CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

>> " Ramirana Emission Reduction Project of Agrícola Super Limitada"

Version number of the document: Third Version of the document.
Date of the document: 11/04/2006

A.2. Description of the project activity:

>> In December 2000, Agrícola Super Limitada (Agrosuper), the largest pork production company in Chile, initiated a voluntary process to implement advanced waste management systems (anaerobic and aerobic digestion of hog manure), in order to reduce greenhouse gas (GHG) emissions into the atmosphere.

The project consists of an advanced improvement to the common practice of swine waste treatment in the country, reducing an important volume of greenhouse gases. The technology implementation is based on the use of an ambient temperature anaerobic digester, an activated sludge treatment plant and a storage lagoon from where treated residues are finally employed for irrigation purposes.

The anaerobic and aerobic digestion technology is being implemented gradually in some of Agrosuper's facilities. The goal is to eventually implement this technology to capture or avoid GHG emissions from all of the company's swine barns. However, this will depend upon the generation of revenues from the sale of Certified Emission Reductions (CERs), which will be used to partially finance the waste treatment systems.

The decision to consider the implementation of more expensive technology was influenced by the adoption of the Kyoto Protocol and the Clean Development Mechanism. The investment decision was further influenced by the confirmation as part of the Marrakech Agreement *"...that a project activity starting as of the year 2000, and prior to the adoption of this decision, shall be eligible for validation and registration as a CDM project activity if submitted for registration before 31 December 2005. If registered, the crediting period for such project activities may start prior to the date of its registration but not earlier than 1 January 2000*".

The expected result from this project activity will be a significant reduction in the volume of methane (CH_4) and nitrous oxide (N_2O) emissions compared to those emissions that would otherwise occur in a scenario with traditional swine manure treatment systems employed on the host country.

According to the approved methodology (AM0006), and based on a cost analysis, the baseline treatment system is represented by the use of open stabilisation lagoons (from now on anaerobic lagoon) as the treatment process of liquid waste from swine production. Anaerobic lagoons lead to the direct release of CH_4, N_2O and CO_2 into the atmosphere as result of the anaerobic digestion process that takes place inside the lagoons. Anaerobic lagoon treatment process should be considered as the current national baseline for the agricultural sector, as will be detailed later in this document.

A.3. Project participants:

>> The following participants are involved in the project: "*Ramirana Emission Reduction Project of Agrícola Super Limitada*":

Table A.1. Project participants.

Name of Party involved	**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)**
Chile (host). *Chile ratified the Kyoto Protocol on August 26, 2002*	Agricola Super Limitada. *Private company engaged in the swine and poultry business.*	NO

Agrosuper: The Company

The **"Ramirana Emission Reduction Project of Agrícola Super Limitada"** is a project developed by Agrosuper, pork, poultry, fruit and salmon producer. Agrosuper has more than 102,000 sows in production and is considered the 8th largest swine producer in the world.

Agrosuper is affiliated with the Swine Producers Association of Chile (ASPROCER) and with the private industry Association (SOFOFA).

Agrosuper's goal is to offer the best product to the market, and at the same time, maintain a good relationship with the community through initiatives such as good environmental performance.

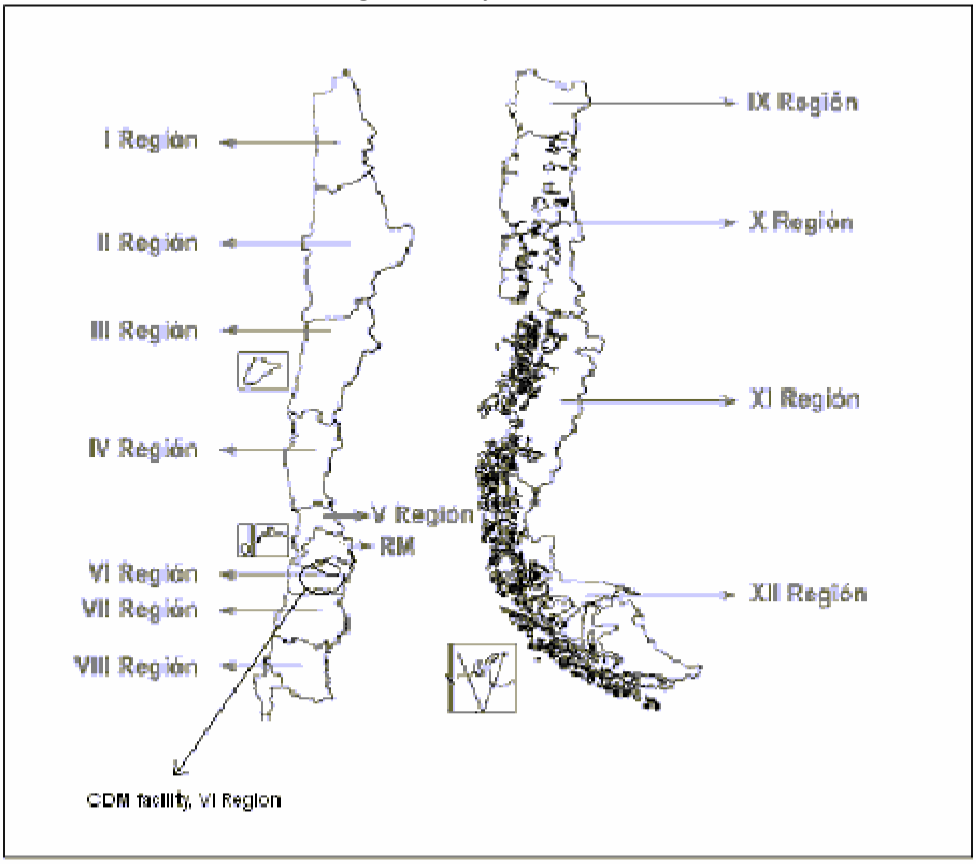
Agrosuper complies with all Chilean environmental regulations. In addition, the swine production department and all farms are certified with quality and environmental management systems under ISO 9001:2000 and ISO 14001:1996, respectively.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

>> The project is located in Central Chile (VI Region), South America

Figure 1 Project Location



A.4.1.1. Host Party (ies):

>> The host party identified for this project Chile.

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

>> La Ramirana Advanced Waste Management System: VI Region, named as Libertador Bernardo O'Higgins, Province of Cachapual

A.4.1.3. City/Town/Community etc:

>> La Ramirana Advanced Waste Management System: Community of Graneros

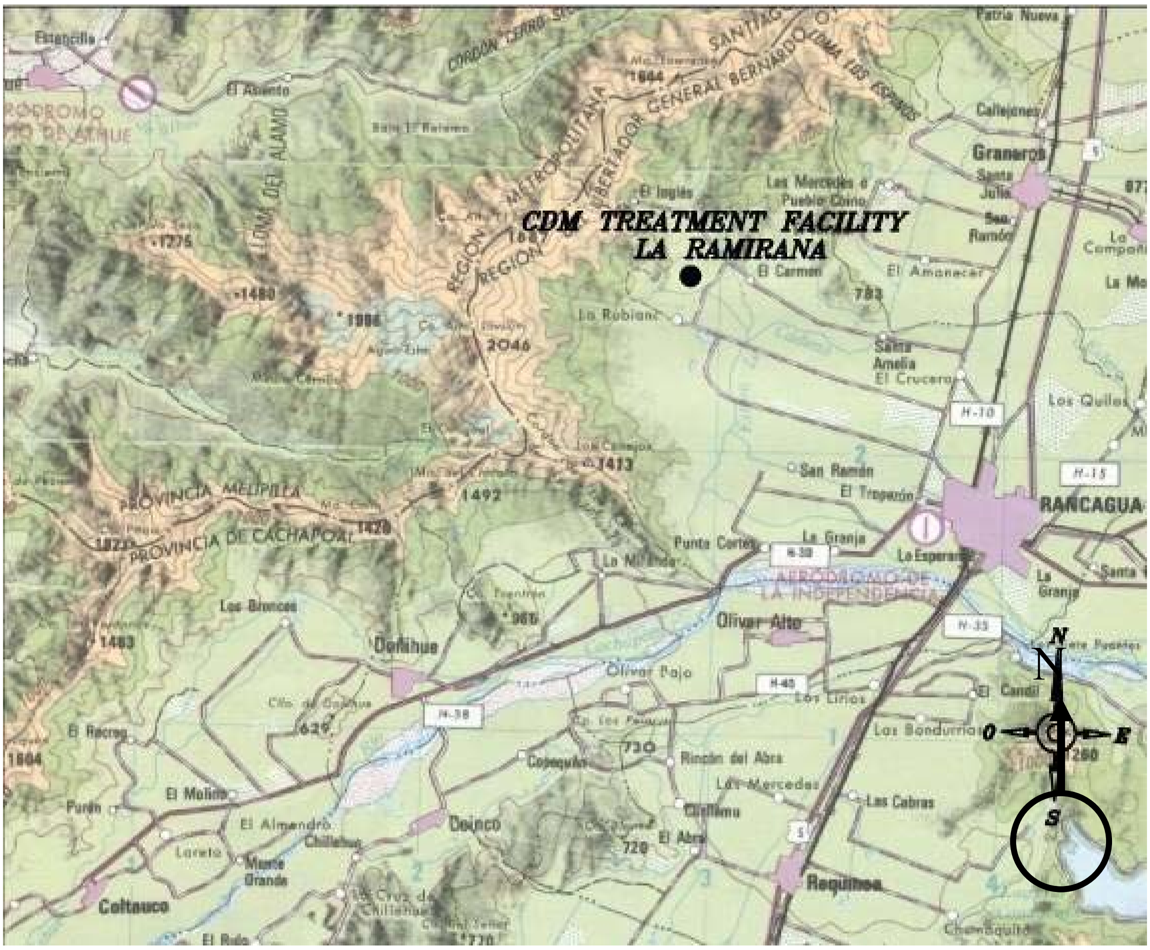
A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

