CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

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Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

Carroll's Foods do Brasil & LOGICarbon – GHG Emission Reductions from Swine Manure Management System, Diamantino, MT, Brazil.

Version 8

Completed in 17/05/2011.

A.2. Description of the project activity:

Carroll's Foods do Brasil S.A. is a swine production and trading company started in 1999. It operates in 2 production sites, "Diamantino I" and "Petrovina", 11,000 and 1,500 sows farrow-to-finish respectively, in typical confined animal feed operation (CAFO), both located in the State of Mato Grosso (MT), Brazil.

Diamantino 1 site is the largest single-site swine farm in Brazil, where the project will be located. In February 2008, Carroll's Foods do Brasil was acquired by Marfrig Group, through its subsidiary Mabella. Therefore, project activity at the farm Diamantino I is referred as "Mabella Diamantino I" in this document. Marfrig is a Brazilian company and is one of the major beef meat and by-product producers in Latin America. Frigorífico Mabella Ltda. ('Mabella') is a pork processing, swine production and trading company started in 2001, with headquarters in Frederico Westphalen, RS.

As the standard of the industrial swine production in Brazil, the existing Animal Waste Management System (AWMS) adopted in Diamantino 1 farm is composed of 2 sets of open anaerobic and aerobic lagoons, which are in compliance with the local and national environmental requirements, being very effective in reducing the organic content of the swine manure before its cropland application. This type of AWMS results in emissions of methane (CH_4) and nitrous oxide (N_2O) as a result of the reduction of the organic content of the swine manure.

From the electricity standpoint, the farm is currently fully supplied by the local electric grid, which is part of the Brazilian National Interconnected System (*Sistema Interligado Nacional* – SIN) and has no electricity generation that impacts the GHG emissions of the grid. The electricity supplied by the Brazilian SIN is generated from many generation units, in its majority from hydroelectric power plants, but also from a minor share of fossil fuel thermoelectric plants, thus resulting in emissions of carbon dioxide (CO_2). As a conclusion, the current electricity consumption by Diamantino 1 is responsible for GHG emissions.

The proposed CDM project activity will be composed of 2 components; the first related to the CH_4 and N_2O emission reductions from the current AWMS (herein referred as "AWMS component") and the second related to the emission reductions of CO_2 through the generation of renewable electricity to replace the energy from the grid (herein referred as "renewable energy component"). For the AWMS component, the project boundary includes the modified AWMS and the methane combustion equipment

(flare and generators). For the renewable energy component, the project boundary encompasses the physical, geographical site of the renewable generation source.

The main purpose of the proposed CDM project activity is the GHG emission reduction at Mabella Diamantino 1 farm through:

1. AWMS component - modification of current AWMS into a system with anaerobic biodigesters and aerobic lagoons with both forced and natural aeration, which will treat 100% of the generated manure; the anaerobic digesters will capture the resulting methane, which will be burnt either in biogas electricity generators or in an enclosed biogas flare; the aerobic lagoons will further digest the effluent organic content and will result in CO_2 emissions, while avoiding CH_4 emissions; N_2O emissions will be reduced in both anaerobic and aerobic treatments of the modified AWMS;

2. Renewable energy component - electricity generation for self consumption and export to the grid, using the resulting methane from the anaerobic digesters in a biogas thermoelectric plant with internal combustion generator groups to replace the electricity from the grid.

As explained in item B.4., the baseline scenario for the AWMS component is the current manure management practice. For the renewable energy generation component the baseline scenario is the continuation of the current situation: consumption of electricity from the grid by the project host and no renewable energy generation by the project host affecting the emissions of the grid. In both components, the continuation of the current practices represents the most plausible scenarios, which characterizes them as the baseline scenarios.

For the AWMS component, the project activity will achieve emission reductions by: 1) combusting the captured CH_4 in the flare or the generators; 2) avoiding CH_4 emissions in the aerobic lagoons; and 3) avoiding N_2O emissions from the open anaerobic and aerobic lagoons. The resulting gas from the CH_4 combustion or the aerobic manure treatment is carbon dioxide (CO_2) and, since the CH_4 global warming potential is 21 times the CO_2's, emission reductions are achieved. In the case of N_2O, its global warming potential is 310 times the CO_2's, so emission reductions are achieved when N_2O emissions are avoided.

For the renewable energy component, the simple replacement of the electricity from the grid, which promotes the emissions of carbon dioxide, by the electricity generated using the biogas from the biodigesters, which is considered to be a renewable source with zero GHG emissions, allows the project to achieve emission reductions.

The proposed CDM project will also produce secondary benefits, which are extremely important for the sustainability of this farm, the environment and the local community, such as:

1. Reduction in the consumption of natural resources, through:

    a) self generation of electricity from renewable source (methane from manure treatment);

    b) re-utilization of the water in the animal production operation;

2. Reduction in water and soil contamination;

3. Reduction in the generation of bad smell and in the proliferation of insects and pathogens;

4. Creation of a model to be applied in other CAFOs;
5. Creation of local short and long-term employment during the project implementation and throughout the project lifetime, given the need for specific labor for its operation, maintenance and monitoring;
6. Improvement of the perception about the Brazilian swine production in external markets; creating more opportunities to export pork meat from Brazil, thus generating more positive incentives to develop the local swine production in a sustainable way.

A.3. Project participants:

Name of party involved (*) ((host) indicates a host party)	Private and/or public entity(ies) Project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	Frigorífico Mabella Ltda.	No
Brazil (host)	LOGICarbon Assessoria Ambiental Ltda.	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Brazil.

A.4.1.2. Region/State/Province etc.:

Mato Grosso (MT).

A.4.1.3. City/Town/Community etc.:

Diamantino.

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

The proposed CDM project will be placed in the production site called Mabella Diamantino 1, which is located at Rod. BR 364, km 600, Diamantino, MT, a small town 180 km north from the capital of the state, the City of Cuiabá. GPS coordinates of the project site are 14˚30’11’’S and 56˚18’31’’W. The detailed geographic location can be observed in the below maps.

Figure 1. Map of Brazil (Host Country)

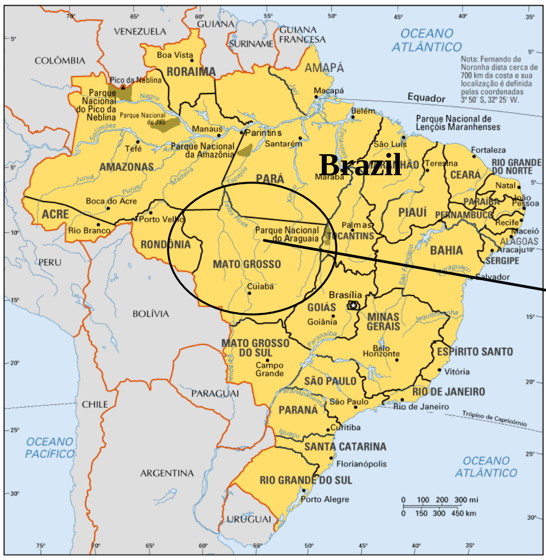


Figure 2. Map of The State of Mato Grosso

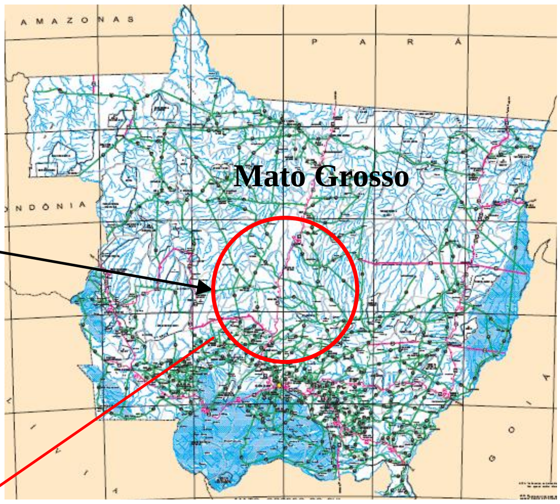
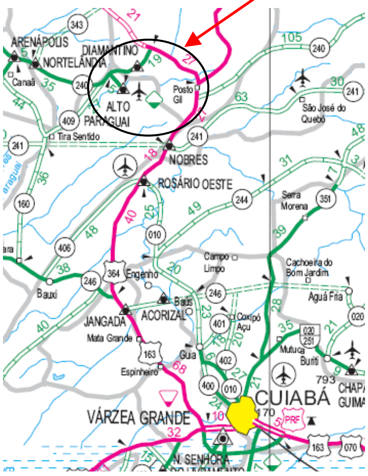


Figure 3. Detailed map, including the Capital (Cuiabá), in the South, and Diamantino, 180 km to the North.



Mabella Diamantino 1 is a farm distributed in 1,000 ha, exclusively dedicated to the confined swine production, producing its own swine feed in a feed mill with a capacity of 50 t/h. The swine population (approximately 125,000 animals) is allocated in 76 barns and the manure management is made with water flushing and pull-plug. The daily manure production is approximately 2,000 m^3, with a chemical oxygen demand (COD) content of 25,000 mg/L.

A.4.2. Category(ies) of project activity:

The proposed CDM project falls in Sectoral Scope 15 – Agriculture; Sectoral Scope 13 – Waste handling and disposal; and Sectoral Scope 1 – Energy industries (renewable/non-renewable sources).

A.4.3. Technology to be employed by the project activity:

The baseline scenario of the AWMS component is the existing AWMS, which is composed of 2 sets of open anaerobic lagoons, each one followed by aerobic lagoons with natural aeration, as shown below:

a) System 1, receiving 1,530 m^3 of manure per day:

   i) 3 sequential anaerobic lagoons with 9,800 m^3 each, 4 m deep;

   ii) 1 anaerobic lagoon with 32,455 m^3, 1.5 m deep;

   iii) Total volume = 61,855 m^3;

   iv) Hydraulic retention time (HRT) = 36 days;

   v) 3 sequential facultative lagoons (aerobic lagoons with natural aeration)[1] with 6,380 m^3 each, 1 m deep;

b) System 2, receiving 1,000 m^3 of manure per day:

   i) 4 sequential anaerobic lagoons with 13.600 m^3 each, 4 m deep;

   ii) 1 anaerobic lagoon with 30,576 m^3, 1.5 m deep;

   iii) Total volume = 84,976 m^3;

   iv) HRT = 85 days;

   v) 2 sequential facultative lagoons (aerobic lagoons with natural aeration) with 7,755 m^3 and 4,818 m^3, 1 m deep each;

All the resulting treated effluent from the existing AWMS is spread on the farm's cropland, including eucalyptus and pasture areas. The resulting sludge, which is removed from time to time from the open anaerobic lagoons, is first placed in sludge drying beds and then spread on the farm's cropland.

The whole existing AWMS system flows by gravity and the reduction of the chemical oxygen demand (COD) in both system is higher than 95%.

As for the renewable energy component, the baseline is the amount of electricity that will be generated by the biogas generator groups, multiplied by the emission coefficient of the Brazilian SIN calculated in a transparent and conservative manner, based on the official data supplied by the Brazilian Ministry of Science and Technology (MCT).

For the two components (AWMS and renewable energy), the baseline scenario and the scenario existing prior to the start of implementation of the project activity are the same, since they are the most plausible scenarios. These 2 existing scenarios are in place since the start of the farm operations.

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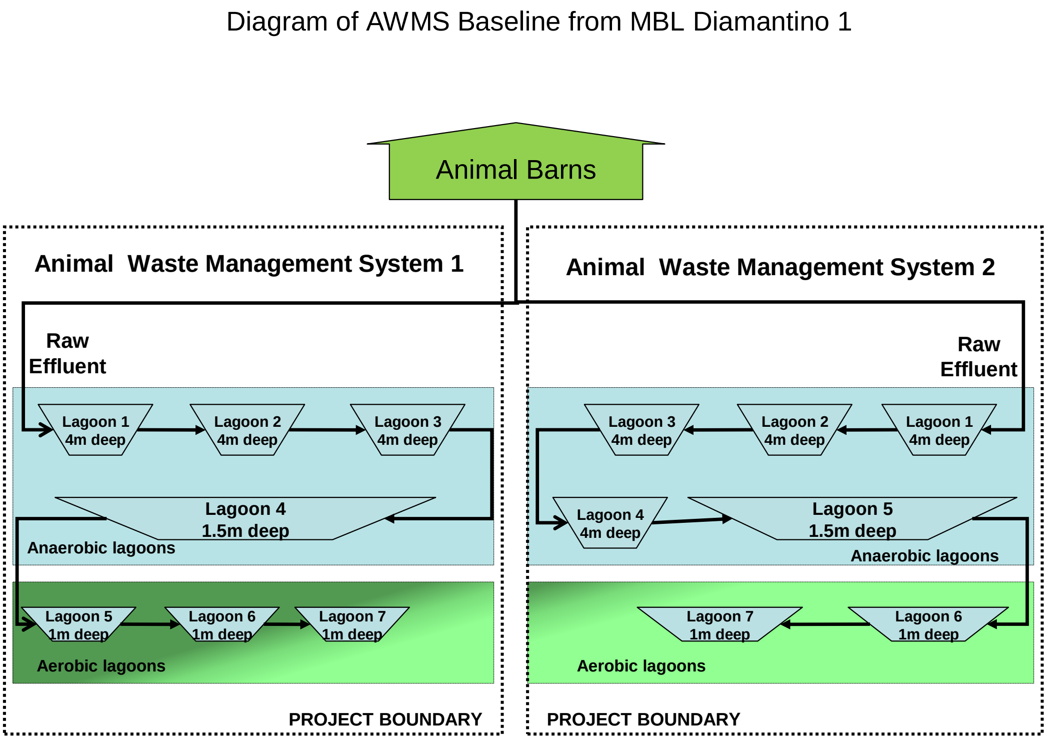
[1] The biological oxidation of manure collected as a liquid with either forced or natural aeration. Natural aeration is limited to aerobic and facultative ponds and wetland systems and is due primarily to photosynthesis. (Table 10.18, 2006 IPCC Guidelines for National Greenhouse Gas Inventories)

Figure 4. Diagram of the manure flow in the AWMS of the baseline scenario



1. Anaerobic biodigesters and aerobic lagoons for animal manure treatment:

This CDM project proposes the upgrade of the existing both AWMS systems to manure treatment systems with ambient temperature anaerobic biodigesters, covered lagoon type. In each system, the effluent resulting from the anaerobic digestion process will be further treated in one aerobic lagoon with forced aeration and then in aerobic lagoons with natural aeration (facultative lagoons).

Mabella Diamantino 1 has a swine population around 11,000 sows F-F (farrow-to-finish), which is about 125,000 swine heads in total, and generates approximately 2,500 m^3/day of swine manure, equivalent to 227 L/sow/day. The total manure generation will be decreased to 2,000 m^3/day, equivalent to 182 L/sow/day, through the implementation of new operating procedures to reduce the water use for manure collection at the barn level, such as the use of high pressure/low flow water cleaning pumps, replacement of animal water drinking devices and personnel training.

The ambient temperature anaerobic digestion will take place in 6 biodigester cells:

a) System 1, that will handle 40% of the manure volume (800 m^3/day), with a total volume of 28,392 m^3 and 35 days of HRT; dimensions are as follow:

   i) Bio A cell, sizing 36 m wide, 69 m long and 4.5 m deep (volume = 9,475 m^3);

   ii) Bio B cell, sizing 39 m wide, 69 m long and 4.0 m deep (volume = 9,359 m^3);

iii) Bio C cell, sizing 39 m wide, 69 m long and 4.1 m deep (volume = 9,558 m^3);

b) System 2, that will handle 60% of the manure volume (1,200 m^3/day), with a total volume of 37,108 m3 and 31 days of HRT; dimensions are as follow:

i) Bio A cell, sizing 42 m wide, 86 m long and 4.5 m deep (volume = 13,246 m^3);

ii) Bio B cell, sizing 42 m wide, 86 m long and 4.3 m deep (volume = 12,982 m^3);

iii) Bio C cell, sizing 42 m wide, 83 m long and 4.0 m deep (volume = 10,880 m^3);

As shown in Figure 5, both systems will work with continuous flow, receiving the effluents from all the barns all day long, with varying flow rates. The hydraulic retention time (HRT) of the anaerobic digesters will be over 30 days in both systems and the effluent will flow by gravity from the barns to each of the 2 biodigester sets. In each system, the effluent will be divided in 2 equal parts in a distribution box, which will feed biodigester cells A and B. From them, the effluent will converge to the biodigester cell C, then it goes to the aerobic lagoon with forced aeration (lagoon 1) and then to the facultative lagoons (4 lagoons in System 1 and 3 lagoons in System 2) that will allow the re-use of 70% of the treated wastewater in the animal barn operation. The remaining 30% will be spread on the farm’s eucalyptus area.

Of the existing open anaerobic lagoons, 2 from System 1 and 3 from system 2 will be used to compose the biodigesters, as they will be completely drained, cleaned and dully adapted. System 1 will have a newly excavated biodigester cell (Bio A cell), due to topography restrictions. The main items, among others, that will be added to the existing lagoons are new effluent pipes, lateral pipes for maintenance, anchorage concrete ring beams and EPDM rubber lining (ethylene propylene diene monomer, Firestone EPDM RubberGard 1,15 mm). The same material will be used to cover the lagoons. The biodigester covers will be sealed and fixed together with the liner, at the anchorage system around the border of the lagoons, with metal plates, bolts and nuts, preventing biogas leakage. Firestone EPDM RubberGard has 10-year warranty and is expected to last more than 30 years.

Lateral pipes that will be installed on the side of the biodigesters will create access to the bottom of the covered lagoons without the need to remove the cover. These pipes will be used to re-circulate the biodigester content and to remove built-up solids (sludge) from the bottom of the biodigesters.

The recirculation process will be made on a daily basis with the use of electric submersible pumps.

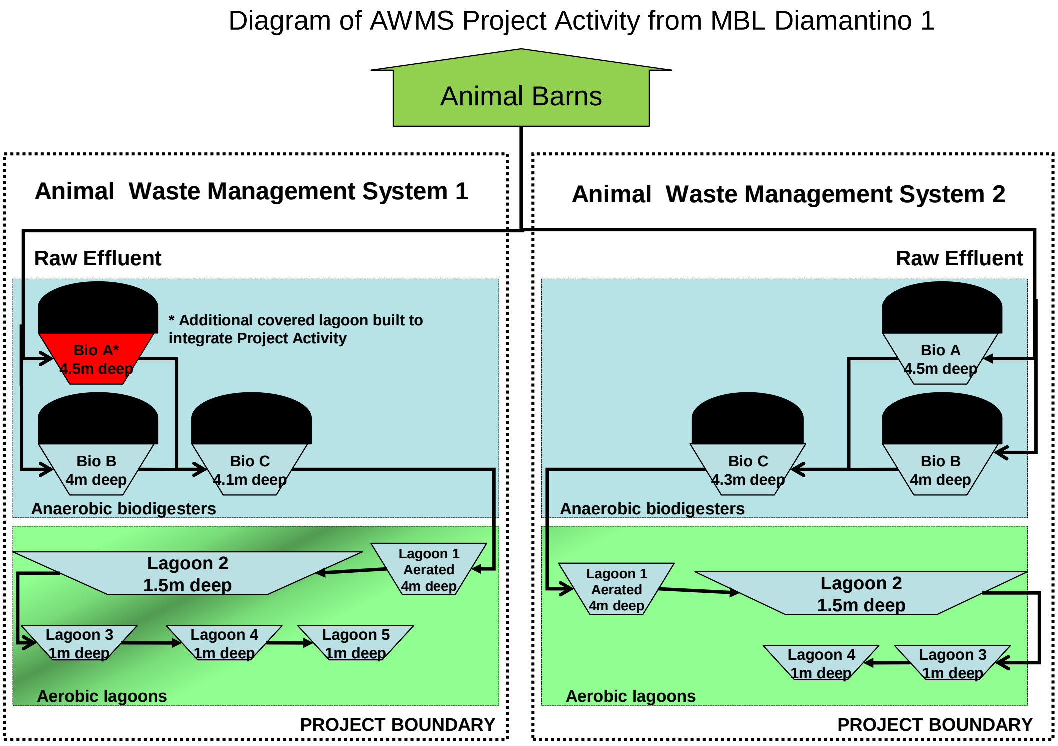
The sludge removal process is expected to take place every 12 months and will allow the biodigesters to keep functional for several years before the need for a more drastic intervention. The sludge will be pumped by tank trucks and then immediately spread on the pasture areas of the farm as fertilizer, located 5 km from the AWMS.

