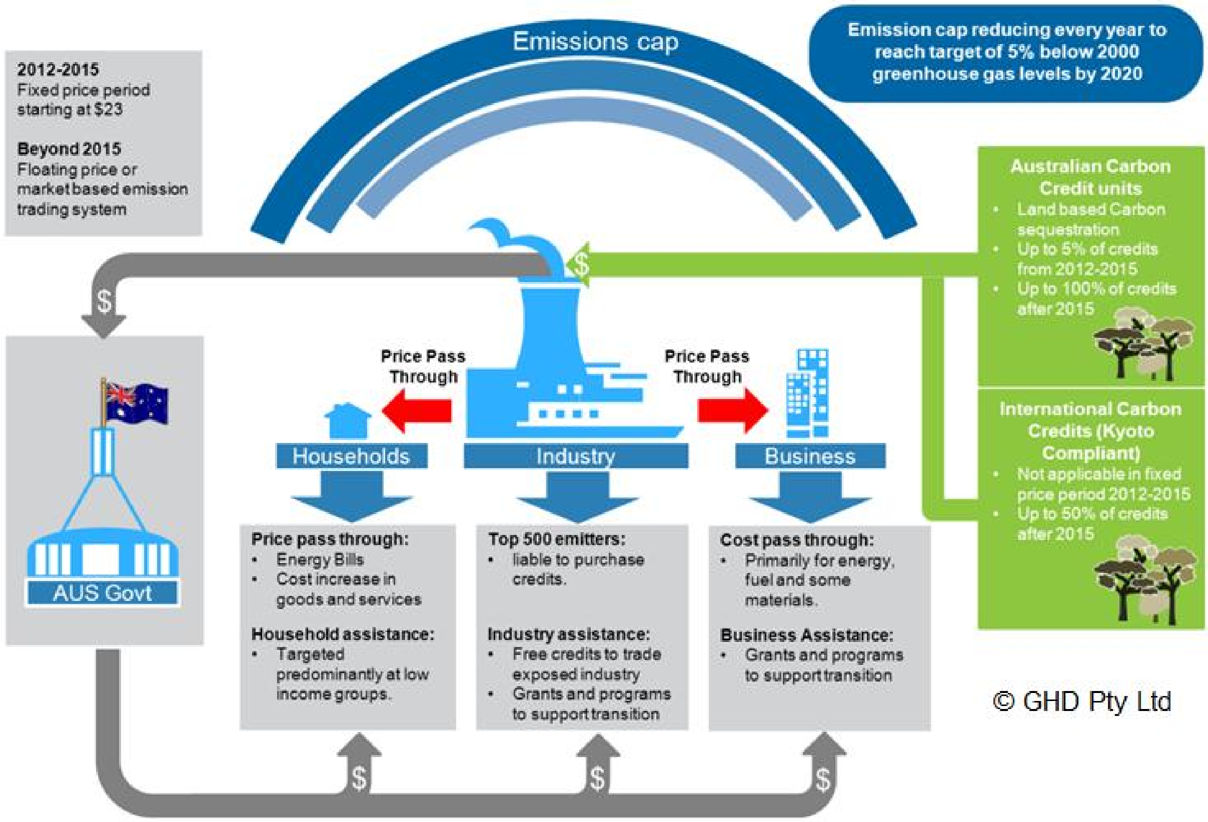


Figure 3-1 Overview of the Clean Energy Future Package

For more information about the how to manage Carbon Pricing Mechanism liability refer to the CER website.

3.1.3 Energy Efficiency

As part of the Clean Energy Future Package, approximately $1.2 billion has been allocated to the Clean Technology Investment Program and the Clean Technology Innovation Program. An additional $12 billion is allocated to the Clean Energy Finance Corporation which predominantly provides funds to renewable energy projects as well as energy efficiency technology projects.

Funds are mainly targeted at the manufacturing sector with a strong focus on food and beverage industries, and foundries. A separate $300 million is allocated to the steel industry to assist with transition. **These programs will offer funding opportunities to many organisations, including red meat processing corporations, which are using innovative ways to reduce carbon emissions.**

3.1.4 Renewable Energy

In addition to the energy efficiency legislation, significant funding for renewable energy is provided under the package through the $10 billion allocated to the Clean Energy Finance Corporation (CEFC) and $3.9 billion allocated over nine years for the Australian Renewable Energy Agency (ARENA) which will provide a competitive grants program for research and development, demonstration and commercialisation of renewable energy technologies.

Apart from the Clean Energy Futures package, there is an existing mandated 20 percent Renewable Energy Target (RET) scheme for Australian energy retailers which will foster investment in the Australian renewable energy sector.

3.1.5 Carbon Farming Initiative

The Carbon Farming Initiative (CFI) has been developed by DCCEE to give farmers, forest growers and landholders the ability to generate accredited domestic offsets for access to domestic and international carbon markets. The CFI is underpinned by the *Carbon Credits (Carbon Farming Initiative) Act 2011*, passed by Parliament in August 2011. The scheme commenced operation in December 2011.

The CFI provides clear rules for the recognition of land-based emission abatement projects carried out in Australia. The initiative includes provisions for the development of methodologies for estimating abatement, approval and registration of projects, issuance of carbon credits for approved projects, and reporting and auditing of abatement and other data relating to projects.

Abatement activities eligible under the CFI scheme are listed below and are dependent on the approval of methodologies by the DCCEE's Domestic Offsets Integrity Committee:

- *Reducing emissions from livestock;*
- *Reducing emissions from fertiliser use;*
- *Reforestation;*
- *Avoided deforestation;*
- *Reducing emissions from waste deposited in landfills before July 2012;*
- *Soil carbon management;*
- *Feral animal management;*
- *Improved forest management; and*

- *Non-forest revegetation.*

Methodologies that have been endorsed by the DCCEE for use under the CFI can be found on the DCCEE website. Those of possible interest to the red meat processing industry (at the time of this report) include:

- Destruction of methane generated from dairy manure in covered anaerobic ponds;
- Destruction of methane from piggeries using engineered biodigesters; and
- Destruction of methane generated from manure in piggeries

To help ensure additionality of projects and avoid unintended consequences of projects that pose a risk to communities or the environment under the CFI, abatement activities are categorised under the CFI as being either from:

- A Positive List, which identifies activities that would be considered additional and eligible to participate in the CFI scheme. (Additional activities on the Positive List are available on the DCCEE website). The list includes:
  – The establishment of permanent plantings on or after 1 July 2007;
  – A forestry project accredited under the Australian Government's Greenhouse Friendly™ initiative;
  – The capture and combustion of methane from livestock manure; or
- A Negative List, which identifies activities that are ineligible to participate in the CFI scheme in certain circumstances because they risk adverse impacts on communities and the environment. In particular, it should be noted that the following projects/activities will not be included on the Positive List (*Positive List Guidelines, DCCEE, 2011)*:
  – Projects that are required by law (regulatory additionality); and
  – Activities that are common practice and already widely adopted.

If an organisation is interested in implementing its own offset projects for recognition under the CFI, it would need to do so from activities on the 'Positive List'.

During the first three years of the fixed carbon price period up to 5 percent of a company's liabilities can be offset by Australian Carbon Credit Units (ACCU). These credits or offsets can be generated under the CFI.

In 2015 when the scheme moves to a market based trading scheme, liable organisations can source up to 50 percent of offsets through international carbon credits (Kyoto compliant) and up to 100 percent of liabilities through Australian Carbon Credit Units.

The $429 million Carbon Farming Futures Fund provides a range of grants to assist landholders develop carbon farming processes and technology.

4. Guidance on the NGER (Measurement) Determination

This chapter provides red meat processing industry guidance on the *NGER (Measurement) Determination 2008*, and subsequent amendments. This guidance is intended to be read in conjunction with the *Determination* and the *NGER Technical Guidelines (2012)*, to help organisations understand their obligations under the *NGER Act.*

This chapter focuses on guidance relevant to the reporting of emissions from wastewater handling, understood to be both a key emissions source and a key knowledge gap for many red meat processing corporations. Guidance relevant to other sources of emission, energy production and energy consumption is included as Appendix B. The appendix includes example calculations and data requirements for typical activities for the industry. The appendix also provides guidance on how to address 'incidental' sources of emissions (refer Appendix B, section 9.4)

Versions of the (Measurement) Determination and Technical Guidelines

The DCCEE undertakes an annual review of the methodologies contained in the *(Measurement) Determination* and associated *Technical Guidelines*. Consequently, it is important that the relevant version of the guidelines is applied for each reporting year. **More recent versions cannot be retrospectively applied for formal NGERS reporting purposes.**

Table 4-1 Versions of the *NGER Technical Guidelines*

Version	Relevant Reporting Year
NGER Technical Guidelines 2011	2011/12
NGER Technical Guidelines 2012	2012/13

The advice provided in these Industry Guidelines is based upon the most recently amended *NGER (Measurement) Determination* and *Technical Guidelines 2012.*

4.1 Sources of Emission - Checklist

Table 4-2 provides a checklist of common sources of emission for red meat processing facilties, and which of these are included in reporting under NGER or covered emissions under the CPM.

Table 4-2 Reporting Checklist – Sources of Emission

Source of Emission	Covered under NGER Reporting?	Covered under the CPM?	Applicable Chapter of *NGER (Measurement) Determination* and *Technical Guidelines (2011)*	Applicable section of this industry guideline
Scope 1 Emissions				
Combustion of fuels – transport	✓	×	Chapter 2	Appendix B
Combustion of fuels – stationary (excl. biomass, biofuel and biogas)	✓	✓	Chapter 2	Appendix B

Combustion of fuels – stationary (biomass, biofuel and biogas)	✓	×	Chapter 2	Appendix B
Industrial Processes Emissions (i.e. SF_6, HFCs)	✓	×	Chapter 4	Appendix B
Waste Emissions (i.e. Wastewater Handling - Industrial)	✓	✓	Chapter 5	Section 4 Appendix C
Scope 2 Emissions				
Electricity consumption	✓	×	Chapter 7	Appendix B

4.2 What are the methods for calculating wastewater emissions?

Emissions are rarely measured directly and are most often estimated by reference to readily observable variables that are closely related to greenhouse gas emissions. The *NGER (Measurement) Determination* provides Methods that broadly allow for both direct emissions monitoring and the estimation of emissions through the tracking of observable, closely-related variables, known as **activity data**.

Four methods are available:

- **Method 1:** the National Greenhouse Accounts default method: Method 1 provides a class of estimation procedures derived directly from the methodologies used by the DCCEE for the preparation of the National Greenhouse Accounts.

- **Method 2:** a facility-specific method using industry sampling and Australian or international standards listed in the Determination to provide more accurate estimates of emissions at the facility level.
Method 2 enables corporations to undertake additional measurements in order to gain more accurate estimates for emissions for that particular facility.

- **Method 3:** a facility-specific method using Australian or international standards listed in the Determination or equivalent standards for both sampling and analysis.
Method 3 is very similar to Method 2, except that it requires, additionally, reporters to comply with Australian or international documented standards for sampling, as well as documented standards for the analyses. In practice, the distinction between Methods 2 and 3 for the red meat processing industry is almost irrelevant.

- **Method 4**: direct monitoring of emission systems, either on a continuous or periodic basis.
Method 4 is not currently available for industrial wastewater.

4.3 Current red meat industry data collection methods

It is understood that the majority of red meat processing corporations who have reported under NGER have used Method 1 for all sources of emissions. However, where sufficient data is available, some corporations have adopted Method 2 for estimating fugitive methane emissions from wastewater treatment.

The provision to select a Method for the estimation of emissions allows each organisation to make its own judgment on the balance of costs of using the higher-order methods, with the benefits of potentially improved emission estimates. There is no requirement to use the same method for all emission sources or for all facilities within an organisation For example:

- one facility may use Method 1 to estimate fugitive emissions from wastewater treatment, and a second facility under the operational control of the same parent company may use Method 2;
- a single facility may use Method 1 to estimate emissions from liquid fuels, Method 1 to estimate fugitive emissions from wastewater treatment and Method 2 to estimate emissions from gaseous fuels.

However, it must be noted that under section 1.18 (2) of the *Determination*, **if an organisation chooses to use a higher order method for a particular emission source from a particular facility, it must continue doing so for four (4) reporting years**.

4.4 Wastewater Handling – Methodology Overview

Chapter 5 of the *NGER (Measurement) Determination* relates to direct emissions from the following sources:

(a) Solid waste disposal on land (see Part 5.2);

(b) Wastewater handling (domestic and commercial) (see Part 5.3);

(c) Wastewater handling (industrial) (see Part 5.4);

(d) Waste incineration (see Part 5.5).

The guidance provided in this section of these Industry Guidelines relates only to "Wastewater handling (industrial)".

4.4.1 Description of Emission Estimation Philosophy for Methane

The *NGER (Measurement) Determination* includes the following equations for the estimation of fugitive methane emissions arising from wastewater handling (industrial):

Equation 1: [5]

$$E_j = CH_4^* - \gamma\left(Q_{cap} + Q_{flared} + Q_{tr}\right)$$

where:

E_j is the emissions of methane released by the plant during the year, measured in CO_2-e tonnes;

CH_4^* is the estimated **theoretical** quantity of methane in biogas generated by the plant during the year, measured in CO_2-e tonnes;

γ is the factor $6.784 \times 10^{-4} \times 21$ converting cubic metres of methane at standard conditions (15°C, 1 atm) to CO_2-e tonnes;

Q_{cap} is the **measured** quantity of methane in biogas captured for combustion for use by the plant during the year, measured in cubic metres;

Q_{flared} is the **measured** quantity of methane in biogas flared during the year by the plant, measured in cubic metres; and

Q_{tr} is the **measured** quantity of methane in biogas transferred out of the plant during the year, measured in cubic metres.

The intent of Equation 1 is to reconcile the estimated **theoretical** amount of methane generated within the wastewater treatment plant (WWTP) (i.e. CH_4^*) with the actual amount of methane **measured** in the captured biogas (i.e. Q_{cap}, Q_{flared} and Q_{tr}). Any difference between these two figures (and assuming

[5] Refer to *NGER (Measurement) Determination*, section 5.42(1).

theoretical CH_4 > measured CH_4) is hence assumed to equal the amount of "fugitive" methane that has escaped to the atmosphere.

To estimate the theoretical methane generation, the *Determination* uses a **steady-state** chemical oxygen demand (COD) mass balance and application of various default emission factors. The reason for using a COD mass balance model is that COD can be directly related to methane generation.

Equation 2: [6]

$$CH_4^* = \begin{array}{l} \left[\left(\sum_{w,i} COD_{w,i} - COD_{sl} - COD_{eff}\right) \times MCF_{ww} \times EF_{wij}\right] \\ + \left[\left(COD_{sl} - COD_{trl} - COD_{tro}\right) \times MCF_{sl} \times EF_{slij}\right] \end{array}$$

where:

$\Sigma_{w,I}$	is the sum total $COD_{w,i}$ of wastewater entering the plant
$COD_{w,i}$	is the quantity of COD in wastewater entering the plant used in the production of any commodity;
COD_{sl}	is the quantity of COD removed as sludge from wastewater and treated in the plant; COD_{eff} is the quantity of COD in effluent leaving the plant during the year;
COD_{trl}	is the quantity of COD in sludge transferred out of the plant and removed to landfill;
COD_{tro}	is the quantity of COD in sludge transferred out of the plant and removed to a site other than landfill;
EF_{wij}	is the maximum methane generation factor for wastewater with a value of 5.3 CO_2-e tonnes per tonne COD;
EF_{slij}	is the maximum methane generation factor for sludge with a value of 5.3 CO_2-e tonnes per tonne COD;
MCF_{ww}	is the methane correction factor for wastewater treatment by the plant during the year; and
MCF_{sl}	is the methane correction factor for sludge treatment by the plant during the year.

All quantities of methane are measured in cubic metres and all COD is measured in tonnes of COD.

A simple process flow diagram is shown in Figure 4-1 to help clarify the definition of terms in Equation 2. The intent of Equation 2 is to estimate the **theoretical quantity of methane generated at the plant**, based on a COD mass balance. The equation is divided into two parts:

- The first part is a COD mass balance over the main wastewater treatment processes (i.e. "liquid train" primary and secondary treatment), where
  - Primary treatment involves physical treatment (i.e. screening, dissolved air flotation etc.); and
  - Secondary treatment involves biological treatment (i.e. activated sludge process, treatment ponds etc.);
- The second part is a COD mass balance over the sludge treatment processes (e.g. anaerobic digesters, sludge lagoons, dewatering, etc.).

[6] Refer to *NGER (Measurement) Determination*, section 5.42(5).

Each COD mass balance determines how much COD is consumed in the treatment process by converting it to a gas (i.e. CO_2 or CH_4):

- Multiplying by the maximum methane generation factor (EF) calculates how much methane would be generated if **100% of the COD consumed was converted to methane**; then
- Multiplying by the process-specific MCF_{ww} or MCF_{sl} factor calculates the expected fraction of methane emissions for that particular type of process (i.e. of the consumed COD, how much is actually anaerobically converted to CH_4 versus aerobic conversion to CO_2)
(refer to Section 4.4.2 for futher detail).

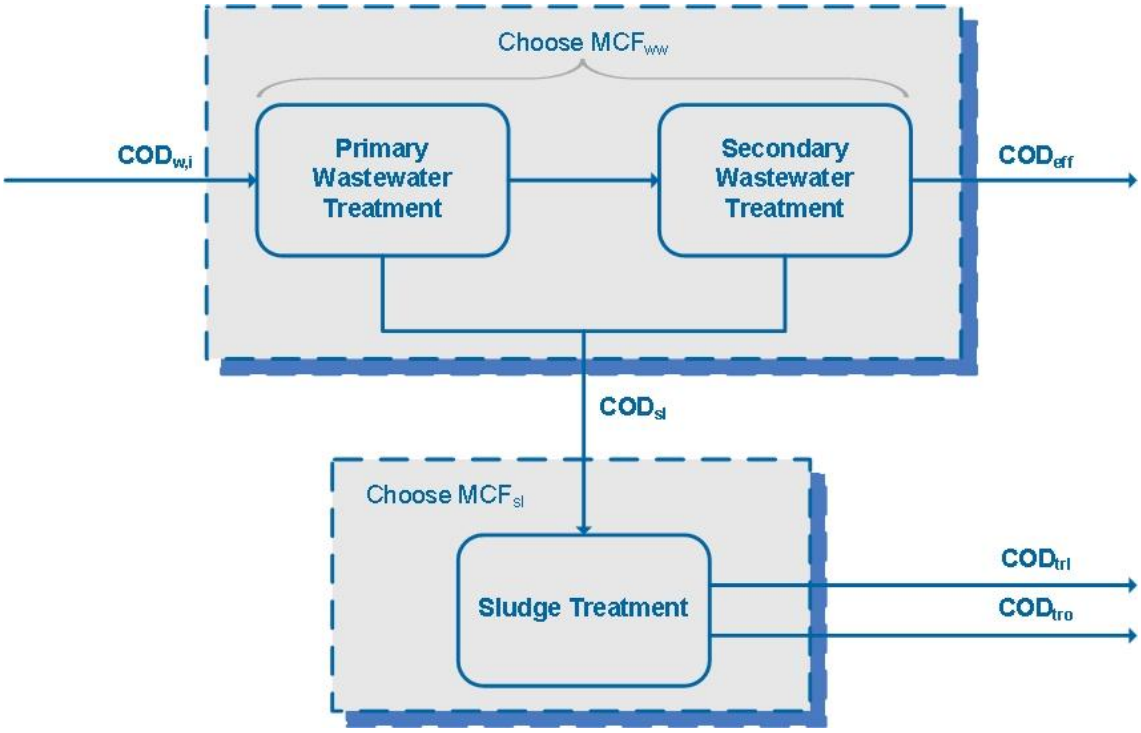


Figure 4-1 Default NGERS COD Mass Balance

4.4.2 Methane Correction Factor Selection

Shown below in Table 4-3 are typical wastewater treatment processes and how they might be classified under the default categories offered in the *(Measurement) Determination*. This categorisation is based only on the judgement and experience of the authors and the project working group[7].. These factors may be used if the organisation has specific information about the type of treatment system and if the treatment process falls under a single category.

In the absence of these conditions, the default MCF value of 0.4 for the meat and poultry industry (ANZIC codes 1111 and 1112) can be assigned in accordance with either Method 1 or Method 2 of the *Determination*. In all cases, the choice of MCF requires substantiation. The choice of MCF depends on the treatment processes at the facility and is independent of whether Method 1 or 2 is used.For example:

- if all wastewater is treated in a DAF plant, followed by aerated lagoons (both managed aerobic treatment), a MCF of 0.0 would apply;
- if all wastewater is treated in an anaerobic digestor, a MCF of 0.8 would apply;

[7] Further research is necessary to better characterise methane emissions from different treatment processes

- if wastewater is treated in a DAF plant followed by anaerobic lagoons (two different process categories) then use the default MCF of 0.4,

Table 4-3 Methane Correction Factors for Typical Wastewater Processes

Treatment Category [1]	MCF Values [1]	Applicable Wastewater Treatment Processes
Managed Aerobic Treatment	0.0	• Preliminary treatment (i.e. screens and presses) [2] • Hydrocyclones • Electro-coagulation • Dissolved air flotation (DAF), induced air flotation (IAF) or cavitation air flotation (CAF) • Secondary sedimentation tanks or clarifiers • Mechanically aerated lagoons • Aerobic digesters
		• Tertiary filtration • Disinfection processes (e.g. chlorination inc. contact tanks, ultraviolet irradiation) • Mechanical dewatering (e.g. centrifuges, belt filter presses) • Activated sludge processes and derivatives, inc. intermittently decanted extended aeration (IDEA), intermittently decanted aerated lagoons (IDAL), sequencing batch reactors (SBR), activated primary tanks, anaerobic fermentation zones [3] and anoxic zones [4] for biological nutrient removal (BNR)
Unmanaged Aerobic Treatment	0.3	• Save alls • Gravity thickeners • Imhoff tanks
Anaerobic Digester / Reactor	0.8	• Anaerobic digesters • High-rate anaerobic reactors (e.g. UASB)
Anaerobic Shallow Lagoon (< 2 m deep)	0.2	• Facultative lagoons • Maturation / polishing lagoons • Sludge drying pans
Anaerobic Deep Lagoon (> 2 m deep)	0.8	• Sludge lagoons • Anaerobic lagoons (covered or uncovered)

Notes:

(1) From *NGER Measurement Determination 2008*

(2) Hydraulic retention times in preliminary treatment steps is usually limited to < 2 h, and there is generally minimal retention of solids. Therefore, there is likely to be negligible methane generation.