>> The next table presents the Universal Transversal Mercator (UTM) co-ordinates for the digester:

Table A.2

Name of the digester	Farm name	Nearest location	North (UTM)	East (UTM)
Ramirana	Fundo La Ramirana	Graneros	6.226.900	328.700

Figure 2: Project Activity, VI Region



The next table summarises the Project Activity characteristics:

Table A.3

Project	Treatment system type	Size of treatment system, volume (m^3)	Irrigation project	Starting date of the project's construction
Ramirana (1st treatment component)	Ambient Temperature Anaerobic Digester	67,000	Yes	01/02/2002
Ramirana (2nd treatment component)	Inclusion of Activated Sludge Plant	3,800 m^3 Anoxic tank and 18,300 m^3 aeration tank		

There are no protected resorts or national monuments located next to the project installations.

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

>> The project can be identified as "Advanced swine manure treatment" (aerobic and anaerobic digestion) which falls into the category of manure management from farming production.

The GHG emissions relevant for this analysis include; the open release of CH_4 from an anaerobic lagoon, losses of CH_4 due to leakage from the digester and emissions of N_2O for each scenario. The fugitive CO_2 generated from anaerobic digestion does not represent any difference in emission volumes between each scenario, because there are no possible additional transformations by the burning of this component. Since the project also considers aerobic treatment for the second phase of implementation, a default decay of nitrogen content via nitrification-denitrification, and an additional decay in the CH_4 generation from treated manure will be established.

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

>> **Anaerobic Digestion**

The project is based on anaerobic digestion in an ambient temperature digester, and additionally a dissolved air flotation solid-separation unit with aerobic treatment. Finally, once treated, the residual liquid manure is derived to a storage lagoon for irrigation purposes.

Figure 3: Methane combustion at Flare as in Ramirana

An anaerobic digester is a reactor sized to receive a daily volume of organic waste and to grow and maintain a steady-state population of methanogenic bacteria for degradation of inflow organic matter. Methanogenic bacteria are slow growing, environmentally sensitive that grow in anoxic conditions and require a pH greater than 6.9 to mainly convert organic acids into biogas over time.

Anaerobic digestion can be simplified and grouped into three steps:

- The first step, **hydrolysis**, is easy to recognise because the decomposition products are volatile organic acids with unpleasant odours. This step breaks down the organic material to usable-sized molecules. Complex organic compounds such as proteins, fats and carbohydrates are transformed by hydrolysis in lower molecular weight compounds. The products from this step are the substrate for bacteria for the next step.
- The second step consists in the conversion of decomposed matter to organic acids, and is named as **acidogenesis**. Acids, salts, carbon dioxide, water and ammonia are formed in this step.
- During the third step, methanogenic bacteria consume the products of the second step to produce biogas (composed of a mix of carbon dioxide and methane), which is a usable fuel by-product. This step is called **methanogenesis**.

The digester technology includes a cover of high-density polyethylene HDPE 40-60 mils, (1–1.5 mm) which is floated over the primary lagoon of a two lagoon system. The primary lagoon is maintained as a constant volume treatment lagoon and the second cell is used to provide storage of treated effluent until the effluent can be properly applied to land.

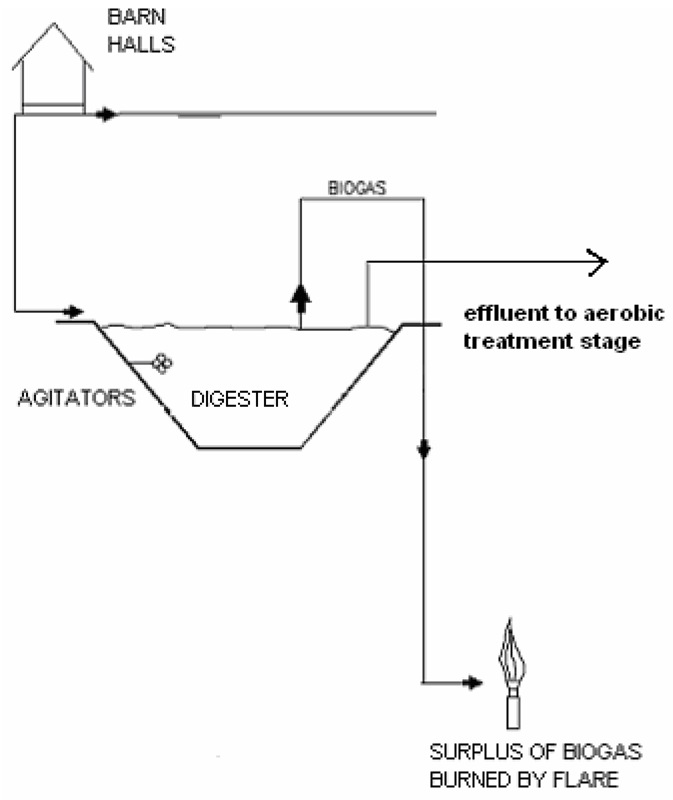
The digester is a complete-mix reactor that decomposes animal manure under anaerobic conditions, constant volume, and continuous mixing. Mixing can be accomplished with mechanical mixers. A

complete-mix digester can be designed to maximise biogas production as an energy source or to optimise volatile solids (VS) reduction with less regard for surplus energy.

The anaerobic digester is one of the few manure treatment options that reduces the environmental impact of manure and generates energy. Biogas extraction and burning from the digester is managed using an automatic control system in which, through parameters such as biogas flow and pressure differences, optimal operation conditions are established. Therefore, it is possible to state that the external environment does not affect digester treatment, i.e., it operates independently from meteorological factors.

The following flowchart explains the digester treatment system (not considering the aerobic treatment).

Figure 5: Flowchart of Treatment System (ambient temperature digester)



The emission reduction achievement is based on the transformation of CH_4 to CO_2 through combustion, therefore avoiding fugitive CH_4 emissions. The chemical reaction is exposed next:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

It's important to emphasise that CH_4 (GWP = 21) has a much more significant impact on global warming than CO_2 (GWP = 1). Thus, the chemical transformation of CH_4 into CO_2 indeed is a contribution in the mitigation on global warming effects.

Treated water is used for the irrigation of eucalyptus plantations and other crops surrounding the areas of the company's property. During the winter season, when no irrigation is required, effluents are accumulated at the storage lagoon.

