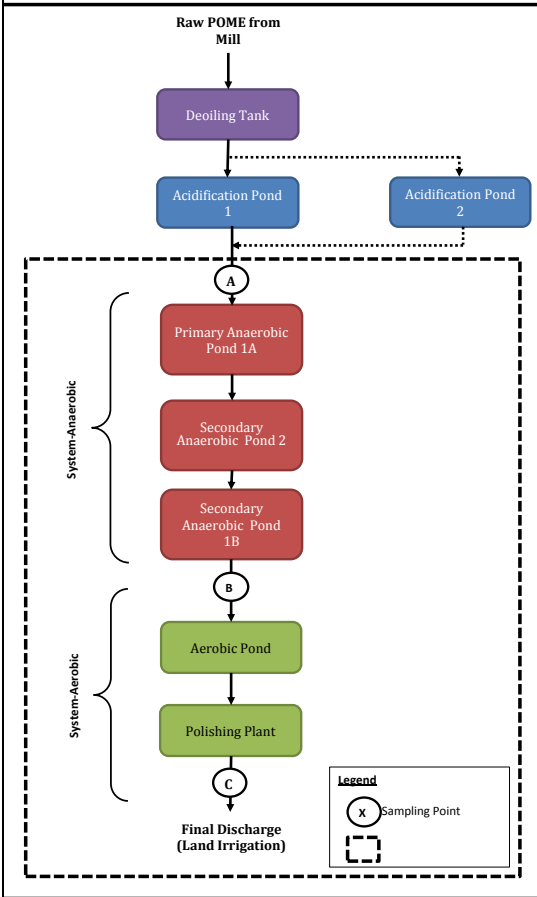
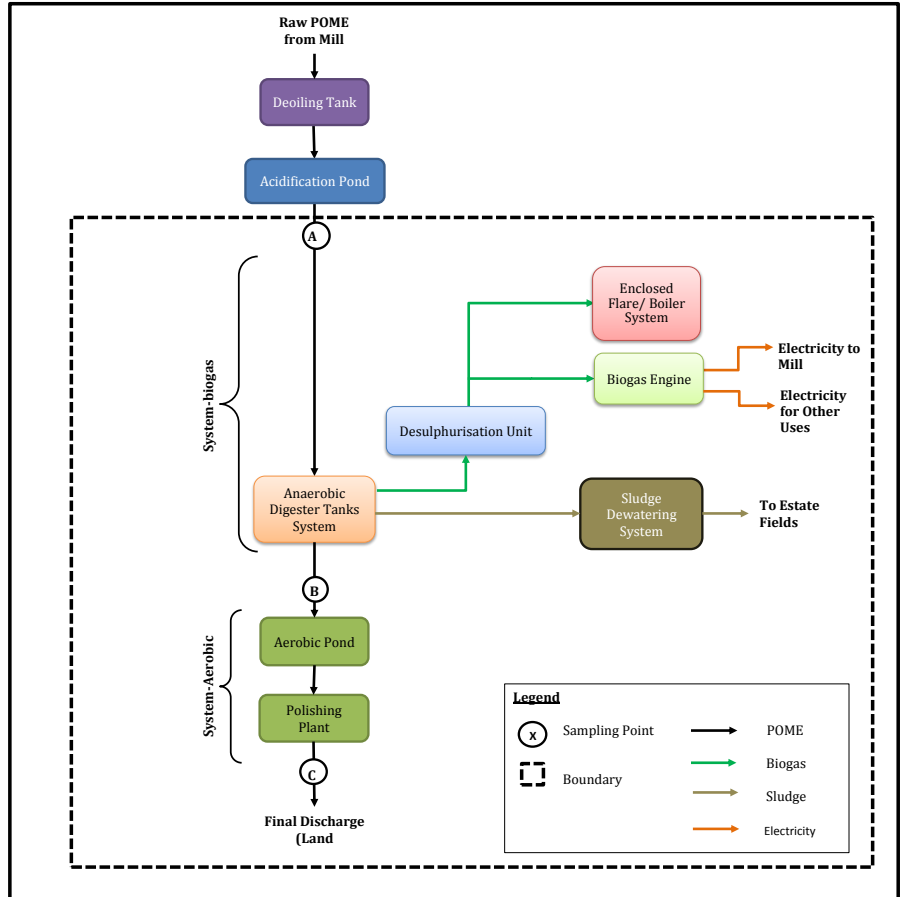


## Carotino Palm Oil Mill

**Baseline Diagram**



**Project Diagram**



**Baseline Wastewater Treatment System Measurement Campaign**

A measurement campaign was undertaken in order to determine the COD values required in order to calculate the ex-ante estimate of baseline emissions. The measurement campaigns was undertaken in the baseline wastewater system, for 10 consecutive days. The measurements were taken during a period of normal operation, which is representative of the typical operating conditions and ambient temperature of the site.