(3) Activated Primary Tanks for fermentation and/or anaerobic zones for biological phosphorus removal are short residence time reactors where anaerobic reactions of hydrolysis and fermentation (acidogenesis) take place, converting solids to soluble compounds, and this in turn into volatile fatty acids. The short residence time and uncontrolled pH environment of these reactors create an optimum environment for fermentation bacteria. On the other hand, methane forming (methanogenic) bacteria have a slow growth rate (24-72 hours) and are highly sensitive to pH (6.8 – 8), requiring long residence time preferably at elevated temperatures (around 35-37 °C) and strict pH control in the complete absence of

oxygen to develop. Given the short residence time, (typically) open surfaces (with some exposure to atmospheric oxygen transfer), and sub-optimal ambient temperature conditions, methane forming bacteria are unlikely to grow in this environment. Therefore, methane formation is likely to be negligible in primary fermenters and anaerobic bio-P zones.

(4) Anoxic zones are typically oxygen deficient and nitrate-rich zones, designed for denitrification of nitrate to nitrogen gas. Under these conditions, there is likely to be negligible methane generation.

For further information on the different wastewater treatment processes listed in Table 4-3, refer to the following sources:

AMPC (2004). *Wastewater Environmental Best Practice Manual,* GHD Pty Ltd.

Metcalf & Eddy Inc., Tchobanoglous, G., Burton, F.L., Stensel, H.D. (eds.) (2003). *Wastewater Engineering: Treatment and Reuse*, 4th ed., McGraw Hill, Boston.

4.5 What is the difference between Method 1 and 2?

The only substantial difference between Method 1 and Method 2 is the approach for determining the COD mass load in the raw wastewater (i.e. $COD_{w,i}$).

Under Method 1, $COD_{w,i}$ is determined using a default wastewater production rate (in kL wastewater per tonne of product) and a default COD concentration (kg COD per kL of wastewater) for the meat industry. In contrast, Method 2 uses actual flow and COD (or BOD) concentration data measured for the individual treatment plant. Hence, Method 1 may over-estimate or under-estimate methane emissions depending on the true strength of the raw wastewater. This is explained further below.

Method 1 should be used when activity data is not routinely collected at the WWTP for raw wastewater.

Under Method 1, the COD entering the WWTP, $COD_{w,i}$, is calculated as:

$$COD_{w,i} = Prod_i \times W_{gen,i} \times \frac{COD_{con,i}}{1000}$$, where:

$Prod_i$ has the meaning of **tonne of product (hot standard carcass weight (HSCW) or live weight basis)** for the meat and poultry industry (ANZSIC codes 1111 and 1112) as produced by the facility during the year;

$W_{gen,i}$ is the wastewater generation rate with a default value of **13.7 cubic metres per tonne of product** for the meat and poultry industry; and

$COD_{con,i}$ is the raw (untreated) wastewater COD concentration with a default value of **6.1 kilograms of COD per cubic metre** of wastewater entering the plant during the year for the meat and poultry industry.

Method 2 may be used when activity data is routinely collected at the WWTP for raw wastewater.

Under Method 2, $COD_{w,i}$ must be estimated using operating data from the facility for wastewater entering the plant that measures either:

1. The volumetric influent flow rate (i.e. ML for the year) and COD concentration (i.e. mg/L or kg/m^3); or
2. The volumetric influent flow rate and biochemical oxygen demand (BOD) concentration (i.e. mg/L or kg/m^3), where BOD data may be converted to COD using the NGER default COD:BOD conversion factor for raw wastewater only, COD = 2.6 t COD/ t BOD_5

Figure 4-2 (below) can be used as a rough guide to determine whether Method 1 is likely to over-estimate or under-estimate methane emissions for any particular meat processing industry wastewater treatment plant. The curve represents the default raw wastewater COD concentrations for various wastewater production rates and concentrations when using Method 1. Therefore, if your raw wastewater COD concentration and production puts you below the line, then Method 1 may result in an overestimation of emissions.

For example, if the average wastewater production rate for a particular meat processing facility is 15 kL per tonne of product (hot standard carcass weight or live weight basis), then using the Method 1 *Determination* default COD mass load value, this would equate to an average raw wastewater COD concentration of approximately 5.6 kg/kL. If the plant operators know from past sampling that the actual raw wastewater COD concentration is actually closer to 4,000 mg/L (4kg/kL), then Method 1 will possibly result in an over-estimation of emissions by up to around 40%.

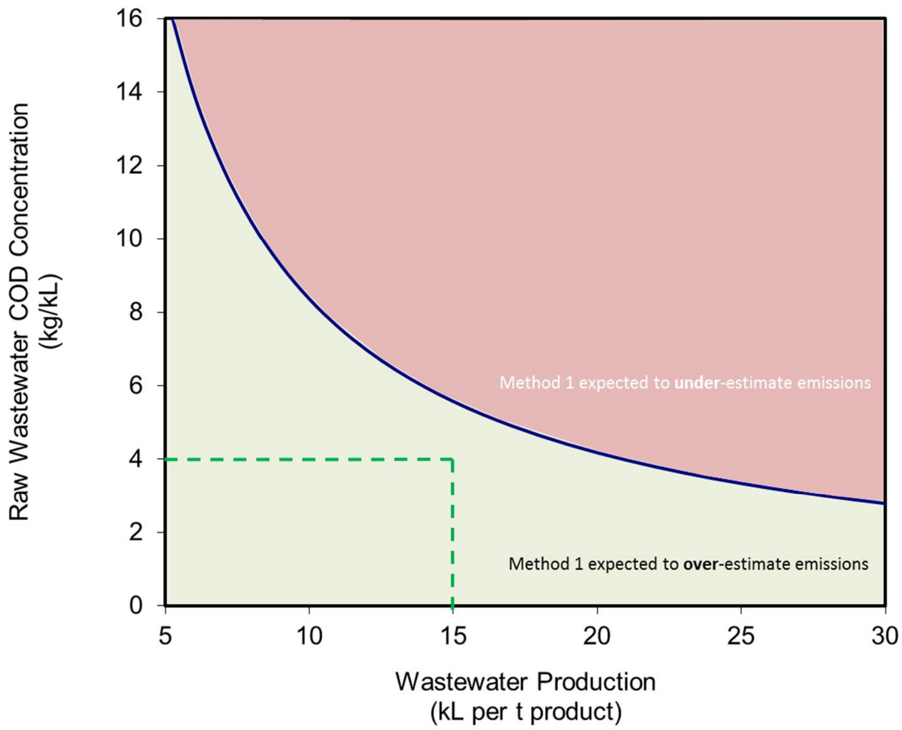


Figure 4-2 - Method 1 vs Method 2

4.6 What needs to be measured?

Method 1

Q_{cap} is the **measured** quantity of methane in biogas captured for combustion for use by the plant during the year;

Q_{flared} is the **measured** quantity of methane in biogas flared during the year by the plant;

Q_{tr} is the **measured** quantity of methane in biogas transferred out of the plant during the year;

COD_{sl} is the quantity of COD removed as sludge from wastewater and can be worked out as

$COD_{sl} = COD_{w,i} \times F_{sl}$;

F_{sl} is the fraction of COD removed from wastewater as sludge by the plant during the year;

COD_{eff} is the **measured** quantity of COD in effluent leaving the plant during the year;

COD_{trl} is the **measured** quantity of COD in sludge transferred out of the plant and removed to landfill; and

COD_{tro} is the **measured** quantity of COD in sludge transferred out of the plant and removed to a site other than landfill.

All quantities of methane are measured in cubic metres and all COD is measured in tonnes of COD.

Some of these parameters may not be relevant to all facilities. In practice, some of the parameters may not be measured or known. In this case they could be assumed to be zero (except for $COD_{w,i}$ the quantity of COD in wastewater entering the plant). Assuming any of the 'methane in biogas' or COD terms are zero will always result in higher calculated emissions. For example, if the quantity of COD in sludge transferred out of the plant and removed to landfill or a site other than a landfill is not measured, then COD_{trl} and COD_{tro} could be assumed to be zero – this will result in higher calculated methane emissions.

Method 2

As per method 1, plus:

$COD_{w,i}$ is the **measured** quantity of COD in wastewater entering the plant, calculated from the measured volumetric influent rate and the influent COD concentration.

Uncertainty in measurements is discussed at Appendix D.

4.6.1 Example calculations for Method 1 and 2

Example – Methane Emissions from WWTP

What is the difference in the methane emissions from a WWTP treating wastewater from a red meat processing facility using Method 1 versus Method 2? Assume the plant processes 322,867 tonnes HSCW in the 2012/13 year. The treatment process consists of:

- Preliminary screening and Dissolved air flotation (DAF);
- Conventional activated sludge secondary treatment;
- 100% effluent reuse for irrigation;
- Anaerobic digestion for combined primary sludge and waste activated sludge;
- Biosolids disposal to landfill; and
- Biogas capture for flaring only.

Activity data for Method 1 & 2:

Tonnes of product for the year, $Prod_i$ = 322,867 tonnes HSCW

Raw wastewater volume, Q = 3,800 ML per year

Effluent COD concentration, $[COD]_{eff}$ = 100 mg/L

Digested sludge to landfill, Q_{trl} = 62.5 tonnes / d = 22,812.5 tonnes per year

Digested sludge volatile solids concentration = 15% volatile solids (by weight)

Biogas flared, B_{flared} = 12,000 m^3/d = 4,380,000 m^3 per year (at 15°C, 1 atm)

Methane concentration in biogas, $\%CH_4$ = 65% (by volume)

Additional activity data required for Method 2:

Raw wastewater COD concentration, $[COD]_w$ = 6,500 mg/L Primary sludge volume (i.e. DAF solids[8]), Q_{ps} = 0.5 ML/d = 182.5 ML per year Primary sludge volatile solids concentration, $[VS]_{ps}$ = 30,000 mg/L Waste activated sludge volume, Q_{was} = 2.8 ML/d = 1,022 ML per year WAS volatile solids concentration, $[VS]_{was}$ = 3,500 mg/L **Emission factors and other values (refer to Appendix B for the basis of these values):** $W_{gen,i}$ = 13.7 cubic metres of wastewater per tonne of product COD_{con} = 6.1 kilograms of COD per cubic metre EF_{wij} = 5.3 t CO_2-e per tonne COD removed EF_{slij} = 5.3 t CO_2-e per tonne COD removed MCF_{ww} = 0.0 (i.e. for PSTs, DAF and activated sludge process) MCF_{sl} = 0.8 (i.e. for anaerobic digestion) F_{sl} = 0.6 (i.e. for primary treatment and activated sludge secondary treatment) VS_{tr} = 1.79 t COD / t VS (average of collected data for the period) γ is the factor $6.784 \times 10^{-4} \times 21$	
Additional emission factors and other values required for Method 2: VS_{psl} = 1.99 t COD / t VS VS_{wasl} = 1.48 t COD / t VS	
Emissions calculations:	
<u>Method 1</u>	**<u>Method 2</u>**
Raw wastewater COD mass load, $COD_{w,i}$ = 322,867 t × 13.7 m^3/t × 6.1 kg/m^3 × (10^{-3} t/kg) = 26,982 tonnes COD	Raw wastewater COD mass load, $COD_{w,i}$ = 3,800 ML × 6,500 mg/L × (10^{-3} t/kg) = 24,700 tonnes COD
Effluent COD mass load, COD_{eff} = 3,800 ML × 100 mg/L × (10^{-3} t/kg) = 380 tonnes COD	
	Primary sludge COD mass load, COD_{psl} = 182.5 ML × 30,000 mg/L × 1.99 × (10^{-3} t/kg) = 10,895 tonnes COD
	WAS COD mass load, COD_{wasl} = 1,022 ML × 3,500 mg/L × 1.48 × (10^{-3} t/kg) = 5,294 tonnes COD
Total sludge COD mass load, COD_{sl} = 0.6 ×26,982 = 16,189 tonnes COD	Total sludge COD mass load, COD_{sl} = 10,895 + 5,294

[8] Raw wastewater composition activity data is typically collected from sampling points downstream of preliminary (screening) units. In such situations, screened solids may be excluded from the COD mass balance calculations and from the primary sludge COD volume.

	= 16,189 tonnes COD
Sludge to landfill COD mass load, COD_{trl} = 22,812.5 wet tonnes × 15% VS × 1.79 = 6,125 tonnes COD	
Sludge transferred to "other" COD mass load, COD_{tro} = 0	
Apply equation from section 5.42 (5): $CH_{4gen} = \frac{(COD_{wi} - COD_{sl} - COD_{eff}) \times MCF_{ww} \times EF_{wij}}{+ (COD_{sl} - COD_{trl} - COD_{tro}) \times MCF_{sl} \times EF_{slij}}$ = {(26,982 – 16,189 – 380) × 0.0 × 5.3} + {(16,189 – 6,125 – 0) × 0.8 × 5.3} = 42,671 tonnes CO_2-e	Apply equation from section 5.42 (5): $CH_{4,gen} = E_{liq} + E_{sl}$ = {(24,700 – 16,189 – 380) × 0.0 × 5.3} + {(16,189 – 6,125 – 0) × 0.8 × 5.3} = 0 + 42,671 = 42,671 tonnes CO_{2-e}
Methane in captured biogas for combustion, Q_{cap} = 0	
Methane in captured biogas for flaring, Q_{flared} = 4,380,000 m^3 × 65% = 2,847,000 m^3 CH_4	
Methane in captured biogas for transfer out of the plant, Q_{tr} = 0	
Apply equation from section 5.42 (2): $\frac{6.784 \times 10^{-4} \times 21 \times (0 + 2{,}847{,}000 + 0)}{42{,}671} = \frac{40{,}560}{42{,}671}$ = 0.95 Hence, CH_4^* = 40,560 × (1/0.75) = 54,080 tonnes CO_2-e	Apply equation from section 5.42 (2) and condition from section 5.43 (2A): {6.784 × 10-4 × 21 (0 + 2,847,000 + 0)}/ 42,671 = 40,560 / 42,671 = 0.95 Hence CH_4^* = CH_4 gen = 42,671 tonnes CO2-e
Apply equation from section 5.42 (1): E_j = 54,080 – 40,560 = **13,520** tCO_2-e	Apply equation from section 5.42 (1): E_j = 42,671 – 40,560 = **2,111** tCO_2-e

Note: For this example, actually measuring the raw wastewater COD concentration (Method 2) results in 84% lower calculated methane emissions, compared to using the default COD per capita of Method 1.

4.7 How can this data be collected?

The table below provides suggested sampling and measurement procedures for collecting activity data for Method 2. Some activity data items will not be relevant to all treatment plants. Appendix B provides further information on addressing data gaps for either Method 1 or Method 2.

Item	Preferred Measurement Procedure	Alternative Measurement Procedure	Sampling / Measurement frequency
Flow Measurement			
Wastewater flow rate	Online flow metering records	Operator logs of flow metering, pump run time records or based on pit water level rate rise	Minimum monthly

Sludge flow rate	Online flow metering records	Operator logs of flow metering or pump run time records or based on pit water level rate rise	Minimum monthly
Biogas flow rate	Online flow metering records	Operator logs of flow metering records	Minimum monthly
Sampling and Composition Analyses			
Wastewater COD concentration	External laboratory: Standard Method 5220 [(1)]	See BOD below	Minimum monthly (flow weighted composite or grab sample)
Wastewater BOD concentration [(2)]	External laboratory Standard Method 5210 [(1)]		Minimum monthly (flow weighted composite or grab sample)
Sludge COD concentration	External laboratory Standard Method 5220 [(1)]	See VS below	Minimum monthly (flow weighted composite or grab sample)
Sludge VS concentration [(3)]	External laboratory: Standard Method 2540G [(1)]	On-site laboratory	Minimum monthly (flow weighted composite or grab sample)
Biogas CH_4 composition	Online composition analysis	External laboratory	Minimum monthly (flow weighted composite or grab sample)

(1) *Standard Methods for the Examination of Water and Wastewater* (22nd Edition, 2012), American Public Health Association (APHA), American Water Works Association (AWWA) & Water Environment Federation (WEF)

(2) Used only if COD data is not available (i.e. COD data is preferred)

(3) Used only if COD data is not available (i.e. COD data is preferred)

4.8 Selecting between Method and Method 2 – Summary

Figure 4-3 below provides a summary of the decision steps to be followed when selecting between Method 1 and Method 2 for wastewater handling.

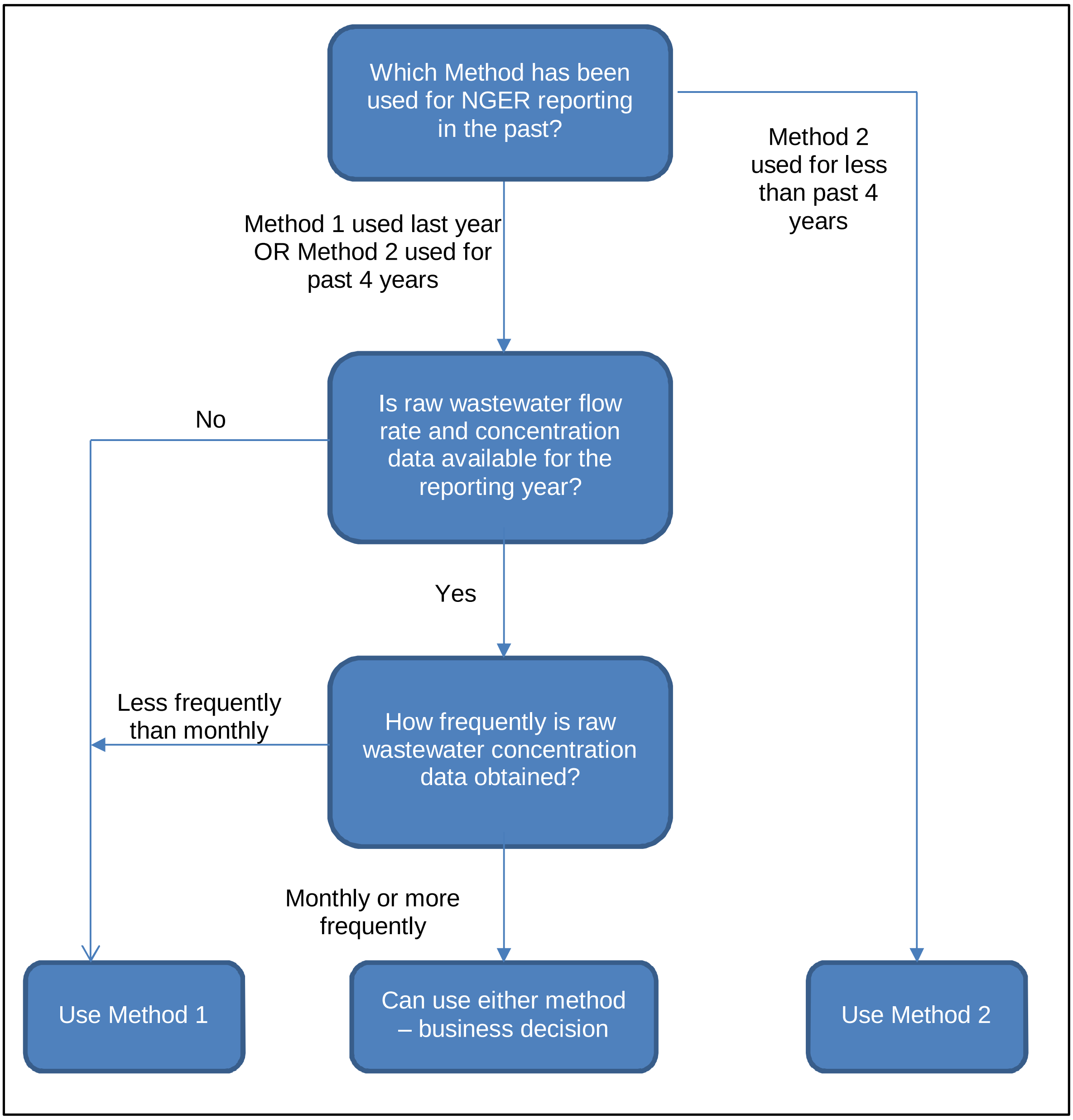


Figure 4-3 Decision Tree – selecting between method 1 and method 2

5. Guidance on the NGER (Audit) Determination

5.1 Purpose of Audits

Greenhouse and energy audits are a key compliance monitoring measure under the NGER Act. Greenhouse and energy audits are undertaken to provide the Clean Energy Regulator (CER), or registered corporation, with assurance it complies with the NGER legislation.

There are three different types of greenhouse and energy audits as defined under the NGER Act: assurance engagements providing either reasonable or limited assurance; and verification engagements, providing no assurance (just factual findings on compliance).

5.2 What does this mean for my site?

A meat processing facility may engage a registered NGER auditor on a voluntary basis to audit the preparation of their NGER report, or may be selected by the Clean Energy Regulator to undertake a mandatory audit. Mandatory audits can be initiated by the Clean Energy Regulator if they suspect a breach of the legislation (in which case the audited corporation is required to fund the audit) or as part of CER's general compliance strategy (in which case the CER funds the audit).

Voluntary and Mandatory audits may examine any or all aspects of an audited body's compliance with the NGER Act, including:

- emissions, energy production and energy consumption reported in accordance with section 19 of the NGER Act;
- definitions of corporate group and facilities through the application of overall and operational control;
- requirements for identification and measurement of emissions sources, energy consumption and production; and
- requirements for accuracy, completeness and validity of reported greenhouse and energy information including record keeping requirements.

5.3 What if I am going to be audited?

Whether your organisation has elected to undertake a voluntary audit or has been selected by the CER to undertake a mandatory audit, it is important to remember that greenhouse and energy audits can assist corporations to understand their obligations and develop efficient reporting processes that meet the needs of government and business. Thus, they can be a beneficial experience for the auditee.

At the commencement of the audit, your auditor will prepare an audit plan. The audit plan will identify the areas of greatest risk in correctly reporting emissions, energy production and energy consumption. The audit plan will outline the scope of the audit activities and the types of information and records that they will expect to see during the audit. This will assist you to prepare for the audit. Your auditor will need to visit your site in order to gain an understanding of the site activites and processes. This also helps the auditor to identify any emission sources that may have been accidently omitted from the NGER report.