Aerobic Treatment (Activated Sludge)

The following component of the advanced waste management system considers the capability to receive raw manure directly from the barns or to be included after the anaerobic digester treatment. For the current case of La Ramirana, it has been considered that after manure is treated in the digester, it goes to solid separation and then enters to aerobic treatment based on the activated sludge

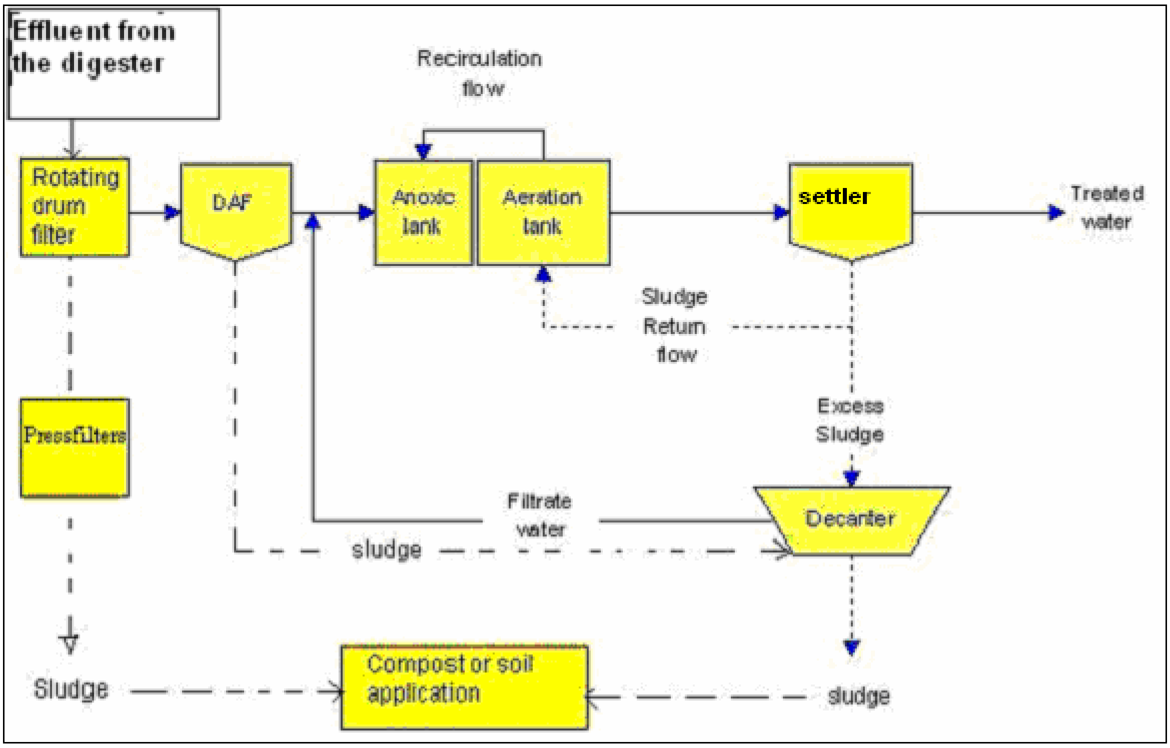
The activated-sludge process is an aerobic, continuous flow, secondary treatment system that uses sludge-containing, active, complex populations of aerobic micro-organisms to break down organic matter in wastewater. Activated sludge is a flocculated mass of microbes comprised mainly of bacteria and protozoa.

Digester effluent is pumped into a rotating drum filter, where an initial volume of sludge is removed. The rest of the effluent is transported to a dissolved air flotation unit (DAF) and then into the anoxic tank of the aerobic system, where it is mixed with an active mass of micro-organisms (referred to as activated sludge) capable of aerobically degrading organic matter into water, new cells, marginal quantities of CO_2 and other end-products. Mechanical aeration maintains the aerobic environment in the basin and keeps reactor contents (referred to as mixed liquor) completely mixed.

After a specific treatment time, water is pumped into a settler unit, where the sludge settles under quiescent conditions and a clarified effluent is obtained. The process recycles a portion of settled sludge back to the aeration basin to maintain the required sludge concentration (within the aerobic basin). The process also intentionally wastes a portion of the separated sludge to maintain the required solid retention time for effective organic (BOD) removal.

Figure 5: Advanced aerobic treatment, activated sludge as in Ramirana

Figure 6: Flowchart of the Aerobic Treatment



The activated sludge treatment process has sludge outflow from the initial solid separation stage and the flotation units. Total sludge is conducted to a centrifugal decanter, where moisture is diminished in order to manage sludge without liquid draining problems. The present project considers the appropriate management of sludge from the aerobic treatment and the storage lagoon's bottom, in aerobic and controlled conditions. The sludge management alternatives are:

- **Land application programs for soil recovery:** The purpose of soil recover, will be achieved through improving soil's structure and stability, hydro retention capacity, adding nutrients, stimulating microbiological activity and helping land working. Sludge application will be done on neighbor fields, outside the project boundaries, with the use of agricultural machinery.
- **Composting treatment of both, degraded sludge and solid separation, along with other residues of the area.** The purpose of the composting process is to achieve definitive sludge stabilization, reducing between 70 to 80% of its original volume, and allowing the refinement of the sludge through it's transformation as compost. Sludge is transported to the composting system on 25 tons capacity trucks.

For both alternatives, methane and nitrous oxide emissions are considered negligible, because there are no anaerobic conditions in each of the sludge management process.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

>> **How the GHGs are reduced by the CDM project activity:**

Agrosuper has improved its swine waste treatment systems in order to reduce GHG emissions. This has been accomplished through the implementation of an advanced system that includes an anaerobic digester followed by an aerobic treatment. The program began in this site in February 2002 with the implementation of the digester of Ramirana.

CDM project activity (Advanced system implemented by Agrosuper):

Digester:

Manure from barns is pumped from a collection and mixing tank to the digester. The digester consists of an earthen pit lined with an impervious membrane. The digester is covered with a floating membrane. All biogas generated is collected by perforated pipes surrounding the digester's edge, below the cover. Biogas is flared to form carbon dioxide. Effluent is removed from the digester and is pumped to a nearby storage lagoon via a retaining tank. This effluent still contains nutrients and can be used as irrigation water. GHG emissions are considerably reduced with this system.

Through this process, the anaerobic treatment is optimal and duly controlled, employing an efficient biogas collection system and a new aerobic post-treatment as a second treatment component of the project.

Activated Sludge:

The activated-sludge process is an aerobic, continuous flow, secondary treatment system that uses sludge-containing, active, complex populations of aerobic micro-organisms to break down organic matter in

wastewater. The treated waste from the digester undergoes forced aeration to provide nitrification and denitrification. The system is able to reduce enormously the organic matter and nitrogen content of waste, considering a highly degraded liquid effluent, separated from a volume of sludge accumulation. The aerobic system uses extended aeration, so it is able to fix nitrogen on its process and does not emit nitrous oxide.

This project has considered the management of sludge in appropriate and controlled aerobic conditions.

Baseline (Anaerobic Lagoon):

Approximately 50% of the companies in Chile (including Agrosuper) have introduced the open lagoon system, in context of the Clean Development Agreement signed in 1999 between the Government and the Pork Industry to enhance the level of swine manure treatment in the country. Assuming a conservative approach, this project activity has considered the anaerobic lagoon as the baseline, based on a cost analysis for the different waste treatment technologies. Approximately 50% of the Pork industry in Chile and most of Agrosuper facilities use this manure management system due to its lower cost, and it's consistency with the Chilean Clean Production Agreement for swine production. Therefore, this represents one of the likely economically attractive scenarios for Agrosuper's pork production.

Also, the resolutions that approve the Environmental Impact assessments of Agrosuper's swine barns, state the design characteristics of the anaerobic lagoons for wastewater management.

In the traditional system the manure is flushed from the barns and then collected in an anaerobic lagoon or other earthen storage facility. In lagoons, manure is partially digested by naturally occurring micro-organisms, and solids settle on the bottom of the storage facility. During the irrigation period, water is pumped from the surface of the lagoon to lower the water table and increase the storage capacity. Water is then used in a land application program, either for use as fertiliser and irrigation water, or for straight land disposal. Solids collected in the bottom of the lagoon are removed once every 10 to 20 years, and are used on land to enhance fertilisation. Low levels of management participation, low development costs, and minor environmental safeguards characterise this system. Additionally, this system is a high source of GHG emissions, particularly, CH_4.

If the CDM project activity was not undertaken, all greenhouse gases from the anaerobic lagoon would have been emitted to the atmosphere from anaerobic lagoons. Therefore, the current practice of using an anaerobic lagoon is more cost effective than the proposed digester. Thus, the net emissions from Agrosuper's facilities have been considerably reduced since the first phase of this project with the anticipated total reduction in tons of CO_2 equivalent detailed in section E.

National and sectoral policies and circumstances

Besides from the existing legislation in Chile that establishes strict water quality parameters that do not allow raw manure to be discharged into watercourses, there is no legislation that requires a specific swine manure treatment.