**10-days COD Measurement Campaign - Analysis Results**

DATE	COD Sampling			Reduction (%) [(Point A-Point B)/Point A]	Reduction (%) [(Point B - Point C)/Point B]
	COD after Acidification Pond (mg/l)	COD after Anaerobic Pond (mg/l)	COD at Final Discharge (mg/l)		
	Point A	Point B	Point C		
13/8/2011	55,720	314	143	99.44%	54.46%
14/8/2011	72,834	537	163	99.26%	69.65%
15/8/2011	51,342	597	143	98.84%	76.05%
16/8/2011	76,814	605	209	99.21%	65.45%
17/8/2011	70,871	480	202	99.32%	57.92%
18/8/2011	66,867	388	176	99.42%	54.64%
19/8/2011	48,448	268	164	99.45%	38.81%
20/8/2011	65,403	482	197	99.26%	59.13%
21/8/2011	79,561	487	207	99.39%	57.49%
22/8/2011	69,391	427	179	99.38%	58.08%
<b>Average</b>	<b>65,725</b>	<b>459</b>	<b>178</b>	<b>99.30%</b>	<b>61.11%</b>
Uncertainty Factor	0.89	0.89	0.89		
<b>COD Removal Efficiency</b>	<b>58,495</b>	<b>408</b>	<b>159</b>	<b>99.30%</b>	<b>61.11%</b>

Annual FFB Projection			
Project Year	Value	Unit	Source
2013	216,000	MT/year	1) Based on mill expansion : 45 ton/hr * 300 days/y * 16 hrs/day 2) Mill will be ready for operation with expanded capacity in January 2013 3) Projected FFB supply source is available.
2014	216,000	MT/year	
2015	216,000	MT/year	
2016	216,000	MT/year	
2017	216,000	MT/year	
2018	216,000	MT/year	
2019	216,000	MT/year	
2020	216,000	MT/year	
2021	216,000	MT/year	
2022	216,000	MT/year	
Average		216,000	MT/year

Inputs for baseline and project wastewater treatment systems				
Inputs for Baseline Wastewater Treatment Systems				
ID	Value	Unit	Description	Source
Operating Hours	4,800	hours/year	Operating Hours per year	Mill Processing Capacity from year 2013 onwards (300 days/y * 16 hrs/day)
FFB Processing per year	216,000	t/yr	Average FFB processing per year	Mill Processing Capacity from year 2013 onwards (45 t/hr * 300 days/y * 16 hrs/day)
Wastewater generation rate	65%		Amount of wastewater produced per tonne of FFB	NA Ludin et. Al, 'Palm Oil Biomass for Electricity Generation in Malaysia', Page 6
$Q_{ww,y}$	140,400	m <sup>3</sup> /year	Volume of wastewater treated in baseline wastewater treatment system in year y. The volume is equivalent for wastewater treated in baseline anaerobic wastewater treatment system, baseline aerobic wastewater treatment system and volume of treated wastewater discharged.	Calculation, FFB * 0.65
$B_{o,ww}$	0.25	kg CH <sub>4</sub> / kg COD	Methane producing capacity of the wastewater	IPCC value of 0.25 kg CH <sub>4</sub> / kg COD. Default value provided in AMS-III.H Ver 16
$UF_{BL}$	0.89	-	Model correction factor to account for model uncertainties	Default value provided in AMS-III.H Ver 16
$GWP_{CH_4}$	21	-	Global Warming Potential of methane	Default value provided in AMS-III.H Ver 16
$COD_{inflow,y}$	0.05850	tonnes/m <sup>3</sup>	Chemical oxygen demand of the wastewater entering the baseline anaerobic treatment system (System-Anaerobic) in year y	Measurement Campaign, Sample Point A. See "Measurement Campaign" tab.
$COD_{outflow,y}$	0.00041	tonnes/m <sup>3</sup>	Chemical Oxygen Demand of the wastewater exiting the baseline anaerobic treatment system (System-Anaerobic) in year y. This is equivalent to the COD entering the baseline aerobic treatment in year y	Measurement Campaign, Sample Point B. See "Measurement Campaign" tab.
$\eta_{COD,BL}$	99%	-	COD removal efficiency of the baseline anaerobic treatment system (System-Anaerobic), determined as per the paragraphs 26, 27 or 28 in AMS III.H	Calculation
$COD_{ww,discharge,BL,y}$	0.00016	tonnes/m <sup>3</sup>	COD of the treated wastewater sent for plantation irrigation purpose	Measurement Campaign, Sample Point C. See "Measurement Campaign" tab.
$MCF_{ww,treatment,BL}$	0.8	-	Methane correction factor of anaerobic baseline wastewater treatment	AMS-III.H Version 16. Table III.H.1. IPCC default values for methane correction factor for anaerobic deep lagoon (depth more than 2 m).
$MCF_{ww,BL,discharge}$	0	-	Methane correction factor of baseline wastewater treatment system sent for plantation irrigation purpose	AMS-III.H Version 16. Table III.H.1. IPCC default values for methane correction factor for aerobic treatment, well managed