5.4 Record keeping under the NGER Act

Under the NGER Act, a registered corporation is required to keep adequate records of the activities of the members of its group to comply with the provisions of the Act. Records can be kept in hard copy or electronic format, but must be easily accessible. Records are required to be kept for seven years from the end of the reporting year in which the recorded activities took place (for example, records for the 2008–09 reporting year should be kept until the end of 2015–16).

Corporations should record both the decision making process on what activities it needs to report and the details of the calculation and data analysis methods used for greenhouse gas emissions and energy production and consumption. Recommended records include but are not limited to:

- a list of all sources monitored;
- the activity data used for calculation of greenhouse gas emissions for each source, categorised by process and fuel or material type;
- documentary evidence of fuel usage, for example, receipts and invoices;
- documentation of the methods used for greenhouse gas emissions and energy estimations;
- documents justifying selection of the monitoring methods chosen;
- documentation of the collection process for activity data for a facility and its sources; and
- records supporting business decisions and accuracy, especially for high-risk areas relating to reporting coverage (for example, applying concepts of controlling corporation, corporate group and facility).

When facility-specific emissions factors are used (e.g. for Methods 2 and above), records should document the monitoring methods used and the results from the development of these emissions factors as well as information such as biomass fractions and oxidation or conversion factors.

5.5 Audits under the Carbon Pricing Mechanism

If your organisation is a liable entity under the carbon pricing mechanism (CPM) (i.e. if your emissions exceed 125,000 tonnes CO_2-e) you are required to arrange a pre-submission audit to provide assurance over your reported emisions. Liable entities must report the amount of covered scope 1 emissions or embodied emissions for which they are liable (see Section Carbon Pricing Mechanism 3.1.2). A copy of the audit report should be submitted with the liable emissions report.

The NGER Regulations require that:

- the audit must be a reasonable assurance engagement;
- it must be conducted in accordance with the National Greenhouse and Energy (Audit) Determination 2009, and
- it must be undertaken by a Category 2 or 3 registered greenhouse and energy auditor.

Note: If the organisation is required to submit a report under the NGER Act, it will not be required to enter the same data into the emissions and energy reporting system (EERS) twice (i.e. for NGER compliance and CPM compliance). Instead EERS will capture the single set of data entered by the liable entity, and use this to calculate liable emissions[9].

5.6 Audit Checklist

An audit checklist has been prepared to assist meat processing companies in the preparation of their NGER report (Appendix E). It indicates the requirements that need to be met at each stage of report preparation to ensure the report is **complete**, **compliant** and **auditable**. It assumes that the requirements for participation (i.e. whether the organisation is required to report) have been met (see Section 2.1).

[9] This is based on CER advice and a review of the EERS for entering the Interim Emissions Number. The full version of EERS is not yet available.

The checklist is applicable to CPM liable organisations and those organisations that are required to report under the NGER Act but are not CPM liable. The requirements for preparing the reports in each case (audit evidence required etc) are the same.

The evidence to be kept for each activity will depend on the measurement criteria and Method used. The checklist has been developed based on using Method 1 for all parameters, except for emissions from wastewater, which includes Method 2.

For fuels, there are four measurement criteria:

- Criterion A – based on invoices issued by the vendor of the fuel. This is the easiest measurement criteria and most widely used by the red meat industry;
- Criterion AA – based on indirect measurement at the point of combustion;
- Criterion AAA – based on direct measurement at the point of combustion; and
- Criterion BBB – estimation based on industry practice.

Note that if you start reporting as either AA or AAA you must keep reporting by the same measurement criterion in future years.

6. Case Studies

Two case study examples are presented below for the estimation of Scope 1 wastewater emissions under *Part 5.4 of the NGER (Measurement) Determination 2008 as amended*.

These case studies are intended to illustrate the differences between Method 1 and Method 2, and to demonstrate the typical activity data requirements for each method. Further, the Plant A case study demonstrates what to do when no sludge data is available, as distinct from Plant B where sludge data is available.

The case studies are based on real processing facilities in Australia. However, the example calculations and estimates below have been edited for the purpose of these guidelines and do not represent any meat processing corporation's actual NGERS inventory for any facility.

6.1 Case Study Plant A

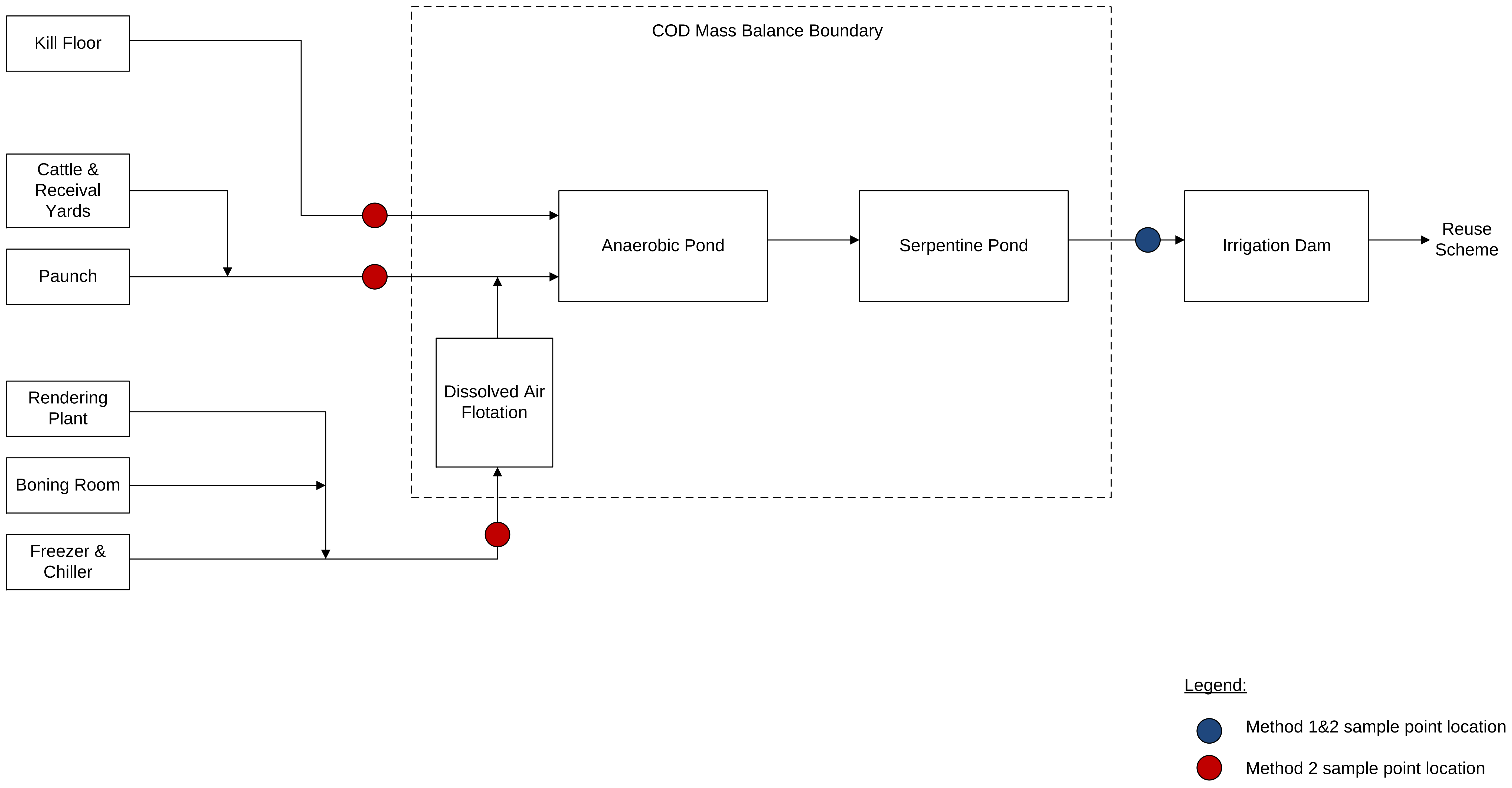
A simplified process flow diagram (PFD) of Plant A's wastewater treatment process is included as Figure 6.1. The mass balance boundary and activity data sources for the calculations are also shown on the PFD.

The wastewater treatment process at Plant A can be summarised as follows:

- Wastewater from the kill floor is screened and then pumped to the anaerobic pond.
- Cattleyard wastewater, tripe wash and paunch dump is screened and then pumped to the anaerobic pond.
- Wastewater from the rendering plant, boning room, chillers and freezer undergoes dissolved air flotation (DAF) treatment to separate fats and solids prior to being pumped to the anaerobic pond.
- The anaerobic pond accepts wastewater from the above sources and represents the first stage of treatment. The lagoon has a natural 'crust' cover. No biogas is captured or recovered.
- Following anaerobic pond treatment, wastewater flows to a serpentine pond for maturation/polishing. The serpentine pond is not aerated or covered.
- Wastewater from the serpentine pond is stored in an irrigation dam before being disposed via land irrigation.
- There is no wastewater sludge treatment process at this plant. Floated solids from the DAF are returned to the rendering plant for further processing. Wastewater sludge is periodically removed from the lagoons for offsite disposal.
- Solid waste (e.g. paunch solids) from meat processing is composted onsite prior to offsite disposal. Direct emissions from composting are excluded from NGER reporting for this plant since the site is not classified as a landfill (refer to Table 2-2 of this report for further information).

Figure 6-1 – Plant A Process Flow Diagram

Case Study Plant A Process Flow Diagram



No	Revision Note:* indicate signature on original issue of drawing or last version of drawing	Drawn	Checked	Approved	Date	Our Reference
0		CP				

CLIENTS | PEOPLE | PERFORMANCE

Level 8, 180 Lonsdale Street, Melbourne VIC 3000 Australia
T 61 3 8687 8000 F 61 3 8687 8111
E melmail@ghd.com.au W www.ghd.com.au

Drawn: C Pepperell
Designed: C Pepperell
Drafting Check
Design Check

Client: Australian Meat Processing Corporation
Project: Meat Processing Industry NGER Guidelines
Title: Figure 6.1 – Plant A Process Flow Diagram

Scale NOT TO SCALE
This Drawing must not be used for Construction Unless signed as approved
Original Size A3
Rev: 0

6.1.1 Method 1 Example – Plant A

Table 6-1 Direct Methane Emissions from Plant A (Method 1)

Item	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 1** Division 5.4.2
Activity data	• Meat production rate, **$Prod_i$ = 78,380 tonnes** (HSCW) (based on daily production logs) • Fraction of COD removed from wastewater as sludge, **F_{sl} = 0** (No sludge removed from the lagoons in 2012-13. No DAF solids records available for either volume or COD concentration. Note: Refer to Case Study B for an example showing how this information can be included if available, and how this information may affect emissions estimates). • Effluent volume, **Q = 737.0 ML** (based on town potable water and bore water supply metering logs for 2012-13. No other flow meters installed. Water supply demand assumed approximately equal to treated effluent in absence of other information). • Effluent COD concentration, **$[COD]_{eff}$ = 414.25 mg/L** (average COD concentration based on monthly serpentine pond effluent sampling and laboratory analysis) • Quantity of COD in sludge transferred out of the plant and removed to landfill, **COD_{trl} = 0** (no sludge removed from the ponds or transferred out of the plant in 2012-13) • Quantity of COD in sludge transferred out of the plant and removed to a site other than landfill, **COD_{tro} = 0** (no sludge removed from the ponds or transferred out of the plant in 2012-13) • Quantity of methane in sludge biogas captured for combustion, **Q_{cap} = 0** (no sludge biogas captured at this plant) • Quantity of methane in sludge biogas flared by the plant, **Q_{flared} = 0** (no sludge biogas captured at this plant) • Quantity of methane in sludge biogas transferred out of the plant, **Q_{tr} = 0** (no sludge biogas captured at this plant)
Emission factors and other values	Section 5.42 (5), (8): • Methane Correction Factor for wastewater treatment, **MCF_{ww} = 0.4** (IPCC default correction factors are not suitable since the plant comprises managed aerobic treatment (i.e. DAF), deep anaerobic lagoon treatment (i.e. anaerobic pond) and shallow anaerobic treatment (i.e. serpentine pond). Therefore select meat industry default value of 0.4 as this value is within the range of IPCC default values for the individual processes). • Methane Correction Factor for sludge, **MCF_{sl} = 0** (no sludge treatment at this facility)

Item	Description and *NGER (Measurement) Determination* References
Emission factors and other values (cont.)	• Wastewater generation rate, **W_{gen} = 13.7 m^3 per tonne product** (ANZSIC codes 1111 and 1112) Raw wastewater COD concentration, **COD_{con} = 6.1 kg per cubic metre** (i.e. 6,100 mg/L) (ANZSIC codes 1111 and 1112) • Methane Emission Factor for wastewater treatment, **EF_{wij} = 5.3 t CO_2-e / t COD** • Methane Emission Factor for sludge treatment, **EF_{slij} = 5.3 t CO_2-e / t COD** • Biogas methane conversion factor, **γ = 6.784 ×10^-4 × 21** (for converting m^3 of methane at standard conditions to CO_2-e tonnes)
Emissions calculation method – step-by-step	1) Raw wastewater COD mass load, $COD_{w,i}$ (tonnes) $COD_{w,i} = Prod_i \times W_{gen,i} \times COD_{con} \times 10^{-3}$ t/kg = 78,380 tonnes × 13.7 m^3/tonne × 6.1 kg/m^3 × 10^{-3} t/kg = 6,550 tonnes COD
	2) Effluent COD mass load, COD_{eff} (tonnes) $COD_{eff} = Q \times [COD]_{eff} \times 10^{-3}$ t/kg = 737.0 ML × 414.25 mg/L × 10^{-3} t/kg = 305 tonnes COD
	3) Total sludge COD mass load, COD_{sl} (tonnes) $COD_{sl} = F_{sl} \times COD_w$ = 0 × 6,550 tonnes COD = 0 tonnes COD
	4) Sludge transferred to landfill COD mass load, COD_{trl} (tonnes) COD_{trl} = 0 tonnes COD
	5) Sludge transferred to “other” COD mass load, COD_{tro} (tonnes) COD_{tro} = 0 tonnes COD
	6) Apply equation from section 5.42 (5): $CH_{4gen} = \left(COD_{w,i} - COD_{sl} - COD_{eff}\right) \times MCF_{ww} \times EF_{wij} + \left(COD_{sl} - COD_{trl} - COD_{tro}\right) \times MCF_{sl} \times EF_{slij}$ = (6,550 – 0 – 305) × 0.4 × 5.3 + (0 – 0 – 0) × 0 × 5.3 = 13,239 t CO_2-e
	7) Methane in captured biogas for combustion, Q_{cap} (m^3) Q_{cap} = 0 m^3
	8) Methane in captured biogas for flaring, Q_{flared} (m^3) Q_{flared} = 0 m^3
	9) Methane in captured biogas for transfer out of the plant, Q_{tr} (m^3) Q_{tr} = 0 m^3

Item	Description and *NGER (Measurement) Determination* References
	10) Apply equation from section 5.25 (2): $$\frac{\gamma(Q_{cap} + Q_{flared} + Q_{tr})}{CH_{4gen}} = \frac{0}{13,239} = 0 \leq 0.75$$ therefore, $CH_4^* = CH_{4gen}$ = 13,239 t CO_2-e
	11) Apply equation from section 5.42 (1): $$E_j = CH_4^* - \gamma(Q_{cap} + Q_{flared} + Q_{tr})$$ = 13,239 - 6.784 ×10^-4 × 21 × (0 + 0 + 0) **= 13,239 t CO_2-e**

In summary, the estimated emissions for Case Study Plant A based on Method 1 are 13,239 t CO_2-e.

6.1.2 Method 2 Example – Plant A

Table 6-2 Direct Methane Emissions from Plant A (Method 2)

Item	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 2** Division 5.4.3
Activity data	• Raw wastewater volume, **Q = 737.0 ML** (based on town potable water and bore water supply metering logs for 2012-13. No other flow meters installed. Water supply demand assumed approximately equal to raw wastewater volume in absence of other information). • Breakdown of total raw wastewater volume from each production source (total wastewater volume $Q_w = Q_{w,red} + Q_{w,green} + Q_{w,fat}$): - Kill Floor ("red stream"): **$Q_{w,red}$ = 325.3 ML** (i.e. 44.1% of Q) - Paunch waste and yards ("green stream"): **$Q_{w,green}$ = 364.8 ML** (i.e. 49.5% of Q) - Rendering and boning ("fat stream"): **$Q_{w,fat}$ = 46.9 ML** (i.e. 6.4% of Q) Metering data for individual waste streams are not available at this plant. In the absence of this data, the percentage of total wastewater volume from each waste source has been estimated based on a targeting measurement campaign. This involved measuring the water level rate rise of pits receiving each of the red, green and fat streams, during both production and cleaning shifts (and during periods of zero pit outflow)[10]. Alternative measurement approaches may be based on pump capacity and daily pump runtime logs. However, actual metering data is expected to be more reliable than these alternative approaches. • Raw wastewater COD concentrations: - Red stream: **$[COD]_{w,red}$ = 6,243 mg/L** - Green stream: **$[COD]_{w,green}$ = 11,348 mg/L** - Fat stream: **$[COD]_{w,fat}$ = 13,431 mg/L** (average COD concentrations based on monthly sampling and laboratory analysis for each waste stream) • Fraction of COD removed from wastewater as sludge, **F_{sl} = 0** (No sludge removed from the lagoons in 2012-13. No DAF solids records available for either volume or COD concentration. Note: Refer to Case Study B for an example showing how this information can be included if available, and how this information may affect emissions estimates). • Effluent volume, **Q_{eff} = 737.0 ML** (based on town potable water and bore water supply metering logs for 2012-13. No other flow meters installed. Water supply demand assumed approximately equal to treated effluent in absence of other information).

[10] E.g. Wastewater flow rate during production (m^3 / d) = Pit surface area (m^2) × water level rise rate (m / h) × production duration (h / d)

Item	Description and *NGER (Measurement) Determination* References
	• Effluent COD concentration, **$[COD]_{eff}$ = 414.25 mg/L** (average COD concentration based on monthly serpentine pond effluent sampling and laboratory analysis) • Quantity of COD in sludge transferred out of the plant and removed to landfill, or a site other than landfill, **COD_{trl} = 0 & COD_{tro} = 0** (No wastewater sludge treatment process at this plant. No sludge removed from the lagoons or transferred out of the plant in 2012-13) • Quantity of methane in sludge biogas captured for combustion, flared or transferred, **Q_{cap} = 0, Q_{flared} = 0 & Q_{tr} = 0** (no sludge biogas captured at this plant)
Emission factors and other values	Section 5.42 (5), (8): • Methane Correction Factor for wastewater treatment, **MCF_{ww} = 0.4** (IPCC default correction factors are not suitable since the plant comprises managed aerobic treatment (i.e. DAF), deep anaerobic lagoon treatment (i.e. anaerobic pond) and shallow anaerobic treatment (i.e. serpentine pond). Therefore select meat industry default value of 0.4 as this value is within the range of IPCC default values for the individual processes). • Methane Correction Factor for sludge, **MCF_{sl} = 0** (no sludge treatment at this facility) • Methane Emission Factor for wastewater treatment, **EF_{wij} = 5.3 t CO_2-e / t COD** • Methane Emission Factor for sludge treatment, **EF_{slij} = 5.3 t CO_2-e / t COD** • Biogas methane conversion factor, **γ = 6.784 ×10^-4 × 21** (for converting m^3 of methane at standard conditions to CO_2-e tonnes)
Emissions calculation method – step-by-step	1) Raw wastewater COD mass load, COD_w (tonnes) $COD_{w,i} = Q_{w,i} \times [COD]_{w,i} \times 10^{-3}$ t/kg $=\{(Q_{w,red} \times [COD]_{w,red}) + (Q_{w,green} \times [COD]_{w,green}) + (Q_{w,fat} \times [COD]_{w,fat})\} \times (10^{-3}$ t/kg) = {(325.3 ML ×6,243 mg/L) + (364.8 ML ×11,348 mg/L) + (46.9 ML × 13,431 mg/L)} × 10^{-3} t/kg = 6,800 t COD
	2) Effluent COD mass load, COD_{eff} (tonnes) $COD_{eff} = Q_{eff} \times [COD]_{eff} \times 10^{-3}$ t/kg = 737.0 ML × 414.25 mg/L × 10^{-3} t/kg = 305 tonnes COD
	3) Total sludge COD mass load, CODsl (tonnes) $COD_{sl} = F_{sl} \times COD_w$ = 0 × 6,550 tonnes COD = 0 tonnes COD

Item	Description and *NGER (Measurement) Determination* References
	4) Sludge transferred to landfill COD mass load, CODtrl (tonnes) COD_{trl} = 0 tonnes COD
	5) Sludge transferred to “other” COD mass load, CODtro (tonnes) COD_{tro} = 0 tonnes COD
Emissions calculation method – step-by-step (cont.)	6) Apply equation from section 5.42 (5): $CH_{4gen} = \begin{array}{l}(COD_{w,i} - COD_{sl} - COD_{eff}) \times MCF_{ww} \times EF_{wij} \\ + (COD_{sl} - COD_{trl} - COD_{tro}) \times MCF_{sl} \times EF_{slij}\end{array}$ = (6,800 – 0 – 305) × 0.4 × 5.3 + (0 – 0 – 0) × 0 × 5.3 = 13,769 t CO_2-e
	7) Methane in captured biogas for combustion, Qcap (m3) Q_{cap} = 0 m^3
	8) Methane in captured biogas for flaring, Qflared (m3) Q_{flared} = 0 m^3
	9) Methane in captured biogas for transfer out of the plant, Qtr (m3) Q_{tr} = 0 m^3
	10) Apply equation from section 5.25 (2) and section 5.43 (2A): $\frac{\gamma(Q_{cap} + Q_{flared} + Q_{tr})}{CH_{4gen}} = \frac{0}{13{,}769} = 0 \leq 1.00$ therefore, CH_4^* = CH_{4gen} = 13,769 t CO_2-e
	11) Apply equation from section 5.42 (1): $E_j = CH_4^* - \gamma(Q_{cap} + Q_{flared} + Q_{tr})$ = 13,769 - 6.784 ×10^-4 × 21 × (0 + 0 + 0) **= 13,769 t CO_2-e**

In summary, the estimated emissions for Case Study Plant A based on Method 2 are 13,769 t CO_2-e.