Apart from the improvements in manure management achieved by Agrosuper, and described in this PDD, the rest of the swine industry lags behind in the adoption and implementation of manure management technologies. In Chile, the basic technological solution of swine manure management do not provide for the reduction of GHG emissions.

As stated above, about 50% of the Chilean pork production industry use open lagoons for their swine manure treatment. Agrosuper has traditionally implemented the anaerobic lagoon system for all of its

facilities and then has gone even further by installing the advanced waste management system (digester an aerobic treatment) on October of 2005.

During the last years, Agrosuper has used anaerobic lagoons as wastewater treatment due to the fact it is still the most cost-effective alternative. This system was also recognized as the technology that the industry and the Government are encouraging to use in Chile, as stated in the Clean Production Agreement signed in 1999, which establishes the voluntary commitment of open anaerobic lagoons system to be implemented in the industry.

The additionality of the project will be discussed in significantly more detail in Chapter B.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

>> The following table represents the emission reductions results for the Ramirana project activity through the crediting period:

Table A.4 Emission Reduction

Years	Annual estimation of emission reductions in tonnes of CO2 e
Since October 2005	13,204
2006	58,686
2007	58,686
2008	58,686
2009	58,686
2010	58,686
2011	58,686
Until October 2012	45,469
Total estimated reductions (tonnes of CO2e)	**410,790**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	**58,684**

A.4.5. Public funding of the project activity:

>> Not applicable. There is no public funding involved in this Project.

SECTION B. Application of a baseline methodology

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

>> The applicable approved baseline methodology for this project is "**GHG emission reduction from manure management systems**", and is referenced as AM0006. It can be found on the CDM-Executive Board website under the following link:

http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_343163180

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

>> The approved methodology named as AM0006, is applicable to the project activity since the initiative is represented by a swine farm operating under a competitive market, which complies with all the environmental regulations of the host country.

This methodology is also applicable for this project activity as the swine population is managed under confined conditions and the technology only affects emissions from the waste management system. Finally, neither the baseline nor the project activity discharges the wastewater stream into rivers and/or estuaries.

According to the modalities and procedures of the CDM, project participants should select the baseline approach that is most relevant for the proposed project. The baseline approach adopted for this project activity is approach 48 (b). Accordingly, the baseline scenario is determined as the scenario that represents "emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment". This approach assumes that economically rational behaviour determines the most likely future baseline scenario, it seems appropriate to centre this approach in an investment or financial analysis.

The methodology determines the baseline scenario under a cost-benefit evaluation, and concludes that the most costly scenarios would not be implemented. The list of possible baseline scenario alternatives considered was selected from the IPCC Guidelines (Chapter 4, Table 4-8) and the IPCC Good Practice Guidance and Uncertainty Management (Chapter 4, Table 4.11). The list was abridged in view of environmental constraints, current facility infrastructure and Agrosuper's internal policies.

The application of the baseline methodology excludes every waste management alternative, leaving only the proposed project alternative (anaerobic digester and a second component of aerobic treatment) and a likely scenario (baseline) that is economically attractive (anaerobic lagoon).

The proposed project activity involves a significant investment that must compete with other wastewater treatment investments. Therefore it is appropriate to support the decision of different baseline scenarios, under a cost-benefit evaluation.

B.2. Description of how the methodology is applied in the context of the project activity:

>>

The following steps are followed to represent the baseline scenario.

Step 1: List of possible baseline scenarios

The following list of scenario alternatives is composed of a combination of different animal waste treatment stages. Each alternative was chosen considering as key aspects prevailing practices in the company, available technologies and treatment efficiency.

1) Solid Storage – Land application
2) Pit Storage – Land Application
3) Storage Lagoon – Land Application
4) Anaerobic lagoon – Land Application
5) Press (Solid Separation) Anaerobic Lagoon – Land Application
6) Digester – Aerobic Treatment - Storage Lagoon – Land Application
7) Solid Separation – Composting – Land Application

The dry lot system has been excluded because is not applicable to the conditions that prevail at the swine's barns.

Step 2: Identification of plausible scenarios
The following criteria provide convincing justification for the exclusion of some of the potential baseline scenarios presented in step 1.

The exclusion of potential baseline scenarios is first determined by the following aspects:

- Legal constrains
- Historical practice of waste management in the company
- Availability of waste treatment technology
- Consideration of developments for manure management systems appropriate for the national conditions, including technological innovations.

1) Solid Storage – Land application: This kind of system is not applicable for manure that has low solid content. Due to washing and flushing systems of the barns, swine waste in these projects is liquid, therefore pumped from the barns to the waste treatment systems.

2) Pit Storage – Land Application: In the past, Agrosuper evaluated the possibility of constructing this kind of waste management technology. The farm operates under a competitive market in Chile and involves large farm size. Therefore, this technology is whether use nor common in the country. The quantity of manure produced is too large to implement complex storage structure under the barns, and for this reason will be excluded. Also, the excreted volume accumulated under the barns produces enteric fermentation gas, which could intoxicate swine livestock if it is not vented from the barns.

3) Storage Lagoon – Land Application: This system does not consider decay in volatile solids or nitrogen content in treated manure. Because the Chilean legislation requires quality standards for irrigation waters, the area to be irrigated by the storage lagoon effluent will be much larger than if considered an anaerobic lagoon, making this alternative not applicable. The storage lagoon does not comply with the waste treatment quality standards detailed in the environmental impact assessment, as an Agrosuper's commitment. Depending on storage design, this system will not be efficient enough for odour and vector control. So the exclusion of this potential baseline scenario can be justified.

4) Anaerobic Lagoon - Land Application: The anaerobic stabilisation lagoon represents Agrosuper's commitment detailed in the environmental impact assessment, aimed at improving swine manure management improve their manure management treatment. This is the most familiar technology in Agrosuper's waste management. This system considers the removal of solids settled in the bottom of the lagoon once every ten years.

5) Press (Solid Separation) Anaerobic Lagoon – Land Application: This kind of technology has the same qualities described before for the anaerobic lagoon. It additionally has the merit to separate solids before entering the lagoon, in order to have less solids accumulation, therefore, a smaller lagoon. This makes this alternative a potential baseline scenario.

6) Digester – Aerobic Treatment - Storage Lagoon – Land Application: Most of the barriers concerning this technology are described in the additionality test. This will be considered as a predefined scenario, representative for the project initiative.

7) Solid Separation – Composting – Land Application: Composting systems are not adapted to large volumes of water, or moisture contents. This dry aerobic system can only be applied after solid separation

stages of activated sludge. For this reason it is excluded from the list of possible baseline scenarios. Compositing practices in Chile are more common for other type of solid waste treatment.

The list of possible scenarios has been reduced to two potential baselines and one predefined project:
Baselines:

1) Press (Solid Separation) Anaerobic Lagoon – Land Application
2) Anaerobic Lagoon – Land Application

Project:

3) Digester – Aerobic Treatment – Storage Lagoon – Land Application

Step 3: Economic Comparison

The following economic comparison between each waste management scenario, will exclude the least-probable scenario, in order to identify the baseline scenario. For each scenario, all costs and economic benefits are being illustrated in a transparent and complete manner.