Inputs for Project Activity Wastewater Treatment Systems				
ID	Value	Unit	Description	Source
$Q_{ww,y}$	140,400	m <sup>3</sup> /year	Volume of wastewater treated in project wastewater treatment system (System-biogas). This is equivalent to the volume of wastewater treated in project aerobic wastewater treatment system (System-Aerobic), and volume of treated wastewater discharged in year y.	Calculation
$COD_{inflow,y}$	0.05850	tonnes/m <sup>3</sup>	Chemical Oxygen Demand of the wastewater entering the the inlet of the project wastewater treatment system (System-biogas) which is equipped with biogas recovery digester.	COD entering the digester is estimated for the purpose of ex-ante emission reductions to be the same as in the baseline situation, as per the Measurement Campaign Sample Point A. Parameter to be monitored.
$\eta_{PJ}$	80%		Chemical Oxygen Demand removal efficiency of the project wastewater treatment system (System-biogas) which is equipped with biogas recovery digester.	Technologist design guarantee based on 80% COD removal efficiency of the digester.
$COD_{ww,treated,PJ,y}$	0.01170	tonnes/m <sup>3</sup>	Chemical Oxygen Demand of the wastewater exiting the project wastewater treatment system (System-biogas) which is equipped with biogas recovery digester in year y.	Ex-ante estimate based on the removal efficiency of the digester. Parameter to be monitored.
$COD_{removed,PJ}$	0.04680	tonnes/m <sup>3</sup>	The chemical oxygen demand removed by the project wastewater treatment system (System-biogas) which is equipped with biogas recovery digester in year y.	Ex-ante estimate as per the Measurement Campaign Sample Point A; $COD_{inflow,y}$ less design value of digester removal efficiency (80%). Parameter to be recalculated ex post in accordance with paragraph 20.
$\eta_{PJ,Aerobic}$	61%	-	Chemical oxygen demand removal efficiency of the project wastewater treatment system (System-Aerobic) which is not equipped with biogas recovery digester in year y (t/m <sup>3</sup> ). This is equivalent to COD removal efficiency of the baseline aerobic treatment system, determined as per the paragraphs 26, 27 or 28 in AMS III.H	Calculation.
$COD_{ww,discharge,PJ,y}$	0.00455	tonnes/m <sup>3</sup>	COD of the treated wastewater sent for plantation irrigation purpose	Measurement Campaign, Sample Point C. See "Measurement Campaign" tab.
$MCF_{ww,treatment,PJ}$	0.8	-	Methane correction factor for project wastewater treatment system (System-biogas) which is equipped with biogas recovery digester.	MCF values as per table AMS III.H.1. for equipped with biogas recovery system digester
$MCF_{ww,treatment,PJ,Aerobic}$	0.0	-	Methane correction factor for project wastewater treatment system (System-Aerobic) which is not equipped with biogas recovery digester.	AMS-III.H Version 16. Table III.H.1. IPCC default values for methane correction factor for aerobic treatment, well managed
$MCF_{ww,PJ,discharge}$	0.0	-	Methane correction factor of project wastewater treatment system sent for plantation irrigation purpose	Ex-ante estimate for project wastewater treatment system k as per AMS-III.H. Table III.H.1. IPCC default values for aerobic treatment, well managed.

$B_{o,ww}$	0.25	kg CH <sub>4</sub> / kg COD	Methane producing capacity of the wastewater	IPCC value of 0.25 kg CH <sub>4</sub> / kg COD. Default value provided in AMS-III.H Ver 16.
$UF_{PJ}$	1.12	-	Model correction factor to account for model uncertainties	Default value provided in AMS-III.H Ver 16.
$CFE_{ww}$	0.9	-	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems	Default value provided in AMS-III.H Ver 16.
$\eta_{flare,h}$	0.9	-	Flare efficiency in hour y	As per the "Tool to determine project emissions from flaring gases containing methane" for enclosed flare default values of flare efficiency may be used. 90% if temp in the exhaust gas is above 500°C for more than 40 mins during the hour and the manufacturers specifications on proper operation of the flare are met continuously during hour h. The exhaust temperature of the flare will be monitored.

Inputs for Project Activity Power Generation System				
Parameter	Value		Description	Source
Methane Net Heating Value	50	(MJ/kg)	Energy content of the methane available	11946 kcal/kg = 50,016 kJ/kg = 50 MJ/kg <a href="http://www.engineeringtoolbox.com/gross-net-heating-values-d_420.html">http://www.engineeringtoolbox.com/gross-net-heating-values-d_420.html</a>
Methane produced	1,325	tCH <sub>4</sub> /year	Mass flow rate of methane per year	Calculated from the estimated methane production of the wastewater in the digester
Methane combusted by gas engine	275.95	kgCH <sub>4</sub> /hr	Mass flow rate of methane to generator per hour	Calculated from the estimated methane production of the wastewater in the digester per day
Methane to flaring system	0.00	kgCH <sub>4</sub> /hr	Mass flow rate of methane to flaring system in hour h	The flare will be used to combust excess methane/emergency. Parameter to be monitored.
Methane Density	0.716	kg/m <sup>3</sup>	Density of Methane gas at Normal Condition	Methodological "Tool to determine project emissions from flaring gases containing methane" (EB 28, Annex 13)
Methane composition in Biogas	65%	%	Average Methane concentration in Biogas generated from POME	Baseline study of methane emission from anaerobic pondsof palm oil mill effluent treatment Shahrakbah Yacob et.al
Biogas combusted by gas engine, $BG_{fuelled,y}$	2,846,050	Nm <sup>3</sup> /yr	Estimated total biogas generated in the anaerobic digester and combusted in the gas engine and or boiler.	Measured at normal condition
Biogas flared at flaring system, $BG_{flared,y}$	0	Nm <sup>3</sup> /yr	Estimated total biogas combusted in flare system.	Measured at normal condition
Total biogas fuelled or flared	2,846,050	Nm <sup>3</sup> /yr	Estimated total biogas generated in the anaerobic digester	Calculated ( $BG_{fuelled,y} + BG_{flared,y}$ )

Baseline Emissions from Wastewater Treatment			
$BE_y = \{BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}\}$			
Parameter	Value	Description	Source
$BE_y$	30,485	Baseline emissions in year y (tCO <sub>2</sub> e)	From equation 1
$BE_{power,y}$	0	Baseline emissions from electricity or fuel consumption in year y (tCO <sub>2</sub> e)	Paragraph 19
$BE_{ww,treatment,y}$	30,485	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO <sub>2</sub> e)	From equation 2, Paragraph 20
$BE_{s,treatment,y}$	0	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO <sub>2</sub> e)	From equation 3, Paragraph 22
$BE_{ww,discharge,y}$	0	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (tCO <sub>2</sub> e).	From equation 6, Paragraph 24
$BE_{s,final,y}$	0	Baseline methane emissions from anaerobic decay of the final sludge produced in year y (tCO <sub>2</sub> e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.	From equation 7, Paragraph 25