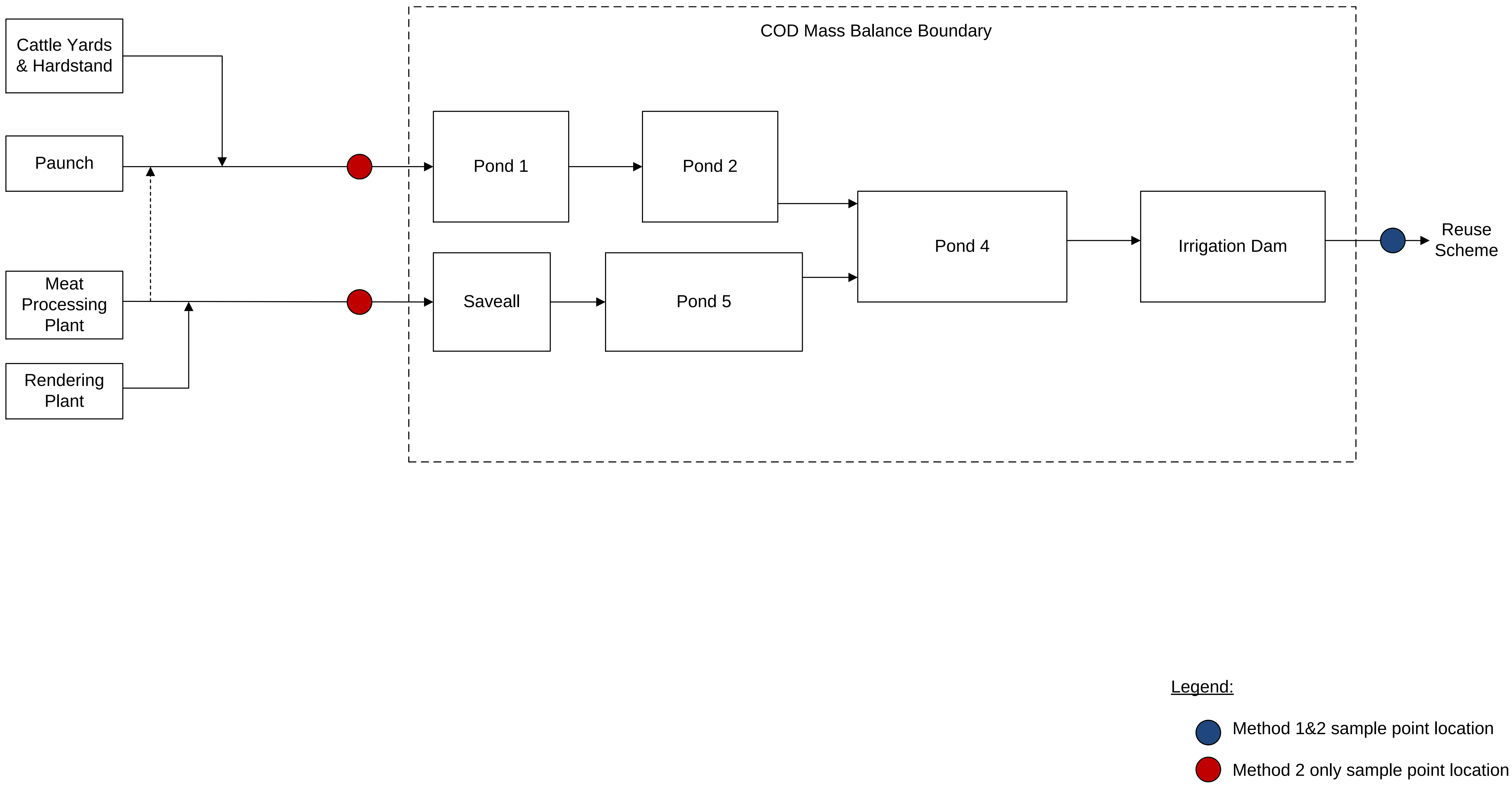
6.2 Case Study Plant B

A simplified PFD of Plant B’s wastewater treatment process is included as Figure 6.2. The mass balance boundaries and the activity data sources for the calculations are also shown on the PFD. The wastewater treatment process at Plant B can be summarised as follows:

- Cattleyard wastewater, hardstand washdown and paunch dump is pumped directly to Pond 1. Pond 1 is a deep anaerobic lagoon with a natural ‘crust’ cover. No biogas is captured or recovered.
- Pond 2 accepts wastewater from Pond 1 for further treatment. Pond 2 is a shallow uncovered lagoon.
- Screened wastewater from the meat processing plant and wastewater from the rendering plant is pumped to the dissolved air flotation (DAF)/saveall unit
- Effluent from the DAF/saveall is pumped to Pond 3. Pond 3 is a deep anaerobic lagoon with a natural ‘crust’ cover. No biogas is captured or recovered.
- Pond 4 accepts wastewater from Pond 2 and Pond 3 for further treatment. Pond 4 is a shallow uncovered lagoon.
- Effluent from Pond 4 is stored in an irrigation dam before being disposed via land irrigation or as recycled water.
- There is no wastewater sludge treatment process at this plant. Floated solids from the DAF/saveall are returned to the rendering plant for further processing. Wastewater sludge is periodically removed from the lagoons for offsite disposal.
- Solid waste (e.g. paunch solids) from meat processing is composted onsite prior to offsite disposal. Direct emissions from composting are excluded from NGER reporting for this plant since the site is not classified as a landfill (refer to Table 2-2 of this report for further information).

Figure 6-2 – Plant B Process Flow Diagram

Case Study Plant B Process Flow Diagram



No	Revision Note:* indicate signature on original issue of drawing or last version of drawing	Drawn	Checked	Approved	Date	Our Reference
0		CP				

GHD CLIENTS | PEOPLE | PERFORMANCE
Level 8, 180 Lonsdale Street, Melbourne VIC 3000 Australia
T 61 3 8687 8000 F 61 3 8687 8111
E melmail@ghd.com.au W www.ghd.com.au

Drawn: C Pepperell
Designed: C Pepperell
Drafting Check
Design Check
Scale NOT TO SCALE
This Drawing must not be used for Construction Unless signed as approved

Client: Australian Meat Processing Corporation
Project: Meat Processing Industry NGER Guidelines
Title: Figure 6.2 – Plant B Process Flow Diagram
Original Size A3
Rev: 0

6.2.1 Method 1 Example – Plant B

Table 6-3 Direct Methane Emissions from Plant B (Method 1)

Item	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 1** Division 5.4.2
Activity data	• Meat production rate, **$Prod_i$ = 93,956 tonnes** (HSCW) (based on daily production logs) • Effluent volume, **Q = 469 ML** (based on town potable water metering logs for 2012-13. No other flow meters installed. Water supply demand assumed approximately equal to treated effluent in absence of other information). • Effluent COD concentration, **$[COD]_{eff}$ = 493 mg/L** (average COD concentration based on monthly irrigation pond effluent sampling and laboratory analysis) • DAF solids volume, **Q_{psl} = 20.5 ML** (estimated based on pump capacity and run time records for 2012-13. No other flow meters installed). • DAF solids COD concentration, **$[COD]_{psl}$ = 50,000 mg/L** (average COD concentration based on ad hoc sampling and laboratory analysis for 2012-13) • Quantity of COD in sludge transferred out of the plant and removed to landfill, **COD_{trl} = 0** (No wastewater sludge treatment process at this plant. No sludge removed from the lagoons or transferred out of the plant in 2012-13) • Quantity of COD in sludge transferred out of the plant and removed to a site other than landfill, **COD_{tro} = 0** (No wastewater sludge treatment process at this plant. No sludge removed from the lagoons or transferred out of the plant in 2012-13) • Quantity of methane in sludge biogas captured for combustion, **Q_{cap} = 0** (no sludge biogas captured at this plant) • Quantity of methane in sludge biogas flared by the plant, **Q_{flared} = 0** (no sludge biogas captured at this plant) • Quantity of methane in sludge biogas transferred out of the plant, **Q_{tr} = 0** (no sludge biogas captured at this plant)
Emission factors and other values	Section 5.42 (5), (8): • Methane Correction Factor for wastewater treatment, **MCF_{ww} = 0.4** (IPCC default correction factors are not suitable since the plant comprises managed aerobic treatment (i.e. DAF), deep anaerobic lagoon treatment (i.e. Pond 1 and Pond 3) and shallow anaerobic treatment (i.e. Pond 2 and Pond 4). Therefore select meat industry default value of 0.4 as this value is within the range of IPCC default values for the individual processes).

Item	Description and *NGER (Measurement) Determination* References
Emission factors and other values (cont.)	• Methane Correction Factor for sludge, **MCF_{sl} = 0** (no sludge treatment at this facility) • Wastewater generation rate, **W_{gen} = 13.7 m^3 per tonne product** (ANZSIC codes 1111 and 1112) Raw wastewater COD concentration, **COD_{con} = 6.1 kg per cubic metre** (i.e. 6,100 mg/L) (ANZSIC codes 1111 and 1112) • Methane Emission Factor for wastewater treatment, **EF_{wij} = 5.3 t CO_2-e / t COD** • Methane Emission Factor for sludge treatment, **EF_{slij} = 5.3 t CO_2-e / t COD** • Biogas methane conversion factor, **γ = 6.784 ×10^-4 × 21** (for converting m^3 of methane at standard conditions to CO_2-e tonnes)
Emissions calculation method – step-by-step	1) Raw wastewater COD mass load, $COD_{w,i}$ (tonnes) $COD_{w,i}$ = $Prod_i$ × $W_{gen,i}$ × COD_{con} × 10^{-3} t/kg = 93,956 tonnes × 13.7 m^3/tonne × 6.1 kg/m^3 × 10^{-3} t/kg = 7,852 tonnes COD
	2) Effluent COD mass load, COD_{eff} (tonnes) COD_{eff} = Q × $[COD]_{eff}$ × 10^{-3} t/kg = 469 ML × 493 mg/L × 10^{-3} t/kg = 231 tonnes COD
	3) Total sludge COD mass load, COD_{sl} (tonnes) COD_{sl} = Q_{psl} × $[COD]_{psl}$ × 10^{-3} t/kg = 20.5 ML × 50,000 mg/L × 10^{-3} t/kg = 1,025 tonnes COD (i.e. F_{sl} = COD_{sl} / COD_w = 1,025 tonnes COD/ 7,852 tonnes COD= 0.13)
	4) Sludge transferred to landfill COD mass load, COD_{trl} (tonnes) COD_{trl} = 0 tonnes COD
	5) Sludge transferred to "other" COD mass load, COD_{tro} (tonnes) COD_{tro} = 0 tonnes COD
	6) Apply equation from section 5.42 (5): $CH_{4gen} = \begin{matrix} (COD_{w,i} - COD_{sl} - COD_{eff}) \times MCF_{ww} \times EF_{wij} \\ + (COD_{sl} - COD_{trl} - COD_{tro}) \times MCF_{sl} \times EF_{slij} \end{matrix}$ = (7,852 – 1,025 – 231) × 0.4 × 5.3 + (1,025 – 0 – 0) × 0 × 5.3 = 13,983 t CO_2-e
	7) Methane in captured biogas for combustion, Q_{cap} (m^3) Q_{cap} = 0 m^3
	8) Methane in captured biogas for flaring, Q_{flared} (m^3)

Item	Description and *NGER (Measurement) Determination* References
	Q_{flared} = 0 m^3
	9) Methane in captured biogas for transfer out of the plant, Q_{tr} (m^3) Q_{tr} = 0 m^3
	10) Apply equation from section 5.25 (2): $\frac{\gamma(Q_{cap} + Q_{flared} + Q_{tr})}{CH_{4gen}} = \frac{0}{13,983} = 0 \leq 0.75$ therefore, CH_4^* = CH_{4gen} = 13,983 t CO_2-e
	11) Apply equation from section 5.42 (1): $E_j = CH_4^* - \gamma(Q_{cap} + Q_{flared} + Q_{tr})$ = 13,983 - 6.784 ×10^-4 × 21 × (0 + 0 + 0) **= 13,983 t CO_2-e**

In summary, the estimated emissions for Case Study Plant B based on Method 1 are 13,983 t CO_2-e.

6.2.2 Method 2 Example – Plant B

Table 6-4 Direct Methane Emissions from Plant B (Method 2)

Item	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 2** Division 5.4.3
Activity data	• Raw wastewater volume, **Q = 469.0 ML** (based on town potable water metering logs for 2012-13. No other flow meters installed. Water supply demand assumed approximately equal to raw wastewater volume in absence of other information). • Breakdown of total raw wastewater volume from each production source (total wastewater volume $Q_w = Q_{w,red} + Q_{w,green}$): - Yards and Paunch waste ("green stream"): **$Q_{w,green}$ = 263.8 ML** (i.e. 56% of Q) - Meat processing and rendering waste ("red stream"): **$Q_{w,red}$ = 205.2 ML** (i.e. 44% of Q) Metering data for individual waste streams are not available at this plant. In the absence of this data, the percentage of total wastewater volume from each waste source has been estimated based on a targeting measurement campaign. This involved measuring the water level rate rise of pits receiving each of the red and green streams, during both production and cleaning shifts (and during periods of zero pit outflow)[11]. Alternative measurement approaches may be based on pump capacity and daily pump runtime logs. However, actual metering data is expected to be more reliable than these alternative approaches. • Raw wastewater COD concentrations: - Green stream: **$[COD]_{w,green}$ = 6,250 mg/L** - Red stream: **$[COD]_{w,red}$ = 16,680 mg/L** (average COD concentrations based on monthly sampling and laboratory analysis for each waste stream) • Effluent volume, **Q_{eff} = 469.0 ML** (based on town potable water metering logs for 2012-13. No other flow meters installed. Water supply demand assumed approximately equal to treated effluent in absence of other information). • Effluent COD concentration, **$[COD]_{eff}$ = 493 mg/L** (average COD concentration based on monthly irrigation pond effluent sampling and laboratory analysis) • Quantity of COD in sludge transferred out of the plant and removed to landfill, a site other than landfill, **COD_{trl} = 0 & COD_{tro} = 0** (No wastewater sludge treatment process at this plant. No sludge removed from the lagoons or transferred out of the plant in 2012-13) • Quantity of methane in sludge biogas captured for combustion, flared or transferred, **Q_{cap} = 0, Q_{flared} = 0 & Q_{tr} = 0**

[11] E.g. Wastewater flow rate during production (m^3 / d) = Pit surface area (m^2) × water level rise rate (m / h) × production duration (h / d)

Item	Description and *NGER (Measurement) Determination* References
	(no sludge biogas captured at this plant)
Emission factors and other values	Section 5.42 (5), (8): • Methane Correction Factor for wastewater treatment, **MCF_{ww} = 0.4** (IPCC default correction factors are not suitable since the plant comprises managed aerobic treatment (i.e. DAF), deep anaerobic lagoon treatment (i.e. Ponds 1 & 3) and shallow anaerobic treatment (i.e. Ponds 2 & 4). Therefore select meat industry default value of 0.4 as this value is within the range of IPCC default values for the individual processes). • Methane Correction Factor for sludge, **MCF_{sl} = 0** (no sludge treatment at this facility) • Methane Emission Factor for wastewater treatment, **EF_{wij} = 5.3 t CO_2-e / t COD** • Methane Emission Factor for sludge treatment, **EF_{slij} = 5.3 t CO_2-e / t COD** • Biogas methane conversion factor, **γ = 6.784 ×10^-4 × 21** (for converting m^3 of methane at standard conditions to CO_2-e tonnes)
Emissions calculation method – step-by-step	1) Raw wastewater COD mass load, COD_w (tonnes) $COD_{w,i} = Q_{w,i} \times [COD]_{w,i} \times 10^{-3}$ t/kg $=\{(Q_{w,red} \times [COD]_{w,red}) + (Q_{w,green} \times [COD]_{w,green})\}$ $\times (10^{-3}$ t/kg) = {(263.8 ML ×6,250 mg/L) + (205.2 ML ×16,680 mg/L)} × 10^{-3} t/kg = 5,072 t COD
	2) Effluent COD mass load, COD_{eff} (tonnes) $COD_{eff} = Q_{eff} \times [COD]_{eff} \times 10^{-3}$ t/kg = 469 ML × 493 mg/L × 10^{-3} t/kg = 231 tonnes COD
	3) Total sludge COD mass load, COD_{sl} (tonnes) $COD_{sl} = Q_{psl} \times [COD]_{psl} \times 10^{-3}$ t/kg = 20.5 ML × 50,000 mg/L × 10^{-3} t/kg = 1,025 tonnes COD (i.e. $F_{sl} = COD_{sl} / COD_w$ = 1,025 tonnes COD / 5,072 tonnes COD = 0.20)
	4) Sludge transferred to landfill COD mass load, COD_{trl} (tonnes) COD_{trl} = 0 tonnes COD
	5) Sludge transferred to "other" COD mass load, COD_{tro} (tonnes) COD_{tro} = 0 tonnes COD

Item	Description and *NGER (Measurement) Determination* References
Emissions calculation method – step-by-step (cont.)	6) Apply equation from section 5.42 (5): $CH_{4gen} = \begin{matrix}(COD_{w,i} - COD_{sl} - COD_{eff}) \times MCF_{ww} \times EF_{wij} \\ + (COD_{sl} - COD_{trl} - COD_{tro}) \times MCF_{sl} \times EF_{slij}\end{matrix}$ = (5,072 – 1,025 – 231) × 0.4 × 5.3 + (1,025 – 0 – 0) × 0 × 5.3 = 8,089 t CO_2-e
	7) Methane in captured biogas for combustion, Q_{cap} (m^3) $Q_{cap} = 0\ m^3$
	8) Methane in captured biogas for flaring, Q_{flared} (m^3) $Q_{flared} = 0\ m^3$
	9) Methane in captured biogas for transfer out of the plant, Q_{tr} (m^3) $Q_{tr} = 0\ m^3$
	10) Apply equation from section 5.25 (2) and section 5.43 (2A): $\frac{\gamma(Q_{cap} + Q_{flared} + Q_{tr})}{CH_{4gen}} = \frac{0}{8{,}089} = 0 \leq 1.00$ therefore, $CH_4^* = CH_{4gen}$ = 8,089 t CO_2-e
	11) Apply equation from section 5.42 (1): $E_j = CH_4^* - \gamma(Q_{cap} + Q_{flared} + Q_{tr})$ = 8,089 - 6.784 ×10^-4 × 21 × (0 + 0 + 0) **= 8,089 t CO_2-e**

In summary, the estimated emissions for Case Study Plant B based on Method 2 are 8,089 t CO_2-e.

6.3 Case Study Summary

The case studies demonstrate the different activity data requirements and resulting calculations for Method 1 and Method 2. The different methods lead to different emissions being calculated for each plant.

This outcome is due to the difference between the Method 1 defaults for wastewater production rate (on a volume per unit production basis) and raw wastewater COD concentration when compared to the actual production rate and actual COD concentrations for these plants based on activity data collected for each plant for the 2012-13 year.

For example, emissions estimates for Plant A when using Method 1 are slightly lower than the emissions estimates using Method 2. This arises because the Plant A raw wastewater COD load (flow rate multipled by COD concentration) of 86.8 kg COD / t HSCW for Method 2 is slightly higher than the COD load based on the Method 1 defaults of 83.6 kg COD / t HSCW.

In contrast, emissions estimates for Plant B when using Method 1 are approximately 70% higher than the emissions estimates using Method 2. This arises because the Plant B raw wastewater COD load (flow rate multipled by COD concentration) of 54.0 kg COD / t HSCW for Method 2 is considerably lower than the COD load based on the Method 1 defaults of 83.6 kg COD / t HSCW.

These outcomes are shown below in Table 6-5 and Figure 6-3.

Table 6-5 Case Study Emissions Summary and Comparison

No.	Item	Plant A	Plant B	Method 1 Default
1.	Wastewater production rate (ML per tonne HSCW)	9.4	5.0	13.7
2.	Raw wastewater COD concentration (mg/L) [12]	9,227	10,813	6,100
3.	COD load (kg COD / t HSCW) (i.e. (1) × (2) × 10^{-3})	86.8	54.0	83.6
4.	Emissions - Method 1 (t CO_2-e)	13,239	13,983	N/A
5.	Emissions - Method 2 (t CO_2-e)	13,769	8,089	N/A
6.	Summary	Method 1 emissions **lower** than Method 2	Method 1 emissions **higher** than Method 2	N/A

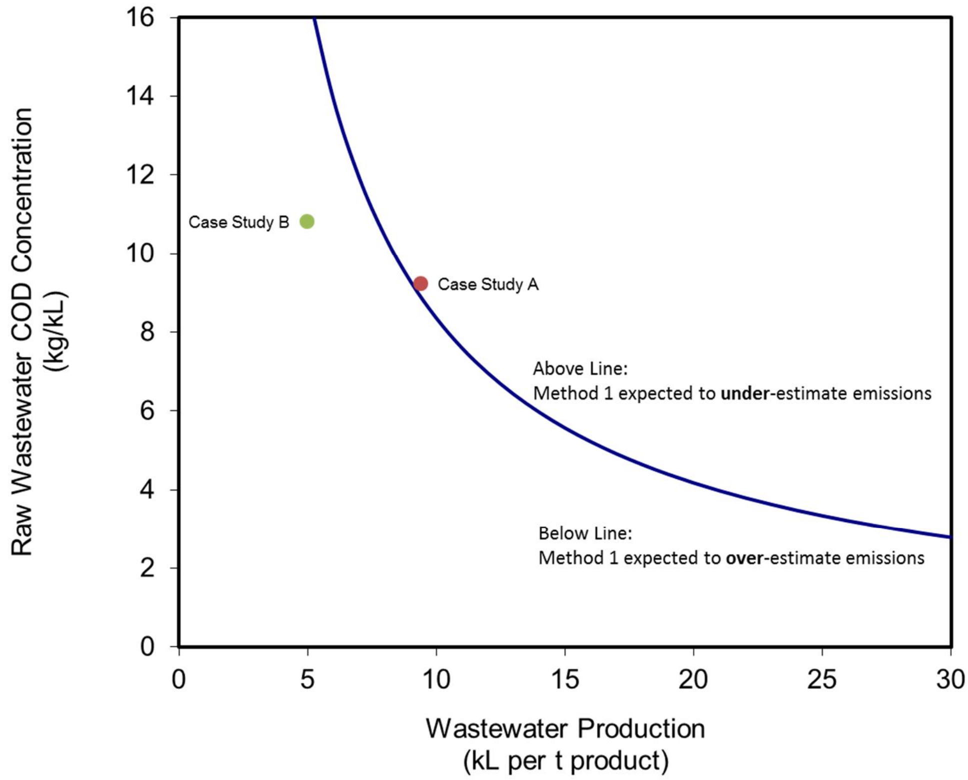


Figure 6-3 Example Use of Figure 4-2

[12] Calculated using the flow weighted average concentration of each raw wastewater stream

7. References

Australian and New Zealand Industry Classification (ANZIC), 2006, *ABS Catalogue No.1292.0*.