Table B.1. Economic Comparison

Baseline I (US$)	Year 1	Year 2	Year n	Year 10
WASTE TREATMENT STAGE I: PRESS + ANAEROBIC LAGOON				
Equipment costs (considering press)	-164,165			
Installation costs	-400,559	0	0	0
Maintenance costs		-16,416	-16,416	-16,416
Additional costs (**Press** Operation, consultancy, engineering, **irrigation costs,** drying solids, sludge removal and land application in 10th year)		-18,580	-18,580	-742,885
TOTAL BASELINE	**-564,724**	**-34,996**	**-34,996**	**-759,301**
NPV (US$) (discount rate = 10 %)	**-$ 1,059,012.39**			

Baseline II (US$)	Year 1	Year 2	Year n	Year 10
WASTE TREATMENT STAGE I: ANAEROBIC LAGOON				
Equipment costs (specify the equipments needed)	-76,165			
Installation costs	-438,592	0	0	0
Maintenance costs		-7,616	-7,616	-7,616
Additional costs (Operation, consultancy, engineering, **irrigation costs,** drying solids, sludge removal and land application in 10th year)		-7,963	-7,963	-929,177
SUBTOTAL	**-514,757**	**-15,579**	**-15,579**	**-936,793**
TOTAL BASELINE	**-514,757**	**-15,579**	**-15,579**	**-936,793**
NPV (US$) (discount rate = 10 %)	**-$ 965,651.09**			

Project (US$)	Year 1	Year 2	Year n	Year 10
WASTE TREATMENT STAGE I: DIGESTER				
Equipment costs (Gas handling skid (GHS) consisting of blower system, PLC, heat exchange system, boiler and flare system).	-124,831			
Installation costs	-1,581,888	0	0	0
Maintenance costs		-12,483	-12,483	-12,483
Additional costs (Operation, consultancy, engineering)		-13,898	-13,898	-13,898
SUBTOTAL	**-1,706,719**	**-26,381**	**-26,381**	**-26,381**
WASTE TREATMENT STAGE II: ACTIVATED SLUDGE				
Equipment costs (aerators, decanter, solid separators)	-1,100,000			
Installation costs	-1,420,207			
Maintenance costs		-110,000	-110,000	-110,000
Additional costs (Operation, consultancy, engineering)		-67,514	-67,514	-67,514
SUBTOTAL	**-2,520,207**	**-177,514**	**-177,514**	**-177,514**
WASTE TREATMENT STAGE III: STORAGE LAGOON				
Equipment costs	-79,200			
Installation costs	-179,790	0	0	0
Maintenance costs		-7,920	-7,920	-7,920
Additional costs (Operation, consultancy, engineering, **irrigation costs,** drying solids, sludge removal and land application in 10th year)		-8,280	-8,280	-543,312
SUBTOTAL	**-258,990**	**-16,200**	**-16,200**	**-551,232**
TOTAL PROJECT	**-4,485,916**	**-220,095**	**-220,095**	**-755,127**
NPV (US$) (discount rate = 10 %)	**-$ 6,044,584.56**			

The assumptions and parameters considered in the analysis were chosen to be conservative.

It can be seen that due to the non existence of positive cash flows, we must base our economic analysis on a comparison of net present value (NPV) parameters.

The following table presents the NPV of each scenario analyzed:

Table B.2. NPV Comparison

	Press (solid separation)-Anaerobic-Land application	Anaerobic Lagoon-Land application	Digester- Aerobic Treatment Storage Lagoon- Land application
NPV (US$) (discount rate = 10 %)	**-$ 1,059,012**	**-$ 965,651**	**-$ 6,044,584**

Because there are no positive cash flows involved, a cost-effective economic comparison is adequate to recognize the best waste economically management scenario, with the lower costs. It can be seen that the anaerobic lagoon is the most attractive course of action, thus the prevailing practice. The project initiative has ranges of NPV far more negative than the other scenarios presented, so it can be assured that the project scenario is additional compared to the chosen baseline.

It has been demonstrated that there are no plausible scenarios except for the project and the baseline scenario among the possible options.

The cost of implementing Anaerobic Digesters and Activated sludge is much higher than the cost of an open anaerobic lagoon system, so it is quantifiable that the project is additional from an economic standpoint.

The proposed project activity is not an "economically attractive" course of action and can be considered as additional. Therefore, the most likely alternative scenario is the "baseline scenario".

The following technologies are considered as components of the baseline and project scenario:

a) Anaerobic Lagoon

Brief description of technology: In an anaerobic treatment lagoon, liquid animal waste is stored for at least 5 months to one year or more. Anaerobic bacteria "treat" the liquid waste and decrease the organic matter content. This results in the emission of CO_2, CH_4, hydrogen sulphide, and ammonia. In the anaerobic treatment lagoon, sludge settles on the bottom of the lagoon. Once a year the supernatant is removed (drawn down) and discarded or beneficially reused in a land application program. Solids are removed once every 10–20 years when the lagoon is full, and used as fertiliser.

b) Digester

Brief description of technology: The advanced anaerobic system consists of an anaerobic digester with a floating cover, were biogas is produced. The digester uses a technology of complete mix reactor. The digester is built as a lined earthen lagoon and is completely sealed with an impervious liner cover. Four mixer units are in permanent operation. Gas produced in the digester is captured by a collection system and flared.

c) Aerobic treatment

Brief description of technology: The CDM project activity scenario includes this component in the manure management process, represented by an active sludge plant. The activated-sludge process is an aerobic, continuous flow, secondary treatment system that uses sludge-containing, active, complex

populations of aerobic micro-organism which break down organic matter in wastewater. Activated sludge is a flocculated mass of microbes comprised mainly of bacteria and protozoa. Mechanical aeration maintains the aerobic environment in the basin and keeps reactor contents (referred to as mixed liquor) completely mixed. The incorporation of this additional wastewater treatment enables the reduction of organic content and nitrogen concentration in the effluent, achieving even lower methane and nitrous oxide emission potential by subsequent treatment stages.

This project considers two appropriate sludge management alternatives, without generation of leakages, which are: composting treatment of degraded sludge and solid separation, along with other residues of the area, or use as a soil fertility enhancement in a land application program. The composting system is independent to the project and will be considered outside the project boundaries.

d) Storage Lagoon

Brief description of technology: The effluent from the advanced system is treated in a storage lagoon, where liquid waste is stored for one year or more. When the lagoon is full (usually in the spring) the contents are used in a land application program. The storage of effluent lasts for at least one winter season (five months), and not more than a year. The storage lagoon is emptied every year. Due to the semi-anaerobic conditions in the storage lagoon, GHGs and ammonia are emitted to the atmosphere. These emissions have been accounted for.

All mentioned manure management treatment systems are legally accepted in Chile. Each of these has a different environmental performance, however, the digester and the activated sludge system reduce odour, modify the chemistry of the waste water effluent making it suitable for irrigation, and reduce GHG emissions beyond the most economically attractive option, namely the anaerobic lagoon.

Step 4: Assessment of Barriers

Although the NPV results provided from the economic comparison in Step 3 are significantly different (showing a clear evidence of additionality), the following analysis can help to reinforce that the proposed project activity is additional.

The following barriers assessment proves that digesters and activated sludge systems are not commonly used in wastewater treatments for animal manure.

*Investment barriers***:** This anaerobic and aerobic manure treatment process is one of the most advanced technologic systems in the world. Only few countries have implemented this alternative because of the high investment costs involved compared to other available systems and also due to subsidies for electric generation.

The Chilean energy market does not give any incentives to sell biogas from these kinds of facilities into the grid. The investment involved in the production of energy by the utilisation of biogas is too high in the electricity market and is not profitable, compared to the electricity prices of generation in Chile.

Technology barriers: To implement a digester-based system, a significant level of waste and barns that are close to each other is required in order to have enough and continuous flow to justify the construction of a digester. Maintenance requirements involved in this technology, including a detailed monitoring program of its performance level, must also be considered.

Legal constrains: The implementation of this project activity by Agrosuper highly exceeds current Chilean regulations for swine waste treatment. Apart from existing legislation in Chile that establishes water quality parameters that do not allow manure to be discharged into watercourses, there is no

legislation in place that requires specific swine manure treatment in the country. That is why the Chilean government and the industry have promoted a voluntary "Clean Production Agreement" aimed at improving swine manure management. Besides from the advancements in manure management made by Agrosuper in this project activity, the remainder of the swine industry lags behind in the adoption and implementation of manure management technologies. In Chile, the basic methods of swine manure management do not provide for the reduction of GHG emissions. There are no expectations that Chilean legislation will require future implementation of digesters or aerobic treatment, due to the significant investments required, without economic compensation.

The potential to sell CERs was one of the main factors that influenced the decision to implement the anaerobic digesters and aerobic treatment systems. It will also influence additional investment in the type of technology at other Agrosuper facilities.

It is possible to implement animal waste management systems such as the anaerobic lagoon system, but they do not reduce similar amounts of GHG than a digester-based system.

It has been demonstrated that the common practice of an industry subjected to economically rational behaviour is the use of anaerobic lagoon for its animal waste management systems. This is the baseline scenario used and it clearly generates more emissions than the project scenario, as it is shown on the carbon balance in B.5.

The emissions for the baseline and project scenario are represented by the following components:

Table B.4. Emission sources for each scenario

Baseline: Anaerobic Lagoon	Project: Anaerobic Digester and aerobic treatment
CH_4 from the anaerobic lagoon	Fugitive CH_4 emissions inside the project boundaries, related to digester losses
N_2O emissions from anaerobic lagoon	Fugitive CH_4 from the aerobic treatment
	Fugitive CH_4 from the storage lagoon
	N_2O emissions from storage lagoon

The CO_2 generated from anaerobic digestion does not represent any difference in emission volumes between each scenario, because there are no possible additional transformations by the burning of this component. The anaerobic lagoon in the baseline scenario and the storage lagoon in the project scenario cause the N_2O emissions.