As all biodigester lagoons will be lined with EPDM, no soil or ground water contamination will take place. In order to confirm the lagoon impermeability, witness drains will be installed in each one of the covered lagoons.

The biodigesters are expected to reduce 90% of the organic load of the effluent. The resulting biogas, rich in methane, will be captured by the biodigester covers from where it will be collected and lead through a PVC pipeline to either the biogas electricity generator groups or the biogas flare. It is

expected a daily biogas production from 16,000 to 22,000 m^3/day, with an average methane concentration of 65%.

Figure 5. Diagram of the manure flow in the AWMS of the CDM project activity



In each system, the aerobic lagoons with forced aeration will follow the anaerobic digesters, installed in existing lagoons with floating electric aerators. They will have their slopes lined with EPDM and will maintain the original impermeability surface in the bottom (compacted clay).

2. Electricity generation

In a first moment, the farm will generate electricity with the methane resulting from the manure anaerobic digestion to supply its own electricity demand. For this purpose, a biogas power plant, with 5 small generator sets, totalizing approximately 700 kWe capacity in continuous operation, will be installed. The basic specifications of the biogas generator sets for the first phase are as follow:

a) Generator:

i) Internal combustion, 4-cycle, water cooled engine;

ii) Synchronous tri-phase generator, with rated power of 200 kVA/160 kWe in emergency operation, 180 kVA/144 kWe in continuous operation, 380/200 V, 4 poles, 1,800 rpm, 60 Hz, star connection with accessible neutral, brushless system;

b) Control, maneuvering and protection panels:

   i) Generator set control panel with microprocessor to control the engine rotation, frequency supervision and, voltage and load regulation.

   ii) Measurement, command and protection panel containing the generator protection relays and the measuring instruments (current, voltage, power and power factor);

   iii) Parallelism panel with micro processed controller to synchronize and allow the parallelism of each generator with the internal distribution grid;

   iv) Low voltages cubicles, containing circuit breakers, disconnecting switches and the low voltage output connection bus bar;

c) Substation

   A substation will be provided to increase the generators voltage to the farm's internal grid voltage, which is 34.5 kV, composed of a tri-phase step-up transformer of 750 kVA, 380 – 34,500 V, with oil insulation and a medium voltage cubicle that will contain the maneuver equipment such as circuit-breaker, disconnecting switches,, measuring instruments and protection devices for both the transformer and the 34.5 kV distribution grid.

d) Auxiliary facilities and equipment:

   i) Heat exchangers for engine's water coolers, composed by radiator and fan;

   ii) Grounding with mesh and rods for transformer's and generator's neutrals connections, and for people and equipments protections in case of short-circuit fault;

   iii) Gas pipeline to transport the biogas from the flare square to the power plant;

   iv) Compressor to pressurize the biogas at the engine admission;

   v) Biogas filtering and drying systems.

The biogas generation equipment to be used is still being selected by the project host, which is evaluating a few potential manufactures that have the biogas electricity generation technology currently available in the Brazilian market, such as ER-BR, GE Jenbacher by Stemac, Bioger, among others.

In a second moment (as of 2010), a new biogas power plant, with the introduction of larger internal combustion biogas engine generator sets, will be installed and will consume the totality of the biogas originated from the project AWMS. This power plant will continue supplying the farm electricity demand and, in order to sell the exceeding generated electricity, the power plant will operate connected to the grid (SIN), through the connection with CEMAT, the local utility that transmits and distribute electricity within the state of Mato Grosso.

For this second phase, two generating sets with nominal power of 925 – 1,038 kWe each will be installed. The smaller generators (1st phase) will be kept on stand-by and shall come into operation in

case of shutdown of one of the new generators for maintenance. Basic specifications of the second phase installations are as follow:

a) Generators:

i) The generating sets will be powered by internal combustion engines on biogas, 4-cycle, with cooling water;

ii) The generators will be three-phase, nominal voltage of 480 V, frequency of 60 Hz, star connection with accessible neutral, synchronous type with brushless excitation system;

iii) There are two alternative proposals that are possibly appropriate and that are deemed feasible to be implemented in the second phase of Mabella's power plant:

- Alternative 1: JENBACHER – with GE Energy Jenbacher engine of 1,800 rpm and generator WEG, 4 poles, with nominal power of 1,297 kVA/1,038 kWe base load;
- Alternative 2: CATTERPILAR generator with 1,200 rpm engine and generator, 6 poles, with nominal power of 1,150 kVA/925 kWe continuous;

b) Control, maneuvering and protection panels:

i) Control Panel of the generator set with microprocessor to control the engine speed, supervision of frequency and regulation of voltage and load of the generator;

ii) Panel of measurement, control and protection with relays for the protection of the generator and the measuring instruments of energy ,current, voltage, power factor and power;

iii) Parallelism panel with micro processed controller to perform the synchronization and the parallelism of each generator to the distribution system of the utility;

iv) Low voltage cabinet, with circuit breakers, disconnecting switches for each generator and the low voltage (LV) busbar.

c) Substation

i) To connect the generators to the distribution network of the utility, whose voltage is 34.5 kV, a substation with a three-phase step-up transformer of 2,500 kVA, 480 – 34,500 V will be installed, with oil insulation and a cubicle for medium voltage maneuvering. The cubicle will hold the operation equipment, such as disconnecting switches, circuit breaker and protection devices for both the transformer and the 34.5 kV transmission line.

d) 34.5 kV transmission line:

i) The energy that exceeds the consumption of the farm will be exported to the SIN through the utility's network of local power, the CEMAT, and should be delivered in its substation located in Diamantino-MT;

ii) Thus, the transmission line that supplies the farm today, with a length of approximately 22 km, will be resized and strengthened to carry the total maximum power of 2,500 kVA at 34.5 kV in the opposite direction.

e) Bay of entry in the substation:

i) At the transmission line arriving to the CEMAT substation, a bay of entry should be built, containing the following:

- Disconnecting switches and circuit breaker for operation and protection of the line;
- Current and voltage transformers for measurement and protection;
- Lightning arresters;
- Panel of energy measuring, for billing purposes;

f) Facilities and auxiliary equipment:

i) Heat exchangers for the engine water cooling, consisting of radiators with fans;

ii) Grounding with mesh and rods for transformer's and generator's neutrals connections, and for people and equipments protections in case of short-circuit fault;

iii) 8'' gas pipeline to transport the biogas from the flare square to the power plant;

iv) Compressor to pressurize the biogas at the engine admission;

v) Biogas filtering and drying systems.

The biogas generators are expected to last from 8 to 10 years before they have to be replaced by new ones.

2. Flare system

When the biogas volume exceeds the consumption capacity of biogas generator sets or in case of their maintenance, biogas will be combusted in a fully automated enclosed flare, specifically designed for biogas combustion and manufactured by BTS Termodinâmica de Sistemas, an experienced and well recognized Brazilian company.

The flare to be installed has the capacity to burn biogas up to a rate of 1,300 Nm^3/h, with a turndown of 1:20. During periods when flare is not operating, automatic blocking valves avoid any biogas venting through the flare. The biogas ignition is made with the use of a LPG pilot flame, which is activated and is kept lit exclusively during the biogas ignition process that takes a few seconds.

The residence time of the biogas in the flare combustion chamber will be more than 0.5 second at the operating temperature of 850˚C, with a CH_4 destruction efficiency of more 98%.

The flare operation will be determined by the internal pressure of the biodigester covers, which will be monitored by pressure transmitters. The biogas will be pulled and pressurized by 2 blowers, one

for each biodigester system, equipped with frequency inverters, regulating the biogas flow rate to the flare according to the internal pressure of the biodigester covers.

During the phase where the electricity generation with biogas will only supply the farm demand, it is expected that the flare will be operational during most of the time. So, the biogas ignition process should take place no more than twice a day. In the next phase, where the biogas will be mostly consumed by the biogas power plant, the flare is expected to rarely operate. Thus the ignition process should happen once a day, at most.

The flare system lifetime is expected to be over 20 years.

3. Monitoring system

All required monitoring equipment will be installed, as required by the *Annex 13 Methodological "Tool to determine project emissions from flaring gases containing methane"*, referred by *ACM0010 Consolidated baseline methodology for GHG emission reductions from manure management*, in order to allow the emission reduction calculation based on the real efficiency rate of the flare system and the generator engines. The monitoring equipment includes:

a) Magnetrol Thermatel, model TA2, or similar, thermal mass flow meter, that uses the constant temperature difference method, measuring the flow rate in units of mass flow (Nm^3/h); 4 flow meters will be installed to measure the biogas flow, one at the outlet of each biodigester system, one just before the flare and one just before the biogas power plant (please, refer to Figure 8, on Annex 4);

b) Landtec AEMS (Automated Extraction Monitoring System):

   i) FAU (Field Analytical Unit) – continuous CH_4 fixed position gas monitoring analyzer; this system is equipped with an auto calibration system (AutoCal), that calibrates the analyzer with a certified gas mixture every hour;

   ii) FSU (Field Server Unit) – collects data from industry standard signal sources, such as 4 – 20 mA, 0 – 5 V, 110 Volt, as well as any PLC device or the FAU; the data is stored locally, then transmitted via the Internet to EnviroComp Report Service on a regular basis; this data storage unit will consolidate the data measuring signals from the FSU, flow meter, flare temperature sensor and exhaust gas analyzer;

c) A thermocouple installed at the flare stack will continuously monitor the temperature of the exhaust gas, positioned at 80% of the flare height;

d) Landtec AEMS Exhaust Monitor – flare emission fixed position analyzer, to continuously measure the concentration of CH_4 and O_2 in the exhaust gas of the flare.

For the AWMS component, the project activity will achieve emission reductions by: 1) combusting the captured CH_4 in the flare or the generators; 2) avoiding CH_4 emissions in the aerobic lagoons; and 3) avoiding N_2O emissions from the open anaerobic and aerobic lagoons. The resulting gas from the CH_4 combustion or the aerobic manure treatment is carbon dioxide (CO_2) and, since the CH_4 global warming potential is 21 times the CO_2's, emission reductions are achieved. In the case of N_2O,

its global warming potential is 310 times the CO_2's, so emission reductions are achieved when N_2O emissions are avoided.

For the renewable energy component, the simple replacement of the electricity from the grid, which promotes the emissions of carbon dioxide, by the electricity generated using the biogas from the biodigesters, which is considered to be a renewable source with zero GHG emissions, allows the project to achieve the emission reductions.

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

Table 1. Project estimated emission reductions

Years	**Annual estimation of emission reductions in tonnes of CO_2e**
2009	28,755
2010	57,510
2011	57,510
2012	57,510
2013	57,510
2014	57,510
2015	57,510
2016	57,510
2017	57,510
2018	57,510
2019	28,755
Total estimated reductions (tonnes of CO_2e per year)	**575,103**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**57,510**

A.4.5. Public funding of the project activity:

No public funding from Parties included in Annex I is to be involved in this CDM project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

For the AWMS component, the approved consolidated baseline methodology ACM0010 "*Consolidated baseline methodology for GHG emission reductions from manure management systems*", version 5, adopted at EB 42, has been chosen. This methodology refers to the following tools:

1. "*Tool to determine project emissions from flaring gases containing methane*", version 01;
2. "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", version 01;
3. "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*", version 02;
4. "*Tool for the demonstration and assessment of additionality*", version 05.2;
5. "*Tool to calculate the emission factor for an electricity system*", version 02.

For the renewable energy component, the applicable methodology is the AMS-I.D. "*Grid connected renewable electricity generation*", version 15, adopted at EB 50, which refers the "*Tool to calculate the emission factor for an electricity system*", version 02.

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The methodology choice was based on the following facts:

1. ACM0010 "*Consolidated baseline methodology for GHG emission reductions from manure management systems*", version 5

   a) The proposed CDM project consists of the modification of the existing AWMS, located at Mabella Diamantino 1 swine production site, to a AWMS with: 1) anaerobic biodigesters, covered lagoon types, that will capture the resulting biogas, which will be combusted in electricity generators or in an enclosed flare; 2) and forced and naturally aerated lagoons that avoid methane emissions;

   b) All Mabella Diamantino 1 animal population is managed under confined conditions;

   c) 100% of the manure at Mabella Diamantino 1 is treated in 2 sets of lagoons, being the anaerobic phase composed of lagoons deeper than 1 m, with a hydraulic retention time over 30 days and a non-permeable layer (compacted clay) at the bottom; for more details, please, refer to the farm blue print, the detailed view and pictures of the existing manure management system at Annex 3 – Baseline Information;

d) The average temperature in Diamantino, MT, is 24.84ºC, much superior than 5ºC;

e) The manure management change will result in less methane emissions to the atmosphere, given that all resulting methane will be captured and combusted.

2. AMS-I.D. "*Grid connected renewable electricity generation*", version 15

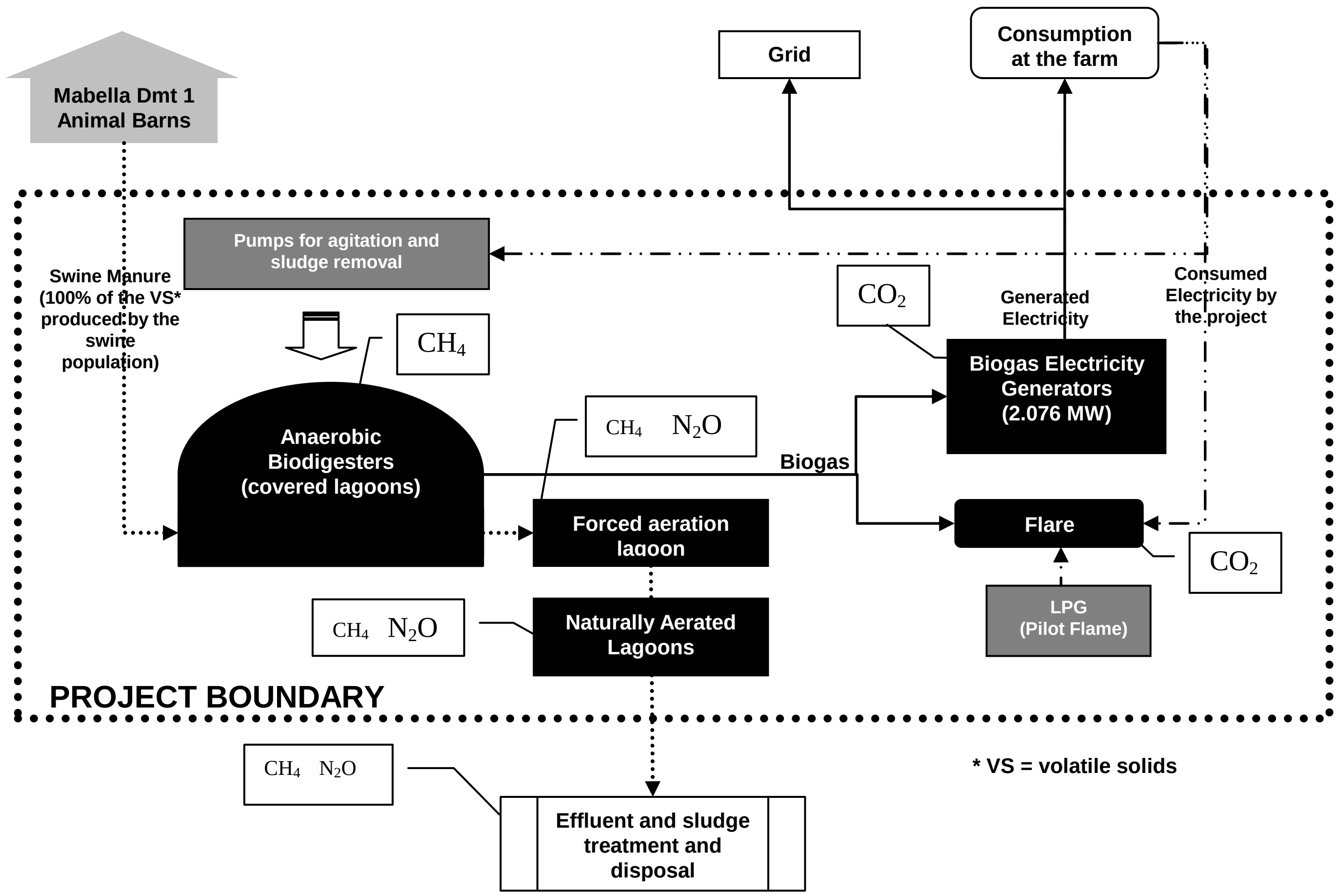
f) The proposed CDM project will generate electricity strictly with the biogas produced and captured in the AWMS;

g) The electricity generation plant capacity shall be 2.076 MW (expected capacity);

h) The generated electricity will be either exported to the grid (majority) or consumed by the farm, replacing the grid electricity consumption.

B.3. Description of the sources and gases included in the project boundary:

Figure 6. Diagrammatic representation of the project activity boundary



For ACM0010, the project boundary basically includes the AWMS (anaerobic biodigesters and aerobic lagoos) and the methane combustion equipment (biogas generation plant and flare), as shown in the flowchart at Figure 6. In the case of AMS I.D., the methodology states that “the project boundary encompasses the physical, geographical site of the renewable generation source”.

Figure 6 shows a flowchart of the process of the project activity boundary and the respective sources of GHG emissions.

The sources and gases included in the project boundary may be found in Table 2.

Table 2. Sources and gases from the project activity

	Source	Gas	Included?	Justification/Explanation
Baseline	Direct emissions from the open anaerobic lagoons	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted
		CH_4	Included	The major source of emissions in the baseline
		N_2O	Included	
	Emissions from electricity consumption	CO_2	Excluded	There is no electricity consumption by the existing AWMS
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small
	Emissions from thermal energy generation	CO_2	Excluded	There is no thermal energy generation from the existing AWMS
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small
Project Activity	Emissions from thermal energy generation	CO_2	Excluded	Excluded for simplification. This emission source (LPG for flare ignition system) is assumed to be very small
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small
	Emissions from on-site electricity use	CO_2	Excluded	Biogas generation plant will supply energy to all equipment that will consume eletricity in the project activity
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small
	Direct emissions from the waste treatment process	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted
		CH_4	Included	The emission from uncombusted methane and physical leakage
		N_2O	Included	

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

For the AWMS component of this proposed project activity, the identification of the baseline scenario is made according to ACM0010/version 5:

Step 1: Define alternative scenarios to the proposed CDM project activity

As the common practice in swine confined animal feed operations (CAFO) in Brazil, for sanitary reasons, manure management is made with major water addition, creating a liquid effluent with low total solid (TS) concentration, varying from 1% to 3%. Usually, the chemical oxygen demand (COD) concentration in swine manure varies between 25,000 to 30,000 mg/L.

For cropland application, CONAMA (Brazilian National Environmental Council) Resolution 357, from 2005, states that effluents shall not promote soil or water contamination, meaning that the effluent must be treated to a certain degree that will not pollute soil or water. In normal conditions, the existing AWMS at Mabella Diamantino 1 efficiently treats the effluents resulting from the swine operation, i.e., reducing 95% of the COD content before its final destination (fertirrigation), consisting in a satisfactory manure treatment from the legal and regulatory stand point.

Regarding other manure management practices implemented previously or currently underway, no official data about the incidence of swine manure treatment in Brazil is available. According to researchers from EMBRAPA (Brazilian Agricultural Research Corporation) (Kunz et al., 2005) [2], considering swine manure management, "in Brazil, the most common practice of waste management is the storage in lagoons or ponds and later application to the cropland (Kunz et al., 2004a)[3]. The lagoons and ponds, if properly sized and operated, are a low cost option for producers who have enough cropland areas, where waste can be used as organic fertilizer". Thus, this type of manure management in lagoons or ponds that is in place for several years in the Brazilian industrial swine production is the only one that can be reasonably considered as common practice.

The technology of anaerobic digestion by anaerobic digesters for stabilization of swine manure has long been known. Several models of digesters have been developed and adapted, aiming to both increase the efficiency of these systems and reduce the costs of the equipment (Kunz et al. 2004b)[4].