Carbon Credits (Carbon Farming Initiative) Act 2011.

Clean Energy Act 2011.

Clean Energy (Consequential Amendments) Act 2011.

Clean Energy Regulations 2011.

Clean Energy Regulator, 2012, *Supplementary Guideline: Aggregated facility reporting, percentage estimates and incidental emissions and energy*.

Clean Energy Regulator, 2012, *Guide to Carbon Price Liability Under the Clean Energy Act 2011*

Clean Energy Regulator, 2012, *NGER Fact Sheet: Assessment of NGER Reports*

Clean Energy Regulator, 2012, *NGER Fact Sheet: Contracts and Leasing*

Clean Energy Regulator, 2012, *NGER Fact Sheet: Record Keeping*

Clean Energy Regulator, 2012, *NGER Fact Sheet: Reporting Uncertainty*

Clean Energy Regulator, 2012, *NGER Supplementary Guideline: Defining Facilities*.

Clean Energy Regulator, 2012, *NGER Supplementary Guideline: Energy Production and Consumption*.

Clean Energy Regulator, 2012, *NGER Supplementary Guideline: Operational Control*.

Clean Energy Regulator, 2012, *NGER Supplementary Guideline: Reporting Under the NGER Act*.

Department of Climate Change and Energy Efficiency, 2008, *National Greenhouse and Energy Reporting Guidelines*.

Department of Climate Change and Energy Efficiency, 2012, *National Greenhouse Accounts (NGA) Factors*.

Department of Climate Change and Energy Efficiency, 2012*, National Greenhouse and Energy Reporting (Measurement) Technical Guidelines*.

Department of Climate Change and Energy Efficiency, 2012, Australian National Grenhouse Accounts, *National Inventory Report 2010*.

Department of Environment and Heritage, Australian Greenhouse Office, 2006, *AGO Factors and Methods Workbook*.

Foley, J., de Haas, D., Hartley, K., and Lant, P., 2010, Comprehensive Life Cycle Inventories of Alternative Wastewater Treatment Systems, *Water Research*, 44(4):1654-1666.

Foley, J. and Lant, P., 2007, *Fugitive Greenhouse Gas Emissions from Wastewater Systems*, Water Services Association of Australia, Melbourne.

IPCC, 2000, *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*.

IPCC, 2006, *IPCC Guidelines for National Greenhouse Inventories*.

IPCC, 2007, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*.

Metcalf and Eddy Inc., Tchobanoglous, G., Burton, F.L., Stensel, H.D. (eds.), 2003, *Wastewater Engineering: Treatment and Reuse*, 4th ed., McGraw Hill, Boston.

National Greenhouse and Energy Reporting Act 2007.

National Greenhouse and Energy Reporting Regulations 2008.

National Greenhouse and Energy Reporting (Audit) Determination 2009.

National Greenhouse and Energy Reporting (Measurement) Determination as amended, July 2012.

Parkin, G., Owen, W. 1986, Fundamentals of Anaerobic Digestion of Wastewater Sludges. *ASCE Journal of Environmental Engineering* 112(5):867-920.

STOWA, GWRC, 2010, *Non CO_2 Greenhouse Gas Emissions from Domestic WWTP*, Global Water Research Coalition, Nijmegen.

World Business Council for Sustainable Development and World Resources Institute, 2004, *The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard*.

World Business Council for Sustainable Development and World Resources Institute, 2003, *GHG Protocol Guidance on Uncertainty Assessment in GHG Inventories and Calculating Statistical Parameter Uncertainty.*

8. Appendix A – Operational Control Scorecard

How to use the Red Meat Processing Industry Operational Control Scorecard:

1. Define the facility boundary by applying the appropriate legislation (refer to section 2.1.3).
2. Fill in the corporate, facility and location details.
3. Review the default list of operational, environmental and occupational health and safety (OH&S) policies to ensure that they are suitably applicable to the activities within the facility being considered.
4. Review the default Policy Scores for both the introduction and implementation of each policy (0 being not important, up to 20 – extremely important).
5. For each corporation involved in the activity, give them a score as to how much authority they have to **introduce** and **implement** the policy. This is the corporate score.
   - The combined corporate scores should equal the policy score.
   - For example, if it is a very important policy, it might have a policy score of 20. Corporation A might have a high degree of authority to introduce, B somewhat and C none. The scores might read:
     A = 15, B = 5, C = 0.
6. After the scores for the corporations are entered against each policy, the corporate scores for each corporation are tallied. The corporation with the highest overall score would be considered to have operational control of the facility, and therefore reporting responsibility for greenhouse gas emissions and energy.

If the scorecard is equal on completion, the scores should be re-tallied using operating and environmental polices only *(see NGER Regulations 2.14 (2)).*

Table 8-1 Template Red Meat Processing Industry Operational Control Scorecard

Facility Name / Description:						
Facility Address:						
Corporation Name		Address (head office)		ABN		
A						
B						
C						
	Policy	**Policy Score**	**Corp. Score A**	**Corp. Score B**	**Corp. Score C**	
OPERATING POLICIES	Ability to influence and implement asset and materials purchase	20				
	Ability to influence and implement facility operation	20				
	Ability to influence and implement strategy, planning and design	20				
	Workforce employment	10				
	Facility maintenance	10				
	Provision of electricity, fuels and other consumables	10				
	Stakeholders / complaints management	10				
	Total	**100**				
ENVIRO. POLICIES	Securing, managing and reporting on enviro. licences	10				
	Environmental Management Plan / System	10				
	Management of discharges, wastes and consumables	10				
	Management and minimisation of energy	10				
	Environmental emergency procedures	10				
	Total	**50**				
OH&S POLICIES	Job Safety Analysis / Safe Work Methods	10				
	Safety Equipment – Prescription and provision	10				
	Facility inductions	10				
	Hazardous facility management	10				
	Emergency procedures and incident reporting	10				
	Total	**50**				
	OPERATIONAL CONTROL TOTAL	**200**				

9. Appendix B – Additional Guidance by Emission Source

The following sections provide guidance on the source data and calculation methodologies for common emission sources for the red meat processing industry.

9.1 Fuel Combustion

Combustion of fuels is a common activity for many organisations. Outlined below are the Method 1 approaches for estimating emissions from the combustion of solid, gaseous and liquid fuels.

9.1.1 Solids Fuels

The general data requirements and calculation approach for determining emissions (and associated uncertainty) from solid fuel combustion are outlined in Table 9-1. There are no specific issues for the industry related to solid fuels combustion, as this is a fairly uncommon practice for the industry.

Table 9-1 Combustion of Solid Fuels

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 1** Division 2.2.2
Activity data required (units)	Annual solid fuel consumption at each facility (tonnes)
Uncertainty level in activity data	Choose from pre-defined criteria (refer to Division 2.2.5 and section 8.6): • Criterion AAA (± 2.5%); • Criterion AA (± 2.5%); • Criterion A (± 1.5%); or • Criterion BBB (± 7.5%).
Energy content factors and emission factors	*NGER (Measurement) Determination*, Schedule 1 (Part 1) (also *Technical Guidelines 2012*, Table 2.2.2): 1) Select appropriate energy content factor from tabulated list of fuels. 2) Select appropriate emission factors (CO_2, CH_4 and N_2O) from tabulated listed of fuels.
Uncertainty level in energy content factors and emission factors	Refer to Part 8.3 for defined uncertainty levels in energy content factors and emission factors.
Emissions calculation method	Emissions (tonnes CO_2-e) for each gas (CO_2, CH_4, N_2O): = tonnes of fuel (t) × fuel energy content (GJ/t) × fuel emission factor (kg CO_2-

Parameter	Description and *NGER (Measurement) Determination* References
	e/GJ) × 10^{-3} (t/kg)
Uncertainty calculation method	Uncertainty (%) = $\pm\sqrt{U\_tonnes^2 + U\_EC^2 + U\_EF^2}$ Addition of emission factor uncertainties (%): $= \pm \frac{\sqrt{(CO_2 \times U\_CO_2)^2 + (CH_4 \times U\_CH_4)^2 + (N_2O \times U\_N_2O)^2}}{CO_2 + CH_4 + N_2O}$

Example – Emissions from Solid Fuel Combustion

A red meat processing corporation estimates that they consumed500 tonnes of solid organic waste (paunch waste) burnt in its boiler in the year 2012-13.

Activity data: 500 tonnes of *biomass municipal and industrial materials, if recycled and combusted to produce heat or electricity* (from Schedule 1 (Part 1, Item 14))	**Uncertainty:** “BBB” uncertainty rating (± 7.5%)
Energy content: 12.2 GJ/t (from Schedule 1 (Part 1))	**Uncertainty:** ± 50.0% (from Part 8.3)
Emission factors: CO_2 = 0.0 kg CO_2-e/GJ CH_4 = 0.6 kg CO_2-e/GJ N_2O = 1.2 kg CO_2-e/GJ (from *NGER (Measurement) Determination*, Schedule 1 (Part 1))	**Uncertainty:** NA (from Part 8.3) ± 50.0% (from Part 8.3 section 8.7) ± 50.0% (from Part 8.3 section 8.7)

Emissions:

CO_2 = 500 t × 12.2 GJ/t × 0.0 kg CO_2-e/GJ × 10^{-3} (t/kg) = 0.0 t CO_2-e

CH_4 = 500 t × 12.2 GJ/t × 0.6 kg CO_2-e/GJ × 10^{-3} (t/kg) = 3.66 t CO_2-e

N_2O = 500 t × 12.2 GJ/t × 1.2 kg CO_2-e/GJ × 10^{-3} (t/kg) = 7.32 t CO_2-e

Overall = 11.0 t CO_2-e

Uncertainty:

$CO_2 = \sqrt{(7.5\%)^2 + (50.0\%)^2} = 50.6\%$

$CH_4 = \sqrt{(7.5\%)^2 + (50.0\%)^2 + (50.0\%)^2} = 71.1\%$

$N_2O = \sqrt{(7.5\%)^2 + (50.0\%)^2 + (50.0\%)^2} = 71.1\%$

$$\text{Overall} = \frac{\sqrt{(0.0 \times 50.6\%)^2 + (3.66 \times 50.6\%)^2 + (7.32 \times 50.6\%)^2}}{0.0 + 3.66 + 7.32} = 37.7\%$$

9.1.2 Gaseous Fuels

The general data requirements and calculation approach for determining emissions from gaseous fuel combustion are outlined in Table 9-2. A particular issue for the red meat processing industry is the combustion of “sludge biogas”, captured from anaerobic treatment processes such as digesters or covered lagoons. Biogas is commonly flared as a waste gas, or utilised for energy recovery (e.g. firing heaters or gas engines). In either case, the emission calculations are the same. An example is given below.

Some red meat processing corporations may hold acetylene onsite for oxy-fuel welding and cutting. Emissions from the combustion of acetylene must be included in NGER reporting (acetylene is covered under Item 27 of Schedule 1 (Part 2) of the *NGER (Measurement) Determination*).

Table 9-2 Combustion of Gaseous Fuels

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 1** Division 2.3.2
Activity data required (units)	Annual gaseous fuel consumption at each facility (m^3 or kL at standard conditions). **Note: Standard conditions for gas measurements are 15°C, 1 atm**
Uncertainty level in activity data	Choose from pre-defined criteria (refer to Division 2.3.6 and section 8.6): • Criterion AAA (± 1.5%); • Criterion AA (± 1.5%); • Criterion A (± 1.5%); or • Criterion BBB (± 7.5%).
Energy content factors and emission factors	*NGER (Measurement) Determination*, Schedule 1 (Part 2) (also *Technical Guidelines 2012*, Table 2.3.2A (stationary energy) and Table 2.3.2B (transport energy)): 1) Select appropriate energy content factor from tabulated list of fuels. 2) Select appropriate emission factors (CO_2, CH_4 and N_2O) from tabulated listed of fuels.
Uncertainty level in energy content factors and emission factors	Refer to Part 8.3 for defined uncertainty levels in energy content factors and emission factors
Emissions calculation method	Emissions (tonnes CO_2-e) for each gas (CO_2, CH_4, N_2O): = volume of fuel (m^3) × fuel energy content (GJ/m^3) × fuel emission factor (kg CO_2-e/GJ) × 10^{-3} (t/kg)

Parameter	Description and *NGER (Measurement) Determination* References
Uncertainty calculation method	Uncertainty (%) = $\pm\sqrt{U\_kL^2 + U\_EC^2 + U\_EF^2}$ Addition of emission factor uncertainties (%): $= \pm \dfrac{\sqrt{(CO_2 \times U\_CO_2)^2 + (CH_4 \times U\_CH_4)^2 + (N_2O \times U\_N_2O)^2}}{CO_2 + CH_4 + N_2O}$

Example – Emissions from Gaseous Fuel Combustion

A red meat processing corporation's natural gas metering records show that they consumed 10,350 m^3 (standardised to 15°C, 1 atm) of natural gas for heating their offices in the year 2012/13.

Activity data: 10,350 m^3 natural gas (distributed in a pipeline)	**Uncertainty:** "AAA" uncertainty rating (± 1.5%)
Energy content: 39.3 × 10^{-3} GJ/m^3 (from *NGER (Measurement) Determination,* Schedule 1 (Part 2))	**Uncertainty:** ± 4.0% (from Part 8.3)
Emission factors: CO_2 = 51.2 kg CO_2-e/GJ CH_4 = 0.1 kg CO_2-e/GJ N_2O = 0.03 kg CO_2-e/GJ (from Schedule 1 (Part 2))	**Uncertainty:** ± 4.0% (from Part 8.3) ± 50.0% (from Part 8.3) ± 50.0% (from Part 8.3)

Emissions:

CO_2 = 10,350 m^3 × 39.3 × 10^{-3} GJ/m^3 × 51.2 kg CO_2-e/GJ × 10^{-3} (t/kg) = 20.83 t CO_2-e

CH_4 = 10,350 m^3 × 39.3 × 10^{-3} GJ/m^3 × 0.1 kg CO_2-e/GJ × 10^{-3} (t/kg) = 0.04 t CO_2-e

N_2O = 10,350 m^3 × 39.3 × 10^{-3} GJ/m^3 × 0.03 kg CO_2-e/GJ × 10^{-3} (t/kg) = 0.01 t CO_2-e

Overall = 20.88 t CO_2-e

Uncertainty:

$$CO_2 = \sqrt{(1.5\%)^2 + (4.0\%)^2 + (4.0\%)^2} = 5.9\%$$

$$CH_4 = \sqrt{(1.5\%)^2 + (4.0\%)^2 + (50.0\%)^2} = 50.2\%$$

$$N_2O = \sqrt{(1.5\%)^2 + (4.0\%)^2 + (50.0\%)^2} = 50.2\%$$

$$\textbf{Overall} = \frac{\sqrt{(20.83 \times 5.9\%)^2 + (0.04 \times 50.2\%)^2 + (0.01 \times 50.2\%)^2}}{20.83 + 0.04 + 0.01} = 5.9\%$$

Example – Emissions from Biogas Flaring

A red meat processing corporation's flow metering records show that they flared 102,740 m^3 (standardised to 15°C, 1 atm) of biogas in the year 2012/13. Monthly sampling and analysis of the biogas showed an average methane content of 0.643 m^3 CH_4 per m^3 biogas, ± 3.5%.

Activity data: 102,740 m^3 biogas × 64.3% methane content = 66,062 m^3 CH_4	**Uncertainty:** "AAA" uncertainty rating for biogas volume – direct measurement (± 1.5%) ± 3.5% (i.e. 95% confidence interval of sampling data for methane content)
Energy content: 37.7×10^{-3} GJ/m^3 (i.e. "Sludge biogas (methane only)" from *NGER (Measurement) Determination,* Schedule 1 (Part 2))	**Uncertainty:** ± 50.0% (from Part 8.3)
Emission factors: CO_2 = 0.0 kg CO_2-e/GJ CH_4 = 4.8 kg CO_2-e/GJ N_2O = 0.03 kg CO_2-e/GJ (from Schedule 1 (Part 2))	**Uncertainty:** N/A ± 50.0% (from Part 8.3) ± 50.0% (from Part 8.3)

Emissions:

CO_2 = 66,062 m^3 × 37.7 × 10^{-3} GJ/m^3 × 0.0 kg CO_2-e/GJ × 10^{-3} (t/kg) = 0.0 t CO_2-e

CH_4 = 66,062 m^3 × 37.7 × 10^{-3} GJ/m^3 × 4.8 kg CO_2-e/GJ × 10^{-3} (t/kg) = 11.95 t CO_2-e

N_2O = 66,062 m^3 × 37.7 × 10^{-3} GJ/m^3 × 0.03 kg CO_2-e/GJ × 10^{-3} (t/kg) = 0.07 t CO_2-e

Overall = 12.02 t CO_2-e

Uncertainty:

CO_2 = N/A

$$CH_4 = \sqrt{(1.5\%)^2 + (3.5\%)^2 + (50.0\%)^2 + (50.0\%)^2} = 70.8\%$$

$$N_2O = \sqrt{(1.5\%)^2 + (3.5\%)^2 + (50.0\%)^2 + (50.0\%)^2} = 70.8\%$$

$$\textbf{Overall} = \frac{\sqrt{(11.95 \times 70.8\%)^2 + (0.07 \times 70.8\%)^2}}{11.95 + 0.07} = 70.4\%$$

9.1.3 Liquid Fuels

The general data requirements and calculation approach for determining emissions from liquid fuel combustion are outlined in Table 9-3. There are no specific issues for the red meat industry related to liquid fuels combustion.

Table 9-3 Combustion of Liquid Fuels

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 1** Division 2.4.2
Activity data required (units)	Annual liquid fuel consumption at each facility (kilolitres)
Uncertainty level in activity data	Choose from pre-defined criteria (refer to Division 2.4.6 and section 8.6): • Criterion AAA (± 1.5%); • Criterion AA (± 1.5%); • Criterion A (± 1.5%); or • Criterion BBB (± 7.5%).
Energy content factors and emission factors	*NGER (Measurement) Determination,* Schedule 1 (Parts 3 and 4) (also *Technical Guidelines 2012*, Table 2.4.2A (stationary energy) and Table 2.4.2B (transport energy)): 1) Select appropriate energy content factor from tabulated list of fuels. 2) Select appropriate emission factors (CO_2, CH_4 and N_2O) from tabulated listed of fuels.
Uncertainty level in energy content factors and emission factors	Refer to Part 8.3 for defined uncertainty levels in energy content factors and emission factors
Emissions calculation method	Emissions (tonnes CO_2-e) for each gas (CO_2, CH_4, N_2O): = kilolitres of fuel (kL) × fuel energy content (GJ/kL) × fuel emission factor (kg CO_2-e/GJ) × 10^{-3} (t/kg)
Uncertainty calculation method	Uncertainty (%) = $\pm\sqrt{U\_kL^2 + U\_EC^2 + U\_EF^2}$ Addition of emission factor uncertainties (%): $= \pm \frac{\sqrt{(CO_2 \times U\_CO_2)^2 + (CH_4 \times U\_CH_4)^2 + (N_2O \times U\_N_2O)^2}}{CO_2 + CH_4 + N_2O}$

Example – Emissions from Liquid Fuel Combustion

A red meat processing corporation's invoice records show that they consumed 650 kL of diesel fuel for their vehicle fleet in the year 2012/13.

Activity data: 650 kL diesel fuel	**Uncertainty:** "A" uncertainty rating (± 1.5%) (from Section 2.50)
Energy content: 38.6 GJ/kL (from	**Uncertainty:** ± 2.0% (from Part 8.3,

NGER (Measurement) Determination, Schedule 1 (Part 4))	Section 8.6)
Emission factors: CO_2 = 69.2 kg CO_2-e/GJ CH_4 = 0.2 kg CO_2-e/GJ N_2O = 0.5 kg CO_2-e/GJ (from *NGER (Measurement) Determination,* Schedule 1 (Part 4))	**Uncertainty:** ± 2.0% (from Part 8.3) ± 50.0% (from Part 8.3) ± 50.0% (from Part 8.3)

Emissions:

CO_2 = 650 kL × 38.6 GJ/kL × 69.2 kg CO_2-e/GJ × 10^{-3} (t/kg) = 1,736 t CO_2-e

CH_4 = 650 kL × 38.6 GJ/kL × 0.2 kg CO_2-e/GJ × 10^{-3} (t/kg) = 5.0 t CO_2-e

N_2O = 650 kL × 38.6 GJ/kL × 0.5 kg CO_2-e/GJ × 10^{-3} (t/kg) = 12.6 t CO_2-e

Overall = 1,754 t CO_2-e

Uncertainty:

$$CO_2 = \sqrt{(1.5\%)^2 + (2.0\%)^2 + (2.0\%)^2} = 3.2\%$$

$$CH_4 = \sqrt{(1.5\%)^2 + (2.0\%)^2 + (50.0\%)^2} = 50.1\%$$

$$N_2O = \sqrt{(1.5\%)^2 + (2.0\%)^2 + (50.0\%)^2} = 50.1\%$$

$$\textbf{Overall} = \frac{\sqrt{(1{,}736 \times 3.2\%)^2 + (5.0 \times 50.1\%)^2 + (12.6 \times 50.1\%)^2}}{1{,}736 + 5.0 + 12.6} = 3.2\%$$

9.2 Fugitive Emissions from Fuels

Chapter 3 of the *NGER (Measurement) Determination* relates to fugitive emissions arising from coal mining, oil & gas production and carbon capture and storage projects. No specific issues for the red meat processing industry related to these activities have been identified.

9.3 Industrial Processes Emissions

Chapter 4 of the *NGER (Measurement) Determination* relates to emissions arising from the industrial manufacturing processes of mineral products, chemicals, metal products and synthetic gases. The *Determination* provides details on the emission estimation methodologies for 15 specific industrial products. Some of these products may be consumed at red meat processing facilities (e.g. lime, aluminium), but would rarely need to be included in the Scope 1 emissions of a red meat processing organisation.