In particular, carbon emissions from methane combusted in a digester's flare will be considered as biogenic. This relies on the solid assumption that organic matter involved in the animal's diet has a renewable and not fossil origin.

The project uses default data to represent the volatile solids content and nitrogen content in raw and treated manure. This is the best alternative for quantifying emissions, because the actual manure management system has a discontinuous wastewater flow and also several inlets to the treatment process. For this reason, the flow rate measurement considers high costs of implementation and operating problems, such as pumps and flow meter obstruction due to the high solids content in the wastewater

stream. To represent the emissions for each treatment stage in the baseline and project scenario, Option B of the methodological approaches mentioned in the Baseline Methodology AM0006 has been chosen

For the first treatment stage of the project (anaerobic digester), corrected IPCC and US-EPA default values to represent the emissions of each scenario are used. Emissions from the storage lagoon will depend on monitored values of nitrogen content and Biochemical Oxygen Demand, relying on Option A as a methodological approach. Baseline data and additional information for emission reduction quantification can be found on Annex 3.

B.3. 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:

>> In Chile, and other countries of South and North America, the traditional system of manure management consists of the storage of swine manure in large open storage facilities and/or the partial treatment of the manure in an anaerobic lagoon followed by land application. Under this system, all CH_4 that is generated in an open lagoon or storage tank is emitted to the atmosphere. Approximately 50% of the Pork industry in Chile and all Agrosuper's facilities used this manure management system due to its lower cost, and its consistency with the Chilean Clean Production Agreement described in Chapter A. Therefore, this represents one of the likely economically attractive scenarios for Agrosuper's pork production.

Swine manure is flushed from the barn and then collected in a lagoon or other earthen storage facility. Then the manure is partially digested at ambient temperature by naturally occurring anaerobic micro-organisms, generating carbon dioxide, methane, hydrogen sulphide, and ammonia in the process. Anaerobic bacteria "treat" the liquid manure and reduce the organic matter content. Solids are allowed to settle on the bottom of the lagoon. Solids settled in the lagoon are removed once every 8 to 10 years approximately, and are used on land to enhance fertility.

During the irrigation period, water is pumped to lower the level and increase the storage capacity. The collected water is then utilised in a land application program, either as fertiliser or irrigation water.

Agrosuper has implemented an advanced treatment system. The anaerobic digester functions to capture a significant portion of the digested volatile solids (VS) in the form of CH_4 and CO_2 produced from the activity of anaerobic bacteria. The digester consists of an earthen pit, lined with an impervious membrane and covered with a floating membrane. Any gas produced is collected by a gas piping and handling system. This collected gas is flared. Mixed effluent is removed from the digester and is pumped to a nearby storage lagoon. This effluent still contains nutrients and is used as irrigation water for crops. Additional solids will settle in the bottom of the lagoon and will be removed once every 10 years for use as fertiliser in land application programs.

Emissions to the atmosphere are avoided due to CH_4 capture in the digester, and its transformation into CO_2, CH_4. The aerobic treatment component after the digester, significantly reduces the volatile solids content in the storage lagoon, along with CH_4 and N_2O fugitive emissions.

The decision of implementing this more expensive technology was influenced by the Kyoto Protocol and the Clean Development Mechanism (CDM) contained therein. The continued investment program has been strongly influenced by the decisions relating to CDM taken by the Conference of the Parties at COP7 in Marrakech. As a direct result of the clear direction given at COP7, Agrosuper took the decision to continue the implementation of more digesters and aerobic treatment systems during 2002 and 2003.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

>> The project boundary for the baseline scenario is restricted to on-site emissions. The application of treated manure in the immediate surroundings of the animal production unit does not contribute to CH_4 emissions in the project boundary. The project boundary includes only the emissions (and emission reductions) from manure management techniques dealing with swine manure from a cluster of production units discharging manure to handling systems.

Approved Methodology AM0006 establishes in page 5 of the UNFCCC document (as presented in Figure 1), that manure management systems may comprise several treatment stages and that emissions should be determined for each treatment stage separately. This same document stands on the use of available IPCC default values for estimating methane emission potential related to each type of treatment, considering each component of the waste management system as an autonomous greenhouse gas emission source.

Figure 1 shows the project activity and baseline boundaries. The segmented line represents the project boundary that is "common" for both the project and baseline scenarios. These diagrams also serve as a schematic figure to represent a carbon balance of each scenario, using the equations presented in the approved methodology:

Figure 1: Baseline Scenario Boundary

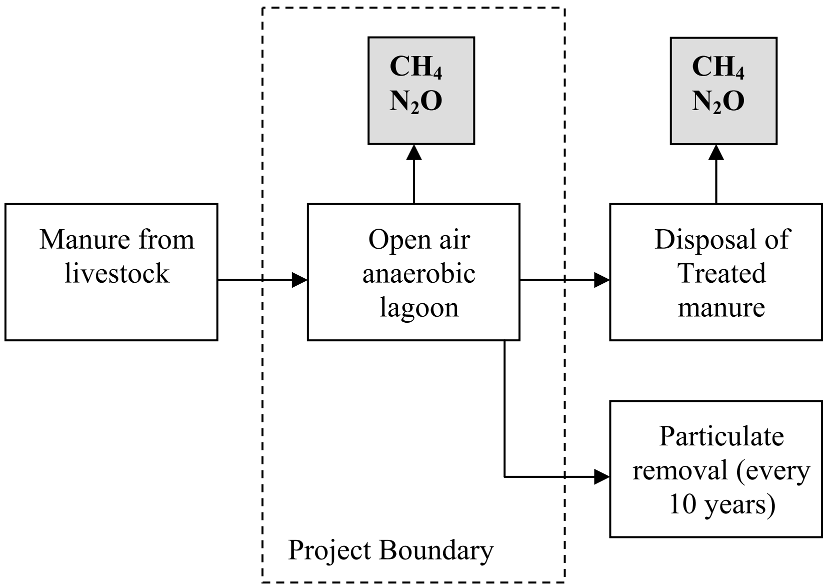
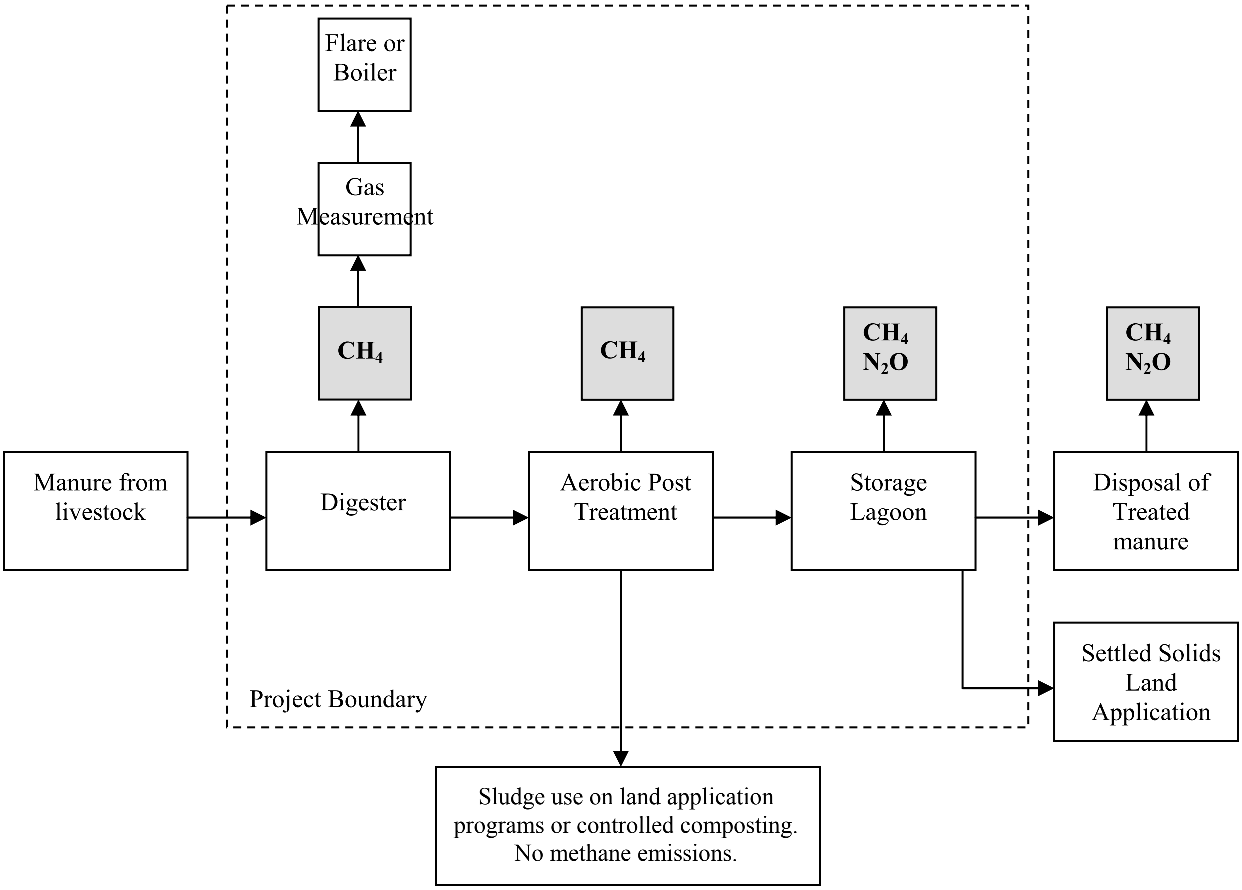