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[2] KUNZ, A.; HIGARASHI, M. M.; OLIVEIRA, P.A. Tecnologias de manejo e tratamento de dejetos de suínos estudadas no Brasil. *Cadernos de Ciência & Tecnologia*, Brasília, v. 22, n. 3, p. 651-665, set./dez. 2005

[3] KUNZ, A.; OLIVEIRA, P.A.; HIGARASHI, M. M.; SANGOI, V. Recomendações técnicas para uso de esterqueiras para a armazenagem de dejetos de suínos. *Comunicado Técnico, Concórdia: Embrapa Suínos e Aves*, n. 361, 1-4, 2004a.

[4] KUNZ, A.; SCHIERHOLT NETO, G. F.; NUNES, L. M. A.; OLIVEIRA, P.A. Estudo da relação maravalha/dejeto a diferentes umidades para incorporação de lodo de dejeto de suínos, Florianópolis, 2004. In: CONGRESSO BRASILEIRO DE CIÊNCIA E TECNOLOGIA EM RESÍDUOS E DESENVOLVIMENTO SUSTENTÁVEL, 2004, Florianópolis. Anais..., 2004.

The introduction of the biodigester technology to treat swine manure in Brazil took place in the 80's, mainly driven by the energetic crisis of the 70's and with major focus in the Southern region that has the largest swine herd of the country. Indian biodigesters were predominant, with brick walls and a hard dome (metal or fiberglass).

According to Palhares (2008)[5], making reference to Palhares & Guidoni (2006), using data from the Agriculture and Livestock Assessment of the State of Santa Catarina (2002-2003) and considering only producers of herds larger than 50 swine heads (7,158 producers), verified that 0.08% of them had biodigesters e 99.2% manure ponds.

Thus, only a small number of biodigesters in Brazil until very recently, when new technology started to be available, mainly based on covered anaerobic lagoons, lined and covered with flexible materials, such as PVC or HDPE. In 2004, a new wave of biodigester projects started, mainly driven by the carbon market opportunity, with the installation of several hundreds digesters under CDM project activities. These CDM project activities have not been considered in the common practice analysis, according to ACM0010's Step 1 for the identification of the baseline scenario.

Considering the incidence of biodigesters in Santa Catarina in 2002-2003 (0.08%), which is the state with the largest swine herd, with 392 thousand housed sows, accounting for about 16% of the Brazilian swine herd, with about 1.5 million sows (ABIPECS 2008), we can estimate that Brazil would have no more than 38 swine operations with biodigesters, demonstrating that this cannot be considered a common practice.

Comparing the proposed CDM project activity with the rare cases where swine farms treat the manure in biodigesters, these biodigesters have purposes other than reducing GHG emissions, such as efficient manure treatment, biogas generation for electricity/heat generation or production of biofertilizer. Therefore, in general, these equipment are not designed nor managed in order to efficiently capture and destroy the resulting methane, resulting in methane venting and/or poor manure decomposition, which results in methane emissions in the subsequent treatment, that usually is a deep pond for biofertilizer storage.

Considering all possible manure management systems listed and defined in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (Chapter 10, Table 10.18) and due to the above mentioned facts, the listed possibilities in Table 3 can be immediately ruled out, because they are not considered plausible and credible alternatives to the project activity scenario and they are definitely not common practices in the Brazilian swine industry.

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[5] PALHARES, J.C.P. Biodigestão anaeróbia de dejetos de suínos: aprendendo com o passado para entender o presente e garantir o futuro. 2008. (http://www.infobibos.com/Artigos/2008_1/Biodigestao/index.htm)

Table 3. List of possible manure management systems not considered as plausible scenario

<table>
<tr><th colspan="2">Manure Management Type</th><th>Reason for exclusion as plausible scenario</th></tr>
<tr><td>1</td><td>Pasture/Range/Paddlock</td><td>Mabella is a CAFO</td></tr>
<tr><td>2</td><td>Daily spread</td><td>Not in accordance with environmental legislation</td></tr>
<tr><td>3</td><td>Solid storage</td><td rowspan="10">Manure management at the barns is made with major water addition. Any movement towards one of these possibilities would require a total change in the animal production management, jeopardizing the sanitary quality of the production and imposing dramatic increments in operation and maintenance labor and costs. Besides these points, none of these solutions can be considered applicable for the Brazilian swine industry.</td></tr>
<tr><td>4</td><td>Dry lot</td></tr>
<tr><td>5</td><td>Liquid/Slurry</td></tr>
<tr><td>6</td><td>Pit storage below animal confinements</td></tr>
<tr><td>7</td><td>Burned for fuel</td></tr>
<tr><td>8</td><td>Cattle and swine deep bedding</td></tr>
<tr><td>9</td><td>Composting - in-vessel</td></tr>
<tr><td>10</td><td>Composting - Static pile</td></tr>
<tr><td>11</td><td>Composting - Intensive windrow</td></tr>
<tr><td>12</td><td>Composting - Passive windrow</td></tr>
<tr><td>13</td><td>Aerobic treatment</td><td>Although it consists in an efficient sole treatment for low-COD wastewater systems, for in natura swine manure treatment, which has high COD content (usually > 25,000 mg/L) and is generated in large volumes, the extremely high costs associtated with required equipment, O&M and energy expenditure make this alternative totally unfeasible and unrealistic as a sole treatment, reason why there is no precedent in industrial swine operations in Brazil. "Aerobic lagoons are considered uneconomical for livestock manure treatment" (Chapter 8.2 in US-EPA, 2001)</td></tr>
<tr><td>14</td><td>Poultry manure with litter</td><td rowspan="2">Not applicable</td></tr>
<tr><td>15</td><td>Poultry manure without litter</td></tr>
</table>

Given the nature of the effluent generated by the swine production at Mabella Diamantino 1, there are 2 plausible scenarios:

1. Uncovered anaerobic lagoons + naturally aerated lagoons (existing AWMS) – the anaerobic treatment of the swine manure in deep open lagoons is the most common practice in the swine industry in Brazil, representing a cost-efficient way to reduce the organic content and contamination potential of the swine manure; this type of treatment allows the application of the resulting effluent on cropland or, if further treated in sequential naturally aerated lagoons (facultative lagoons), disposed on natural water bodies, depending on its standards; since it is perfectly in compliance with the applicable legal and regulatory requirements, continuation of the current practice is a totally

plausible scenario; this practice is the same that is undergoing in the majority of the swine production sites in Brazil.

2. Anaerobic digesters + aerobic lagoons with forced and/or natural aeration (proposed project activity) – despite all the extra benefits that this type of manure management system brings, much beyond the legal and regulatory requirements, the needed investment for this technology is relatively high and swine producers are not likely to invest only for the environmental extra benefits; there is no incentive for the utilization of waste gas for energy generation in Brazil, but the possibility to generate energy from the biogas could stimulate the investment on the installation of anaerobic digesters; against this trend, poor adequate equipment, the high costs of biogas generation units and the high operation and maintenance costs demanded by this type of equipment still do not make this investment attractive enough for the swine industry by itself.

As indicated by ACM0010/Version 5, using Sub-step 1b of the latest version of the "Tool for the demonstration and assessment of additionality", the two above mentioned scenarios are in compliance with CONAMA Resolution 357, from 2005, which is the mandatory regulation.

CDM project activities were not considered in this analysis.

Step 2: Barrier analysis

Project proponents did not identify barriers that could prevent the two identified alternative scenarios from occurring. Therefore, in order to demonstrate that the existing scenario is, in fact, the baseline scenario and that the proposed CDM project activity is additional, the investment analysis was carried out according to the guidelines of ACM0010/Version 5.

Step 3: Investment analysis

The investment analysis of both alternatives clearly indicates that the continuation of the current practice (uncovered anaerobic and naturally aerated lagoons) is much more financially attractive than installing a system with anaerobic digesters and forced aeration lagoons with biogas energy generation.

Since the current AWMS would require no investment to continue its operation, the only parameter to be considered is the cost for operation and maintenance (O&M) of these lagoons. There is no revenue coming from this alternative, so IRR cannot be calculated. In Table 4, the NPV for the continuation of the existing scenario is -R$ 649,245, with a discount rate of 15.71%[6], following Sub-step 2b: Option III – apply benchmark analysis, as described in option "(a) government bond rates, increased by a suitable risk premium to reflect private investment and/or the project type, as substantiated by an independent (financial) expert or documented by official publicly available financial data", of the "*Tool for demonstration assessment and of additionality*", version 05.2. Further, it was assumed an extremely conservative annual O&M cost of R$ 120,000, since this type of waste management system has never demanded dedicated personnel or sophisticated equipment.

[6] All parameters and assumptions used in the investment analysis are based on official historical data, based on the project start date (15 December 2008).

Considering the second alternative, which is the proposed CDM project activity, eliminating the CER component from the financial analysis, the large investments needed to install anaerobic digesters (conservative value), forced aeration lagoons and the biogas electricity generation equipment and the O&M costs result in an NPV equal to -R$ 3,676,119, as shown in Table 5.

For calculation purposes, it has been assumed that the biogas electricity generation will be 18,186 MWh/year, based on the expected production of biogas, being able to supply 100% of the farm electricity consumption (average 2,655 MWh/year, by an average price of R$ 290.23/MWh) and to export 15,531 MWh/year to the grid, at a selling price of R$ 116.14/MWh. As conservative approach, the O&M costs of the AWMS, flare and monitoring systems were estimated in 5% per year of their capital costs (R$ 2,743,903), which is extremely low, considering that only the required labor (5 employees) to operate the project activity will consume about 85% of the O&M budget (R$ 137,195/year). In the case of the generation units, the O&M cost considered is R$ 65/MWh, according to information gathered among different biogas generator suppliers and Silva *et al.*, 2008[6].

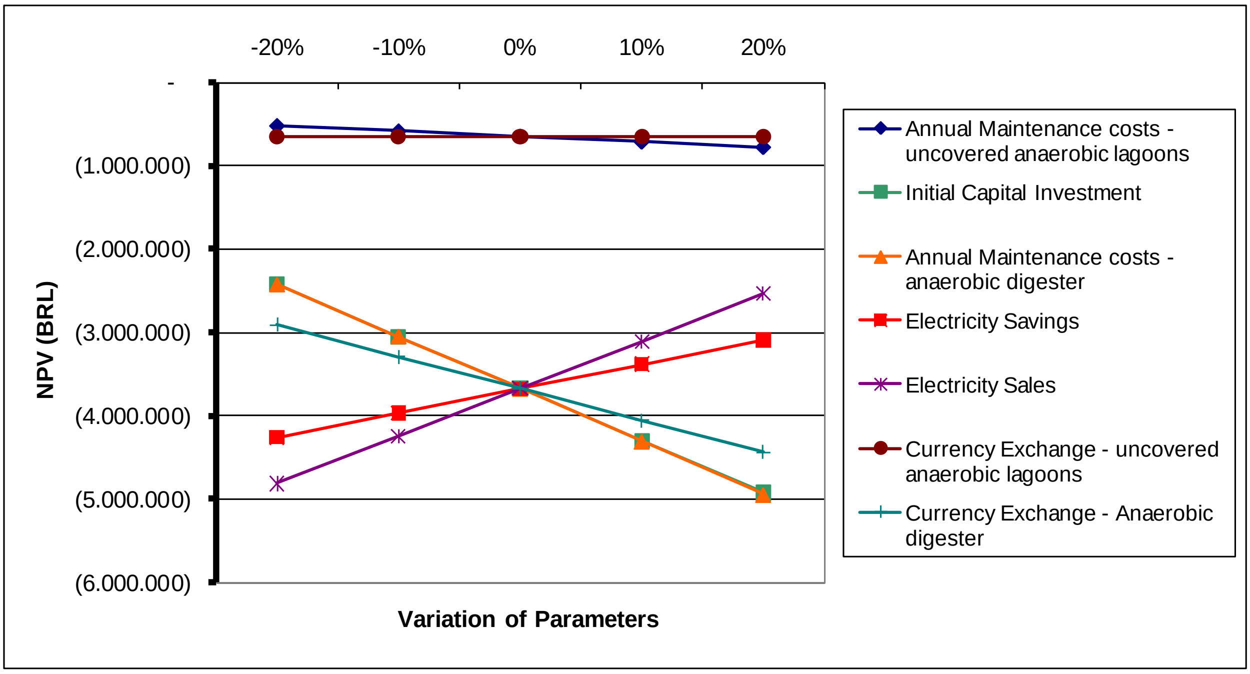
The sensitivity analysis, illustrated in figure 7, shows that in any scenario within a variation of +/- 20% for critical assumptions of the financial analysis (annual maintenance costs for uncovered anaerobic lagoons; initial capital investment; annual maintenance costs for anaerobic digester; electricity savings; electricity sales; currency exchange – uncovered anaerobic lagoons; and currency exchange – anaerobic digester), the maintenance of the existing scenario (uncovered anaerobic lagoons) is more attractive than the project scenario (anaerobic digesters and biogas electricity generation).

The conclusion is that the continuation of the current manure management practice is the most financially attractive alternative, meaning that this must be the considered baseline scenario for the AWMS component and that the proposed project activity is additional.

As for the electricity generation component with recovered methane emissions, based on the low financial attractiveness of the project demonstrated in Table 5, the only realistic and credible scenario without the CDM incentive is the continuation of the current situation: the project host consumes electricity from the grid and no renewable energy generation from the project host affects the emissions of the grid. So, according to AMS I.D./Version 15, “the baseline emissions are the product of electrical energy baseline $EG_{RE,y}$ expressed in kWh of electricity produced by the renewable generating unit multiplied by an emission factor”.

[6] Silva, CL; Rabelo, JM; Bollmann, HA. Energia no lixo: uma avaliação da viabilidade do uso do biogás a partir de resíduos sólidos urbanos. *IV Encontro Nacional da Anppas*, 2008.

Figure 7. Sensitivity analysis



Step 4: Baseline revision at renewal of crediting period

Since the proposed project activity will have a fixed crediting period of 10 years, no baseline revision at renewal of crediting period is needed.

Table 4. Calculation of NPV for the continuation of the current AWMS (uncovered anaerobic lagoons)

COSTS AND BENEFITS (BRL)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Equipment costs													
Uncovered anaerobic lagoons	0	0	0	0	0	0	0	0	0	0	0	0	0
Installation costs	0	0	0	0	0	0	0	0	0	0	0	0	0
Maintenance costs	**120,000**	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
Revenues	0	0	0	0	0	0	0	0	0	0	0	0	0
CASHFLOW	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**	**-120,000**
NPV (BRL); Discount Rate = 15.710%	**-649,245**												

Table 5. Calculation of NPV for project activity (anaerobic digesters + energy generation) without the CER revenue component

COSTS AND BENEFITS (BRL)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Equipment costs													
Anaerobic digester	2,059,516												
Combustion system		397,550											
Monitoring system		286,837											
Biogas power plant		2,400,584	4,607,900										
Maintenance costs		2,059,516	309,774	1,319,270	1,319,270	1,319,270	1,319,270	1,319,270	1,319,270	1,319,270	1,981,649	1,319,270	1,319,270
Revenues													
Value of assets after assessment period													5,319,919
Electricity savings			770,591	770,591	770,591	770,591	770,591	770,591	770,591	770,591	770,591	770,591	770,591
Electricity sales				1,803,670	1,803,670	1,803,670	1,803,670	1,803,670	1,803,670	1,803,670	1,803,670	1,803,670	1,803,670
CASHFLOW	**-2,059,516**	**-5,144,487**	**-4,147,083**	**1,254,991**	**1,254,991**	**1,254,991**	**1,254,991**	**1,254,991**	**1,254,991**	**1,254,991**	**592,611**	**1,254,991**	**6,574,910**
NPV (BRL); Discount Rate = 15.710%	**-3,676,119**												

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

As demonstrated in item B.4. for the baseline scenario identification, the implementation of the proposed project activity – anaerobic digesters and forced aeration lagoon at the swine AWMS at Mabella Diamantino 1, with methane capturing and combustion and renewable energy generation with the recovered methane – will reduce emissions that would occur if the baseline scenario at Mabella Diamantino 1 – AWMS with open anaerobic and aerobic lagoons and electricity consumption from the grid – were to be continued.

Under certain conditions, if correctly designed, uncovered anaerobic lagoons are very efficient in converting organic matter into methane-rich biogas. Methane is an important greenhouse gas, with a global warming potential 21 times greater than carbon dioxide. According to IPCC 2006 guidelines, volume 4, chapter 10, Table 10.17, this type of AWMS, in a tropical region where Diamanatino is, with an annual average temperature of 24.84^{o}C, has a methane conversion factor (MFC) of 79%.

The anaerobic digesters proposed by this CDM project are as effective as open anaerobic lagoons in the methane formation from the swine manure. However, the totality of the methane will be captured by the biodigester covers and burnt in biogas generation units or in a flare, resulting in emissions of carbon dioxide and water, instead of methane, thus greatly reducing the impact of the current swine manure management as a greenhouse gas emitter.

In the case of forced aerated lagoons, the main purpose of the introduction of oxygen in the liquid mass is the degradation of organic matter in aerobic conditions by aerobic microorganisms. The resulting gas of this treatment process is basically CO_2. IPCC guidelines specify emissions from aerobic lagoons as 0.1% of total methane generating potential of the waste processed, which can be used as a default for all types of aerobic AWMS treatment.

Emissions of N_2O are reduced in the anaerobic digesters and in the aerobic lagoons with forced aeration. In the anaerobic digester, with a cover in place, ammonia volatilization losses are eliminated, leaving only settling and precipitation as pathways for N loss (US EPA 2001, chapter 8.2, page 8-70). In aerobic digestion, total N reduction can also be substantial, with either ammonia stripping or nitrification-denitrification serving as the primary mechanism, depending on the dissolved oxygen concentration of the mixed liquor (US-EPA 2001, chapter 8.2, page 8-77). Further, limited oxidation in facultative lagoons may increase emissions compared to forced aeration systems (Table 10.21, 2006 IPCC Guidelines).

Additionally, by displacing electricity that would be supplied by the grid, the energy generation with the recovered methane at Mabella Diamantino 1 will reduce emissions caused by the electricity generation in fossil fuel-based power plants connected to the grid. According to official data supplied by the Brazilian Ministry of Science and Technology (MCT, http://www.mct.gov.br/index.php/content/view/74689.html) , the Brazilian grid emission factor was 0.1635 tons of CO_2 per MWh, based on available data from 2009 (please, refer to Table 29).

"The Interministerial Commission on Global Climate Change (CIMGC), in its 43rd meeting on 29 April 2008, (…) decided to adopt a SINGLE SYSTEM as the pattern for CDM projects using the tool for

calculating emission factors associated with the ACM0002 methodology to estimate their greenhouse gas reductions" (MCT, http://www.mct.gov.br/upd_blob/0024/24834.pdf).

"The CO_2 emission factors calculated according to the methodological 'Tool to calculate the emission factor for an electricity system' approved by the CDM Executive Board are intended to estimate the contribution in reducing CO_2 emissions, of a CDM project that generates electricity for the grid. Briefly, the emission factor of the grid for the CDM is a combination of the emission factor of the operating margin, which reflects the intensity of CO_2 emissions from energy dispatched at the margin, with the emission factor of the building margin, which reflects the intensity of CO_2 emissions from power plants built last. It is an algorithm widely used to quantify the contribution of a future power plant that will generate electricity for the network in terms of reducing CO_2 emissions for a baseline scenario. This factor serves to quantify the issue that is being displaced at the margin. Its usefulness is related to CDM projects, and applies only for estimating the certified emission reductions (CERs) for CDM projects" (MCT, http://www.mct.gov.br/index.php/content/view/74689.html).

Thus, by introducing carbon-neutral electricity to the grid, generated with biogas from Mabella Diamantino 1 AWMS, the proposed project effectively reduces greenhouse gas emissions.

As the PDD has been published for global stakeholder consultation on 25/09/2008 and, therefore, before the project start date, the project is in compliance with Annex 22 of EB 49 – Guidelines on the demonstration and assessment of prior consideration of CDM.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

For calculation purposes, the average population and feed intake figures, divided by animal category, of the last 12 available months were considered (Table 6.). Data was obtained from Mabella Diamantino 1 official accounting reports, which are generated with PigChamp reports and a internal report called "*Boletim Mensal*".

Swine animal categories are defined according to table 10.1 from 2006 IPPC Guidelines. Energy digestibility indexes for each animal category are the average of the numbers indicated in table 10.2 from the same source, in order to reflect the Brazilian industry standards.