The only additional guidance provided in these Industry Guidelines relates to Part 4.5 – emissions released from the consumption of synthetic gases (i.e. hydrofluorocarbons and sulfur hexafluoride).

9.3.1 Emissions of Hydrofluorocarbons

Hydrofluorocarbons (HFCs) are synthetic gases, commonly used as refrigerants in air conditioning and refrigeration systems. Typically, they have very high global warming potentials (GWP) (e.g. 1 kg HFC-143a is equivalent to 3,800 kg CO_2).

The Method 1 estimation of HFC emissions is based on gathering data on the type and quantity (or "stock") of HFC gas used in each piece of equipment, applying a default annual leakage rate (refer to *Determination* section 4.102) and then multiplying by the gas' GWP (refer to *Technical Guidelines 2012*, Appendix C). However, under section 4.100 of the *NGER (Measurement) Determination*, emissions of HFCs need only be estimated if:

- The HFC gases are used in commercial air conditioning, commercial refrigeration or industrial refrigeration;
- The equipment type contains a refrigerant charge of **more than 100 kilograms for each unit;**
- The refrigerants have a weighted-average GWP of over 1000; and
- The equipment is operated by a facility attributable to one of the following ANZSIC classifications:
  - Food product manufacturing (ANZSIC subdivision 11);
  - Beverage and tobacco product manufacturing (ANZSIC subdivision 12);
  - Retail trade (ANZSIC division G);
  - Warehousing and storage services (ANZSIC number 530);
  - Wholesale trade (ANZSIC division F); or
  - Rental, hiring and real estate services (ANZSIC division L).

Red meat processing organisations fall in the ANZSIC subdivision 11 "Food product manufacturing", and hence need to estimate HFC emissions.

Table 9-4 Emissions of Hydrofluorocarbons

<table>
<tr><th>Parameter</th><th>Description and NGER (Measurement) Determination References</th></tr>
<tr><td>Determination reference</td><td>Method 1 Part 4.5, section 4.102</td></tr>
<tr><td>Activity data required (units)</td><td>Stock of HFC contained in each piece of equipment (tonnes)</td></tr>
<tr><td>Annual leakage rate</td><td>Section 4.102 (4)
1. Commercial air conditioning: 0.09
2. Commercial refrigeraton: 0.23
3. Industrial refrigeration: 0.16</td></tr>
<tr><td>Global warming potential (GWP)</td><td>Technical Guidelines 2012, Appendix C:
<table>
<tr><th>HFC</th><th>GWP</th></tr>
<tr><td>HFC-23</td><td>11,700</td></tr>
<tr><td>HFC-32</td><td>650</td></tr>
<tr><td>HFC-41</td><td>150</td></tr>
</table></td></tr>
</table>

Parameter	Description and *NGER (Measurement) Determination* References	
	HFC-43-10mee	1,300
	HFC-125	2,800
	HFC-134	1,000
	HFC-134a	1,300
	HFC-143	300
	HFC-143a	3,800
	HFC-152a	140
	HFC-227ea	2,900
	HFC-236fa	6,300
	HFC-245ca	560
Aggregated uncertainty level	± 30% Refer to Part 8.9 for defined aggregated uncertainty level for emissions of HFCs	
Emissions calculation method	Emissions (tonnes CO_2-e) = HFC stock (kg) × leakage rate × GWP (kg CO_2-e/kg) × 10^{-3} (t/kg)	

Example – HFC Emissions

A red meat processing facility includes industrial refrigeration for its chiller room. The stock of HFC-23 is 200 kg.

Activity data: 200 kg HFC-23

Annual leakage rate: 0.16 (from *NGER (Measurement) Determination,* Section 4.102(4))

Emissions: = 200 kg × 0.16 × 11,700 kg CO_2-e/kg HFC-23 × 10^{-3} (t/kg) = 374 tonnes CO_2-e

Default aggregated uncertainty: ± 30%

9.3.2 Emissions of Sulfur hexafluoride

Sulfur hexafluoride (SF_6) is a synthetic gas commonly used in gas insulated switchgear and circuit breaker applications. It has a very high GWP – 1 kg SF_6 = 23,900 kg CO_2. Under section 4.101 of the *Determination*, **all emissions of SF_6 must be reported**.

Table 9-5 Emissions of Sulfur hexafluoride

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 1** Part 4.5, section 4.102
Activity data required (units)	Stock of SF_6 contained in each piece of equipment (tonnes)

Parameter	Description and *NGER (Measurement) Determination* References
Annual leakage rate	Section 4.102 (4) 1. Gas insulated switchgear and circuit breaker applications: 0.0089
Global warming potential	23,900 kg CO_2-e / kg SF_6 *Technical Guidelines 2012*, Appendix C
Aggregated uncertainty level	± 30% Refer to Part 8.9 for defined aggregated uncertainty level for emissions of SF_6
Emissions calculation method	Emissions (tonnes CO_2-e) = SF_6 stock (kg) × leakage rate × GWP (kg CO_2-e/kg) × 10^{-3} (t/kg)

Example – SF_6 Emissions

A red meat processing corporation operates gas insulated electrical switchgear, as part of an energy recovery facility at its wastewater treatment plant. The stock of SF_6 in the switchgear is 10 kg.

Activity data: 10 kg SF_6

Annual leakage rate: 0.0089 (from *NGER (Measurement) Determination,* Section 4.102(4))

Emissions: = 10 kg × 0.0089 × 23,900 kg CO_2-e/kg SF_6 × 10^{-3} (t/kg) = 2.1 tonnes CO_2-e

Default aggregated uncertainty: ± 30%

9.4 Incidental Emissions and Energy

In accordance with Regulation 4.27 of the *NGER Regulations*, Figure 9 in the Supplementary Guideline: *Aggregated facility reporting, percentage estimates and incidental emissions and energy* provides advice on "incidental" greenhouse gas emissions and energy from small sources at a facility, allowing organisations to estimate these emissions or energy using a method of its own choosing, when the data is not readily available or would be costly to obtain. This advice may be applicable for estimating emissions from minor emissions sources if these emissions are lower than the upper limits specified below (and providing that the other conditions outlined in the *Supplementary Guideline* are also valid).

Table 9-6 "Incidental" Emissions and Energy

Emissions and energy from within the facility	Emissions (CO_2-e)	Energy consumed	Energy produced
Actual amount from an individual source, and/or Percentage of facility totals from an individual source	3,000 t 0.5%	15 TJ 0.5%	15 TJ 0.5%
Actual amount from sources that can be aggregated, and/or Percentage of facility totals that can be aggregated	12,000 t 2%	60 TJ 2%	60 TJ 2%

Note: Absolute values and percentages must be applied together. Whichever value is lower takes precedence.

Based on these upper limits, emissions from an individual source totalling less than 125 t CO_2-e (i.e. 25,000 × 0.5% = 125) would be considered “incidental” for a facility triggering the threshold at 25,000 t CO_2-e (i.e. less than 0.5% and less than 3,000 t). This is a relatively small amount (i.e. equivalent to approximately 46.4 kL annual diesel consumption).

9.5 Energy Production and Consumption

In addition to greenhouse gas emissions, NGERS requires the formal quantification of energy production and consumption. This assists the DCCEE in tracking energy flows through the economy. The requirements for these calculations are set out in Chapter 6 of the *NGER (Measurement) Determination*.

9.5.1 Energy Production

The general data requirements and calculation approach for determining energy production are outlined in Table 9-7. **For the red meat processing industry, it should be noted that flaring of waste biogas must be reported under energy production.**

Table 9-7 Energy Production

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	Part 6.1
Activity data required and units	Q_i , the quantity of fuel type (i) produced during the year Units for solid fuels: tonnes Units for gaseous fuels: m^3 or kL at standard conditions Units for liquid fuels: kilolitres Units for electricity: kilowatt-hours Refer to table under section 6.3A of *Technical Guidelines 2011* for the list fuels and other energy commodities that may be sources for energy production.
Energy content factors	Select appropriate energy content factor from tabulated list of fuels. Solid fuels – NGER (Measurement) Determination, Schedule 1 (Part 1) (also *Technical Guidelines 2012*, Table 2.2.2) Gaseous fuels – NGER (Measurement) Determination, Schedule 1 (Part 2) (also *Technical Guidelines 2012*, Table 2.3.2A (stationary energy) and Table 2.3.2B (transport energy)) Liquid fuels – NGER (Measurement) Determination, Schedule 1 (Parts 3 and 4) (also *Technical Guidelines 2012*, Table 2.4.2A (stationary energy) and Table 2.4.2B (transport energy)) Electricity – 0.0036 GJ per kWh
Energy production calculation method	Energy production (GJ) for each fuel type (i), Z_i: = quantity of fuel (t, kL, kWh) × fuel energy content (GJ per t, kL, kWh)

Example – Energy Production from Biogas Flaring

A red meat processing corporation's flow metering records show that they flared 102,740 m^3 (standardised to 15°C, 1 atm) of biogas in the year 2011/12. Monthly sampling and analysis of the biogas showed an average methane content of 0.643 m^3 CH_4 per m^3.

Activity data: 102,740 m^3 biogas × 64.3% methane content = 66,062 m^3 CH_4

Energy content: 37.7 × 10^{-3} GJ/m^3 (i.e. "Sludge biogas (methane only)" from *NGER (Measurement) Determination,* Schedule 1 Part 2)

Energy Production: Z = 66,062 m^3 × 37.7 × 10^{-3} GJ/m^3 = **2,490.5 GJ**

Example – Energy Production from Mini-Hydro

A red meat processing corporation generated 1,370.5 kWh from a solar generation plant installed at its facility.

Activity data: 1,370.5 kWh

Energy Production: Z = 1,370.5 kWh × 0.0036 GJ/kWh = **4.94 GJ**

As in the example above, if the operation of a facility produces electricity, the corporation must also report whether the electricity was produced using:

a) thermal generation; or

b) geothermal generation; or

c) solar generation; or

d) wind generation; or

e) water generation; or

f) biogas generation.

The corporation's report must also identify the amount of the electricity that was:

1. Produced for use in the facility; and
2. Produced for use outside the facility, either within or outside an electricity transmission or distribution network.

Refer to the example reporting tables provided under section 6.3A of the *Technical Guidelines 2012*.

9.5.2 Energy Consumption

The general data requirements and calculation approach for determining energy consumption are outlined in Table 9-8. **For the red meat processing industry, it should be noted that flaring of waste biogas must also be reported under energy consumption.**

Table 9-8 Energy Consumption

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	Part 6.2
Activity data required	Q_i , the quantity of fuel type (i) consumed during the year

and units	Units for solid fuels: tonnes Units for gaseous fuels: m^3 or kL at standard conditions Units for liquid fuels: kilolitres Units for electricity: kilowatt-hours
Energy content factors	Select appropriate energy content factor from tabulated list of fuels. Solid fuels – *NGER (Measurement) Determination*, Schedule 1 (Part 1) (also *Technical Guidelines 2012*, Table 2.2.2) Gaseous fuels – *NGER (Measurement) Determination,* Schedule 1 (Part 2) (also *Technical Guidelines 2012*, Table 2.3.2A (stationary energy) and Table 2.3.2B (transport energy)) Liquid fuels – *NGER (Measurement) Determination,* Schedule 1 (Parts 3 and 4) (also *Technical Guidelines 2012*, Table 2.4.2A (stationary energy) and Table 2.4.2B (transport energy)) Electricity – 0.0036 GJ per kWh
Energy consumption calculation method	Energy consumption (GJ) for each fuel type (i), Z_i: = quantity of fuel (t, kL, kWh) × fuel energy content (GJ per t, kL, kWh)

Note: If a facility consumes:

a) solar energy for electricity generation; or

b) wind energy for electricity generation; or

c) water energy for electricity generation; or

d) geothermal energy for electricity generation,

then the energy content of the consumed energy is taken to be equal to energy content of the electricity produced. Refer also to the example reporting table provided under section 6.5A of the *Technical Guidelines 2012*.

Example – Energy Consumption from Natural Gas
A red meat corporation's natural gas metering records show that they consumed 10,350 m^3 (standardised to 15°C, 1 atm) of natural gas for heating their corporate offices in the year 2009/10.
Activity data: 10,350 m^3 natural gas (distributed in a pipeline)
Energy content: 39.3 × 10^{-3} GJ/m^3 (*NGER (Measurement) Determination,* Schedule 1, Part 2)
Energy Consumption: Z = 10,350 m^3 × 39.3 × 10^{-3} GJ/m^3 = **406.8 GJ**

9.6 Scope 2 Emissions

The general data requirements and calculation approach for determining Scope 2 emissions are outlined in Table 9-9.

Table 9-9 Scope 2 Emissions

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 1** Part 7.2 – Purchase of electricity from main electricity grid in a State or Territory
Activity data required (units)	Electricity consumption (kWh). Under NGERS there is no requirement to disaggregate electricity consumption below the facility level, however such an approach may be useful for targeted energy efficiency improvements.
Emission factor	*NGER (Measurement) Determination,* Schedule 1 (Part 6) (also *Technical Guidelines 2011,* Table 7.2) Select the appropriate State-based grid emission factor from the tabulated list of State and Territories
Emissions calculation method	Emissions (tonnes CO_2-e) = kWh $\times$ grid emission factor (kg CO_2-e/kWh) $\times$ 10^{-3} (t/kg)

Note: Scope 2 emissions do not require an uncertainty assessment.

Example – Scope 2 Emissions

From its electricity invoices, a red meat proessing corporation in Queensland used 1,200,370 kWh at its processing facility in 2012/13.

Activity data: 1,200,370 kWh

State-based grid emission factor: 0.86 kg CO_2-/kWh (*NGER (Measurement) Determination*, Schedule 1, Part 6)

Emissions: = 1,200,370 kWh $\times$ 0.86 kg CO_2-e/kWh $\times$ 10^{-3} (t/kg) = 1,032 tonnes CO_2-e

Under the present rules of the *NGER (Measurement) Determination*, all electricity purchased from the state electricity grid (whether “black” or “green”) must be assessed using the relevant State-based grid emission factor for the purposes of reporting Scope 2 emissions. Offset Scope 2 totals, accounting for voluntary purchases of GreenPower™ and/or RECs can be voluntarily reported separately as Contextual Data (refer section 2.3.1 of this guideline).

10. Appendix C – Additional Guidance on Emissions from Wastewater Handling

The following sections provide additional technical guidance on the activity data and calculation methodologies for estimating methane emissions from wastewater handling.

10.1 General Data Requirements and Calculation Approach

10.1.1 Methane Emissions from Wastewater Handling (Method 1)

The general data requirements and **Method 1** calculation approach for determining methane emissions (and associated uncertainty) from red meat processing corporation's wastewater handling facilities are outlined in Table 10-1.

Table 10-1 Direct Methane Emissions from WWTPs (Method 1)

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 1** Division 5.4.2
Activity data required (units)	• Effluent volume, Q (ML) • Effluent COD concentration, $[COD]_{eff}$ (mg/L) Typically > 750 mg/L for primary treatment processes Typically > 50 – 200 mg/L for secondary treatment processes • Primary sludge volume, Q_{ps} (ML) • Primary sludge volatile solids concentration, $[VS]_{ps}$ (mg/L) (if applicable, and optional, refer Explanation Box 1 below) Typically 10,000 – 30,000 mg/L • Waste activated sludge (WAS) volume, Q_{was} (ML) (if applicable and optional, refer Explanation Box 1 below) • WAS volatile solids concentration, $[VS]_{was}$ (mg/L) (if applicable and optional, refer Explanation Box 1 below) Typically 3,000 – 6,000 mg/L for activated sludge processes • Sludge mass or volume transferred to landfill, Q_{trl} (t, ML) (if applicable) • Sludge mass or volume transferred to "other", Q_{tro} (t, ML) (if applicable) • Transferred sludge volatile solids concentration, $[VS]_{tr}$ (mg/L, % w/w) (if applicable) Heavily dependent on type of treatment process and operating philosophy • Biogas captured for combustion for use by the plant (e.g. for sludge heaters, energy recovery gas engines, etc.), B_{cap} (m^3 at 15°C, 1 atm) (if applicable) • Biogas flared by the plant, B_{flared} (m^3 at 15°C, 1 atm) (if applicable)

Parameter	Description and *NGER (Measurement) Determination* References
	• Biogas transferred out of the plant, B_{tr} (m^3 at 15°C, 1 atm) (if applicable) • Methane concentration in biogas, $\%CH_4$ (if applicable) Typically 60 – 70% for anaerobic digesters Typically 80 – 90% for primary anaerobic lagoons
Default emission factors and other values	Section 5.42 (5): • Methane Correction Factor for wastewater treatment, MCF_{ww} – **select from** • **above** • Methane Correction Factor for sludge, MCF_{sl} – **select from** • **above** Section 5.42 (8): • Wastewater generation rate, $W_{gen,I}$ = 13.7 m^3 per tonne product (ANZSIC codes 1111 and 1112) • Raw wastewater COD concentration, $COD_{con,I}$ = 6.1 kg per cubic metre (i.e. 6,100 mg/L) (ANZSIC codes 1111 and 1112) Other assumptions: • Fraction of COD removed as sludge from wastewater and treated in the plant during the year, F_{sl} – **select using Explanation Box 1 below** • COD:VS_{ps} conversion factor for primary sludge only, VS_{psl} = 1.99 t COD / t VS **(see Explanation Box 1 below)** • COD:VS_{was} conversion factor for WAS only, VS_{wasl} = 1.48 t COD / t VS **(see Explanation Box 1 below)** • COD:VS_{tr} conversion factor for transferred sludge equals weighted composite of primary sludge and waste activated sludge – e.g. 100 tonnes primary sludge + 50 tonnes WAS $VS_{tr} = (100 \times 1.99 + 50 \times 1.48) / (100 + 50) = 1.82$ t COD / t VS • Biogas volumetric flow rates may be normalised to standard conditions (15°C, 1 atm) using the ideal gas equation, if necessary. An example of this calculation is included in section 6.
Emissions calculation method – step-by-step	1) Raw wastewater COD mass load, $COD_{w,i}$ (tonnes) $COD_{w,i} = Prod_i \times W_{gen,i} \times COD_{con,I} \times (10^{-3}$ t/kg)
	2) Effluent COD mass load, COD_{eff} (tonnes) $COD_{eff} = Q_{eff} \times [COD]_{eff} \times (10^{-3}$ t/kg) Q_{eff} as ML and $[COD]_{eff}$ as mg/L
	3) Total sludge COD mass load, COD_{sl} (tonnes)

Parameter	Description and *NGER (Measurement) Determination* References
	If using default values: • $COD_{sl} = F_{sl} \times COD_{w}$, *If using plant activity data:* • Primary sludge COD mass load, COD_{psl} (tonnes): $COD_{psl} = Q_{ps} \times [VS]_{ps} \times VS_{psl} \times (10^{-3} \text{ t/kg})$ Q_{ps} as ML and $[VS]_{ps}$ as mg/L • WAS COD mass load, COD_{wasl} (tonnes): $COD_{wasl} = Q_{was} \times [VS]_{was} \times VS_{wasl} \times (10^{-3} \text{ t/kg})$ Q_{was} as ML and $[VS]_{was}$ as mg/L • Total sludge COD mass load, COD_{sl} (tonnes): $COD_{sl} = COD_{psl} + COD_{wasl}$
	4) Sludge transferred to landfill COD mass load, COD_{trl} (tonnes) $COD_{trl} = Q_{trl} \times [VS]_{tr} \times VS_{tr} \times (10^{-3} \text{ t/kg})$ Q_{trl} as ML and $[VS]_{tr}$ as mg/L $COD_{trl} = Q_{trl} \times [VS]_{tr} \times VS_{tr}$ Q_{trl} as t and $[VS]_{tr}$ as % w/w
	5) Sludge transferred to "other" COD mass load, COD_{tro} (tonnes) $COD_{tro} = Q_{tro} \times [VS]_{tr} \times VS_{tr} \times (10^{-3} \text{ t/kg})$ Q_{tro} as ML and $[VS]_{tr}$ as mg/L $COD_{tro} = Q_{tro} \times [VS]_{tr} \times VS_{tr}$ Q_{tro} as t and $[VS]_{tr}$ as % w/w
	6) Apply equation from section 5.42 (5): $CH_{4gen} = (COD_{w,i} - COD_{sl} - COD_{eff}) \times MCF_{ww} \times EF_{wij} + (COD_{sl} - COD_{trl} - COD_{tro}) \times MCF_{sl} \times EF_{slij}$
	7) Methane in captured biogas for combustion, Q_{cap} (m^3) $Q_{cap} = B_{cap} \times \%CH_4$
	8) Methane in captured biogas for flaring, Q_{flared} (m^3) $Q_{flared} = B_{flared} \times \%CH_4$
	9) Methane in captured biogas for transfer out of the plant, Q_{tr} (m^3) $Q_{tr} = B_{tr} \times \%CH_4$
	10) Apply equation from section 5.25 (2):

Parameter	Description and *NGER (Measurement) Determination* References
	If $\frac{\gamma(Q_{cap} + Q_{flared} + Q_{tr})}{CH_{4gen}} \leq 0.75$ then, $CH_4^* = CH_{4gen}$ Or if $\frac{\gamma(Q_{cap} + Q_{flared} + Q_{tr})}{CH_{4gen}} > 0.75$ then, $CH_4^* = \gamma(Q_{cap} + Q_{flared} + Q_{tr}) \times \left(1/0.75\right)$
	11) Apply equation from section 5.42 (1): $E_j = CH_4^* - \gamma(Q_{cap} + Q_{flared} + Q_{tr})$
Uncertainty calculation method	Not applicable. Under **Method 1 only**, default aggregated uncertainty is **± 65%** for all Scope 1 industrial wastewater handling emissions. Refer to Part 8.10.

10.1.2 Methane Emissions from Wastewater Handling (Method 2)

The general data requirements and **Method 2** calculation approach for determining methane emissions (and associated uncertainty) from industrial wastewater handling facilities are outlined in Table 10-2.