Figure 3: CDM Project Activity Boundary



Potential Emissions outside the project's boundaries

In particular, carbon emissions from methane combusted in a digester's flare or boiler will be considered as biogenic. This relies on the solid assumption that organic matter involved in the animal's diet has a renewable and not fossil origin.

The activated sludge treatment process has sludge outflow from the solid separation stage (filters) and the flotation units. Total sludge is conducted to the centrifugal decanter, where moisture is reduced. The present project considers the appropriate management of sludge from the aerobic treatment and the storage lagoon's bottom. The sludge management alternatives are:

- **Land application programs for soil recovery**. The purpose of soil recover will be achieved through improving soil's structure and stability, hydro retention capacity, adding nutrients, stimulating microbiological activity and helping land working. Sludge application will be done on neighbor fields, outside the project boundaries, with the use of a distributor carriage.
- **Composting of both, degraded sludge and solid separation, along with other residues of the area.** The purpose of the composting process is to achieve definitive sludge stabilization, reducing between 70 to 80% of its original volume, and allowing the refinement of the sludge through it's transformation as compost. Sludge is transported to the composting system on trucks. The purpose of composting is to generate a stabilized organic soil fertilizer, taking advantage of sludge and solids from the aerobic treatment.

For both alternatives, methane and nitrous oxide emissions are considered negligible, mostly because there are no anaerobic conditions in each of the final management process.

Sludge from biological treatment phase in the aerobic treatment process do not reveal ammonia volatilization problems, because all nitrogen has volatilized as gaseous nitrogen (N_2). The potential N_2O emission generation from this source (leakage due to emissions outside the project boundaries) is marginal.

The project does not envisage emissions generated outside the project boundary which are significant and reasonably attributable to changes in liquid manure treatment. The project already includes the potential fugitive emissions related to the digester (cover, piping) or aerobic treatment, as emissions in the project boundary.

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

Date of completing the final draft of this baseline section (DD/MM/YYYY):

09/08/2005

Name of person/entity determining the baseline:

Provide contact information and indicate if the person/entity is also a project participant listed in Annex 1.

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Note: Both entities, CO2e.com and Poch Ambiental S.A. are not project participants of the project activity

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

This project applies for a crediting period of 7 years with the potential for subsequent renewal(s).

C.1.1. Starting date of the project activity:

>> 1st of February of 2002.

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

>>50 years (expected)

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

C.2.1. Renewable crediting period

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

>>01/10/2005

C.2.1.2. Length of the first crediting period:

>> 7 years

C.2.2. Fixed crediting period: Not applicable

C.2.2.1. Starting date:

>> **Not applicable**

C.2.2.2. Length:

>> **Not applicable**

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

>> The applicable approved monitoring methodology for this project is "**GHG emission reduction from manure management systems**", referenced as AM0006.

It can be found on the CDM-Executive Board website by following the link:

http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_343163180

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

>>An adequate monitoring methodology has been developed in order to quantify emissions for each scenario. This has been approved by the CDM's Meth Panel and named as AM0006. Baseline Methodology AM0006 describes each of the formulae that represent the emissions for every source in baseline and project scenario. It contains the elements to be monitored that match with the project characteristics and context, so it is considered as applicable.

Monitored parameters and default data are used to calculate project emissions and the resulting reductions compared to the baseline.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	**For how long is archieved data kept?**	Comment
D.2-1	Number	Daily Swine stock	Heads	Measured	Weekly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	All of the pig barns have an exhaustive counting of the stock of pigs.
D.2-2	Mass	Average weight of pigs	kg	Measured	Record of entrance and exit of animals to the barn	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Necessary for treatment stages with no monitored wastewater parameters available (Volatile solids, Nitrogen content, and biochemical oxygen demand).
D.2-3	Volatile solid excretion per animal and	Corrected IPCC	kg dry matter / animal /	Calculated	monthly	100%	Electronic	At least two years from completion of	Corrected IPCC default data of

	day)	Default data	day					authorisation period or last CERs issued	volatile solids excretion will be used, for it will not be necessary to measure this variable. The correction is a function of the average animal weight.
D.2-4	Nitrogen excretion per animal and day)	Corrected IPCC Default data	kg dry matter / animal / day	Calculated	monthly	100%	Electronic	At least two years from completion of authorisation period or last CERs issued	Corrected IPCC default data of nitrogen excretion will be used, for it will not be necessary to measure this variable. The correction is a function of the average animal weight.
D.2-5	Flow rate	Manure flow to the aerobic post-treatment	m^3/day	Measured	Monthly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon and guarantee the

									effective operation days of the treatment system. This parameter is calculated with total inlet flow minus sludge volume. Total inlet flow is monitored from a flow meter installed before the activated sludge.
D.2-6	Concentration	5 days Biochemical Oxygen Demand (BOD) in storage lagoon after aerobic treatment	mg/L	Measured	Monthly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon and guarantee the effective operation days of the second component of the treatment system.
D.2-7	Concentration	Total Nitrogen content in	mg/L	Measured	Monthly	100%	Paper and electronic	At least two years from completion of authorisation	Option A of the baseline methodology is

		second phase plant effluent.						period or last CERs issued	chosen to represent emissions from the storage lagoon and guarantee the effective operation days of the second component of the treatment system.
D.2-8	Temperature	Temperature of manure in second phase plant effluent.	ºC	Measured	Monthly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon and guarantee the effective operation days of the second component of the treatment system.
D.2-9	Flow rate	Biogas flow extracted by digester	m^3/day	Measured	Every working day	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	This parameter shows the performance of the digester and gas recovery indicating

									operation*.
D.2-10	Percentile	CO2 concentration in gas flow	%	Measured	Every working day	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	This parameter shows the performance of anaerobic digestion*.
D.2-11	Percentile	Flare efficiency	%	Default values from design	-	100%	Paper and electronic	Duration of the crediting period	This parameter will not be monitored because the efficiency combustion of candlestick flares cannot be measured. Design combustion efficiency, provided by Perennial Energy (designers of equipment).

*: Either monitoring of biogas flow rate or carbon dioxide concentration on gas flow can be an evidence of the correct performance from the anaerobic digester.

Note: All variables collected under this monitoring plan, will be filed and stored for the crediting period + two years.

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

For the purpose of project emission quantification, the first treatment stage will be considered as the anaerobic digester. The second and third treatment stages are the activated sludge system and the storage lagoon, respectively.

CH_4 Emission equations for Manure Management Systems

EQ. 1: CH_4 Emissions related to first stage of manure management

$$E_{CH4,mm,1,y} = VS \bullet Bo \bullet D_{CH4} \bullet MCF_1 \bullet GWP_{CH4} \bullet N_y \bullet 365 / 1000$$

EQ. 2: CH_4 Emissions related to the second stage of manure management

$$E_{CH4,mm,2,y} = VS \bullet [1- R_{VS}] \bullet Bo \bullet D_{CH4} \bullet MCF_2 \bullet GWP_{CH4} \bullet N_y \bullet 365 / 1000$$

EQ. 3: CH_4 Emissions related to the storage lagoon stage of manure management

$$E_{CH4,mm,sl,y} = 0.25 \bullet BOD_{lt,y} \bullet F_{,y} \bullet MCF_{sl} \bullet GWP_{CH4} \bullet N_y \ / 1,000,000$$

Only for the second phase of the project's operation (2004), consisting in the inclusion of an activated sludge system.