$BE_{power,y} = EG_{BL,y} * EF_{CO2}$			
Parameter	Value	Description	Source
$BE_{power,y}$	0	Baseline emissions from electricity consumption in year y (tCO <sub>2</sub> e)	Power supply to the wastewater treatment system is from the mill.
Power supply to the wastewater treatment system is mainly from the biomass boiler using mesorcarp fibre and/or palm kernel shell; which is considered as carbon neutral. Thus, the baseline electricity consumption is considered as zero.			

$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} * COD_{inflow,i,y} * \eta_{COD,BL,i} * MCF_{ww,treatment,BL,i}) * B_{o,ww} * UF_{BL} * GWP_{CH4}$			
Parameter	Value	Description	Source
$BE_{ww,treatment,y}$	30,485	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO <sub>2</sub> e)	From equation 2, Paragraph 20
$Q_{ww,y}$	140,400	Volume of wastewater treated in baseline anaerobic wastewater treatment system in the year y	Calculation. To be monitored.
$COD_{inflow,y}$	0.05850	Chemical oxygen demand of the wastewater entering the baseline anaerobic treatment system (System-Anaerobic) in year y	Measurement Campaign, Sample Point A. See "Measurement Campaign" tab.
$\eta_{COD,BL}$	99%	COD removal efficiency of the baseline anaerobic treatment system (System-Anaerobic), determined as per the paragraphs 26, 27 or 28 in AMS III.H	Calculation. To be monitored.
$MCF_{ww,treatment,BL}$	0.8	Methane correction factor of anaerobic baseline wastewater treatment system	AMS-III.H Version 16. Table III.H.1. IPCC default values for methane correction factor for anaerobic deep lagoon (depth more than 2 m).
$B_{o,ww}$	0.25	Methane producing capacity of the wastewater	IPCC value of 0.25 kg CH <sub>4</sub> /kg COD. Default value provided in AMS-III.H. Ver 16.
$UF_{BL}$	0.89	Model correction factor to account for model uncertainties	Default value provided in AMS-III.H Ver 16
$GWP_{CH4}$	21	Global Warming Potential of methane	Default value provided in AMS-III.H Ver 16

$BE_{treatment,s,y} = \sum_j S_{j,BL,y} * MCF_{s,treatment,BL,j} * DOC_s * UF_{BL} * DOC_F * F * 16/12 * GWP_{CH4}$			
Parameter	Value	Description	Source
$BE_{treatment,s,y}$	0	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO <sub>2</sub> e)	From equation 3, Paragraph 22
The baseline scenario does not involve sludge treatment. Therefore, on this basis $BE_{treatment,s,y}$ is considered to be zero.			

$BE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{BL} * COD_{ww,discharge,BL,y} * MCF_{ww,BL,discharge}$			
Parameter	Value	Description	Source
$BE_{ww,discharge,y}$	0	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (tCO <sub>2</sub> e).	From equation 6, Paragraph 24

$Q_{ww,y}$	140,400	Volume of treated wastewater discharged in year y ( $m^3$ )	Estimated for the purpose of the ex-ante emission reductions calculation. Based on average FFB processing capacity, plant operating hours/days and waste water generation rates. Parameter to be monitored.
$COD_{ww,discharge,BL,y}$	0.00016	COD of the treated wastewater sent for plantation irrigation purpose	Measurement Campaign, Sample Point C. See "Measurement Campaign" tab.
$MCF_{ww,BL,discharge}$	0	Methane correction factor of baseline wastewater treatment system sent for plantation irrigation purpose	AMS-III.H Version 16. Table III.H.1. IPCC default values for methane correction factor for aerobic, well-managed
$B_{o,ww}$	0.25	Methane producing capacity of the wastewater	IPCC value of 0.25 kg $CH_4$ /kg COD. Default value provided in AMS-III.H. Ver 16.
$UF_{BL}$	0.89	Model correction factor to account for model uncertainties	Default value provided in AMS-III.H. Ver 16.
$GWP_{CH_4}$	21	Global Warming Potential of methane	Default value provided in AMS-III.H. Ver 16.

$BE_{s,final,y} = S_{final,BL,y} * DOC_s * UF_{BL} * MCF_{s,BL,final} * DOC_r * F * 16/12 * GWP_{CH_4}$			
Parameter	Value	Description	Source
$BE_{s,final,y}$	0	Baseline methane emissions from anaerobic decay of the final sludge produced in year y ( $tCO_2e$ ). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.	From equation 7, Paragraph 25
In the baseline scenario sludge is periodically removed from the anaerobic open lagoons and sent to the plantation for soil application as a fertiliser. All of the sludge produced in the baseline scenario is used for soil application under aerobic conditions. Therefore, on this basis $BE_{s,final,y}$ is considered to be zero.			