Table 10-2 Direct Methane Emissions from WWTPs (Method 2)

Parameter	Description and *NGER (Measurement) Determination* References
Determination reference	**Method 2** Division 5.4.3
Activity data required (units)	• Raw wastewater volume, Q (ML) • Raw wastewater COD or biochemical oxygen demand (BOD) concentration, $[COD]_w$ or $[BOD]_w$ (mg/L) (13) Typically 1,300 – 7,500 mg/L COD for red meat processing raw wastewater; and 700 – 4,000 mg/L BOD for for red meat processing raw wastewater • Effluent COD concentration, $[COD]_{eff}$ (mg/L) Typically > 750 mg/L for primary treatment processes Typically > 50 – 200 mg/L for secondary treatment processes • Primary sludge volume, Q_{ps} (ML) (if applicable) • Primary sludge volatile solids concentration, $[VS]_{ps}$ (mg/L) (if applicable) Typically 10,000 – 30,000 mg/L

[13] COD is considered to be the preferred analyte for calculating fugitive methane emissions using Method 2. BOD analysis and an applicable COD/BOD ratio should be used in situations where insufficient COD data are available.

Parameter	Description and *NGER (Measurement) Determination* References
	• Waste activated sludge volume, Q_{was} (ML) (if applicable) • WAS volatile solids concentration, $[VS]_{was}$ (mg/L) (if applicable) Typically 3,000 – 6,000 mg/L for activated sludge processes • Sludge mass or volume transferred to landfill, Q_{trl} (t, ML) (if applicable) • Sludge mass or volume transferred to “other”, Q_{tro} (t, ML) (if applicable) • Transferred sludge volatile solids concentration, $[VS]_{tr}$ (mg/L, % w/w) (if applicable) Heavily dependent on type of treatment process and operating philosophy • Biogas captured for combustion for use by the plant (e.g. for sludge heaters, energy recovery gas engines, etc.), B_{cap} (m^3 at 15°C, 1 atm) (if applicable) • Biogas flared by the plant, B_{flared} (m^3 at 15°C, 1 atm) (if applicable) • Biogas transferred out of the plant, B_{tr} (m^3 at 15°C, 1 atm) (if applicable) • Methane concentration in biogas, $\%CH_4$ (if applicable) Typically 60 – 70% for anaerobic digesters Typically 80 – 90% for primary anaerobic lagoons
Uncertainty level in activity data	• Flow metering error for Q, Q_{ps}, Q_{was}, Q_{trl}, Q_{tro}, B_{cap}, B_{flared} and B_{tr} • All analytical measurements – i.e. $[BOD]_w$, $[COD]_w$, $[COD]_{eff}$, $[VS]_{ps}$, $[VS]_{was}$, $[VS]_{tr}$ and $\%CH_4$ – require 95% confidence interval of sampling data (± %): Refer to section 11.1.1 of these *Industry Guidelines*.
Default emission factors and other values	• Methane Correction Factor for wastewater treatment, MCF_{ww} – **select from** • **above** • Methane Correction Factor for sludge treatment, MCF_{sl} – **select from** • **above** Section 5.43 (2b): • COD:BOD conversion factor for raw wastewater only, COD_{BOD} = 2.6 t COD / t BOD_5 Other assumptions: • COD:VS_{ps} conversion factor for primary sludge only, VS_{psl} = 1.99 t COD / t VS **(see Explanation Box 1 below)** • COD:VS_{was} conversion factor for WAS only, VS_{wasl} = 1.48 t COD / t VS **(see Explanation Box 1 below)** • COD:VS_{tr} conversion factor for transferred sludge equals weighted composite of primary sludge and waste activated sludge – e.g.

Parameter	Description and *NGER (Measurement) Determination* References
	100 tonnes primary sludge + 50 tonnes WAS $COD{:}VS_{tr} = (100 \times 1.99 + 50 \times 1.48) / (100 + 50) = 1.82$ t COD / t VS • Biogas volumetric flow rates may be normalised to standard conditions (15°C, 1 atm) using the ideal gas equation as follows (if necessary): $Q_{normalised} = Q_{ref} \times (1 / P_{ref}) \times (T_{ref} / 288.15)$, where: - $Q_{normalised}$ is the biogas flow rate normalised to NGER standard pressure of 1 atm and standard temperature of 15°C (i.e. 288.15°K) - Q_{ref} is the biogas flow rate measured at any given temperature and pressure (i.e. reference conditions) - P_{ref} is the biogas reference pressure measurement condition, in units of atm - T_{ref} is the biogas reference temperature measurement condition, in units of °K (where a°C = a + 273.15°K)
Uncertainty level in emission factors and other values	• The volume-to-mass conversion factor, γ is based on ideal gas properties. Therefore, uncertainty level = ± 0% • The maximum methane emission factors EF_{wii} and EF_{slij} are based on the chemical oxygen demand stoichiometry of methane. Therefore, uncertainty level for EF_{wij} and EF_{slij} = ± 0%. • No guidance is provided in the *Determination* on the uncertainty level associated with methane correction factors. - Refer to Table 6.3, p.6.13, *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Wastewater Treatment and Discharge*. This provides value ranges for various methane correction factors. - Based on these IPCC ranges, a reasonable uncertainty level for all MCF values = ± 25%. • No guidance is provided in the *Determination* on the uncertainty level associated with COD:VS ratios. - In the absence of site-specific data, a reasonable uncertainty level for all COD:VS ratios = ± 12% (based on industry experience). • No guidance is provided in the *Determination* on the uncertainty level associated with the COD:BOD ratio for raw wastewater. This ratio varies for all raw wastewater streams, and could be anywhere between 2.0 and 3.5 for raw wastewater. - In the absence of site-specific data, a reasonable uncertainty level for the COD:BOD ratio for raw wastewater = ± 30% (based on industry experience).
Emissions calculation method – step-by-	1) Raw wastewater COD mass load, COD_w (tonnes) $COD_{w,i} = Q \times [BOD]_w \times COD_{BOD} \times (10^{-3}$ t/kg)

Parameter	Description and *NGER (Measurement) Determination* References
step	2) Effluent COD mass load, COD_{eff} (tonnes) $COD_{eff} = Q \times [COD]_{eff} \times (10^{-3}\ t/kg)$
	3) Primary sludge COD mass load, COD_{psl} (tonnes) $COD_{psl} = Q_{ps} \times [VS]_{ps} \times VS_{psl} \times (10^{-3}\ t/kg)$
	4) WAS COD mass load, COD_{wasl} (tonnes) $COD_{wasl} = Q_{was} \times [VS]_{was} \times VS_{wasl} \times (10^{-3}\ t/kg)$
	5) Total sludge COD mass load, COD_{sl} (tonnes) $COD_{sl} = COD_{psl} + COD_{wasl}$
Emissions calculation method – step-by-step (cont.)	6) Sludge transferred to landfill COD mass load, COD_{trl} (tonnes) $COD_{trl} = Q_{trl} \times [VS]_{tr} \times VS_{tr} \times (10^{-3}\ t/kg)$ Qtrl as ML and [VS]tr as mg/L $COD_{trl} = Q_{trl} \times [VS]_{tr} \times VS_{tr}$ Qtrl as t and [VS]tr as % w/w
	7) Sludge transferred to "other" COD mass load, COD_{tro} (tonnes) $COD_{tro} = Q_{tro} \times [VS]_{tr} \times VS_{tr} \times (10^{-3}\ t/kg)$ Qtrl as ML and [VS]tr as mg/L $COD_{tro} = Q_{trl} \times [VS]_{tr} \times VS_{tr}$ Q_{tro} as t and $[VS]_{tr}$ as % w/w
	8) Apply equation from section 5.25 (5): $$CH_{4gen} = \begin{matrix} (COD_{w,i} - COD_{sl} - COD_{eff}) \times MCF_{ww} \times EF_{wij} \\ + (COD_{sl} - COD_{trl} - COD_{tro}) \times MCF_{sl} \times EF_{slij} \end{matrix}$$ i.e. $CH_{4\ gen}$ = Emissions from "liquid train", E_{liq} + Emissions from "sludge", E_{sl}
	9) Methane in captured biogas for combustion, Q_{cap} (m^3) $Q_{cap} = B_{cap} \times \%CH_4$
	10) Methane in captured biogas for flaring, Q_{flared} (m^3) $Q_{flared} = B_{flared} \times \%CH_4$
	11) Methane in captured biogas for transfer out of the plant, Q_{tr} (m^3) $Q_{tr} = B_{tr} \times \%CH_4$
	12) Apply equation from section 5.25 (2) **and condition from section 5.43 (2A)**:

Parameter	Description and *NGER (Measurement) Determination* References
	If $\frac{\gamma(Q_{cap}+Q_{flared}+Q_{tr})}{CH_{4gen}} \leq 1.00$ then, $CH_4^* = CH_{4gen}$ Or if $\frac{\gamma(Q_{cap}+Q_{flared}+Q_{tr})}{CH_{4gen}} > 1.00$ then, $CH_4^* = \gamma(Q_{cap}+Q_{flared}+Q_{tr}) \times (1/1.00)$
	13) Apply equation from section 5.42 (1): $E_j = CH_4^* - \gamma(Q_{cap}+Q_{flared}+Q_{tr})$
Uncertainty calculation method	1) Uncertainty in COD_w (%), U_COD_w: $= \pm \sqrt{U\_Q^2 + U\_[BOD]_w^2 + U\_COD_{BOD}^2}$
	2) Uncertainty in COD_{eff} (%), U_COD_{eff}: $= \pm \sqrt{U\_Q^2 + U\_[COD]_{eff}^2}$
	3) Uncertainty in COD_{psl} (%), U_COD_{psl}: $= \pm \sqrt{U\_Q_{ps}^2 + U\_[VS]_{ps}^2 + U\_VS_{psl}^2}$
	4) Uncertainty in COD_{wasl} (%), U_COD_{wasl}: $= \pm \sqrt{U\_Q_{was}^2 + U\_[VS]_{was}^2 + U\_VS_{wasl}^2}$
	5) Uncertainty in COD_{sl} (%), U_COD_{sl}: $= \pm \frac{\sqrt{(COD_{psl} \times U\_COD_{psl})^2 + (COD_{wasl} \times U\_COD_{wasl})^2}}{COD_{psl} + COD_{wasl}}$
	6) Uncertainty in COD_{trl} (%), U_COD_{trl}: $= \pm \sqrt{U\_Q_{trl}^2 + U\_[VS]_{tr}^2 + U\_VS_{tr}^2}$
	7) Uncertainty in COD_{tro} (%), U_COD_{tro}: $= \pm \sqrt{U\_Q_{tro}^2 + U\_[VS]_{tr}^2 + U\_VS_{tr}^2}$
	8) Uncertainty in $CH_{4\ gen}$ (%), $U\_CH_{4\ gen}$: a. Uncertainty in "liquid train" COD mass balance (%), U_MB_{liq}: $= \pm \frac{\sqrt{(COD_w \times U\_COD_w)^2 + (COD_{eff} \times U\_COD_{eff})^2 + (COD_{sl} \times U\_COD_{sl})^2}}{COD_w - COD_{eff} - COD_{sl}}$

Parameter	Description and *NGER (Measurement) Determination* References
	b. Uncertainty in “liquid train” emissions (%), U_E_{liq}: $= \pm \sqrt{U\_MB_{liq}^{2} + U\_MCF_{w}^{2} + U\_EF_{wij}^{2}}$ c. Uncertainty in “sludge” COD mass balance (%), U_MB_{sl}: $= \pm \frac{\sqrt{(COD_{sl} \times U\_COD_{sl})^2 + (COD_{trl} \times U\_COD_{trl})^2 + (COD_{tro} \times U\_COD_{tro})^2}}{COD_{sl} - COD_{trl} - COD_{tro}}$ d. Uncertainty in “sludge” emissions (%), U_E_{sl}: $= \pm \sqrt{U\_MB_{sl}^{2} + U\_MCF_{sl}^{2} + U\_EF_{slij}^{2}}$ e. Combined uncertainty in $CH_{4\ gen}$ (%), $U\_CH_{4\ gen}$: $= \pm \frac{\sqrt{(MB_{liq} \times U\_MB_{liq})^2 + (MB_{sl} \times U\_MB_{sl})^2}}{MB_{liq} - MB_{sl}}$
	9) Uncertainty in Q_{cap} (%), U_Q_{cap}: $= \pm \sqrt{U\_B_{cap}^{2} + U\_\%CH_{4}^{2}}$
	10) Uncertainty in Q_{flared} (%), U_Q_{flared}: $= \pm \sqrt{U\_B_{flared}^{2} + U\_\%CH_{4}^{2}}$
	11) Uncertainty in Q_{tr} (%), U_Q_{tr}: $= \pm \sqrt{U\_B_{tr}^{2} + U\_\%CH_{4}^{2}}$
	12) Uncertainty in total measured methane production $\gamma(Q_{cap} + Q_{flared} + Q_{tr})$ (%), U_Q_{total}: $= \pm \frac{\sqrt{(Q_{cap} \times U\_Q_{cap})^2 + (Q_{flared} \times U\_Q_{flared})^2 + (Q_{tr} \times U\_Q_{tr})^2}}{Q_{cap} + Q_{flared} + Q_{tr}}$ **Note: Uncertainty level for γ = ± 0 %**
	13) Overall uncertainty in E_j (%), U_E_j (assuming $CH_4^{*} = CH_{4\ gen}$): $= \pm \frac{\sqrt{(CH_{4gen} \times U\_CH_{4gen})^2 + (\gamma(Q_{cap} + Q_{flared} + Q_{tr}) \times U\_Q_{total})^2}}{CH_{4gen} - \gamma(Q_{cap} + Q_{flared} + Q_{tr})}$

10.2 Addressing Data Gaps

The explanation box below outlines alternative data collection approaches for use in circumstances where COD data is not available (particularly effluent and sludge COD concentrations). However, it should be noted that direct COD data collection is preferable to the alternative approaches outlined below.

Explanation Box No.1 – Effluent COD and Sludge COD

For either Method 1 or Method 2, COD mass loads for process streams other than raw wastewater (i.e. COD_{eff}, COD_{sl}, COD_{trl} and COD_{tro}) can be estimated using one of two approaches:

1. Using the default values specified in the *Determination*, where*:*

   • The quantity of COD removed as sludge from wastewater and treated in the plant, COD_{sl}, is calculated as:

   $COD_{sl} = COD_{w,i} \times F_{sl}$, where:

   F_{sl} is the fraction of COD removed as sludge from wastewater and treated in the plant during the year;

   There is no guidance in the *Determination* or the *NGER Technical Guidelines 2012* surrounding the range of typical F_{sl} values for different WWTP configurations. Shown below are typical F_{sl} values for common red meat industry wastewater treatment processes, based only on the judgement and experience of the authors and the project working group. Futher research is necessary to better characterise the range of sludge production values by treatment process.

WWTP Process	F_{sl} Estimate	Typical Range
Physical treatment only (i.e. gross solids and fat removal)	0.4	0.3 – 0.5
Physical treatment and pond based treatment	0.5	0.3 – 0.6
Physical treatment and biological treatment (i.e. activated sludge)	0.6	0.4 – 0.7

2. In accordance with industry practice relevant to the measurement of the quantity of wastewater. Based on the judgement and experience of the authors and the project working group, these practices would typically include the following:

- Treated effluent (COD_{eff}):

  - The volumetric effluent flow rate (i.e. ML for the year) and COD concentration (i.e. mg/L or kg/m^3); or

  - The volumetric effluent flow rate and BOD concentration (i.e. mg/L or kg/m^3), where BOD data may be converted to COD using a facility-specific COD:BOD conversion factor (based on effluent COD and BOD measurements).

- Sludge streams (COD_{sl}, COD_{trl} and COD_{tro})

  - The volumetric sludge flow rate (i.e. ML for the year) and COD concentration (i.e. mg/L or kg/m^3); or

  - The sludge mass flow rate (i.e. tonnes of dry solids or wet solids) and the COD mass concentration (i.e. mg/kg or kg/t); or

  - The sludge flow rate (mass or volumetric) and volatile solids (VS) concentration (i.e. mg/L, mg/kg or % of total solids), where VS data may be converted to COD using facility-specific COD:VS conversion factor (based on sludge COD and VS measurements) or the following default COD conversion factors for domestic wastewaters (refer *NGER Determination*, Part 5.3) :

- $COD:VS_{ps}$ conversion factor for primary sludge only,
  VS_{psl} = 1.99 t COD / t VS [(14)]

- $COD:VS_{was}$ conversion factor for WAS only,

VS_{wasl} = 1.48 t COD / t VS [(15)]
Note: Since these conversion factors are not specifically applicable to the red meat processing industry, direct sampling of COD would be preferable to use of these factors.

Worked example calculations using these data sources are included in in sections 4.6.1 of this guideline and also in the case study examples (section 6).

It is important to note that the process streams defined under the default NGER COD mass balance approach (i.e. COD_{sl}, COD_{tro} and COD_{trl} in particular) may not be relevant to individual wastewater treatment plants. With this in mind, organisations are recommended to develop simple process flow diagrams to identify the relevant process streams and resulting activity data requirements for characterising a representative COD mass balance for estimating wastewater emissions.

[14] Based on the complete oxidation of an assumed molecular formula for primary sludge of $C_{10}H_{19}O_3N$ (Parkin, G., Owen, W. 1986, Fundamental of anaerobic digestion of wastewater sludges, *ASCE Journal of Environmental Engineering* 112(5): 867-920.)

$C_{10}H_{19}O_3N + 12.5\ O_2 \rightarrow 10\ CO_2 + 8\ H_2O + NH_3$

[15] Based on the complete oxidation of an assumed molecular formula for activated sludge of $C_7H_{10}O_3N$ (Ekama, G. *et al*. 1984, *Theory, Design and Operation of Nutrient Removal Activated Sludge Processes*, prepared for Water Research Commission by University of Cape Town, City Council of Johannesburg and National Institute for Water Research, Pretoria)

$C_7H_{10}O_3N + 7.25\ O_2 \rightarrow 7\ CO_2 + 3.5\ H_2O + NH_3$

11. Appendix D – Uncertainty

11.1 Assessment of Uncertainty

Reporting of uncertainty associated with Scope 1 emissions is mandatory under NGERS, so that the range for an emissions estimate encompasses the actual amount of the emissions with 95% confidence**.** Uncertainty data is used by the DCCEE for National Inventory Reporting purposes only. **Under the Clean Energy legislative package, there is no carbon liability associated with Scope 1 uncertainty estimates.**

The *NGER (Measurement) Determination* and *Technical Guidelines 2011* provide guidance on uncertainty estimation, which is based on the *GHG Protocol Guidance on Uncertainty Assessment in GHG Inventories and Calculating Statistical Parameter Uncertainty*, 2003.

Figure 11-1 shows the types of uncertainty that are associated with the estimation of greenhouse gas emissions. For the purposes of NGERS reporting, it is only necessary to calculate **statistical (i.e. random) uncertainty** – that is, the uncertainty due to the underlying random variability of activity data, caused by, for example, random human errors in the measurement process or random fluctuations in the measurement equipment

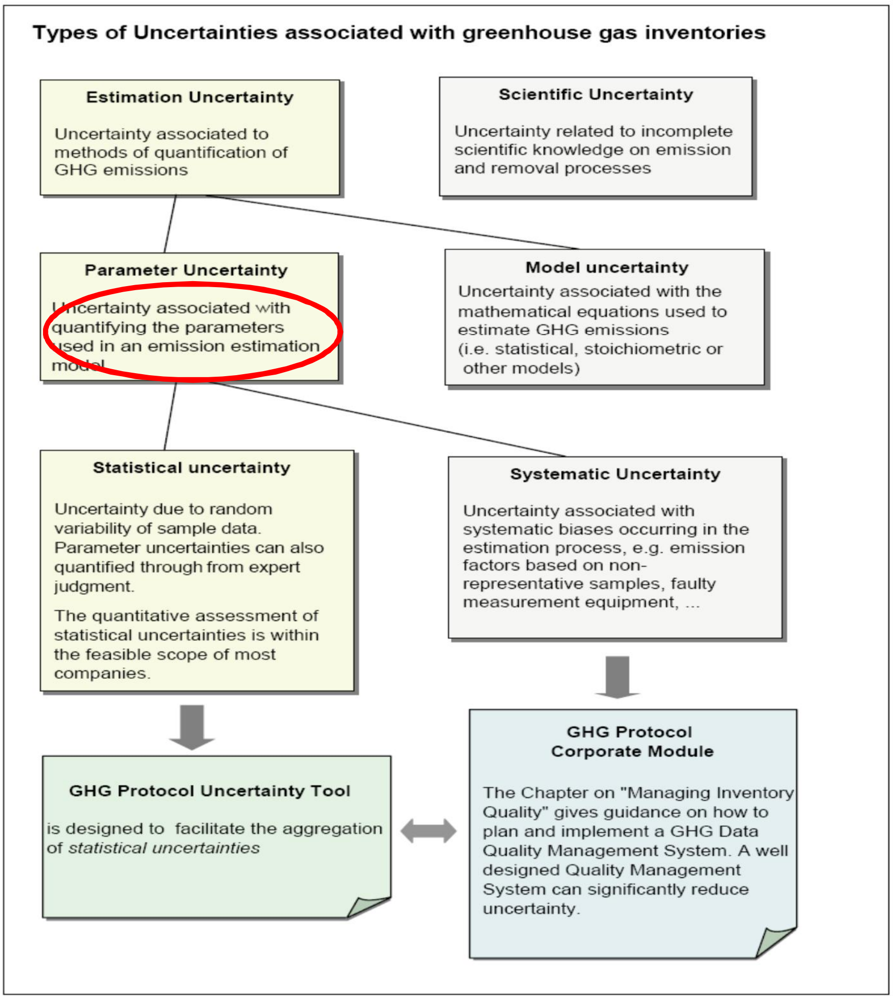


Figure 11-1 Types of Uncertainty [16]

[16] *GHG Protocol Guidance on Uncertainty Assessment in GHG Inventories and Calculating Statistical Parameter Uncertainty*, 2003

Whilst the *Determination* allows for the use of default aggregated uncertainties for Method 1 emission estimates (e.g. ± 65% for industrial wastewater handling), it is necessary to calculate uncertainty from first principles, in accordance with the *GHG Protocol Guidance on Uncertainty Assessment* (2003), for emission estimates determined by Methods 2, 3 or 4. It is also allowable to calculate uncertainty from first principles for Method 1 emission calculations.

Additional general guidance on the first principles approach is also provided below.

11.1.1 Uncertainty Calculation Methods – 95% Confidence Intervals

To calculate uncertainty from first principles, it is necessary to start by determining the 95% confidence interval around the mean value of the activity data set (for activity data, other than fuels combustion).