Table 6. Average swine population and feed intake at Mabella Diamantino 1, by category

Animal Data			
Category	Average Population in the Year	Average Feed Intake (kg/hd/day)	Digestibility
Sows	10,899	2.68	75%
Gilts	1,539	2.93	75%
Boars	119	1.13	75%
Nursers	30,013	1.33	85%
Finishers	69,586	1.96	85%

http://www.cnpsa.embrapa.br/SP/suinos/nutricao.html

http://www.nap.edu/catalog.php?record_id=6016

2006 IPCC Guidelines for National Greenhouse Gas Inventories

TABLE 10.1 REPRESENTATIVE LIVESTOCK CATEGORIES

TABLE 10.2 REPRESENTATIVE FEED DIGESTIBILITY FOR VARIOUS LIVESTOCK CATEGORIES

I. AWMS COMPONENT

For the AWMS component, following ACM0010/Version 5, emission reductions $ER_{AWMS,y}$ by the project activity during a given year *y* are the difference between the baseline emissions (BE_y) and the sum of project emissions (PE_y) and Leakage, as follows:

$$ER_{AWMS,y} = BE_y - PE_y - LE_y$$

Where:

$ER_{AWMS,y}$	Emission reductions from AWMS component in year *y*, in tCO_2e/year
BE_y	Baseline emissions from AWMS component in year *y*, in tCO_2e/year
PE_y	Project emissions from AWMS component in year *y*, in tCO_2e/year
LE_y	Net leakage of N_2O and CH_4 from AWMS component in year y, in tCO_2e/year

For calculation purposes, the average population and feed intake figures, divided by animal category, of the last 12 available months were considered. Data was obtained from Mabella Diamantino 1 official accounting reports, which are generated with PigChamp reports. PigChamp is the software used by Mabella Diamantino 1 to manage the entire swine activity.

1. **Baseline emissions**

For the AWMS component of the project, baseline emissions are calculated by the sum of methane emissions, nitrous oxide emissions and emissions from electricity and/or heat used by the baseline scenario, all in tones of CO_2e per year, as shown in the following formula. This last baseline emission source ($BE_{elec/heat}$) has been excluded from the calculation, since the existing AWMS does not have electricity or heat consumption.

$$BE_y = BE_{CH4,y} + BE_{N2O,y} + BE_{elec/heat,y}$$

a) **Methane emissions**

Methane emissions from the baseline scenario are calculated according to the amount of volatile solids produced by the swine population and sent to the existing AWMS (open anaerobic lagoons). The calculation is made according to the formula below.

$$BE_{CH4,y} = GWP_{CH4} \cdot D_{CH4} * \sum_{j,LT} MCF_j * B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_{Bl,j}$$

Where:

$BE_{CH4,y}$	The annual baseline methane emissions in t CO_2e/y
GWP_{CH4}	Global Warming Potential (GWP) of CH_4 (21)
D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20ºC) and 1 atm pressure)
MCF_j	Annual methane conversion factor (MCF) for the baseline AWMSj from IPCC 2006 table 10.17, chapter 10, volume 4 (79% for uncovered lagoons at 24.84ºC average annual temperature). A conservativeness factor should be applied by multiplying MCF values (estimated as per above bullet) with a value of 0.94, to account for the 20% uncertainty in the MCF values as reported by IPCC 2006.
$B_{0,LT}$	Maximum methane producing potential of the volatile solid generated, in m^3CH_4/kg_dm, by animal type LT; the North American default value 0.48 m^3CH_4/kg_dm, from IPCC 2006 tables 10 A-7 and 10 A-8, chapter 10, volume 4, has been adopted, considering that: 1) the swine genetic adopted by Mabella Diamantino 1 is Agroceres PIC, which has an international genetic pool, originated from several Annex I countries; 2) average weights of Mabella's animals (over 46 kg for market swine and over 260 kg for breeding swine) are larger than the IPCC standards for both breeding and market categories in North America and Europe; 3) as validated from the farms reports, animals are fed with formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;

4) the basic components of the FFR are soybean and corn, similar to swine formulated feeds in North American countries.[7]

N_{LT}	Annual Average number of animals of type LT for the year y, expressed in numbers.
$VS_{LT,y}$	Annual volatile solid for livestock LT entering all AWMS [on a dry matter weight basis (kg-dm/animal/year), as estimated below
$MS\%_{Bl,j}$	Fraction of manure handled in system j, which is 100%
LT	All types of livestock

As country specific data is not available, volatile solid excretion is estimated following the second option indicated by ACM0010, based on site specific livestock feed intake, with the formula below:

$$VS_{LT,y} = \left[GE_{LT} * \left(1 - \frac{DE_{LT}}{100} \right) + \left(UE * GE_{LT} \right) \right] * \left[\left(\frac{1 - ASH}{ED_{LT}} \right) \right] * nd_y$$

Where:

$VS_{LT,y}$	Annual volatile solid excretions on a dry matter weight basis (kg-dm/year)
GE_{LT}	Daily average gross energy intake in MJ/day, obtained by multiplying the energy density (18.45 MJ/kg DM) by the average daily feed intake of livestock LT[8]
DE_{LT}	Digestible energy of the feed in percent. IPCC 2006 defaults indicate growing swine animals vary digestibility from 80% to 90% and mature swine animals from 70% to 80%. Considering the technical available information from Agroceres PIC and from the Brazilian swine market, an average value has been adopted for each one of the animal classes
$UE*GE_{LT}$	Urinary energy expressed as fraction of GE. Typically 0.04GE can be considered urinary energy excretion by most ruminants (reduce to 0.02 for ruminants fed with 85% or more grain in the diet or for swine). Use country-specific values where available

[7] According to ACM0010, "developed countries $B_{0,LT}$ values can be used provided the following conditions are satisfied:

- The genetic source of the production operations livestock originate from an Annex I Party;
- The farm use formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;
- The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);
- The project specific animal weights are more similar to developed country IPCC default values."

[8] Average feed intake data is acquired from official Mabella's activity reports.

ASH	Ash content of manure calculated as a fraction of the dry matter feed intake. Use country-specific values where available
ED_{LT}	Energy density of the feed in MJ/kg (IPCC notes the energy density of feed, ED, is typically 18.45 MJ/kg DM, which is relatively constant across a wide variety of grain-based feeds.) fed to livestock type LT. The project proponent will record the composition of the feed to enable the DOE to verify the energy density of the feed
nd_y	Number of days in year *y* where the treatment plant was operational (considered 365 days, since the swine operation works all year round)

b) Nitrous oxide emissions

Continuing the calculation of the baseline emissions, the next item is the baseline N_2O emissions, calculated by the following formulas:

$$BE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} .(E_{N2O,D,y} + E_{N2O,ID,y})$$

Where:

$BE_{N2O,y}$	Annual baseline N_2O emissions in t CO_2e/yr
GWP_{N2O}	Global Warming Potential (GWP) for N_2O (310)
$CF_{N2O-N,N}$	Conversion factor N_2O-N to N_2O (44/28)
$E_{N2O,D,y}$	Direct N_2O emission in kg N_2O-N/year, calculated below
$E_{N2O,ID,y}$	Indirect N_2O emission in kg N_2O-N/year, calculated below

$$E_{N2O,D,y} = \sum_{j,LT} (EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_{Bl,j})$$

Where:

$E_{N2O,D,y}$	Direct nitrous oxide emissions in kg of N_2O per year
$EF_{N2O,D,j}$	Direct N_2O emission factor for the treatment system j of the manure management system in kg N_2O-N/kg N (for uncovered anaerobic lagoons, the default EF_3 is zero and, for aerobic lagoons with natural aeration, is 0.01; from table 10.21, chapter 10, volume 4, in the IPCC 2006 Guidelines for National Greenhouse Gas Inventories)
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year, estimated as the below calculation

$MS\%_{Bl,j}$	Fraction of manure handled in system j, in % (100% for all systems)
N_{LT}	Annual Average number of animals of type LT for the year *y* estimated as per equation (5.a) or (5.b), expressed in numbers

Total direct N_2O emissions are the sum of N_2O emissions from the anaerobic lagoons (that result in zero emissions) and from the facultative lagoons.

$$E_{N2O,ID,y} = \sum_{j,LT} (EF_{N2O,ID,j} \cdot F_{gasm} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_{Bl,j})$$

Where:

$E_{N2O,ID,y}$	Indirect nitrous oxide emissions in kg of N_2O per year
$EF_{N2O,ID,j}$	Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N/kg NH_3-N and NOx-N emitted (for both uncovered anaerobic lagoons and facultative lagoons, 0.01 kg N_2O-N/kg N is the default value for EF_4 from table 11.3, chapter 11, volume 4 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories)
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year, estimated as the below calculation
$MS\%_{Bl,j}$	Fraction of manure handled in system j (100% for all systems)
F_{gasm}	Percent of managed manure nitrogen for livestock category that volatilizes as NH_3 and NOx in the manure management system; for uncovered anaerobic lagoons for swine manure, the default value for F_{gasm} is 40%, from table 10.22, chapter 10, volume 4 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories; given there are no country specific data nor IPCC default value for aerobic lagoons with natural aeration, also the default value of 40% for anaerobic lagoons were used (Table 10.22, chapter 10, volume 4, IPCC 2006 Guidelines);
N_{LT}	Annual Average number of animals of type LT for the year y estimated as per equation (5.a) or (5.b), expressed in numbers

Total indirect N_2O emissions is the sum of N_2O emissions from the anaerobic lagoons and facultative lagoons (aerobic lagoons with natural aeration).

For both direct and indirect N_2O emission calculations, for the subsequent treatment stage (facultative lagoons, considered aerobic lagoons with natural aeration), the reduction of the nitrogen during a treatment stage is estimated based on referenced data for different treatment types, according to Chapter 8.2 in US-EPA (2001). Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stage (uncovered anaerobic lagoons) by multiplying by

(1 - R_N), where R_N is the relative reduction of nitrogen from the previous stage. The default R_N for uncovered anaerobic lagoons is 0.5, obtained from Annex 1 of ACM0010/Version 5.

$$NEX = N_{intake} * (1 - N_{retention})$$

Where:

N_{intake}	The annual N intake per animal – kg N/animal-year, as calculated below
$N_{retention}$	The portion of that N intake that is retained in the animal. (Default value value is 0.3 from Table 10.20 in IPCC 2006 guidelines, volume 4, chapter 10)

$$N_{intake} = \left(\frac{GE}{18.45}\right) * \left(\frac{CP/100}{6.25}\right)$$

Where:

CP	Crude percent of protein. Using values from Agroceres PIC[9], average crude protein content for sows is 17% and for gilts is 17%. Embrapa[10] indicates that the conservative CP content for nursery growing pigs is 17% and for fattening pigs 14%. NRC swine 1998[11] says that boars feed should have minimum of 13% CP in their diet.
GE	Gross energy intake of the animal, in enteric model, obtained by multiplying the energy density (18.45 MJ/kg DM) by the average daily feed intake of livestock LT
18.45	Conversion factor for dietary GE per kg of dry matter (MJ/kg). This value is relatively constant across a wide range of forage and grain-based feeds commonly consumed by livestock
6.25	Conversion from kg of dietary protein to kg of dietary N, kg feed protein (kg $N)^{-1}$

2. Project emissions

As the project activity includes the anaerobic digesters, the forced aeration lagoons and the facultative lagoons as the components of the AWMS, project emissions are related to the 3 stages and are calculated according to the following formula:

[9] Agroceres PIC *Female Management Guidelines* (http://www.agrocerespic.com.br/images/arqDownload/15guia_manejo1.pdf)
[10] Embrapa nutritional guidelines for swine production (http://www.cnpsa.embrapa.br/SP/suinos/nutricao.html)
[11] *NRC Swine Nutrient Requirements 1998* (http://www.nap.edu/catalog.php?record_id=6016)

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{PL,y} + PE_{flare,y} + PE_{elec/heat}$$

Where:

$PE_{AD,y}$	Leakage from AWMS systems that capture's methane in t CO2e/yr
$PE_{Aer,y}$	Methane emissions from AWMS that aerobically treats the manure in t CO2e/yr
$PE_{N2O,y}$	Nitrous oxide emission from project manure waste management system in t CO2e/yr
$PE_{PL,y}$	Physical leakage of emissions from biogas network to flare the captured methane or supply to the facility where it is used for heat and/or electricity generation in t CO_2e/yr
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in t CO2e/yr
$PE_{elec/heat}$	Project emissions from use of heat and/or electricity in the project case in t CO_2e/yr

a) Leakage from AWMS that captures methane

The leakage from the anaerobic digesters is calculated according to the following formula:

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \sum_{LT} (B_{0,LT} * N_{LT} * VS_{LT,y})$$

Where:

D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure)
LF_{AD}	Methane leakage from Anaerobic digesters, default of 0.15[12]

[12] The default value for leakage from digesters - 0.15 - has been adopted due to the difficulty to measure the biogas leaks during monitoring. But it is PPs understanding that this is a too conservative (high) value, considering that other approved consolidated baseline methodology – ACM0014 – establishes for the same parameter (leaks from the digester) a default value of 0.05 and that the features of the proposed project for Mabella Diamantino I, such as:

- the chosen biodigester technology and materials (EPDM), after fully assembled, offer complete sealing between the cover and the liner, avoiding physical leakage.
- due to the corrective and preventive maintenance plans, any event that prevents the biogas from being captured and/or burnt shall be solved in less than 24 hours.
- the biodigester technology applied in the proposed project activity is basically the addition of a biogas capturing structure (EPDM cover), with no heating, therefore it should not significantly improve the methane conversion capacity of the existing AWMS (well managed open anaerobic lagoons).
- furthermore, when fully installed, the project will have complete redundancy, resulting in a capacity to burn the double of the expected volume of biogas to be produced by the digesters. So, the inability to combust methane by the project activity will be extremely rare.

F_{AD}	Fraction of volatile solid directed to anaerobic digester
LT	Index for livestock type
$B_{0,LT}$	CH_4 production capacity from manure for livestock type LT, in m^3 CH_4/kg-VS; value is the same one used to calculate baseline methane emissions
N_{LT}	Annual average number of animals of type LT for the year *y*
$VS_{LT,y}$	Annual volatile solid excretion of livestock type LT on a dry-matter basis in kg/animal/year; values used are the same as those calculated for baseline methane emissions
$MS\%_j$	Fraction of manure handled in system j

b) Methane emissions from aerobic treatment

For the aerobic treatment phase of the AWMS (with forced and natural aeration), methane emissions are calculated according to the following formula:

$$PE_{Aer,y} = GWP_{CH4} \cdot D_{CH4} * 0.001 * F_{Aer} * \left[\prod_{n=1}^{N} (1 - R_{VS,n}) \right] * \sum_{j,LT} (B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j) + PE_{Sl,y}$$

Where:

$R_{VS,n}$	Fraction of volatile solid degraded in AWMS treatment method *n* of the N treatment steps prior to waste being treated in aerobic lagoon
D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure)
F_{Aer}	Fraction of volatile solid directed to aerobic system
LT	Index for livestock type
$B_{0,LT}$	CH_4 production capacity from manure for livestock type LT, in m^3 CH_4/kg-VS; value is the same one used to calculate baseline methane emissions
N_{LT}	Annual average number of animals of type LT for the year *y*
$VS_{LT,y}$	Annual volatile solid excretion of livestock type LT on a dry-matter basis in kg/animal/year; values used are the same as those calculated for baseline methane emissions
$PE_{Sl,y}$	CH_4 emissions from sludge disposed of in storage pit prior to disposal during the year *y*, expressed in tons of CO_2e /yr,
$MS\%_j$	Fraction of manure handled in system j

c) Nitrous oxide emissions

Project nitrous oxide emissions are calculated in the same way of baseline nitrous oxide emissions, using the same formulas:

$$PE_{N2O,y} = GWP_{N2O} * CF_{N2O-N,N} * \frac{1}{1000} * (E_{N2O,D,y} + E_{N2O,ID,y})$$

$$E_{N2O,D,y} = \sum_{j,LT} (EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_{Bl,j})$$

$$E_{N2O,ID,y} = \sum_{j,LT} (EF_{N2O,ID,j} \cdot F_{gasm} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_{Bl,j})$$

For both direct and indirect project N_2O emission calculations, for the subsequent treatment stages after the anaerobic digesters (aerobic lagoons with forced and natural aeration), the reduction of the nitrogen during a treatment stage is estimated based on referenced data for different treatment types, according to Chapter 8.2 in US-EPA (2001). Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stage by multiplying by (1 - R_N), where R_N is the relative reduction of nitrogen from the previous stage. The default R_N for anaerobic digesters is 0.25 and for aerobic lagoons with forced aeration is 0.7, obtained from Annex 1 of ACM0010/Version 5.

d) Physical Leakage from distribution network of the captured methane

According to ACM0010/Version 5, physical leakage refers to leaks in the biogas system from the biogas pipeline delivery system. The sum of the quantities of captured methane fed to the flare and to the power plant (measured as per the monitoring plan) must be compared annually with the total methane generated as measured by meter at the outlet of the methane generating digester. The difference between the monitored value of methane generated and that consumed in flare/electricity generation/heat shall be accounted as leakage from the pipelines.

The physical leakage from the biogas pipeline is considered zero for *ex-ante* calculation purposes. During the project monitoring period, the actual leakage shall be measured as mentioned above.

e) Project emissions from flaring of the residual gas stream

Combustion of the biogas will occur mainly in the biogas generator sets, when the biogas power plant is fully installed. According to the methodological “Tool to determine project emissions from flaring gases containing methane”, “the biogas flow to electricity or heat equipment in a moment can be considered destroyed, by monitoring that the equipment was working at this time”.

Less than 10% of the biogas is expected to be directed to be combusted by the flare during the project lifetime, since the great majority of the biogas will be gainfully used for electricity

generation, i.e., only the exceeding volume will be directed to be burnt by the flare. Considering that the second phase generation equipment is sized to consume all the biogas, the flare is expected to serve only as a backup, during maintenance of the biogas power plant. According to the enclosed flare manufacturer specifications (BTS Termodinâmica de Sistemas Ltda.), the methane destruction efficiency of the flare is at least 98%[13], value that has been conservatively adopted for *ex-ante* calculation purposes.

As per ACM0010, project emissions from flaring of the residual gas stream ($PE_{flare,y}$) should be determined following the procedure described in the "Tool to determine project emissions from flaring gases containing Methane". This tool also provides procedures to determine the flare efficiency in hour *h* based on measurements or default values ($\eta_{flare,h}$). The following data is required by this tool:

Parameter	SI Unit	Description
$fv_{i,h}$	-	Volumetric fraction of component *i* in the residual gas in the hour *h* where i = CH_4, CO, CO_2, O_2, H_2, N_2
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal (NTP) conditions[2] in the hour *h*
$t_{O2,h}$	-	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h* (only in case the flare efficiency is continuously monitored)
$fv_{CH4,FG,h}$	mg/m^3	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h* (only in the case the flare efficiency is continuously monitored)
T_{flare}	°C	Temperature in the exhaust gas of the enclosed flare
		Any other parameters required to monitor proper operation of the flare according to the manufacturer's specification (only in the case of use of a default value for the flare efficiency of enclosed and open flares)

According to the baseline methodology procedures provided by the tool, "project emissions from flaring of the residual gas stream are calculated based on the flare efficiency and the mass flow rate of methane in the residual gas stream that is flared. The flare efficiency depends on both the actual efficiency of combustion in the flare and the time that the flare is operating. The efficiency of combustion in the flare is calculated from the methane content in the exhaust gas of the flare, corrected for the air used in the combustion process, and the methane content in the residual gas".

This tool involves the following seven steps:

STEP 1: determination of the mass flow rate of the residual gas that is flared;

STEP 2: determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas;

STEP 3: determination of the volumetric flow rate of the exhaust gas on a dry basis;

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[13] According to Technical Proposal from the flare manufacturer BTS Termodinâmica de Sistemas Ltda. (S2913T Rev.05)

STEP 4: determination of methane mass flow rate of the exhaust gas on a dry basis;

STEP 5: determination of methane mass flow rate of the residual gas on a dry basis;

STEP 6: determination of the hourly flare efficiency;

STEP 7: calculation of annual project emissions from flaring based on measured hourly values or based on default flare efficiencies.

These steps are to be used in order to calculate *ex-post* $PE_{flare,y}$ based on the measured hourly flare efficiency or based on the default values for $\eta_{flare,h}$. The calculation procedure determines the flow rate of methane before and after the destruction in the flare, taking into account the amount of air supplied to the combustion reaction and the exhaust gas composition (oxygen and methane). The flare efficiency is calculated for each hour of a year based either on measurements or default values plus operational parameters. Project emissions are determined by multiplying the methane flow rate in the residual gas with the flare efficiency for each hour of the year.