Project Emissions from Wastewater Treatment			
$PE_y = PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y}$			
Parameter	Value	Description	Source
$PE_y$	3,091	Project activity emissions in the year y (tCO <sub>2</sub> e)	Calculated
$PE_{power,y}$	0	Emissions from electricity or fuel consumption in the year y (tCO <sub>2</sub> e)	As per paragraph 19, for the situation of the project scenario, using energy consumption data of all equipments/devices used in the project activity wastewater and sludge treatment systems for biogas recovery and flaring/gainful use.
$PE_{ww,treatment,y}$	0	Methane Emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (tCO <sub>2</sub> e)	From equation 2 in Paragraph 20 using uncertainty factor 1.12 and data applicable to the project situation.
$PE_{s,treatment,y}$	0	Methane emissions from sludge treatment systems affected by the project activity and not equipped with biogas recovery in year y (tCO <sub>2</sub> e)	From equation 3 and 4 in Paragraph 22, using an uncertainty factor of 1.12 and data applicable to the project situation.
$PE_{ww,discharge,y}$	0	Methane emissions from degradable organic carbon in treated wastewater in year y (tCO <sub>2</sub> e)	From equation 6 in Paragraph 24, using an uncertainty factor of 1.12 and data applicable to the project conditions.
$PE_{s,final,y}$	0	Methane emissions from anaerobic decay of the final sludge produced in year y (tCO <sub>2</sub> e)	From equation 7 in Paragraph 25, using an uncertainty factor of 1.12 and data applicable to the project conditions.
$PE_{fugitive,y}$	3,091	Methane emissions from biogas release in capture systems in year y (tCO <sub>2</sub> e)	Calculated as per paragraph 30
$PE_{flaring,y}$	0	Methane emission due to incomplete flaring in year y (tCO <sub>2</sub> e)	As per the "Tool to determine project emissions from flaring gases containing methane"(Version 1, 15th December 2006). See calculation sheet 'PE <sub>flaring</sub> '
$PE_{biomass,y}$	0	Methane emission from biomass stored under anaerobic conditions	As per the "Tool to determine methane emission avoided from disposal of waste at a solid waste disposal site"

$PE_{power,y} = EG_{PJ,consumption,y} * EF_{CO2}$			
Parameter	Value	Description	Source
$PE_{power,y}$	0	Emissions from electricity or fuel consumption in the year y (tCO <sub>2</sub> e)	Electricity for all equipment used in the proposed project activity will be sourced from the biogas engines; thus carbon neutral.
Project activity emissions from electricity consumption are determined as per the procedures described AMS.III.H paragraph 19. In the project scenario, electricity use for all equipment used in the proposed project activity will be sourced from the biogas engine or mill. The emission factor for electricity sourced from renewable energy is zero and therefore, on this basis $PE_{power,y}$ is considered to be zero. In any event of any external electricity or fuel consumption, the project emission will be calculated based on "Tool to calculate project or leakage CO <sub>2</sub> emissions from fossil fuel combustion" (Version 2, 2nd August 2008).			

$PE_{ww,treatment,y} = \sum_k (Q_{ww,k,y} * COD_{inflow,k,y} * \eta_{PJ,k} * MCF_{ww,treatment,PJ,k} * B_{o,ww} * UF_{PJ} * GWP_{CH4})$			
Parameter	Value	Description	Source
$PE_{ww,treatment,y}$	0	Methane Emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (tCO <sub>2</sub> e)	From equation 2 in Paragraph 20 using uncertainty factor 1.12 and data applicable to the project situation.
$Q_{ww,y}$	140,400	Volume of wastewater treated in project wastewater treatment system (System-Aerobic).	Calculation. To be monitored.
$COD_{ww,treated,PJ,y}$	0.01170	Chemical Oxygen Demand of the wastewater exiting the project wastewater treatment system (System-biogas) which is equipped with biogas recovery digester in year y.	Ex-ante estimate based on the removal efficiency of the digester. Parameter to be monitored.
$\eta_{PJ,Aerobic}$	61%	Chemical oxygen demand removal efficiency of the project wastewater treatment system (System-Aerobic) which is not equipped with biogas recovery digester in year y (t/m <sup>3</sup> ). This is equivalent to COD removal efficiency of the baseline aerobic treatment system, determined as per the paragraphs 26, 27 or 28 in AMS III.H	Calculation. To be monitored.
$MCF_{ww,treatment,PJ,Aerobic}$	0	Methane correction factor for project wastewater treatment system (System-Aerobic) which is not equipped with biogas recovery digester.	AMS-III.H Version 16. Table III.H.1. IPCC default values for methane correction factor for aerobic treatment, well managed
$B_{o,ww}$	0.25	Methane producing capacity of the wastewater	IPCC value of 0.25 kg CH <sub>4</sub> /kg COD. Default value provided in AMS-III.H. Ver 16.

UF <sub>PJ</sub>	1.12	Model correction factor to account for model uncertainties	Default value provided in AMS-III.H. Ver 16.
GWP <sub>CH4</sub>	21	Global Warming Potential of methane	Default value provided in AMS-III.H. Ver 16 .

PE <sub>s,treatment,y</sub>			
Parameter	Value	Description	Source
PE <sub>s,treatment,y</sub>	0	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO <sub>2</sub> e)	From equation 3 and 4 in Paragraph 22, using an uncertainty factor of 1.12 and data applicable to the project situation.

In the proposed project activity there is no sludge treatment system. Therefore on this basis PE<sub>s,treatment,y</sub> is considered to be zero.