> The uncertainty level (the ± percentages – otherwise known as the confidence limits) is to be calculated so that there is a 95% probability that the true value of the estimate is encompassed by the estimated uncertainty levels (the confidence limits). For example, an emission estimate of 100,000 t ± 10% at the 95% confidence interval means that the true value lies between 90,000 t and 110,000 t with a probability of 95%.
>
> *NGER Technical Guidelines 2012*, p.431

The *Determination* assumes that each activity data set is normally distributed, and hence the 95% confidence interval can be calculated using the Student's *t*-distribution [17], as follows:

$$\bar{x} \pm t(\tfrac{\alpha}{2}; n-1)\frac{s}{\sqrt{n}}$$

where:

$\bar{x}$	is the arithmetic mean of the activity data set;
t	is the Student's *t*-distribution factor;
α	is equal to 0.05 for a 95% confidence interval;
n	is the number of samples in the activity data set; and
s	is the standard deviation of the activity data set.

The Student's t-distribution factor can be found using look-up tables in any standard statistics textbook, or Annex A of the *GHG Protocol Guidance on Uncertainty Assessment in GHG Inventories and Calculating Statistical Parameter Uncertainty*, 2003. Alternatively, the t-distribution factor can be calculated using a simple function in MS Excel.

MS Excel Calculation Tip – "TINV" Function

The "TINV" function in MS Excel returns the t-factor of the two-tailed Student's *t*-distribution, as a function of the desired confidence interval and the sample size:

Syntax

[17] The Student's t-distribution is special variation of the standard normal distribution that is better applied to data sets with a small number of samples. The Student's t-distribution has thicker tails than the standard normal distribution, but for data sets with a very large number of samples, the Student's t-distribution approaches the shape of the standard normal distribution.

= TINV(probability,deg_freedom)

where:

probability = 0.05 (for the 95% confidence interval)

deg_freedom = number of data in activity data set, n – 1

Example – Uncertainty Assessment for COD_w

A red meat processing corporation collects monthly composite samples of its raw wastewater for the purpose of determining the average influent COD concentration, $COD_{w,i}$.

January 5,020 mg/L	May 5,200 mg/L	September 4,690 mg/L
February 5,010 mg/L	June 4,800 mg/L	October 5,000 mg/L
March 4,990 mg/L	July 5,820 mg/L	November 5,200 mg/L
April 5,060 mg/L	August 4,680 mg/L	December 5,100 mg/L

Using MS Excel for the calculations:

Average = 5,048 mg/L

Standard deviation = 298 mg/L

Number of samples = 12

Student's *t*-distribution factor = 2.20 (for **α** = 0.05, n = 12)

Uncertainty at 95% confidence level = $2.20 \times 298 / \sqrt{12}$ = 189 mg/L or 3.8% of the mean

Result: Average COD_w concentration is 5,048 mg/L ± 3.8%

Where data are insufficient for a statistical analysis, it may be possible to use "expert judgment" to estimate an uncertainty range [(16)]. However, strict rules apply to this "expert elicitation" approach to avoid cognitive biases. Further guidance is provided in the *GHG Protocol Guidance on Uncertainty Assessment* (2003).

11.1.2 Combining Uncertainty Intervals

First Order Propagation Techniques

In the compilation of emission estimates, it is often necessary to combine the uncertainty intervals of different data sets. Under the *Determination*, this can be simply done using the first order propagation technique. This approach requires validation of four key assumptions:

1. The errors in each parameter must be normally distributed (i.e. Gaussian);
2. There must be no biases in the estimator function (i.e. that the estimated value is the mean value);
3. The estimated parameters must be uncorrelated (i.e. all parameters are fully independent); and
4. Individual uncertainties in each parameter must be less than 60% of the mean.

For the purposes of this Guideline, it has been assumed that the first order propagation technique is valid. Examples of the relevant first order propagation calculations are shown below.

Case 1 – Multiplying and/or dividing uncertainty intervals:

If (A ± a%) × (B ± b%) × (C ± c%) = D ± d%, then

$$d = \sqrt{a^2 + b^2 + c^2}$$

Example – Multiplying Uncertainty Intervals

A red meat processing corporation collects monthly composite samples of its raw wastewater for the purpose of determining the average influent COD concentration, and has calculated it to be 5,048 mg/L ± 3.8%. From its on-line control system, instrumentation data sheets and calibration records, it has also calculated the annual total flowrate into the wastewater treatment plant to be 3,830 ML ± 1.5%.

Using MS Excel for the calculations:

Average annual COD mass load = 3,830 ML × 5,048 mg/L **= 19,333,840 kg COD per year**

Uncertainty at 95% confidence level = $\sqrt{(3.8\%)^2 + (1.5\%)^2}$ = 4.1%

Result: Average $COD_{w,i}$ is 19,333,840 kg COD per year ± 4.1%

Case 2 – Adding and Subtracting Uncertainties

If (A ± a%) + (B ± b%) + (C ± c%) = D ± d%, then

$$d = \frac{\sqrt{(A \times a)^2 + (B \times b)^2 + (C \times c)^2}}{A + B + C}$$

Or if (A ± a%) - (B ± b%) - (C ± c%) = D ± d%, then

$$d = \frac{\sqrt{(A \times a)^2 + (B \times b)^2 + (C \times c)^2}}{A - B - C}$$

Example – Adding Uncertainty Intervals

Using Method 2, a red meat processing corporation has estimated the annual emissions from its “liquid train” wastewater treatment process to be 13,650 t CO_2-e ± 12.5%, and the annual emissions from its “solids handling train” process to be 12,845 t CO_2-e ± 7.6%.

Facility total annual emissions = 13,650 + 12,845 t CO_2-e **= 26,495 t CO_2-e**

Uncertainty at 95% confidence level

$$= \frac{\sqrt{(13{,}650 \times 12.5\%)^2 + (12{,}845 \times 7.6\%)^2}}{13{,}650 + 12{,}845} = 7.4\%$$

Result: Annual emissions are 26,495 t CO_2-e ± 7.4%

12. Appendix E – Audit checklist

Item	Description	Legislative/Guideline Reference	Meat Industry Guidline Reference	Requirement	Y	N	N/A	Actions
1	Have you obtained the latest NGER Measurement Determination and Technical Guidelines?	The latest version of the NGER Measurement Determination is available on the Clean Energy Regulator's website: http://www.cleanenergyregulator.gov.au/National-Greenhouse-and-Energy-Reporting/Legislation-and-regulations/Development-and-Review/Pages/default.aspx	Section 4, Table 4-1 of the NGER Red Meat Processing Industry Guidelines	Obtain the latest version of the NGER Measurement Determination. This document provides methods and criteria for calculating greenhouse and energy data and will indicate if any calculation methodology changes, changes to emission factors etc need to be made. This should be done prior to the commencement of the preparation of the current year's report.				
2	**FUEL USE** **For each type of fuel used (solid/liquid/gas), there are four different measurement criteria. The requirements and audit evidence for each are described below. Records of fuel use for transportation purposes (e.g. in road-registered vehicles) should be kept separately to fuel use for stationary purposes (e.g. in boilers and other machinery). NOTE: This checklist assumes that Method 1 is being used for reporting fuel use. It does not cover higher order methods.**							
2.1	SOLID FUELS Does your facility use any solid fuels (for example, coal?). If yes, then select the **one** measurement criteria that is most applicable for each solid fuel (2.1.1, 2.1.2, 2.1.3 or 2.1.4 below). If no, move on to point 2.2.							
2.1.1	Method 1	Sections 2.4 & 2.14 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion A Do you have invoices issued by the fuel vendor containing the quantity of fuel delivered to site for the entire year?				
2.1.2		Sections 2.4 & 2.15 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion AA Do you have invoices issued by the fuel vendor containing the quantity of fuel delivered to site for the entire year? Was the volume of solid fuel in the stockpile measured using aerial or general survey in accordance with industry practice? Was the bulk density of the stockpile measured in accordance with ASTM D/6347/D 6347M-99 or the procedure outlined in Section 2.15 of the NGER Measurement Determination?				
2.1.3		Sections 2.4 & 2.16 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion AAA Was the quantity of solid fuel measured at the point of combustion using measuring equipment (e.g. a weightometer)? Has the measuring equipment been calibrated in accordance with the manufacturer's recommendations? Do you have a copy of the calibration certificate for the reporting year?				
2.1.4		Sections 2.4 & 2.17 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion BBB Is the quantity of solid fuel estimated based on standard industry practice? Do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)?				
2.2	GASEOUS FUELS Does your facility use any gaseous fuels (for example, natural gas, biogas captured from anaerobic treatment lagoons or acetylene in workshops?). If yes, then select the **one** measurement criteria that is most applicable for each gaseous fuel (2.2.1, 2.2.2, 2.2.3 or 2.2.4 below). If no, move on to point 2.3.							
2.2.1	Method 1	Sections 2.20 & 2.29 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion A Do you have invoices issued by the fuel vendor containing the quantity of fuel delivered to site (in m^3 or GJ) for the entire year?				
2.2.2		Sections 2.20 & 2.30 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion AA Do you have invoices issued by the fuel vendor containing the quantity of fuel delivered to site for the entire year? Was the change in gaseous fuel stock estimated during the year? Do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)?				
				For criterion AAA Was the quantity of gaseous fuel measured at the point of combustion using measuring equipment?				

2.2.3		Sections 2.20 & 2.31 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	Was the volume measurement calculated using a flow computer that measures and analyses the flow signals, relative density and gas composition at the delivery location? Was the volumetric flow rate continuously recorded and continuously integrated using an integration device? Is the integration device isolated from the flow computer so that if the flow computer fails the last reading that was on the computer and the previously stored information immediately prior to the failure is retained by the integration device? Did the measurement equipment comply with the transmitter and accuracy requirements in section 2.31 (4) of the NGER Measurement Determination? Were all measurements calculated at standard conditions (air pressure 101.325 kPa, air temperature 15.0 ^{o}C, air density 1.225 kg/m^3) and expressed in cubic metres? Were all measurements, calculations and procedures in accordance with the procedures listed in sections 2.34, 2.35. 2.36 and 2.37 of the NGER Measurement Determination?				
2.2.4		Sections 2.20 & 2.38 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion BBB Is the quantity of gaseous fuel estimated based on standard industry practice? Do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)?				
2.3	LIQUID FUELS (other than petroleum based oils and greases) Does your facility use any liquid fuels (for example, diesel fuel or petrol (referred to as gasoline in NGER)?). If yes, then select the **one** measurement criteria that is most applicable for each liquid fuel (2.3.1, 2.3.2, 2.3.3, 2.3.4 below). If no, move on to point 3.							
2.3.1	Method 1	Sections 2.41 & 2.50 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion A Do you have invoices issued by the fuel vendor containing the quantity of fuel delivered to site for the entire year?				
2.3.2		Sections 2.41 & 2.51 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion AA Do you have invoices issued by the fuel vendor containing the quantity of fuel delivered to site for the entire year? Was the change in the liquid fuel stock estimated during the year (e.g. through tank dips)? Do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)?				
2.3.3		Sections 2.41 & 2.52 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion AAA Was the quantity of liquid fuel measured at the point of combustion using measuring equipment? Has the measuring equipment been calibrated in accordance with the manufacturer's recommendations? Do you have a copy of the calibration certificate for the reporting year? Was the measurement carried out at ambient temperature and converted to standard temperature? If the measurement was carried out at the point of sale, was the change in the stockpile less than 1% of the total combustion for the facility and the stockpile of the fuel at the beginning of the year less than 5% of total combustion from the facility for the year?				
2.3.4		Sections 2.41 & 2.53 of NGER Measurement Determination	Appendix B, Section 9.1 of the NGER Red Meat Processing Industry Guidelines	For criterion BBB Is the estimation of liquid fuel in accordance with accepted industry practice? Do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)?				
3	**PETROLEUM BASED OILS AND GREASES** For the use of petroleum based oils and greases, there are four different measurement criteria. The requirements and audit evidence for each are described below. NOTE: This checklist assumes that Method 1 is being used for reporting of petroleum based oils and greases. It does not cover higher order methods. Also note that petroleum based oils and petroleum based greases are required to be entered separately for NGER reporting. Does your facility use any petroleum based oils and greases (for example, lubricating oils in machinery or vehicles?). If yes, then select the **one** measurement criteria that is most applicable (3.1, 3.2, 3.3, 3.4 below). If no, move on to point 4.							
3.1	Method 1	Sections 2.40A, 2.48A and 2.50 of NGER Measurement Determination	None (no specific issues identified for the red meat industry)	For criterion A Do you have invoices issued by the vendor containing the quantity of petroleum based oils and greases delivered to site for the entire year? Do you have receipts for the quantity of petroleum based oils and greases transferred offsite (eg: for recycling) for the entire year?				
3.2		Sections 2.40A, 2.48A and 2.51 of NGER Measurement Determination	None (no specific issues identified for the red meat industry)	For criterion AA Do you have invoices issued by the vendor containing the quantity of petroleum based oils and greases delivered to site for the entire year? Do you have receipts for the quantity of petroleum based oils and greases transferred offsite for the entire year? Was the change in petroleum based oils and greases stock and waste oil to be transferred offsite estimated during the year?				

				Do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)?				
3.3		Sections 2.40A, 2.48A and 2.52 of NGER Measurement Determination	None (no specific issues identified for the red meat industry)	For criterion AAA Was the quantity of petroleum based oils and greases measured at the point of combustion using measuring equipment? Has the measuring equipment been calibrated in accordance with the manufacturer's recommendations? Do you have a copy of the calibration certificate for the reporting year? Was the measurement carried out at ambient temperature and converted to standard temperature? If the measurement was carried out at the point of sale, was the change in the stockpile less than 1% of the total combustion for the facility and the stockpile of the fuel at the beginning of the year less than 5% of total combustion from the facility for the year?				
3.4		Sections 2.40A, 2.48A and 2.53 of NGER Measurement Determination	None (no specific issues identified for the red meat industry)	For criterion BBB Is the estimation of petroleum based oils and greases in accordance with accepted industry practice? Do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)?				
4	**EMISSIONS FOR HYDROFLUOROCARBONS (HFC) AND SULPHUR HEXAFLUORIDE (SF_6)** Does your facility use over 100 kg hydrofluorocarbon refrigerant gases (typically found in industrial refrigeration systems)? Does your facility use any sulphur hexafluoride (typically found in insulated switchgear and circuit breakers)? If yes, the requirements and audit evidence required are described below. If no, move on to point 5. NOTE: This checklist assumes that Method 1 is being used for reporting of HFCs and SF_6. It does not cover higher order methods							
4.1	Method 1	Section 4.102 of NGER Measurement Determination	Appendix B, Section 9.3 of the NGER Red Meat Processing Industry Guidelines	Do you have the stated capacity of hydrofluorocarbons or sulphur hexafluoride according to the manufacturer's nameplate for all equipment at the facility at any time during the year? OR Do you have records of the opening stock of HFCs or SF_6? and Do you have invoices for purchases of new equipment and replenishments of HFCs or SF_6? and Do you have receipts for the disposal of equipment or HFCs or SF_6?				
5	**WASTEWATER HANDLING** **This checklist assumes Method 1 or Method 2 is being used for reporting emissions from wastewater handling. It does not cover higher order methods.** Does your facility treat wastewater (e.g. using any managed or unmanaged aerobic or anaerobic process such as treatment plants and lagoons)? If yes requirements and audit evidence are described below. If No, move on to point 6.							
5.1	Wastewater handling – Method 1	Section 5.42 of NGER Measurement Determination	Sections 4.4-4.8, 6, Appendix C of the NGER Red Meat Processing Industry Guidelines	Do you have production records showing tonnes of hot standard carcass weight (or live weight) for the year? *Treated effluent* Do you have records of effluent volumes? Do you have monthly laboratory analysis of the effluent COD concentration? Are these results representative? *Sludge handling* Do you have the fraction of COD removed from wastewater as sludge? If yes, do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)? Do you have the sludge mass or volume removed or transferred to landfill or another site? Do you have monthly laboratory analysis of the sludge COD concentration? Are these results representative? *Biogas* If you captured sludge biogas for combustion, have you met all the requirements outlined in Point 2.2 of this checklist? If you flared sludge biogas, have you met all the requirements outlined in Point 2.2 of this checklist? If you transferred sludge biogas out of the plant (eg: to an offsite flare or electricity generation facility), have you met all the requirements outlined in Point 2.2 of this checklist? If you captured, flared or transferred sludge biogas, do you have monthly laboratory analysis of the methane concentration in the biogas?				
	Wastewater	[illegible]		*Influent* Do you have volumes of wastewater generated in the plant and sent to the treatment system? Do you have monthly laboratory analysis of the COD (or BOD) concentration of influent wastewater (ie: prior to entering the treatment system)? If Yes, are the laboratory results representative? *Treated effluent* Do you have records of effluent volumes?				

5.2	handling – Method 2	Section 5.43 of NGER Measurement Determination	Sections 4.4-4.8, 6, Appendix C of the NGER Red Meat Processing Industry Guidelines	Do you have monthly laboratory analysis of the effluent COD concentration? Are these results representative? *Sludge handling* Do you have the fraction of COD removed from wastewater as sludge? If yes, do you have evidence to support the estimate (e.g. estimation protocols, calculations, process data)? Do you have the sludge mass or volume removed or transferred to landfill or another site? Do you have monthly laboratory analysis of the sludge COD concentration? Are these results representative? *Biogas* If you captured sludge biogas for combustion, have you met all the requirements outlined in Point 2.2 of this checklist? If you flared sludge biogas, have you met all the requirements outlined in Point 2.2 of this checklist? If you transferred sludge biogas out of the plant, have you met all the requirements outlined in Point 2.2 of this checklist? If you captured, flared or transferred sludge biogas, do you have monthly laboratory analysis of the methane concentration in the biogas?				
5.3	Flaring of methane in sludge biogas – Method 1	Section 5.48 of NGER Measurement Determination	Appendix B, Section 9.1.2 of the NGER Red Meat Processing Industry Guidelines	Have you met all the requirements outlined in Point 2.2 of this checklist				
6	**ELECTRICITY CONSUMPTION (SCOPE 2 EMISSIONS FROM PURCHASED ELECTRICITY)** The requirements and audit evidence required for electricity consumption from the grid at your facility are described below:							
6.1	Electricity consumption	Section 7.3 of NGER Measurement Determination	Appendix B, Section 9.6 of the NGER Red Meat Processing Industry Guidelines	Do you have invoices for electricity purchased during the year showing the quantity of electricity consumed (typically in kWh)? Is the invoicing period exactly from 1 July to 30 June? If no to the above: - have you made adjustments to calculate the electricity used during the financial year? - have you recorded how you have made these adjustments?				
7	ENERGY PRODUCTION Does your facility capture sludge biogas? Does your facility produce steam that is transferred from your facility to another end user? Does your facility generate electricity at your site in a generating unit that has the capacity to produce 0.5 MW of more of electricity and generates more than 100,000 kWh of electricity in the year? Does your facility have a cogeneration system that has the capacity to produce 30 MW of electricity and produced more than 30 GWh in the year? If yes, the requirements and audit evidence required are described below. If no, move on to point 8.							
7.1	Captured biogas	Section 6.2 of NGER Measurement Determination	Appendix B, Section 9.5 of the NGER Red Meat Processing Industry Guidelines	Do you record the quantity of captured sludge biogas, measured in accordance with all the requirements outlined in Point 2.2 of this checklist?				
7.2	Transferring steam from your facility	Section 6.2 of NGER Measurement Determination	Appendix B, Section 9.5 of the NGER Red Meat Processing Industry Guidelines	Do you have invoices, contractual arrangements or metering records for the quantity of steam (in GJ) transferred from your facility?				
7.3	Electricity generating units	Section 6.2 of NGER Measurement Determination	Appendix B, Section 9.5 of the NGER Red Meat Processing Industry Guidelines	Do you have invoices, contractual arrangements or metering records for the quantity of electricity generated at your facility? If electricity is exported to the grid or another facility, do you have invoices, contractual arrangements or metering records for the quantity of electricity generated at your facility?				
8	ENERGY CONSUMPTION Does your facility have a cogeneration system that has the capacity to produce 30 MW of electricity and produced more than 30 GWh in the year? If yes, the requirements and audit evidence required are described below. All other energy consumption audit requirements are included in other sections of this checklist							
8.1	Cogeneration system	Sections 2.70 and 6.5 of NGER Measurement Determination	Appendix B, Section 9.5 of the NGER Red Meat Processing Industry Guidelines	Have you allocated the amount of energy consumed in the cogeneration system in accordance with the requirements of Section 2.70 of the NGER Measurement Determination?				
9	**SUMMARY** Items for consideration once emissions and energy have been estimated (but prior to reporting):							
9.1	Reporting	Part 4, Division 4.2 of the NGER	Section 2.1 of the NGER Red Meat	Does your corporation exceed the corporate group emissions reporting threshold? (NB: registered corporations are still required to submit a report even if no threholds are exceeded) Does your corporation exceed the corporate group energy reporting threshold? (NB: registered corporations are still required to submit a report even if no threholds are exceeded)				

9.1	thresholds	Regulations	Processing Industry Guidelines	Does your corporation include facilities which exceed the facility emissions reporting threshold? (NB: registered corporations are still required to submit a report even if no threholds are exceeded) Does your corporation include facilities which exceed the facility energy reporting threshold? (NB: registered corporations are still required to submit a report even if no threholds are exceeded)				
9.2	Deregistration	Part 3, Division 3.4 of the NGER Regulations	Section 2.5 of the NGER Red Meat Processing Industry Guidelines	Does your corporation, or is it likely to, exceed any of the reporting thresholds for this reporting year and the next two reporting years? Is your corporation, or is it likely to be, a liable entity for this year and the two years following this year? Are all other conditions for deregistration satisfied (refer to division 3.4 of the NGER Regulations)?				

GHD

180 Lonsdale Street
Melbourne, Victoria 3000
T: (03) 8687 8000 F: (03) 8687 8111 E: melmail@ghd.com.au

G:\21\21695\WP\Milestone 5 - v1\Progress Draft (v0.4).docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0.2	C Pepperell	S Trahair	Sue Trahair	S Trahair	Sue Trahair	26/3/13
0.3	F Walmsley	S Trahair	Sue Trahair	S Trahair	Sue Trahair	3/4/13
0.4	C Pepperell	S Trahair	Sue Trahair	S Trahair	Sue Trahair	5/11/13

www.ghd.com