For the calculation of the *ex-ante* annual mass flow of methane ($TM_{,y}$), the below formula was created, considering the difference between the annual methane baseline emissions and the annual methane project emissions due to leakage from the anaerobic digester, both in tCO_2e, which is multiplied by the fraction of methane that is expected to be combusted by the flare, divided by the methane global warming potential and multiplied by 1,000, resulting in the annual methane mass flow in kg.

$$TM_y = (BE_{CH4,y} - PE_{AD,y}) * F_{flare} / GWP_{CH4} * 1000$$

Where:

$TM_{,y}$	Mass flow of methane in the year *y*
$BE_{CH4,y}$	The annual baseline methane emissions in t CO_2e/y
$PE_{AD,y}$	Leakage from AWMS systems that capture's methane in t CO_2e/yr
F_{flare}	Fraction of methane directed to be combusted by the flare

Further, $\eta_{flare,h}$ is conservatively considered to be 98%, as previously explained.

Finally, with estimated and assumed values for $TM_{,y}$ and $\eta_{flare,h}$, $PE_{flare,y}$ can be calculated using the adapted formula from Step 7 of the methodological "Tool to determine project emissions from flaring gases containing methane":

$$PE_{flare,y} = TM_y * (1 - \eta_{flare,h}) * \frac{GWP_{CH4}}{1000}$$

Where:

$PE_{flare,y}$	Methane emissions from combustion of the residual gas stream in the flare, in year *y*, in tCO_2e/year
$TM_{,y}$	Mass flow of methane in the year *y*
$\eta_{flare,y}$	Flare efficiency (98%)

3. **Leakage**

According to ACM0010, "Leakage covers the emissions from land application of treated manure, outside the project boundary. These emissions are estimated as net of those released under project activity and those released in the baseline scenario. Net leakage of N_2O and CH_4 are only considered if they are positive."

The formula supplied by the methodology to calculate leakage is:

$$LE_y = (LE_{P,N2O} - LE_{B,N2O}) + (LE_{P,CH4} - LE_{B,CH4})$$

Where:

$LE_{P,N2O}$	N_2O emissions released during project activity from land application of the treated manure, in tCO_2e/year
$LE_{B,N2O}$	N_2O emissions released during baseline scenario from land application of the treated manure, in tCO_2e/year
$LE_{P,CH4}$	CH_4 emissions released during project activity from land application of the treated manure, in tCO_2e/year
$LE_{B,CH4}$	CH_4 emissions released during baseline scenario from land application of the treated manure, in tCO_2e/year

Considering that the current practice for land application (fertirrigation on cropland) of the treated manure and the sludge at Mabella Diamantino 1 will remain basically the same after the installation of the proposed project activity, all parameters for both baseline and project emissions are the same, resulting in zeroed net leakage of N_2O and CH_4. Therefore, the remaining calculations for leakage were excluded for simplification.

II. RENEWABLE ENERGY COMPONENT

Biogas generation plant sizing and calculations

For *ex-ante* calculation purposes, it has been considered that the proposed project activity will have a 2.076 MWe biogas generation plant that will operate continuously. This power plant size was calculated based on: 1) the daily methane availability from the AWMS; 2) the methane heat value and; 3) the expected electricity output from biogas internal combustion engine generation groups.

The daily methane availability was calculated based on the baseline methane emissions (67,501.33 tCO2/year), by simply dividing it by GWP_{CH4} (21), by D_{CH4} (0.00067 t/m^3) and by 365 days/year, which results in 13,144 m^3 of methane per day (547.67 m^3/h).

According to the US-EPA[14], the methane heat value is 10.48 kWh/m^3.

Also, according to the biogas generator's supplier, to provide 1,038 kW of electricity output, the equipment fuel consumption is 2,717 kW. Therefore, the efficiency rate of the equipment is 38.2 % (1,038 kW / 2,717 kW = 0.382).

Thus, a 24-h/day biogas power plant with these parameters (547.67 m^3/h x 10.48 kWh/m^3 x 38.2%) would allow a plant with around 2,192 kW power capacity (2,076 kW when adjusted to fit the equipment characteristics available at the supplier - 2 sets of 1,038 kW).

Finally, to estimate the electricity generation potential for *ex-ante* calculations, it has been conservatively considered the full time operation of the biogas power plant per year (8,760 hs/year), disregarding maintenance stops of the biogas engines.

Baseline emissions

For the renewable electricity generation component, according to AMS I.D./Version 15, "the baseline emissions are the product of electrical energy baseline $EG_{RE,y}$ expressed in kWh of electricity produced by the renewable generating unit multiplied by an emission factor", which is represented by the formula below.

$$BE_{RE,y} = EF_{grid,CM,y} * EG_y$$

Where:

$BE_{RE,y}$	Baseline emissions from the grid, in tCO_2
$EF_{grid,CM,y}$	Grid combined margin emission factor in year y, in tCO_2/MWh
EG_y	Electricity exported to the grid in year y, in MWh

The Brazilian Designated National Authority (DNA), presided by the Ministry of Science and Technology, have defined that, for CDM purposes, Brazil has a single electric connected system, the National Interconnected System (SIN). Option (a) of paragraph 9 of AMS I.D., which says that "a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the 'Tool to calculate the emission factor for an electricity system'", has been chosen to calculate the grid emission coefficient for this project activity. Both emission factors for OM and BM are supplied by the Brazilian National Operator of the Electric System (ONS).

[14] http://www.epa.gov/lmop/res/converter.htm

The combined margin emission coefficient is calculated according to the “Tool to calculate the emission factor for an electricity system”, version 2, using the formula below:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:

$EF_{grid,BM,y}$ Build margin CO_2 emission factor in year y (tCO_2/MWh). The 2009 value 0.0794 tCO_2/MWh, has been used for *ex-ante* calculation purpose

$EF_{grid,OM,y}$ Operating margin CO_2 emission factor in year y (tCO_2/MWh). Given that the Brazilian ONS calculates this emission factor based on dispatch data analysis OM (option “c” of the step 3 – select an operating margin (OM) method, from the “Tool to calculate the emission factor for an electricity system”, version 02), the value from the last available full year (2009), 0.2476 tCO_2/MWh, has been used for *ex-ante* calculation purpose

w_{OM} Weighting of operating margin emissions factor. According to the “Tool to calculate the emission factor for an electricity system”, 0.5 is the indicated value for this type of project

w_{BM} Weighting of build margin emissions factor. According to the “Tool to calculate the emission factor for an electricity system”, 0.5 is the indicated value for this type of project

In this project, according to the “Tool to calculate the emission factor for an electricity system”, version 02, the operating margin (OM) emission factor will be calculated *ex-post*, using the year in which the project activity displaces grid electricity and updating the emission factor annually during monitoring. The build margin (BM) emission factor is calculated *ex-ante*, “based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation”. Thus, the combined margin emission coefficient will be calculated *ex-post* during the entire crediting period of the proposed project activity.

Considering that emissions from electricity generation with renewable sources, such as the biogas from animal waste management, are zero, emission reductions from this project are equal to the baseline emissions, as shown in following formula:

$$ER_{RE,y} = BE_{RE,y} - PE_{RE,y}$$

Where:

$ER_{RE,y}$ Emission reductions from the renewable energy component in year *y*, in tCO_2/year

$BE_{RE,y}$ Baseline emissions from the grid in year *y*, in tCO_2/year

$PE_{RE,y}$ Project emissions from biogas energy generation in year *y*, in tCO_2/year

III. TOTAL EX-ANTE EMISSION REDUCTIONS

This is basically the sum of the emission reductions from the AWMS component and from the renewable energy component.

$$ER_y = ER_{AWMS,y} + ER_{RE,y}$$

Where:

ER_y Total project emission reductions in the year y, in tCO_2/year

$ER_{AWMS,y}$ Emission reductions from AWMS component in year *y*, in tCO_2/year

$ER_{RE,y}$ Emission reductions from renewable energy component in year *y*, in tCO_2/year

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential for CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	---

Data / Parameter:	**D_{CH4}**
Data unit:	t/m^3
Description:	Density of methane
Source of data used:	Technical literature
Value applied:	0.00067
Justification of the choice of data or	0.00067 t/m^3 at room temperature 20^oC and 1 atm pressure

description of measurement methods and procedures actually applied :	
Any comment:	---

Data / Parameter:	**$MS\%_{Bl,j}$**
Data unit:	Percent
Description:	Fraction of manure handled in system *j* in the baseline scenario
Source of data used:	Project proponents
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied :	---
Any comment:	---

Data / Parameter:	**ED_{LT}**
Data unit:	MJ/kg DM
Description:	Energy density of feed fed to livestock type LT
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	18.45
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to IPCC notes, cited in ACM0010, energy density of feed is typically 18.45 MJ/kg DM, which is relatively constant across a wide variety of grain-based feeds.
Any comment:	---

Data / Parameter:	**DE_{LT}**
Data unit:	%
Description:	Digestible energy of the feed

Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	Growing swine – 85% Mature swine – 75%
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC 2006 defaults indicate growing swine digestibility varies from 80 to 90% and mature swine's from 70 to 80%. Mid-term values were used based on technical available information from Agroceres PIC and from the Brazilian swine market.
Any comment:	---

Data / Parameter:	**UE**
Data unit:	Fraction
Description:	Urinary energy expressed as fraction of GE
Source of data used:	ACM0010/Version 5
Value applied:	Growing swine – 0.02
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to ACM0010/Version 5, the value for ruminants fed with 85% or more grain in the diet or for swine is 0.02
Any comment:	---

Data / Parameter:	$\mathbf{nd_y}$
Data unit:	Number
Description:	Number of days treatment plant was operational in year *y*
Source of data used:	Project proponent
Value applied:	365
Justification of the choice of data or description of measurement methods and procedures actually applied :	The swine operation works all year round
Any comment:	---

Data / Parameter:	**GWP_{N2O}**
Data unit:	tCO_2e/tN_2O
Description:	Global warming potential for N_2O
Source of data used:	IPCC
Value applied:	310
Justification of the choice of data or description of measurement methods and procedures actually applied :	310 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	---

Data / Parameter:	**$CF_{N2O-N,N}$**
Data unit:	---
Description:	Conversion factor N_2O-N to N_2O = 44/28
Source of data used:	Technical literature
Value applied:	44/28 = 1.57
Justification of the choice of data or description of measurement methods and procedures actually applied :	Archive electronically during project plus 5 years
Any comment:	---

Data / Parameter:	**$EF_{N2O,D}$**
Data unit:	kg N_2O-N/kg N
Description:	Direct N_2O emission factor for the treatment system of the manure management system
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Value applied:	Uncovered anaerobic lagoons – 0

	Aerobic lagoons with natural aeration – 0.01
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default EF_3 from table 10.21, chapter 10, volume 4, in the IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Any comment:	---

Data / Parameter:	**$EF_{N2O,ID}$**
Data unit:	kg N_2O-N/kg N
Description:	Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	Uncovered anaerobic lagoons and aerobic lagoons with natural aeration – 0.01
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default values for EF_4 from table 11.3, chapter 11, volume 4 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Any comment:	---

Data / Parameter:	**F_{gasm}**
Data unit:	%
Description:	Percent of managed manure nitrogen for livestock category that volatilizes as NH_3 and NOx in the manure management system
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	Uncovered anaerobic lagoons for swine manure – 40 Aerobic lagoons, with natural aeration – 40 Anaerobic digesters – 0 Aerobic lagoons, with forced aeration – 40

Justification of the choice of data or description of measurement methods and procedures actually applied :	For uncovered anaerobic lagoons, default value for F_{gasm} from table 10.22, chapter 10, volume 4 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories. Due to the lack of country specific data or IPCC default values for aerobic lagoons with forced and/or natural aeration, the default value of 40% for F_{gasm} for anaerobic lagoons (table 10.22, chapter 10, volume 4 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories) has been used, as a conservative approach, given it results in a lower N_2O emission reductions. For anaerobic digesters, according to Chapter 8.2 in US-EPA (2001), "a covered lagoon will not lose NH_3-N to the atmosphere", then F_{gasm} has been considered zero.
Any comment:	

Data / Parameter:	$\mathbf{N_{retention}}$
Data unit:	Fraction
Description:	Portion of N_{intake} that is retained in the animal
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, volume 4, chapter 10
Value applied:	0.3
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value is zero from Table 10.20
Any comment:	---

Data / Parameter:	$\mathbf{R_N}$
Data unit:	Fraction
Description:	N degradation factor of previous treatment system
Source of data used:	Annex 1 of ACM0010/Version 5, Chapter 8.2 in US-EPA (2001)
Value applied:	Anaerobic lagoons – 0.5

	Anaerobic digesters – 0.25 Conventional aerobic lagoons – 0.70
Justification of the choice of data or description of measurement methods and procedures actually applied :	Anaerobic lagoons – default R_N for two-cell lagoon Anaerobic digesters – default R_N for covered first cell of two-cell lagoon
Any comment:	---

Data / Parameter:	$\mathbf{R_{VS}}$
Data unit:	Fraction
Description:	VS degradation factor of previous treatment system (anaerobic digester)
Source of data used:	Annex 1 of ACM0010/Version 5, Chapter 8.2 in US-EPA (2001)
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default R_{VS} for covered first cell of two-cell lagoon
Any comment:	---

Data / Parameter:	$\mathbf{EF_{grid,BM,y}}$
Data unit:	t CO_2/MWh
Description:	Build margin emission factor in year *y*
Source of data used:	Brazilian National Operator of the Electric System (ONS), from the Ministry of Science and Technology website (http://www.mct.gov.br/index.php/content/view/74689.html)
Value applied:	0.0794
Justification of the choice of data or description of measurement methods and procedures actually applied :	Brazilian build margin factor of 2009, which was the last available value at the time the PDD was submitted to the DOE for validation

Any comment:	---

B.6.3. Ex-ante calculation of emission reductions:

Table 6. Average swine population and feed intake at Mabella Diamantino 1, by category

Animal Data			
Category	Average Population in the Year	Average Feed Intake (kg/hd/day)	Digestibility
Sows	10,899	2.68	75%
Gilts	1,539	2.93	75%
Boars	119	1.13	75%
Nursers	30,013	1.33	85%
Finishers	69,586	1.96	85%

http://www.cnpsa.embrapa.br/SP/suinos/nutricao.html

http://www.nap.edu/catalog.php?record_id=6016

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TABLE 10.1 REPRESENTATIVE LIVESTOCK CATEGORIES

TABLE 10.2 REPRESENTATIVE FEED DIGESTIBILITY FOR VARIOUS LIVESTOCK CATEGORIES

I. AWMS COMPONENT

1. Baseline emissions

$$BE_y = BE_{CH4,y} + BE_{N2O,y} + BE_{elec/heat,y}$$

Table 7. Baseline emissions calculation

Baseline emissions	BE_y	**75,376.39**	**tCO2e/yr**
Baseline methane emissions	$BE_{CH4,y}$	67,501.33	tCO2e/yr
Baseline N_2O emissions	$BE_{N2O,y}$	7,875.05	tCO2e/yr
Baseline CO_2 emissions from electricity and/or heat used	$BE_{elec/heat,y}$	0	tCO2e/yr

a) Methane emissions

$$BE_{CH4,y} = GWP_{CH4} \cdot D_{CH4} * \sum_{j,LT} MCF_j * B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_{Bl,j}$$

Table 8. Baseline methane emissions

		Sows	Gilts	Boars	Nursers	Finishers	
Annual CH_4 baseline emissions	$BE_{CH4,y}$	**13,472.49**	**2,092.08**	**62.61**	**11,625.76**	**40,248.40**	**tCO2e/yr**
Global warming potential methane	GWP_{CH4}	21	21	21	21	21	
CH4 density	D_{CH4}	0.00067	0.00067	0.00067	0.00067	0.00067	t/m3
Annual methane conversion factor	***MCF***	0.7426	0.7426	0.7426	0.7426	0.7426	
Max methane producing potential of the volatile solid generated	B_0	0.48	0.48	0.48	0.48	0.48	m^3CH_4/kg_dm
Average number of animals per year	**N**	10899.17	1539.42	118.50	30013.08	69585.92	Heads
Annual volatile solid for livestock	VS_y	246.47	270.98	105.35	77.24	115.33	kg_dm/animal/year
Fraction of manure handled in system	*MS%*	1	1	1	1	1	

The North American default value for B_0 0,48 m3CH4/kg_dm, from IPCC 2006 tables 10 A-7 and 10 A-8, chapter 10, volume 4, has been adopted, considering that: 1) the swine genetic adopted by Mabella Diamantino 1 is Agroceres PIC, which has an international genetic pool, originated from several Annex I countries (please refer to http://www.pic.com/cms/Brazil/539.html); 2) average weights of Mabella's animals (over 46 kg for market swine and over 260 kg for breeding swine) are larger than the IPCC standards for both breeding and market categories in North America and Europe; 3) as validated from the farms reports, animals are fed with formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics; 4) the basic components of the FFR are soybean and corn, similar to swine formulated feeds in North American countries.

$$VS_{LT,y} = \left[GE_{LT} * \left(1 - \frac{DE_{LT}}{100} \right) + \left(UE * GE_{LT} \right) \right] * \left[\left(\frac{1 - ASH}{ED_{LT}} \right) \right] * nd_y$$

Table 9. Daily volatile solid production, based of dietary intake of livestock (option 2)

		Sows	Gilts	Boars	Nursers	Finishers	
Volatile Solids	***VS***	**246.47**	**270.98**	**105.35**	**77.24**	**115.33**	**kg-dm/animal/year**
Average daily DM intake	***DM***	2.68	2.93	1.13	1.33	1.96	kg/animal/day
Gross energy intake	***GE***	49.50	54.07	20.76	24.49	36.25	MJ/day
Digestible energy of the feed	*DE*	75	75	75	85	85	%
Urinary energy	*UE*	0.02	0.02	0.02	0.02	0.02	Fraction of GE
Ash content of manure	***ASH***	0.07	0.06	0.05	0.06	0.05	Fraction of the DM feed intake
Energy density of the feed	*ED*	18.45	18.45	18.45	18.45	18.45	MJ/kg
Number of days in year where the treatment plant was operational	nd_y	365	365	365	365	365	days

b) Nitrous oxide emissions

$$BE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} . (E_{N2O,D,y} + E_{N2O,ID,y})$$

Table 10. Baseline N_2O emissions from manure management

Annual N_2O baseline emissions	$BE_{N2O,y}$	**7,875.05**	**tCO2e/yr**	
Global warming potential N_2O	GWP_{N2O}	310		
Conversion factor N_2O-N to N_2O	$CF_{N2O-N,N}$	1.57		44/28 standard value given by ACM0010
Direct N_2O emission	$E_{N2O,D,y}$	7,348.09	kg N_2O-N/yr	
Indirect N_2O emission	$E_{N2O,ID,y}$	8,817.71	kg N_2O-N/yr	

$$E_{N2O,D,AnL,y} = \sum_{AnL,LT} (EF_{N2O,D} * NEX_{LT,y} * N_{LT} * MS\%_{Bl,AnL})$$

Table 11. Direct N_2O emissions from anaerobic lagoons

		Sows	Gilts	Boars	Nursers	Finishers	
Direct N_2O emission from anaerobic lagoons	$E_{N2O,D,AnL}$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**kg N_2O-N/yr**
Direct N_2O emission factor (EF_3)	$EF_{N2O,D}$	0	0	0	0	0	kg N_2O-N/kg N
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	**N**	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{Bl,AnL}$	1	1	1	1	1	

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TABLE 10.21 DEFAULT EMISSION FACTORS FOR DIRECT N2O EMISSIONS FROM MANURE MANAGEMENT (EF3)

$$E_{N2O,D,FL,y} = (1 - R_N) * \sum_{FL,LT} (EF_{N2O,D} * NEX_{LT,y} * N_{LT} * MS\%_{Bl,FL})$$

Table 12. Direct N_2O emissions from facultative lagoons (natural aeration)