PE <sub>ww,discharge,y</sub> = Q <sub>ww,y</sub> * GWP <sub>CH4</sub> * B <sub>o,ww</sub> * COD <sub>ww,discharge,PJ,y</sub> * MCF <sub>ww,PJ,discharge</sub> * UF <sub>PJ</sub>			
Parameter	Value	Description	Source
PE <sub>ww,discharge,y</sub>	0	Methane emissions from degradable organic carbon in treated wastewater in year y (tCO <sub>2</sub> e).	From equation 6 in Paragraph 24, using an uncertainty factor of 1.12 and data applicable to the project conditions.
Q <sub>ww,y</sub>	140,400	Volume of treated wastewater discharged in year y (m <sup>3</sup> )	Estimated for the purpose of the ex-ante emission reductions calculation. Based on projected FFB processing capacity, plant operating hours/days and waste water generation rates. Parameter to be monitored.
COD <sub>ww,discharge,PJ,y</sub>	0.00455	COD of the treated wastewater sent for plantation irrigation purpose	Measurement Campaign, Sample Point C. See "Measurement Campaign" tab.
MCF <sub>ww,PJ,discharge</sub>	0	Methane correction factor of baseline wastewater treatment system sent to irrigation to plantation	AMS-III.H Version 16. Table III.H.1. IPCC default values for methane correction factor for aerobic, well-managed
B <sub>o,ww</sub>	0.25	Methane producing capacity of the wastewater	IPCC value of 0.25 kg CH <sub>4</sub> /kg COD. Default value provided in AMS-III.H. Ver 16.
UF <sub>PJ</sub>	1.12	Model correction factor to account for model uncertainties	Default value provided in AMS-III.H. Ver 16.
GWP <sub>CH4</sub>	21	Global Warming Potential of methane	Default value provided in AMS-III.H. Ver 16.

PE <sub>s,final,y</sub> = S <sub>final,PJ,y</sub> * DOC <sub>s</sub> * UF <sub>PJ</sub> * MCF <sub>s,PJ,final</sub> * DOC <sub>F</sub> * F * 16/12 * GWP <sub>CH4</sub>			
Parameter	Value	Description	Source
PE <sub>s,final,y</sub>	0	Methane emissions from the anaerobic decay of the final sludge generated in wastewater system in year y (tCO <sub>2</sub> e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.	From equation 7 in Paragraph 25, using an uncertainty factor of 1.12 and data applicable to the project conditions.

In the proposed project activity, all of the sludge produced is used for soil application under aerobic conditions. Therefore on this basis PE<sub>s,final,y</sub> is considered to be zero.

PE <sub>fugitive,y</sub> = PE <sub>fugitive,ww,y</sub> + PE <sub>fugitive,s,y</sub>			
Parameter	Value	Description	Source
PE <sub>fugitive,y</sub>	3,091	Methane emissions from biogas release in capture system in year y (tCO <sub>2</sub> e)	Calculated as per paragraph 30
PE <sub>fugitive,ww,y</sub>	3,091	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment system year y (tCO <sub>2</sub> e)	Calculated as per paragraph 30
PE <sub>fugitive,s,y</sub>	0	Fugitive emissions through capture inefficiencies in the sludge treatment in year y (tCO <sub>2</sub> e)	Calculated as per paragraph 30

PE <sub>fugitive,ww,y</sub> = (1 - CFE <sub>ww</sub> ) * MEP <sub>ww,treatment,y</sub> * GWP <sub>CH4</sub>			
Parameter	Value	Description	Source
PE <sub>fugitive,ww,y</sub>	3,091	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment system year y (tCO <sub>2</sub> e)	Calculated as per paragraph 30
CFE <sub>ww</sub>	0.9	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems	Default value of 0.9 provided in AMS-III.H. Ver 16.
MEP <sub>ww,treatment,y</sub>	1,472	Methane emission potential of the wastewater treatment system equipped with biogas recovery system in year y (tCH <sub>4</sub> )	From equation 11, paragraph 30
GWP <sub>CH4</sub>	21	Global Warming Potential of methane	Default value provided in AMS-III.H. Ver 16

MEP <sub>ww,treatment,y</sub> = Q <sub>ww,y</sub> * B <sub>o,ww</sub> * UF <sub>PJ</sub> * Σ <sub>k</sub> COD <sub>removed,PJ,k</sub> * MCF <sub>ww,treatment,PJ,k</sub>			
Parameter	Value	Description	Source
MEP <sub>ww,treatment,y</sub>	1,472	Methane emission potential of the wastewater treatment system equipped with biogas recovery system in year y (tCH <sub>4</sub> )	From equation 11, paragraph 30
Q <sub>ww,y</sub>	140,400	Volume of treated wastewater discharged in year y (m <sup>3</sup> )	Calculation. To be monitored.
B <sub>o,ww</sub>	0.25	Methane producing capacity of the wastewater	IPCC value of 0.25 kg CH <sub>4</sub> / kg COD. Default value provided in AMS-III.H. Ver 16.
UF <sub>PJ</sub>	1.12	Model correction factor to account for model uncertainties	Default value provided in AMS-III.H. Ver 16.



COD <sub>removed,PJ</sub>	0.04680	The chemical oxygen demand removed by the project wastewater treatment system (System-biogas) which is equipped with biogas recovery digester in year y.	Ex-ante estimate as per the Measurement Campaign Sample Point A; COD inflow <sub>y</sub> less design value of digester removal efficiency (80%). Parameter to be recalculated ex-post in accordance with paragraph 20.
MCF <sub>ww,treatment,PJ</sub>	0.8	Methane correction factor for project wastewater treatment system (System-biogas) which is equipped with biogas recovery digester.	Ex-ante estimate for project wastewater treatment system as per AMS-III.H. Table III.H.1. IPCC default values for anaerobic reactor without methane recovery.