		Sows	Gilts	Boars	Nursers	Finishers	
Direct N_2O emission from facultative lagoons	$E_{N2O,D,FL}$	**958.70**	**147.96**	**3.96**	**1,558.68**	**4,678.78**	**kg N_2O-N/yr**
Relative reduction of nitrogen from the previous stage (anaerobic lagoons)	R_N	0.50	0.50	0.50	0.50	0.50	
Direct N_2O emission factor (EF_3)	$EF_{N2O,D}$	0.01	0.01	0.01	0.01	0.01	kg N_2O-N/kg N
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	**N**	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{Bl,FL}$	1	1	1	1	1	

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TABLE 10.21 DEFAULT EMISSION FACTORS FOR DIRECT N2O EMISSIONS FROM MANURE MANAGEMENT (EF3 for aerobic treatment with natural aeration)

Chapter 8.2 in US-EPA (2001), R_N for two-cell lagoon (conservatively)

$$E_{N2O,ID,AnL,y} = \sum_{AnL,LT} EF_{N2O,ID} * F_{gasm} * NEX_{LT,y} * N_{LT} * MS\%_{Bl,AnL}$$

Table 13. Indirect N_2O emissions from anaerobic lagoons

		Sows	Gilts	Boars	Nursers	Finishers	
Indirect N_2O emission from anaerobic lagoons	$E_{N2O,ID,AnL}$	**766.96**	**118.37**	**3.17**	**1,246.95**	**3,743.02**	**kg N_2O-N/yr**
Indirect N_2O emission factor (EF_4)	$EF_{N2O,ID}$	0.01	0.01	0.01	0.01	0.01	kg N_2O-N/kg N
Percent of managed manure nitrogen that volatilises as NH_3 and NOx	F_{gasm}	40%	40%	40%	40%	40%	
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	**N**	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{Bl,AnL}$	1	1	1	1	1	

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TABLE 10.22 DEFAULT VALUES FOR NITROGEN LOSS DUE TO VOLATILISATION OF NH3 AND NOX FROM MANURE MANAGEMENT (Fgasm)

TABLE 11.3 DEFAULT EMISSION, VOLATILISATION AND LEACHING FACTORS FOR INDIRECT SOIL N2O EMISSIONS (EF4)

$$E_{N2O,ID,FL,y} = (1 - R_N) * \sum_{FL,LT} EF_{N2O,ID} * F_{gasm} * NEX_{LT,y} * N_{LT} * MS\%_{Bl,FL}$$

Table 14. Indirect N_2O emissions from facultative lagoons (with natural aeration)

		Sows	Gilts	Boars	Nursers	Finishers	
Indirect N_2O emission from facultative lagoons	$E_{N2O,ID,FL}$	**383.48**	**59.18**	**1.59**	**623.47**	**1,871.51**	**kg N_2O-N/yr**
Relative reduction of nitrogen from the previous stage (anaerobic lagoons)	R_N	0.50	0.50	0.50	0.50	0.50	
Indirect N_2O emission factor (EF_4)	$EF_{N2O,iD,FL}$	0.01	0.01	0.01	0.01	0.01	kg N_2O-N/kg N
Percent of managed manure nitrogen that volatilises as NH_3 and NOx	$F_{gasm,FL}$	40%	40%	40%	40%	40%	
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	**N**	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{Bl,FL}$	1	1	1	1	1	

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TABLE 10.22 DEFAULT VALUES FOR NITROGEN LOSS DUE TO VOLATILISATION OF NH3 AND NOX FROM MANURE MANAGEMENT (Fgasm) - used Fgasm for anaerobic lagoons of swine as a conservative approach, given there are no published country specific data nor IPCC defalut value regarding Fgasm for lagoons with natural aeration.

Chapter 8.2 in US-EPA (2001), R_N for two-cell lagoon (conservatively)

$$NEX = N_{intake} * (1 - N_{retention})$$

Table 15. Nitrogen excrection per head

		Sows	Gilts	Boars	Nursers	Finishers	
Annual avg nitrogen excretion per head	NEX_y	**17.592**	**19.223**	**6.692**	**10.387**	**13.447**	**Kg N/head/yr**
Annual N intake per animal	N_{intake}	0.069	0.075	0.026	0.041	0.053	Kg N/head/day
Portion of N retained in the animal	$N_{retention}$	0.3	0.3	0.3	0.3	0.3	
Number of days treatment plant was operational in year y	nd_y	365	365	365	365	365	

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TABLE 10.20 DEFAULT VALUES FOR THE FRACTION OF NITROGEN IN FEED INTAKE OF LIVESTOCK THAT IS RETAINED BY THE DIFFERENT LIVESTOCK SPECIES/CATEGORIES (FRACTION N-INTAKE RETAINED BY THE ANIMAL)

$$N_{intake} = \left(\frac{GE}{18.45}\right) * \left(\frac{CP/100}{6.25}\right)$$

Table 16. Daily Nitrogen intake per head

		Sows	Gilts	Boars	Nursers	Finishers	
Daily N intake per animal	***N*** ***intake***	**0.069**	**0.075**	**0.026**	**0.041**	**0.053**	**Kg N/animal/day**
Crude protein	***CP***	16.04	16.05	14.55	19.14	16.74	%
Gross energy intake of the animal	***GE***	49.50	54.07	20.76	24.49	36.25	MJ/day

Crude protein average values obtained from the feed formulation available at the farm

Standard Values for Crude Protein (%)	NRC Swine 1998	16.05	15.15	**13**	23.45	15.6
	Agroceres PIC	**17.00**	**17.5**	-	-	-
	Embrapa	15.75	-	-	**17**	**14**

Crude Protein Values Based on Brazilian standards for swine nutrition (Agroceres PIC, Embrapa and NRC 1998)

http://www.nap.edu/catalog.php?record_id=6016

http://www.cnpsa.embrapa.br/SP/suinos/nutricao.html

http://www.agrocerespic.com.br/images/arqDownload/15guia_manejo1.pdf

2. Project emissions

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{PL,y} + PE_{flare,y} + PE_{elec/heat}$$

Table 17. Project emissions calculation from AWMS component

Project emissions AWMS component	PE_y	**20,839.17**	**tCO2e/yr**
Leakage from AWMS	$PE_{AD,y}$	13,634.80	tCO2e/yr
Methane emission from aerobic treatment	$PE_{Aer,y}$	9.09	tCO2e/yr
Project N_2O emissions	$PE_{N2O,y}$	7,087.55	tCO2e/yr
Physical leakage from biogas pipeline	$PE_{PL,y}$	0.00	tCO2e/yr
Project emissions from flaring and combustion	$PE_{flare,y}$	107.73	tCO2e/yr
Emissions from use of heat and/or electricity	$PE_{elec/heat}$	0.00	tCO2e/yr

Physical leakage from biogas pipeline considered zero for ex-ante calculation purposes.

Emissions from use of heat and/or electricity excluded from calculation for simplification, because are considered negligible

a) Leakage from AWMS that captures methane

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \sum_{LT} (B_{0,LT} * N_{LT} * VS_{LT,y})$$

Table 18a. Methane emissions from AWMS where gas is captured

		Sows	Gilts	Boars	Nursers	Finishers	
Leakage from AWMS systems that capture's methane	$PE_{AD,y}$	**2,721.35**	**422.59**	**12.65**	**2,348.32**	**8,129.89**	**tCO2e/yr**
Global warming potential methane	GWP_{CH4}	21	21	21	21	21	
CH4 density	D_{CH4}	0.00067	0.00067	0.00067	0.00067	0.00067	t/m3
Methane leakage from anaerobic digesters	LF_{AD}	0.15	0.15	0.15	0.15	0.15	
Fraction of volatile solids directed to the anaerobic digester	F_{AD}	1	1	1	1	1	
Max methane producing potential of the volatile solid generated	B_0	0.48	0.48	0.48	0.48	0.48	m^3CH_4/kg_dm
Average number of animals per year	**N**	10899.17	1539.42	118.50	30013.08	69585.92	Heads
Annual volatile solid for livestock	VS_y	246	271	105	77	115	kg_dm/yr

Volatile solids production values are obtained from Table 9.

Adopted the very conservative deafult value of 0.15 for leakage from anaerobic digesters, as per the methodology.

b) Methane emissions from aerobic treatment

$$PE_{Aer,y} = GWP_{CH4} \cdot D_{CH4} * 0.001 * F_{Aer} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n}\right) \right] * \sum_{j,LT} (B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j) + PE_{Sl,y}$$

Table 18b. Methane emissions from aerobic AWMS treatment

		Sows	Gilts	Boars	Nursers	Finishers	
Methane emissions from AWMS that aerobically treats the manure	$PE_{Aer,y}$	**1.81**	**0.28**	**0.01**	**1.57**	**5.42**	**tCO2e/yr**
Global warming potential methane	GWP_{CH4}	21	21	21	21	21	
CH4 density	D_{CH4}	0.00067	0.00067	0.00067	0.00067	0.00067	t/m3
Fraction of volatile solids directed to the aerobic system	F_{Aer}	1	1	1	1	1	
Fraction of volatile solid degrated in the anaerobic digester	R_{VS}	0.9	0.9	0.9	0.9	0.9	
Max methane producing potential of the volatile solid generated	B_0	0.48	0.48	0.48	0.48	0.48	m^3CH_4/kg_dm
Average number of animals per year	**N**	10,899.17	1,539.42	118.50	30,013.08	69,585.92	Heads
Annual volatile solid for livestock	VS_y	246	271	105	77	115	kg_dm/yr
Fraction of manure handled in system *j*	$MS\%_j$	1	1	1	1	1	
CH4 emissions from sludged disposed of an storaged pit prior to disposal during year *y*	$PE_{Sl,y}$	0	0	0	0	0	kg_dm/yr

There will be no sludge disposal in storage pit

Chapter 8.2 in US-EPA (2001), R_N for covered first cell of two-cell lagoon (conservatively)

c) Nitrous oxide emissions

$$PE_{N2O,y} = GWP_{N2O} * CF_{N2O-N,N} * \frac{1}{1000} * (E_{N2O,D,y} + E_{N2O,ID,y})$$

Table 19. N_2O emission from project manure waste management system

Annual N_2O project emissions	$PE_{N2O,y}$	**7,087.55**	**tCO2e/yr**	
Global warming potential N_2O	GWP_{N2O}	310		
Conversion factor N_2O-N to N_2O	$CF_{N2O-N,N}$	1.57		44/28 standard value given by AMS0010
Direct N_2O emission	$E_{N2O,D,y}$	8,817.71	kg N_2O-N/yr	
Indirect N_2O emission	$E_{N2O,ID,y}$	5,731.51	kg N_2O-N/yr	

$$E_{N2O,D,AD,y} = \sum_{AD,LT} (EF_{N2O,D} * NEX_{LT,y} * N_{LT} * MS\%_{P,AD})$$

Table 20. Direct N_2O emissions from anaerobic digester

		Sows	Gilts	Boars	Nursers	Finishers	
Direct N_2O emission from anaerobic lagoons	$E_{N2O,D,AD}$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**kg N_2O-N/yr**
Direct N_2O emission factor (EF_3)	EF_{N2O}	0	0	0	0	0	kg N_2O-N/kg N
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	N	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{P,AD}$	1	1	1	1	1	

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TABLE 10.21 DEFAULT EMISSION FACTORS FOR DIRECT N2O EMISSIONS FROM MANURE MANAGEMENT (EF3)

$$E_{N2O,D,AerFA,y} = (1 - R_N) * \sum_{j,LT} (EF_{N2O,D} * NEX_{LT,y} * N_{LT} * MS\%_{P,AerFA})$$

Table 21. Project direct N_2O emissions from aerobic lagoons (with forced aeration)

		Sows	Gilts	Boars	Nursers	Finishers	
Direct N_2O emission from aerobic lagoons (forced aeration)	$E_{N2O,D,AerFA,y}$	**719.03**	**110.97**	**2.97**	**1,169.01**	**3,509.08**	**kg N_2O-N/yr**
Relative reduction of nitrogen from the previous stage (anaerobic digesters)	R_N	0.25	0.25	0.25	0.25	0.25	
Direct N_2O emission factor (EF_3)	$EF_{N2O,D}$	0.005	0.005	0.005	0.005	0.005	kg N_2O-N/kg N
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	N	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{P,AerFA}$	1	1	1	1	1	

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TABLE 10.21 DEFAULT EMISSION FACTORS FOR DIRECT N2O EMISSIONS FROM MANURE MANAGEMENT (EF3 for aerobic treatment with forced aeration)

Chapter 8.2 in US-EPA (2001), R_N for covered first cell of two-cell lagoon (conservatively)

$$E_{N2O,D,AerNA,y} = (1 - R_N) * \sum_{AerNA,LT} (EF_{N2O,D} * NEX_{LT,y} * N_{LT} * MS\%_{P,AerNA})$$

Table 22. Project direct N_2O emissions from aerobic lagoons (with natural aeration)

		Sows	Gilts	Boars	Nursers	Finishers	
Direct N_2O emission from aerobic lagoons (natural aeration)	$E_{N2O,D,AerNA}$	**431.42**	**66.58**	**1.78**	**701.41**	**2,105.45**	**kg N_2O-N/yr**
Relative reduction of nitrogen from the previous stage (aerobic lagoons with forced aeration)	R_N	0.70	0.70	0.70	0.70	0.70	
Direct N_2O emission factor (EF_3)	$EF_{N2O,D}$	0.010	0.010	0.010	0.010	0.010	kg N_2O-N/kg N
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	**N**	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{P,AerNA}$	1	1	1	1	1	

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TABLE 10.21 DEFAULT EMISSION FACTORS FOR DIRECT N2O EMISSIONS FROM MANURE MANAGEMENT (EF3 for aerobic treatment with natural aeration)

Chapter 8.2 in US-EPA (2001), pp 8-77, R_N for conventional aerobic lagoons

$$E_{N2O,ID,AD,y} = \sum_{AD,LT} EF_{N2O,ID} * F_{gasm} * NEX_{LT,y} * N_{LT} * MS\%_{P,AD}$$

Table 23. Project indirect N_2O emissions from anaerobic digesters

		Sows	Gilts	Boars	Nursers	Finishers	
Indirect N_2O emission from anaerobic lagoons	$E_{N2O,ID,AD}$	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**kg N_2O-N/yr**
Indirect N_2O emission factor	$EF_{N2O,ID}$	0.01	0.01	0.01	0.01	0.01	kg N_2O-N/kg N
Percent of managed manure nitrogen that volatilises as NH_3 and NOx	F_{gasm}	0%	0%	0%	0%	0%	
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	**N**	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{P,AD}$	1	1	1	1	1	

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TABLE 10.22 DEFAULT VALUES FOR NITROGEN LOSS DUE TO VOLATILISATION OF NH_3 AND NOx FROM MANURE MANAGEMENT

TABLE 11.3 DEFAULT EMISSION, VOLATILISATION AND LEACHING FACTORS FOR INDIRECT SOIL N_2O EMISSIONS

According to Chapter 8.2 in US-EPA (2001), "a covered lagoon will not lose NH_3-N to the atmosphere"

$$E_{N2O,\,ID,\,AerFA,\,y} = (1 - R_N) * \sum_{AerFA,LT} EF_{N2O,\,ID} * F_{gasm} * NEX_{LT,\,y} * N_{LT} * MS\%_{P,\,AerFA}$$

Table 24. Project indirect N_2O emissions from aerobic lagoons (with forced aeration)

		Sows	Gilts	Boars	Nursers	Finishers	
Indirect N_2O emission from aerobic lagoons (forced aeration)	$E_{N2O,ID,AerFA}$	**575.22**	**88.78**	**2.38**	**935.21**	**2,807.27**	**kg N_2O-N/yr**
Relative reduction of nitrogen from the previous stage	R_N	0.25	0.25	0.25	0.25	0.25	
Indirect N_2O emission factor (EF_4)	$EF_{N2O,ID}$	0.01	0.01	0.01	0.01	0.01	kg N_2O-N/kg N
Percent of managed manure nitrogen that volatilises as NH_3 and NOx	F_{gasm}	40%	40%	40%	40%	40%	
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	**N**	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{P,AerFA}$	1	1	1	1	1	

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TABLE 11.3 DEFAULT EMISSION, VOLATILISATION AND LEACHING FACTORS FOR INDIRECT SOIL N2O EMISSIONS (EF4)

TABLE 10.22 DEFAULT VALUES FOR NITROGEN LOSS DUE TO VOLATILISATION OF NH3 AND NOX FROM MANURE MANAGEMENT (Fgasm) - used Fgasm for anaerobic lagoons of swine as a conservative approach, given there are no published country specific data nor IPCC defalut value regarding Fgasm for lagoons with natural aeration.

$$E_{N2O,\,ID,\,AerNA,\,y} = (1 - R_N) * \sum_{AerNA,LT} EF_{N2O,\,ID} * F_{gasm} * NEX_{LT,\,y} * N_{LT} * MS\%_{P,\,AerNA}$$

Table 25. Indirect N_2O emissions from facultative lagoons (with natural aeration)

		Sows	Gilts	Boars	Nursers	Finishers	
Indirect N_2O emission from aerobic lagoons (natural aeration)	$E_{N2O,ID,AerNA}$	**172.57**	**26.63**	**0.71**	**280.56**	**842.18**	**kg N_2O-N/yr**
Relative reduction of nitrogen from the previous stage (aerobic treatment with forced aeration)	R_N	0.70	0.70	0.70	0.70	0.70	
Indirect N_2O emission factor (EF_4)	$EF_{N2O,ID}$	0.01	0.01	0.01	0.01	0.01	kg N_2O-N/kg N
Percent of managed manure nitrogen that volatilises as NH_3 and NOx	F_{gasm}	40%	40%	40%	40%	40%	
Annual avg nitrogen excretion per head	NEX_y	17.592	19.223	6.692	10.387	13.447	Kg N/head/yr
Average number of animals per year	**N**	10,899.2	1,539.4	118.5	30,013.1	69,585.9	heads
Fraction of manure handled in system	$MS\%_{P,AerNA}$	1	1	1	1	1	

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TABLE 11.3 DEFAULT EMISSION, VOLATILISATION AND LEACHING FACTORS FOR INDIRECT SOIL N2O EMISSIONS (EF4) and TABLE 10.22 DEFAULT VALUES FOR NITROGEN LOSS DUE TO VOLATILISATION OF NH3 AND NOX FROM MANURE MANAGEMENT (Fgasm) - used Fgasm for anaerobic lagoons of swine as a conservative approach, given there are no published country specific data nor IPCC defalut value regarding Fgasm for lagoons with natural aeration.

Chapter 8.2 in US-EPA (2001), R_N for conventional aerobic digestion, page 8-77)

d) Project emissions from flaring of the residual gas stream

$$PE_{flare,\,y} = TM_y * (1 - \eta_{flare,\,h}) * \frac{GWP_{CH4}}{1000}$$

Table 26. Project emissions from methane combustion in the generators

Project emissions from flaring	$PE_{flare,y}$	**107.73**	**tCO2e/yr**
Mass flow of methane in the year	TM_y	256,507.31	kg/yr
Global warming potential methane	GWP_{CH4}	21	
Flare efficiency (minimum expected)	η_{flare}	98%	

Adapted from the methodological "Tool to determine project emissions from flaring gases containing methane" (Annex 13)

$$TM_y = (BE_{CH4,\,y} - PE_{AD,\,y}) * F_{flare} / GWP_{CH4} * 1000$$

Table 27. Mass flow of methane in the year

Mass flow of methane	TM_y	**256,507.31**	**kg/yr**
Annual CH4 baseline emissions	$BE_{CH4,y}$	67,501.33	tCO2e/yr
Project emissions due leakage from anaerobic digesters	$PE_{AD,y}$	13,634.80	tCO2e/yr
Fraction of methane directed to be combusted by the flare	F_{flare}	0.1	
Global warming potential methane	GWP_{CH4}	21	

This formula considers the difference between the annual methane baseline emissions (calculated in Table 7) and the annual methane project emissions due to physical leakage from the anaerobic digester (calculated in Table 16), both in tCO2e, which is multiplied by the fraction of methane that is expected to be combusted by the flare, divided by the methane global warming potential and multiplied by 1,000, resulting in the annual methane mass flow in kg.

Concluding, for the AWMS component, emission reductions of the proposed CDM project are calculated and shown on Table 28.

$$ER_{AWMS,y} = BE_y - PE_y - LE_y$$

Table 28. Emission reductions calculation from AWMS component

Emission reductions AWMS component	$ER_{AWMS,y}$	**54,537.22**	**tCO2e/yr**
Baseline emissions AWMS Component	BE_y	75,376.39	tCO2e/yr
Project emissions AWMS Component	PE_y	20,839.17	tCO2e/yr
Project leakage AWMS Component	LE_y	0	tCO2e/yr

II. RENEWABLE ELECTRICITY TO GRID COMPONENT

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$$

Table 29. Emission factor calculation for Brazilian grid

Emission Factor Combined Margin	$EF_{grid,CM,y}$	**0.1635**	**tCO_2/MWh**
Build Margin CO2 EF - Brazil (2009)	$EF_{grid,BM,y}$	0.0794	tCO_2/MWh
Operating Margin CO2 EF - Brazil (2009)	$EF_{grid,OM,y}$	0.2476	tCO_2/MWh
Weighting of operating marigin EF	W_{BM}	0.5	
Weighting of build margin EF	W_{OM}	0.5	

$$BE_{RE,y} = EF_{grid,CM,y} * EG_y$$

Table 30. Baseline emissions for the renewable energy component

Baseline emissions from the grid	$BE_{RE,y}$	**2,973.07**	**$tCO_2/year$**
Emission Factor Combined Margin	$EF_{grid,CM,y}$	0.1635	tCO_2/MWh
Energy supplied to the grid	EG_y	18,186	MWh

$$ER_{RE,y} = BE_{RE,y} - PE_{RE,y}$$

Table 31. Emission reductions from the renewable energy component

Emission reductions renewable energy component	$ER_{RE,y}$	**2,973.07**	**tCO_2/MWh**
Baseline emissions from the grid	$BE_{RE,y}$	2,973.07	tCO_2/MWh
Project emissions from renewable electricity generation	$PE_{RE,y}$	0.00	tCO_2/MWh

III. TOTAL EX-ANTE EMISSION REDUCTIONS

The calculated total ex-ante emission reductions achieved by the project activity are calculated by summing the emission reductions from the methane capturing and combustion and from the renewable energy component. The result can be seen on Table 23.

$$ER_y = ER_{AWMS,y} + ER_{RE,y}$$

Table 32. Total emission reductions from the project activity

Total emission reductions	ER_y	**57,510.29**	**tCO_2/yr**
Emission reductions AWMS component	$ER_{AWMS,y}$	54,537.22	tCO2e/yr
Emission reductions renewable energy component	$ER_{RE,y}$	2,973.07	tCO_2/yr

B.6.4 Summary of the ex-ante estimation of emission reductions:

Table 33. Summary of the ex-ante estimation of emission reductions

Years	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2e)
2009	10,420	39,175	0	**28,755**
2010	20,839	78,349	0	**57,510**
2011	20,839	78,349	0	**57,510**
2012	20,839	78,349	0	**57,510**
2013	20,839	78,349	0	**57,510**
2014	20,839	78,349	0	**57,510**
2015	20,839	78,349	0	**57,510**
2016	20,839	78,349	0	**57,510**
2017	20,839	78,349	0	**57,510**
2018	20,839	78,349	0	**57,510**
2019	10,420	39,175	0	**28,755**
Total (tonnes of CO_2e)	**208,392**	**783,495**	**0**	**575,103**

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**Type**
Data unit:	---
Description:	Type of barn and AWMS
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission	Swine

reductions in section B.5	
Description of measurement methods and procedures to be applied:	---
QA/QC procedures to be applied:	---
Any comment:	Barn and AWMS layout and configuration.

Data / Parameter:	**N_{LT}**
Data unit:	Number
Description:	Annual average number of animals of type LT for the year *y*
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Sows – 10,899; Gilts – 1,539; Boars – 119; Nursers – 30,013; Finishers – 69,586
Description of measurement methods and procedures to be applied:	Data was obtained from Mabella Diamantino 1 official accounting reports, which are generated with PigChamp reports. PigChamp is the software used by Mabella Diamantino 1 to manage the entire swine activity. Archive electronically during project plus 5 years. Monitoring frequency will be monthly.
QA/QC procedures to be applied:	---
Any comment:	Swine animal categories are defined according to table 10.1 from 2006 IPPC Guidelines.

Data / Parameter:	**MCF**
Data unit:	Fraction
Description:	Methane correction factor
Source of data to be used:	IPCC 2006 Guidelines, table 10.17, chapter 10, volume 4
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.7426

Description of measurement methods and procedures to be applied:	MCF for uncovered lagoons, from 23ºC to 26ºC average annual temperature, is 0.79, multiplied by 0.94 for uncertainties, according to ACM0010, resulting in 0.7426. Archive electronically during project plus 5 years. Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	

Data / Parameter:	**T**
Data unit:	ºC
Description:	Annual average ambient temperature at Project site
Source of data to be used:	Historical data between 1960 and 1990, from the Climate Data Base of Portal de Tecnologia da Informação para Meteorologia, from Centro de Previsão de Tempo e Estudos Climáticos (CPTEC), http://bancodedados.cptec.inpe.br/climatologia
Value of data applied for the purpose of calculating expected emission reductions in section B.5	24.84ºC
Description of measurement methods and procedures to be applied:	Archive electronically during project plus 5 years. Monitoring frequency will be monthly.
QA/QC procedures to be applied:	---
Any comment:	Used to select the annual MCF from IPCC 2006 guidelines

Data / Parameter:	**$B_{0,LT}$**
Data unit:	m^3CH_4/kg_dm
Description:	Maximum methane producing potential of the volatile solid generated
Source of data to be used:	Technical literature

Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.48
Description of measurement methods and procedures to be applied:	The North American default value 0.48, from IPCC 2006 tables 10 A-7 and 10 A-8, chapter 10, volume 4, has been adopted, considering that: 1) the swine genetic adopted by Mabella Diamantino 1 is Agroceres PIC, which has an international genetic pool, originated from several Annex I countries; 2) average weights of Mabella's animals (over 46 kg for market swine and over 260 kg for breeding swine) are larger than the IPCC standards for both breeding and market categories in North America and Europe; 3) as validated from the farms reports, animals are fed with formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics; 4) the basic components of the FFR are soybean and corn, similar to swine formulated feeds in North American countries. Archive electronically during project plus 5 years. Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	---

Data / Parameter:	$\mathbf{VS_{LT,y}}$
Data unit:	kg-dm/animal/year
Description:	Annual volatile solid excretion per animal
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Sows – 246.47 Gilts – 270.98 Boars – 105.35 Nursers – 77.24 Finishers – 115.33
Description of measurement methods and procedures to be applied:	Annual volatile solid for livestock LT entering all AWMS (on a dry matter weight basis), based on dietary intake of the livestock.

	Archive electronically during project plus 5 years. Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	---

Data / Parameter:	**DM_{LT}**
Data unit:	Kg/Head$_{LT}$/day
Description:	Daily average dry matter feed intake
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Sows – 2.68; Gilts – 2.93; Boars – 1.13; Nursers – 1.33; Finishers – 1.96
Description of measurement methods and procedures to be applied:	Average feed intake is calculated by dividing the monthly amount of feed produced for each category LT, by the average LT population of each month. Data is acquired from official Mabella's activity reports, which are prepared from data obtained from PigChamp reports. PigChamp is the system used for data management at Mabella Diamantino 1. Archive electronically during project plus 5 years. Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	---

Data / Parameter:	**GE_{LT}**
Data unit:	MJ/d
Description:	Gross energy intake of the animal
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Sows – 49.50; Gilts – 54.07; Boars – 20.76; Nursers – 24.49; Finishers – 36.25

Description of measurement methods and procedures to be applied:	Gross energy intake of the animal, in enteric model, obtained by multiplying the energy density (18.45 MJ/kg DM) by the average daily feed intake of livestock LT. Feed intake data was obtained from Mabella Diamantino 1 official accounting reports, which are generated with PigChamp reports. PigChamp is the software used by Mabella Diamantino 1 to manage the entire swine activity. Archive electronically during project plus 5 years. Monitoring frequency will be continuous.
QA/QC procedures to be applied:	---
Any comment:	Swine animal categories are defined according to table 10.1 from 2006 IPPC Guidelines.

Data / Parameter:	**ASH**
Data unit:	Fraction of the dry matter feed intake
Description:	Ash content of feed calculated as a fraction of the dry matter feed intake.
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Sows – 0.07; Gilts – 0.06 Boars – 0.05; Nursers – 0.06; Finishers – 0.05
Description of measurement methods and procedures to be applied:	The weighted average values of Crude Protein and Ash were calculated taking into consideration the yearly production of each feed ratio in the 12-month period prior to the PDD preparation (August 07 to July 08). Archive electronically during project plus 5 years. Monitoring frequency will be annually. * Given that the feed formulation varies along the time and that the contents of macronutrients may vary, as a conservative approach, considering the formulations of all feed ratios between June 07 and August 08, the lowest Crude Protein and the highest Ash values, from the different formulations of each feed in the period, were considered for NEX and VS calculation purposes, respectively. ** Due to the lack of specific data, the largest ash content value found among all other Mabella's feeds was considered for Final,

	Gestação and Recria Marrã feeds (6.96%), as conservative approach.
QA/QC procedures to be applied:	---
Any comment:	Swine animal categories are defined according to table 10.1 from 2006 IPPC Guidelines.

Data / Parameter:	**$NEX_{LT,y}$**
Data unit:	Kg N/animal/year
Description:	Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year estimated as described in Annex 2
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Sows – 17.592; Gilts – 19.223; Boars – 6.692; Nursers – 10.387; Finishers – 13.447
Description of measurement methods and procedures to be applied:	Archive electronically during project plus 5 years. Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	Swine animal categories are defined according to table 10.1 from 2006 IPPC Guidelines.

Data / Parameter:	**N_{intake}**
Data unit:	Kg N/$Head_{LT}$/year
Description:	Daily nitrogen intake
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Sows – 0.069; Gilts – 0.075; Boars – 0.026; Nursers – 0.041; Finishers – 0.053
Description of measurement methods and procedures to be applied:	Weighted average crude protein content of the feed is calculated using information from the feed formulation for each category LT. Archive electronically during project plus 5 years.

	Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	Swine animal categories are defined according to table 10.1 from 2006 IPPC Guidelines.

Data / Parameter:	**CP**
Data unit:	%
Description:	Crude protein percent
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Sows – 16.04; Gilts – 16.05; Boars – 14.55; Nursers – 19.14; Finishers – 16.74
Description of measurement methods and procedures to be applied:	The weighted average values of Crude Protein and Ash were calculated taking into consideration the yearly production of each feed ratio in the 12-month period prior to the PDD preparation (August 07 to July 08). Archive electronically during project plus 5 years. Monitoring frequency will be annually. * Given that the feed formulation varies along the time and that the contents of macronutrients may vary, as a conservative approach, considering the formulations of all feed ratios between June 07 and August 08, the lowest Crude Protein and the highest Ash values, from the different formulations of each feed in the period, were considered for NEX and VS calculation purposes, respectively.
QA/QC procedures to be applied:	---
Any comment:	Swine animal categories are defined according to table 10.1 from 2006 IPPC Guidelines.

Data / Parameter:	$\mathbf{LF_{AD}}$
Data unit:	Fraction

Description:	Fraction of methane leakage from anaerobic digesters
Source of data to be used:	IPCC 2006 Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.15
Description of measurement methods and procedures to be applied:	The default value for leakage from digesters - 0.15 - has been adopted for ex ante calculation due to the difficulty to measure the biogas leaks during monitoring. Archive electronically during project plus 5 years. Monitoring frequency – annually.
QA/QC procedures to be applied:	---
Any comment:	IPCC default of 0.15 or less if documented evidence can be provided (to be checked by DOE). It is PPs understanding that this is a too conservative (high) value, considering that other approved consolidated baseline methodology – ACM0014 – establishes for the same parameter (leaks from the digester) a default value of 0.05 and that the features of the proposed project for Mabella Diamantino I, such as: - the chosen biodigester technology and materials (EPDM), after fully assembled, offer complete sealing between the cover and the liner, avoiding physical leakage. - due to the corrective and preventive maintenance plans, any event that prevents the biogas from being captured and/or burnt shall be solved in less than 24 hours. - the biodigester technology applied in the proposed project activity is basically the addition of a biogas capturing structure (EPDM cover), with no heating, therefore it should not significantly improve the methane conversion capacity of the existing AWMS (well managed open anaerobic lagoons). - furthermore, when fully installed, the project will have complete redundancy, resulting in a capacity to burn the double of the expected volume of biogas to be produced by the digesters. So, the inability to combust methane by the project activity will be extremely rare.

Data / Parameter:	F_{AD}
Data unit:	Fraction
Description:	Fraction of volatile solids directed to anaerobic digesters
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1
Description of measurement methods and procedures to be applied:	All animal waste produced in the farm will be directed to the digesters. Archive electronically during project plus 5 years. Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	---

Data / Parameter:	F_{Aer}
Data unit:	Fraction
Description:	Fraction of volatile solids directed to aerobic treatment
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1
Description of measurement methods and procedures to be applied:	All the effluent from the digesters will be directed to the aerobic lagoons. Archive electronically during project plus 5 years. Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	---

Data / Parameter:	**$MS\%_{P,j}$**
Data unit:	Percent
Description:	Percent of manure handled in the system j in project activity
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	100%
Description of measurement methods and procedures to be applied:	Fraction of manure handled in system j, which is 100%, because all animal waste produced in the farm will be directed to the digesters. Archive electronically during project plus 5 years. Monitoring frequency will be annually.
QA/QC procedures to be applied:	---
Any comment:	---

Data / Parameter:	**$EF_{grid,OM,y}$**
Data unit:	t CO_2/MWh
Description:	Operating margin emission factor in year *y*
Source of data to be used:	Brazilian National Operator of the Electric System (ONS), from the Ministry of Science and Technology website (http://www.mct.gov.br/index.php/content/view/74689.html)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.2476
Description of measurement methods and procedures to be applied:	Brazilian operating margin factor from 2009, which was the last available full year value at the time the PDD was submitted to the DOE for validation
QA/QC procedures to be applied:	---
Any comment:	---

Data / Parameter:	$\mathbf{EF_{grid,CM,y}}$
Data unit:	t CO_2/MWh
Description:	Grid combined margin emission factor in year *y*
Source of data to be used:	Calculated *ex-post* during the entire crediting period, according to the “Tool to calculate the emission factor for an electricity system”, version 02
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.1635
Description of measurement methods and procedures to be applied:	Calculated according to the formula: $EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$, where w_{OM} e w_{BM} are both 0.5.
QA/QC procedures to be applied:	---
Any comment:	---

Data / Parameter:	$\mathbf{EG_{,y}}$
Data unit:	MWh
Description:	Electricity supplied to grid
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	18,186
Description of measurement methods and procedures to be applied:	Net electricity supplied by the project activity to the grid and/or the farm. Measurement results will be cross-checked with records for sold electricity and/or consumption by the farm. Continuous measurement and monthly recording are required. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	

Any comment:	Electricity meters will undergo maintenance/calibration subject to appropriate industry standards. The accuracy of the meter readings will be verified by receipts issued by the purchasing power company. Uncertainty of the meters to be obtained from the manufacturers.

Data / Parameter:	**V_f (= $FV_{RG,h}$)***
Data unit:	m^3
Description:	Biogas flow
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	---
Description of measurement methods and procedures to be applied:	The biogas flow will be measured by flow meters installed before the flare (FmF), before the biogas generators (FmG) and at the outlet pipes of each biodigester system (Fm1 and Fm2). Flow meters will define how much of the gas goes to the flare or to the generators; data is stored in a digital data logger. The monitoring frequency will occur continuously by the flow meters and will be reported cumulatively on weekly basis, at most.
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration subject to appropriate industry standards. Thermatel TA2 flow meter is enabled with a self-diagnosis system, which detects and alert when there is any problem. As per the manufacturer instructions, only in this case the flow meter shall be sent to maintenance and recalibration.
Any comment:	The biogas flow to electricity or heat equipment in a moment can be considered destroyed, by monitoring that the equipment was working at this time. * V_f, from AMS0010/Version 5 and $FV_{RG,h}$, from the “Tool to determine project emissions from flaring gases containing methane” are the same parameters.

Data / Parameter:	**C_{CH4} (= $fv_{i,h}$)***
Data unit:	Fraction
Description:	Methane fraction of biogas
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	---
Description of measurement methods and procedures to be applied:	C_{CH4} will be measured by a biogas methane analyzer at a fixed point, with continuous analysis of methane concentration of the residual gas. As a simplified approach, only the volumetric fraction of methane will be measured and the difference to 100% will be considered as nitrogen (N_2). Readings will be periodically made and the data will be stored locally in an electronic data acquisition and storage system, which will routinely upload and transmit it via the Internet to a secure server via dial-up using landline or cellular. Automatic calibration will be made using standard gases. Archive electronically during project plus 5 years. Shall be measured on wet basis.
QA/QC procedures to be applied:	The variability of CH_4 concentration in the biogas is estimated between 50% to 70%. Minimum precision of the methane analyzer is +/- 1%, according to following range specified by the manufacturer: 0-5% CH_4 – Precision ± 0.2%; 5-15% CH_4 – Precision ± 0.5%; >15% CH_4 – Precision ± 1.0%. The level of accuracy will be deducted from average concentration of measurement.
Any comment:	* C_{CH4}, from AMS0010/Version 5 and $fv_{i,h}$, from the “Tool to determine project emissions from flaring gases containing methane” are the same parameters.

Data / Parameter:	**$PE_{flare,y}$**
Data unit:	tCO_{2e}/year
Description:	Project emissions from flaring of the residual gas stream in year *y*
Source of data to be used:	---

Value of data applied for the purpose of calculating expected emission reductions in section B.5	107.73
Description of measurement methods and procedures to be applied:	The parameters used for determining the project emissions from flaring of the residual gas stream in year y ($PE_{flare,y}$) should be monitored as per the "Tool to determine project emissions from flaring gases containing Methane". Monitoring frequency will be based on daily readings and reporting on flare operation temperatures (flare and exhaust gas)
QA/QC procedures to be applied:	The parameters used for determining the project emissions from flaring of the residual gas stream in year y ($PE_{flare,y}$) should use QA/QC procedures as per the "Tool to determine project emissions from flaring gases containing Methane".
Any comment:	---

Data / Parameter:	$\mathbf{t_{O2,h}}$
Data unit:	---
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Source of data to be used:	Measurements using a continuous gas analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	---
Description of measurement methods and procedures to be applied:	Fixed-point automatic extractive sampling analyzer, in wet basis. The point of measurement will be at 80% of total flare height. Sampling will be conducted with appropriate inconel probes. Monitoring will be continuous and values will be averaged hourly or at a shorter time interval.
QA/QC procedures to be applied:	Analyzers will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas.
Any comment:	---

Data / Parameter:	**$fv_{CH4,FG,h}$**
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
Source of data to be used:	Measurements using a continuous gas analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	---
Description of measurement methods and procedures to be applied:	Fixed-point automatic extractive sampling analyzer, in wet basis. The point of measurement will be at 80% of total flare height. Sampling will be conducted with appropriate inconel probes. Monitoring will be continuous and values will be averaged hourly or at a shorter time interval.
QA/QC procedures to be applied:	Analyzers will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas.
Any comment:	Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m^3 simply multiply by 0.716. 1% equals 10,000 ppmv.

Data / Parameter:	**T_{flare}**
Data unit:	ºC
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measurements using thermocouple.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	---
Description of measurement methods and procedures to be applied:	Monitoring will be continuous.
QA/QC procedures to be applied:	Thermocouples will be replaced or calibrated every year.
Any comment:	

Data / Parameter:	$PE_{PL,y}$
Data unit:	tCO_{2e}
Description:	Physical Leakage from distribution network of the captured methane in
Source of data to be used:	Recorded data from flow meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Zero
Description of measurement methods and procedures to be applied:	The sum of the quantities of captured methane fed to the flare and to the power plant (measured as per the monitoring plan) must be compared annually with the total methane generated as measured by meter at the outlet of the methane generating digester. The difference between the monitored value of methane generated and that consumed in flare/electricity generation/heat shall be accounted as leakage from the pipelines.
QA/QC procedures to be applied:	The parameters used for determining the project emissions from flaring of the residual gas stream in year y ($PE_{flare,y}$) should be monitored as per the “Tool to determine project emissions from flaring gases containing Methane”.
Any comment:	---

Data / Parameter:	**Regulations**
Data unit:	---
Description:	Existence and enforcement of relevant regulation
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	---
Description of measurement methods and procedures to be applied:	Relevant regulation into force at the start of the crediting period
QA/QC procedures to be applied:	Quality control for the existence and enforcement of relevant regulations and incentives is beyond the bounds of the project

	activity. Instead, the DOE will verify the evidence collected.
Any comment:	---

B.7.2. Description of the monitoring plan:

Mabella Diamantino 1 will designate a specific group of operators dedicated to work on the daily operation of the project activity. The specific staff will be properly trained by LOGICarbon – the project developer – and by equipment suppliers on operation, maintenance and monitoring of the installed facilities. Training sessions will be repeated once a year or, when required, more frequently.