<b>PE<sub>fugitive,s,y</sub> = (1-CFE<sub>s</sub>) * MEP<sub>s,treatment,y</sub> * GWP<sub>CH4</sub></b>			
Parameter	Value	Description	Source
PE <sub>fugitive,s,y</sub>	0	Fugitive emissions through capture inefficiencies in the sludge treatment in year y (tCO <sub>2</sub> e)	From equation 12, paragraph 30
In the proposed project activity there is no sludge treatment system. Therefore on this basis PE <sub>fugitive,s,y</sub> is considered to be zero.			

**"Tool to determine methane emission avoided from disposal of waste at a solid waste disposal site"**

<b>PE<sub>biomass,y</sub></b>			
Parameter	Value	Description	Source
PE <sub>biomass,y</sub>	0	Methane emission from biomass stored under anaerobic conditions	No biomass is stored under anaerobic condition
Storage of biomass under anaerobic conditions will not take place due to the proposed project activity. Therefore, on this basis PE <sub>biomass,y</sub> is considered to be zero.			

<b>PE<sub>flaring,y</sub></b>			
Parameter	Value	Description	Source
PE <sub>flaring,y</sub>	0	Methane emission due to incomplete flaring in year y (tCO <sub>2</sub> e) - Equal to PE <sub>flare</sub>	Calculated as per the "Tool to determine project emissions from flaring gases containing methane".
The mass flow rate of the residual gas will be directly monitored using a mass flow meter that includes temperature and pressure compensation to accurately account for the			

<b>PE<sub>flare</sub> = <math>\sum_{h=1}^h FM_{RG,h} * (1-\eta_{flare,h}) * (GWP_{CH4}/1000)</math></b>			
Parameter	Value	Description	Source
PE <sub>flare</sub>	0	Project emission from flaring of methane in year y	Calculated
h	4,800.00	Hours of operation per year (h/y)	Future Mill Capacity
TM <sub>RG,h</sub>	0.00	Mass flow rate of methane in hour h (kg/h)	The flare will be used to combust excess methane.
$\eta_{flare,h}$	0.9	Flare efficiency in hour y	As per the "Tool to determine project emissions from flaring gases containing methane" for enclosed flare default values of flare efficiency may be used. 90% if temp in the exhaust gas is above 500°C for more than 40 mins during the hour and the manufacturers specifications on proper operation of the flare are met continuously during hour h. The exhaust temperature of the flare will be monitored.
GWP <sub>CH4</sub>	21	Global Warming Potential of methane	Default value provided in AMS-III.H. Ver 16.

Emission Reduction				
Year	AMS III.H			
	BE <sub>y,ex ante</sub>	PE <sub>y,ex ante</sub>	LE <sub>y,ex ante</sub>	ER <sub>y,ex ante</sub>
01/01/2013 – 31/12/2013	30,485	3,091	0	27,394
01/01/2014 – 31/12/2014	30,485	3,091	0	27,394
01/01/2015 – 31/12/2015	30,485	3,091	0	27,394
01/01/2016 – 31/12/2016	30,485	3,091	0	27,394
01/01/2017 – 31/12/2017	30,485	3,091	0	27,394
01/01/2018 – 31/12/2018	30,485	3,091	0	27,394
01/01/2019 – 31/12/2019	30,485	3,091	0	27,394
01/01/2020 – 31/12/2020	30,485	3,091	0	27,394
01/01/2021 – 31/12/2021	30,485	3,091	0	27,394
01/01/2022– 31/12/2022	30,485	3,091	0	27,394
<b>Total</b>	<b>304,850</b>	<b>30,910</b>	<b>0</b>	<b>273,940</b>
Average per annum	30,485	3,091	0	27,394

## Number of COD Sample Calculator

### COD Sampling (Point A)

Sample No.	Sample Date	Sample Value
1	13/8/2011	55,720
2	14/8/2011	72,834
3	15/8/2011	51,342
4	16/8/2011	76,814
5	17/8/2011	70,871
6	18/8/2011	66,867
7	19/8/2011	48,448
8	20/8/2011	65,403
9	21/8/2011	79,561
10	22/8/2011	69,391

<b>Mean</b>	65,725
<b>Standard Deviation, SD</b>	10,603

### Requirement

<b>Confidence Level</b>	90%
<b>Precision Level</b>	10%

### T-Distribution Analysis

Guess of estimated samples	9
$t_{n-1}$ Distribution value	1.860
Final number of sample required, n	9

### Calculation method

The calculation method has been done in accordance to "BEST PRACTICES EXAMPLES FOCUSING ON SAMPLE SIZE AND RELIABILITY CALCULATIONS" (Paragraph 96 - 109) Annex 6 of EB 67. The details as follows:

#### Paragraph 101

If the sampling times are sufficiently far apart the data can be regarded as a set of independent observations and treated as a simple random sample. The number of COD measurements that are required to meet the 90/10 reliability is:

$$n = ((t_{n-1} \times SD) / (0.1 \times \text{mean}))^2$$

#### Paragraph 102

Where  $t_{n-1}$  is the value of the t-distribution for 90% confidence when the sample size is n. However, the sample size is not yet known, and so a first step is to use the value for 90% confidence when the sample is large, i.e. 1.645, and then refine the calculation.

$$n = ((1.645 \times SD) / (0.1 \times \text{mean}))^2$$

#### Paragraph 103

This gives  $n = ((1.645 \times 6200) / (0.1 \times 31750))^2 = 10.3$  which rounds up to 11.