LOGICarbon will manage O&M and monitoring of the proposed project throughout the project lifetime, being responsible for all data management, processing, quality control and storage (physical and electronic), as well as the preparation of monitoring reports and the coordination of the emission reduction Verifications.

All the equipment will be monitored by the operation team, guaranteeing that the project is achieving its objective of reducing GHG emissions. To support the operation team, an automated system furnished with alarms will control and monitor biogas flow and combustion by either electricity generators or flare.

All the information related to biogas flow, methane concentration and flare efficiency will be registered in a data logger, wired and stored via internet to an independent system that will check and validate for precision and file the downloaded information. All the monitoring information will be available online to those related to the project and at the site of the project activity. Monthly monitoring reports will be prepared by the operation team in specific format, including all the monitoring data, and sent to LOGICarbon.

In case of preventive and corrective maintenance, the farm maintenance team will be trained specifically for each type of equipment, to quickly assist Mabella Diamantino 1 in case of necessity. Depending on the type of maintenance required, service providers specialized in specific equipments or materials may be used.

A maintenance log book will be kept in the farm office and every maintenance event will be recorded by the project operation staff. All equipment will undergo maintenance and calibration according to recommendations of the suppliers.

At the project activity site, the following data will be available for inspection for each verification period:

Baseline emissions:

1. Blue prints with diagrammatic representation of animal waste management system existing on the project site prior to project implementation;

2. Parameters MCF, B_0, and R_{VS} for estimating methane emissions from AWMS in the baseline;

3. EF_{N2O} and R_N for estimating nitrogen emission from AWMS in the baseline;

4. Ambient temperature at the AWMS site, with data from the local meteorological station obtained at the Climate Data Base of Portal de Tecnologia da Informação para Meteorologia, from Centro de Previsão de Tempo e Estudos Climáticos (CPTEC), http://bancodedados.cptec.inpe.br/climatologia;

5. Net electricity supplied by the project activity to the grid and/or the farm. Measurement results will be cross-checked with records for sold electricity and/or consumption by the farm. Continuous measurement and monthly recording are required.

6. The following data is not applicable to the baseline scenario and will not be monitored:

   a. Amount of electricity used for the operation of the AWMS in the baseline;

   b. Amount of fossil fuel used for the operation of the AWMS in the baseline;

   c. Data and parameters for estimating heat and electricity emission factors.

Project emissions:

7. Population of each livestock category:

   a. Number of heads of each population and the average animal weight of each category are obtained from Mabella Diamantino 1 official accounting reports, which are generated with PigChamp reports and an internal report called "*Boletim Mensal"*; given that the swine production at Mabella Diamantino 1 is for commercial purposes, this kind of data is highly controlled and dully audited;

   b. PigChamp is a commercially available software for the management of swine operations; it allows daily inputs of the introduced, transferred or removed animals of each animal category and provides a reliable and accurate record of the daily stock at the farm;

8. Parameters MCF, B_0, and R_{VS} for estimating methane emissions from AWMS in the project case; Mabella Diamantino 1 swine operation is very similar to those in North America and the following information will be monitored on an annual basis, in order to confirm the choice of the B_0 value:

   i. The **swine genetic** adopted by Mabella Diamantino 1;

   ii. **Average weights** of Mabella's animals;

   iii. As validated from the farm reports, **animals are fed with formulated feed rations (FFR)** which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics; given that this component has a major impact in the production costs of commercial swine operations, this kind of data is thoroughly controlled by the farm operation;

   iv. **The basic components of the FFR**;

9. EF_{N2O} and R_N for estimating nitrogen emission from AWMS in the project scenario;

10. The default volatile solid excretion values or other parameters required for estimating the volatile solids; in the case of this proposed project activity, since the VS excretion is calculated with the dietary intake method, the feed intake of animals and its energy will be monitored:

    a. Daily average dry matter feed intake, which is calculated by dividing the monthly amount of feed produced for each category LT, by the average LT population of each month; data will be acquired from official Mabella's activity reports; a consolidated report will be prepared on an annual basis;

    b. Weighted ash content of the feed for each animal category, calculated using information from the feed formulation for each category LT; a consolidated report will be prepared on an annual basis;

11. Leakage from anaerobic digester:

    a. The chosen biodigester technology (covered lagoon type) and materials (EPDM), offer complete sealing between the cover and the liner, avoiding physical leakage; the cover where the biogas will be captured presents no opening for venting; the only possibilities for physical leakages would be punctures/ruptures of the cover or the complete and long-term outage of the combustion systems (biogas generators and flare), which will cause the biogas venting through pressure relieve valves; when fully installed, the project will have complete redundancy, resulting in a capacity to burn the double of the expected volume of biogas to be produced by the digesters; the inability to combust methane by the project activity will be extremely rare;

    b. As part of the operation team routine, the digesters will be daily checked for:

        i. Integrity of the biodigester covers;

        ii. Quality of the sealing between the biodigester covers and liners;

        iii. Check for leakages or obstructions of the manure transfer system to assure that 100% of the manure is being sent to digesters;

    c. The biogas flow at the outlet (Fm1 and Fm2) and the internal pressure of the biodigester covers will be continuously monitored, enabling operators to rapidly identify the existence of leakages from the biodigesters;

    d. Due to the corrective and preventive maintenance plans, any event that prevents the biogas from being captured and/or burnt shall be solved in less than 24 hours; during the project monitoring period, these events shall be dully recorded in the maintenance registry book; the crosscheck with values registered by the flow meters will demonstrate that, in the occurrence of these rare events, lower methane volumes were burnt in that period and, thus, resulting in the reduction of claimed emission reductions.

    e. A consolidated report will be prepared on an annual basis;

12. The default nitrogen excretion per animal or parameters required to estimate nitrogen excretion;

   a. Daily average dry matter feed intake, which is calculated by dividing the monthly amount of feed produced for each category LT, by the average LT population of each month; data will be acquired from official Mabella's activity reports, which are prepared from data obtained from PigChamp or other farm official reports; a consolidated report will be prepared on an annual basis;

   b. Weighted crude protein content of the feed for each animal category, calculated using information from the feed formulation for each category LT; a consolidated report will be prepared on an annual basis;

13. Amount of electricity used in the project case will not be recorded, since it will be supplied by the biogas power plant to be installed in the project site;
14. Fuel consumption for generation of heat used in the project case will not be monitored, since there will be no fuel consumption for generation of heat in the project case;

15. Flow of biogas to the flare and electricity generation:

   a. There will be 4 flow meters installed: 1 at the outlet of each of the 2 digester systems (Fm1 and Fm2), 1 before the flare (FmF) and 1 before the electricity equipment (FmG) (please, refer to Figure 8, at Annex 4, Monitoring Information); the flow meters that precede the flare and the generators will define how much of the gas is being burned; data will be stored in servers at the site and at an independent system with online access through the Internet;

   b. Flow meters will undergo maintenance/calibration according to manufacturer recommendations. Thermatel TA2 flow meter is enabled with a self-diagnosis system, which detects and inform when there is any problem. As per the manufacturer instructions, only in this case the flow meter shall be sent to maintenance and recalibration;

   c. The operation team will periodically check the proper operation of the flow meters, taking readings and preparing specific reports;

   d. Besides that, the alarm system will warn operators in the occurrence of any unusual event. There will be spare units for replacement performed by trained operators. These events shall be recorded at the maintenance log book.

   e. A consolidated report will be prepared on an annual basis;

16. Concentration of methane of the residual gas:

   a. The methane concentration of the residual gas will be continuously measured at outlet of the anaerobic digesters, on a wet basis, by a biogas methane analyzer at a fixed point;

   b. Readings will be periodically made and the data will be stored locally in an electronic data acquisition and storage system, which will routinely upload and transmit it via the Internet to a secure server via dial-up using landline or cellular;

   c. The device will count with an automatic calibration with standard gases, in order to keep a minimum +/- 1% of accuracy of the analyses;

d. The operation team will perform periodic readings of the methane concentration in the residual gas and reports; the alarm system will be activated if any unusual event occurs;

e. A consolidated report will be prepared on an annual basis;

17. The parameters used for determining the project emissions from flaring of the residual gas stream in year *y* ($PE_{flare,y}$):

  a. Parameters will be monitored as per the "Tool to determine project emissions from flaring gases containing Methane";

  b. The project will have an enclosed flare with automatic ignition and flame programmer, that avoid the biogas to be vented without being burnt; a thermocouple, installed at 80% of the flare stack height, will continuously monitor the temperature of the exhaust gas; an alarm system will warn in case of any failure of the ignition system;

  c. A fixed position analyzer (Landtec AEMS Exhaust Monitor) will continuously measure the CH_4 and O_2, at low concentrations (ppm), of the exhaust gas; data will be stored in servers at the site and at an independent system with online access through the Internet;

  d. Operators will perform periodic readings and reports on the flare operation temperature;

  e. A consolidated report will be prepared on an annual basis;

18. Biogas leakage in project through leaks in the pipeline during transportation of biogas:

  a. The automated monitoring system will continuously provide information on biogas flow at the outlet of digesters and at the entrance of the flare or the electricity generator; it will monitor the differential ratio of biogas flow between the outlet of digesters and the inlet of flare and generators and be set with an alarm to warn operators to check the pipeline in case of occurrence of changes in the values either being caused by leakage or obstruction;

  b. Periodic checking for pipeline integrity and obstructions;

  c. A consolidated report will be prepared on an annual basis;

19. The CM emission factor for the electricity supplied by the grid will be calculated during the entire crediting period, using the *ex-ante* BM emission factor and the OM emission factor from the year in which the project activity displaces grid electricity and update the emission factor annually during monitoring, according to the "Tool to calculate the emission factor for an electricity system", version 02.; (http://www.mct.gov.br/index.php/content/view/74689.html)

Leakage:

According to ACM0010, "Leakage covers the emissions from land application of treated manure, outside the project boundary. These emissions are estimated as net of those released under project activity and those released in the baseline scenario. Net leakage of N_2O and CH_4 are only considered if they are positive."

The current practice for land application (fertirrigation on cropland) of the treated manure and sludge at Mabella Diamantino 1 will remain basically the same after the installation of the proposed project activity, thus all parameters for both baseline and project emissions are the same, resulting in zeroed net leakage of N_2O and CH_4.

The current disposal practice of the treated manure and sludge will be documented for the state environmental agency (SEMA-MT) and such documents will be used to monitor the continuation of this practice during the crediting period.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

28/08/2008.

Responsible entity: LOGICarbon Assessoria Ambiental Ltda.
Project participant and project developer
R. Tapuia, 444, Indaiatuba, SP

Contact: Miguel H. G. de Oliveira or Rodrigo F. Gatti
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SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

15/12/2008.

The starting date of the project activity was determined by the signature of the contract for the project construction and implementation between Mabella/Marfrig and Mokva Engenharia, which was held on 15 December 2008 and is considered the evidence for such event.

C.1.2. Expected operational lifetime of the project activity:

The project is expected to last more than 30 years.

C.2. Choice of the crediting period and related information:

C.2.1. Renewable crediting period:

This project will use a fixed crediting period.

C.2.1.1. Starting date of the first crediting period:

Not applicable.

C.2.1.2. Length of the first crediting period:

Not applicable.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/03/2010 or the date of the project registration, the one that occurs later.

C.2.2.2. Length:

10 years.

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

There are no specific laws or regulations for animal effluents in Brazil. For cropland application, CONAMA (Brazilian National Environmental Council) Resolution 357, from 2005, states that effluents shall not promote soil or water contamination, meaning that the effluent must be treated to a certain degree that will not pollute soil or water. In normal conditions, the existing AWMS at Mabella Diamantino 1 efficiently treats the effluents resulting from the swine operation, i.e. reducing 95% of the COD content before its final destination (fertirrigation), consisting in a satisfactory manure treatment from the legal and regulatory stand point. The State Environmental Agency monitors the efficiency of the AWMS by requiring, from farm personnel, periodic laboratory analysis of the wastewater trough samples collected at the inlet and outlet points of the AWMS. The COD content is one of the monitored parameters. According to the project calculations (based on literature references and the design of the AWMS stages) submitted to the State Environmental Agency (SEMA MT), the project activity will keep the same COD reduction efficiency. Furthermore, the project foresees the reuse of 70% of the water from the treated wastewater for the farm operation (e.g. cleaning of the barns).

In fact, there are no negative environmental impacts resulting from the project activity, since the project activity concerns to the upgrade of the existing AWMS system (open anaerobic lagoons) to covered lagoon type digesters. Mabella Diamantino 1 has a approved Installation License for the project (LI#57632/2010), issued by the State Environmental Agency (SEMA MT) in March 11, 2010 and valid until March 11, 2014 showing that there is no restraint to the project implementation. Hence, Diamantino 1 Farm has a valid and approved Environmental License (LAU – Licença Ambiental Única) # 008/2004, of March 08, 2004, which encompasses both, Preliminary and Installation licenses and farm operation activities. The LAU was initially valid until 08 March 2009 but, according to the State of Mato Grosso Environmental Agency’s Decree nº 807, of 11 October 2007, its validation has been postponed until 08

March 2012. All these licenses demonstrate that there are no issues pending with the State Environmental Agency.

Besides the principal benefit of mitigating GHG emissions (the primary focus of the proposed project), the proposed activities will also result in positive environmental co-benefits. They include:

1. Reduction of atmospheric emissions of Volatile Organic Compounds (VOCs) that cause odor, improving the air quality and the farm workers and neighborhood quality of life;

2. Reduction of the population of flies and associated enhancement to on-farm bio-security thus reducing the possible spread of disease;

3. The biogas resulting from the anaerobic process is an excellent energy source for electricity generation; the use of this clean and renewable energy source allows the farm to decrease the use of electric energy from the grid;

The combination of these factors makes the proposed project site more “neighbour friendly” and environmentally responsible.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Not applicable.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

According to the Resolutions Number 1, 4 and 7 of the Brazilian Designed National Authority (CIMGC – Comissão Interministerial de Mudança Global do Clima/Interministerial Commission on Global Climate Change), project participants sent letters to local stakeholders 15 days before the start of the validation period, in order to receive comments. To satisfy and comply with this ruling, invitation letters describing the project and requesting comments have been sent to the local stakeholders.

The invitation for comments was sent by official letter by LOGICarbon through the Brazilian mail (Correios) on 01 August 08. An additional invitation was sent on 11 August 08, also by official letter.

Invitees include:

1. Executive and Legislative Public Powers of Diamantino, MT;
2. Environmental Public Agencies of Mato Grosso and Diamantino;
3. Fórum Brasileiro de ONG's e Movimentos Sociais para o Meio Ambiente e Desenvolvimento - http://www.fboms.org.br;
4. Federal and State Public Attorney Offices;
5. Agriculture and livestock associations.

All correspondences were received by the intended recipients until 18 August 2008, according to the Brazilian Mail receipts. Version 1 of this PDD was posted in LOGICarbon's website (http://www.logicarbon.com/pt/projetos/carrols_logicarbon280808.pdf) on 29 August 08, as indicated in the invitation for comments. Commenting period was ended on 12 September 08. The validation process is to start after this date.

E.2. Summary of the comments received:

No comments were received until the conclusion of this PDD.

E.3. Report on how due account was taken of any comments received:

Not applicable.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Not applicable.

Annex 3

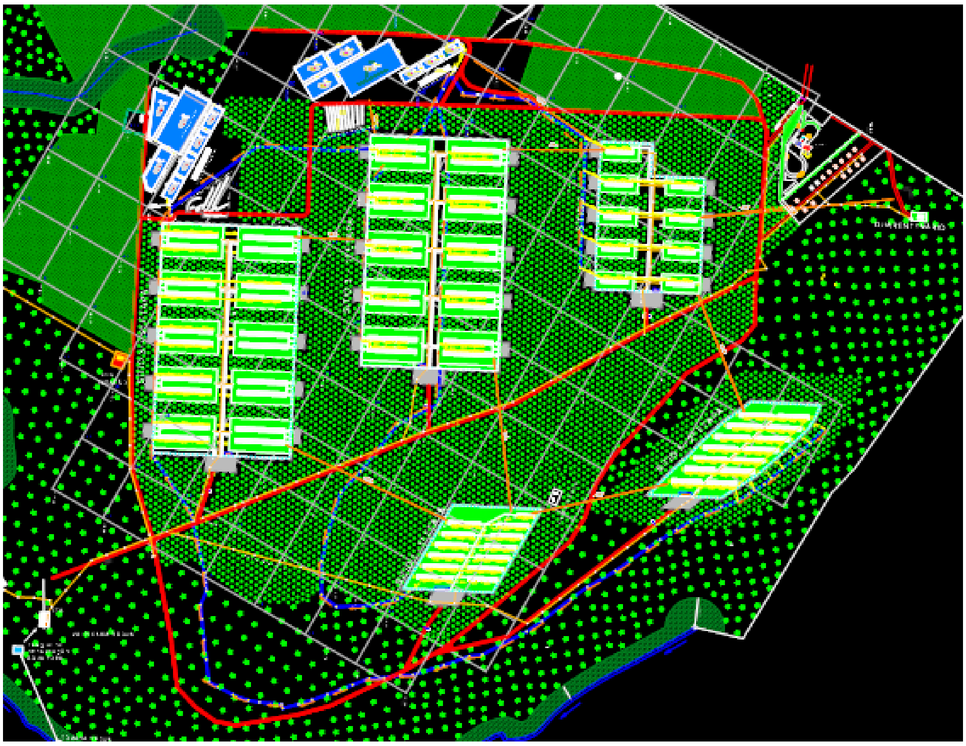
BASELINE INFORMATION

General view of Mabella Diamantino 1, with the animal barns in the upper half and the manure treatment system in the bottom half.

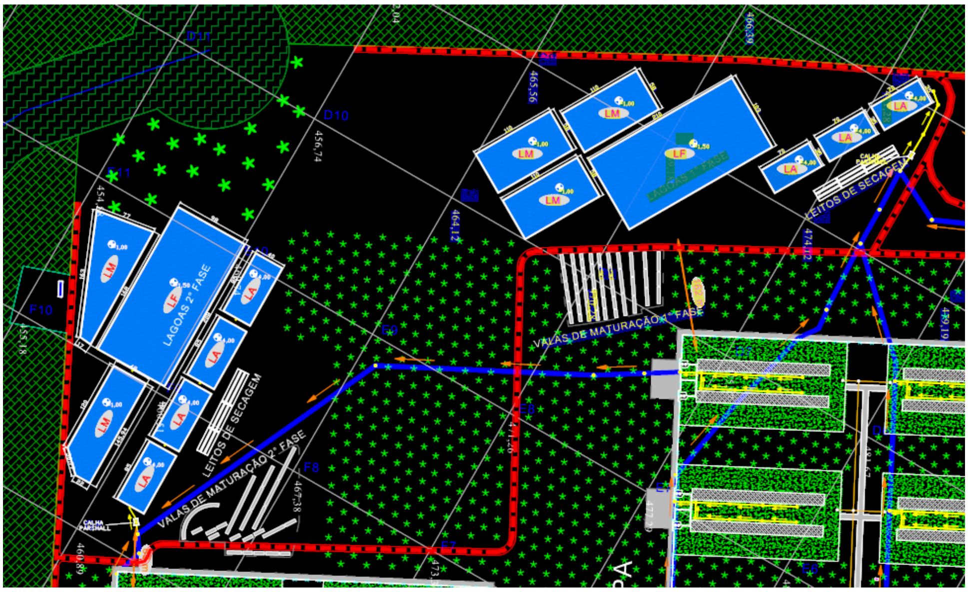
Existing AWMS (open anaerobic lagoons)

Existing AWMS (open anaerobic lagoons)

General blueprint of Mabella Diamantino 1



Detailed view of the existing AWMS



Annex 4

MONITORING INFORMATION

Figure 8. Flow diagram and biogas flow measurement points of project activity