#### Paragraph 104

The calculation now needs to be repeated using the t-value for 90% confidence and  $n=11$ .

#### Paragraph 105

The exact figure for this t-value can be acquired from any set of general statistical tables or using standard statistical software. For a sample size of 11 the value is 1.812.

#### Paragraph 106

The calculation now gives  $n = ((1.812 \times 6200) / (0.1 \times 31750))^2 = 12.5$  which rounds up to 13.

#### Paragraph 107

The process should be iterated until there is no change to the value of n. Here the repeat calculation would have a t-value of 1.782 and the calculation would yield  $n = 12.11$ , which would be rounded up to 13. The sample size calculation suggests that sampling every four weeks should be sufficient for 90/10 reliability.

## Number of COD Sample Calculator

### COD Sampling (Point B)

Sample No.	Sample Date	Sample Value
1	13/8/2011	314
2	14/8/2011	537
3	15/8/2011	597
4	16/8/2011	605
5	17/8/2011	480
6	18/8/2011	388
7	19/8/2011	268
8	20/8/2011	482
9	21/8/2011	487
10	22/8/2011	427

Mean	459
Standard Deviation, SD	111

### Requirement

Confidence Level	90%
Precision Level	10%

### T-Distribution Analysis

Guess of estimated samples	18
$t_{n-1}$ Distribution value	1.740
Final number of sample required, n	18

### Calculation method

The calculation method has been done in accordance to "BEST PRACTICES EXAMPLES FOCUSING ON SAMPLE SIZE AND RELIABILITY CALCULATIONS" (Paragraph 96 - 109) Annex 6 of EB 67. The details as follows:

#### Paragraph 101

If the sampling times are sufficiently far apart the data can be regarded as a set of independent observations and treated as a simple random sample. The number of COD measurements that are required to meet the 90/10 reliability is:

$$n = ((t_{n-1} \times SD)/(0.1 \times \text{mean}))^2$$

#### Paragraph 102

Where  $t_{n-1}$  is the value of the t-distribution for 90% confidence when the sample size is n. However, the sample size is not yet known, and so a first step is to use the value for 90% confidence when the sample is large, i.e. 1.645, and then refine the calculation.

$$n = ((1.645 \times SD)/(0.1 \times \text{mean}))^2$$

#### Paragraph 103

This gives  $n = ((1.645 \times 6200)/(0.1 \times 31750))^2 = 10.3$  which rounds up to 11.

#### Paragraph 104

The calculation now needs to be repeated using the t-value for 90% confidence and  $n=11$ .

#### Paragraph 105

The exact figure for this t-value can be acquired from any set of general statistical tables or using standard statistical software. For a sample size of 11 the value is 1.812.

#### Paragraph 106

The calculation now gives  $n = ((1.812 \times 6200)/(0.1 \times 31750))^2 = 12.5$  which rounds up to 13.

#### Paragraph 107

The process should be iterated until there is no change to the value of n. Here the repeat calculation would have a t-value of 1.782 and the calculation would yield  $n = 12.11$ , which would be rounded up to 13. The sample size calculation suggests that sampling every four weeks should be sufficient for 90/10 reliability.

## Number of COD Sample Calculator

### COD Sampling (Point C)

Sample No.	Sample Date	Sample Value
1	13/8/2011	143
2	14/8/2011	163
3	15/8/2011	143
4	16/8/2011	209
5	17/8/2011	202
6	18/8/2011	176
7	19/8/2011	164
8	20/8/2011	197
9	21/8/2011	207
10	22/8/2011	179

Mean	178
Standard Deviation, SD	25

### Requirement

Confidence Level	90%
Precision Level	10%

### T-Distribution Analysis

Guess of estimated samples	8
$t_{n-1}$ , Distribution value	1.895
Final number of sample required, n	8

### Calculation method

The calculation method has been done in accordance to "BEST PRACTICES EXAMPLES FOCUSING ON SAMPLE SIZE AND RELIABILITY CALCULATIONS" (Paragraph 96 - 109) Annex 6 of EB 67. The details as follows:

#### Paragraph 101

If the sampling times are sufficiently far apart the data can be regarded as a set of independent observations and treated as a simple random sample. The number of COD measurements that are required to meet the 90/10 reliability is:

$$n = ((t_{n-1} \times SD)/(0.1 \times \text{mean}))^2$$

#### Paragraph 102

Where  $t_{n-1}$  is the value of the t-distribution for 90% confidence when the sample size is n. However, the sample size is not yet known, and so a first step is to use the value for 90% confidence when the sample is large, i.e. 1.645, and then refine the calculation.

$$n = ((1.645 \times SD)/(0.1 \times \text{mean}))^2$$

#### Paragraph 103

This gives  $n = ((1.645 \times 6200)/(0.1 \times 31750))^2 = 10.3$  which rounds up to 11.

#### Paragraph 104

The calculation now needs to be repeated using the t-value for 90% confidence and  $n=11$ .

#### Paragraph 105

The exact figure for this t-value can be acquired from any set of general statistical tables or using standard statistical software. For a sample size of 11 the value is 1.812.

#### Paragraph 106

The calculation now gives  $n = ((1.812 \times 6200)/(0.1 \times 31750))^2 = 12.5$  which rounds up to 13.

#### Paragraph 107

The process should be iterated until there is no change to the value of n. Here the repeat calculation would have a t-value of 1.782 and the calculation would yield  $n = 12.11$ , which would be rounded up to 13. The sample size calculation suggests that sampling every four weeks should be sufficient for 90/10 reliability.