Where

$E_{CH4,mm,1,y}$: CH_4 emissions from manure management in the first treatment stage of the manure management system during the year y in tons of CO_2 equivalent.
$E_{CH4,mm,2,,y}$: CH_4 emissions from manure management in the second treatment stage of the manure management system during the year y in tons of CO_2 equivalent.
$E_{CH4,mm,sl,,y}$: CH_4 emissions from manure management on a storage lagoon during the year y in tons of CO_2 equivalent.
GWP_{CH4} : Approved Global Warming Potential (GWP) of CH_4.
MCF_1 : Methane conversion factor (MCF) for treatment of manure in the first treatment stage in per cent (digester in the project scenario).
MCF_2 : Methane conversion factor (MCF) for treatment of manure in the second treatment stage in per cent (activated sludge).
MCF_{sl}: Methane conversion factor (MCF) for treatment of manure in the storage lagoon in per cent.
D_{CH4} : CH_4 density (0.67 kg/m^3 at room temperature, 20 ºC, and 1 atm pressure).
VS : Volatile solid excretion per day on a dry-matter basis for a defined livestock population in kg-dm/animal/day, for year y.
R_{VS}: Relative reduction of volatile solids in the first treatment stage in per cent, referenced from EPA-CAFO default value.
B_0: Maximum CH_4 production capacity from manure per animal for a defined livestock population (m_3 CH_4/kg-dm).
N_y : Livestock of a defined population for year y.
F_y: Manure outflow from the aerobic treatment stage, during the year y in m^3.
$BOD_{lt,y}$: Long term biochemical oxygen demand of the manure flow to the storage lagoon treatment stage in mg/l, for year y.

N_2O Emissions equations from anaerobic lagoon & Storage losses

EQ. 4: N2O Emissions related to the anaerobic lagoon, baseline scenario.

$$E_{N2O,mm,1,y} = GWP_{N2O} \bullet NEX_y \bullet N_y \bullet EF_{N20,mmmi} \bullet CF_{N20\text{-}N,N} \ /1000$$

Where:

$E_{N2O,mm,1,y}$: Nitrous oxide emissions from the anaerobic lagoon in tons of CO_2 equivalents per year.
GWP_{N2O} : Approved Global Warming Potential (GWP) for N_2O.
$EF_{N2O,mm,1}$: N_2O emission factor for the first treatment stage of the manure management system in kg N_2O-N/kg N (EF_3 in 1996 Revised IPCC Guidelines and IPCC GPG).
$CF_{N2O\text{-}N,N}$: Conversion factor N_2O-N to N (44/28).
NEX_y : Annual average nitrogen excretion per animal of the defined livestock population in kg N/animal/year, for year y.
N_y : Livestock of a defined population for year y.

EQ. 5: N2O Emissions related to the storage lagoon treatment stage, project scenario.

$$E_{N2O,mm,2,y} = GWP_{N2O} \bullet Nit_y \bullet EF_{N20,mmm} \bullet F_y$$

Where:

$E_{N2O,mm,2,y}$: N_2O emissions from manure management in the storage lagoon stage of the project activity during the year y in tons of CO_2 equivalents.
GWP_{N2O} : Approved Global Warming Potential (GWP) for N_2O.
$EF_{N2O,mm}$: N_2O emission factor for the storage lagoon stage in kg N_2O-N/kg N (EF_3 in 1996 Revised IPCC Guidelines and IPCC GPG).
Nit_y : Average nitrogen content in the manure flowing to the treatment stage i during the year y in kg N/m^3.
F_y : Manure flow to the storage lagoon during the year y in m^3.

Weighting and Correction of key parameters

i) Volatile Solids in Raw manure

The correction of volatile solids in raw manure is linear and it is a function of the weight quotient, with the purpose of making this parameter representative. In order to quantify emission reductions, the IPCC default values are corrected as follows:

EQ. 6: Volatile solids content in raw manure

$$VS_{site} = (W_{site} / W_{default}) \text{ x } VS_{default}$$

Where:

VS_{site} : Adjusted volatile solid excretion per day on a dry-matter basis for a defined livestock population at the project site in kg-dm/animal/day.
W_{site} : Average animal weight of a defined population at the project site in kg.
$W_{default}$: Default average animal weight of a defined population in kg.
$VS_{default}$: Default value (IPCC or US-EPA) for the volatile solid excretion per day on a drymatter basis for a defined livestock population in kg-dm/animal/day.

ii) Nitrogen Content in Raw manure

The nitrogen content in raw manure is obtained from corrected IPCC default values. The correction of nitrogen excretion in raw manure is linear and it is a function of the weight quotient, with the purpose of making this parameter representative.

In order to quantify emission reductions, the IPCC default values are corrected as follows, whenever monitored data is not available:

EQ. 7: Nitrogen excretion rate for raw manure in kg/head/day

$$NEX_{site} = (W_{site} / W_{default}) \times NEX_{default}$$

Where

NEX_{site}: Adjusted annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.
W_{site}: Average animal weight of a defined population at the project site in kg.
$W_{default}$: Default average animal weight of a defined population in kg.
$NEX_{default}$: Default value (IPCC) for the nitrogen excretion per head of a defined livestock population in kg N/animal/year.

iii) Five-day Biochemical Oxygen Demand

Both, the Biochemical Oxygen Demand BOD and the manure flow F between the treatment stages should be monitored for the project manure management system. Usually, the five-day biochemical oxygen demand BOD5 is measured. The long-term biochemical oxygen demand can then be calculated with the BOD5 and the reaction constant k as follows:

EQ. 8: Five-day biochemical oxygen demand

$$BOD_{lt} = BOD_5 / (1-10^{-5k})$$

Where:
BOD_{lt}: Long term biochemical oxygen demand of the manure flow to the storage lagoon treatment stage in mg/l.
$BOD_{5,i}$: Five-day biochemical oxygen demand of the manure flow to storage lagoon treatment stage in mg/l.
K: Reaction constant for the biochemical oxygen demand.

EQ. 9: Variability BOD rate constant

$$K = K_{20} \bullet \theta^{(T-20^o)}$$

Where:

K: Reaction constant for the biochemical oxygen demand at the temperature T.
K_{20}: Default BOD rate constant, **0.1** for wastewater at 20ºC (Metcalf & Eddy).

θ: Constant in the Van.t-Hoff-Arrhenius relationship. 1.047 will be considered as an appropriate referential value for wastewater in lukewarm conditions (Metcalf & Eddy).
T : Temperature of the manure flow to the treatment stage i (storage lagoon) in degree Celsius.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :									
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	**For how long is archieved data kept?**	Comment
D.2-1	Number	Daily Swine stock	Heads	Measured	Weekly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	All of the pig barns have an exhaustive counting of the stock of pigs.
D.2-2	Mass	Average weight of pigs	kg	Measured	Record of entrance and exit of animals to the barn	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Necessary for treatment stages with no monitored wastewater parameters available (Volatile solids, Nitrogen content, and biochemical oxygen demand).
D.2-3	Volatile solid excretion per animal and day)	Corrected IPCC Default data	kg dry matter / animal / day	Calculated	monthly	100%	Electronic	At least two years from completion of authorisation period or last CERs issued	Corrected IPCC default data of volatile solids excretion will be used, for it will not be necessary to measure this variable. The correction is a function of the average animal weight.
D.2-4	Nitrogen excretion per animal and day)	Corrected IPCC Default data	kg dry matter / animal / day	Calculated	monthly	100%	Electronic	At least two years from completion of authorisation	Corrected IPCC default data of nitrogen excretion will be used, for it will not be necessary to measure this variable. The correction is a

								period or last CERs issued	function of the average animal weight.
D.2-5	Flow rate	Manure flow to the aerobic post-treatment	m3/day	Measured	Monthly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon and guarantee the effective operation days of the treatment system. This parameter is calculated with total inlet flow minus sludge volume. Total inlet flow is monitored from a flow meter installed before the activated sludge.
D.2-6	Concentration	5 days Biochemical Oxygen Demand (BOD) in storage lagoon after aerobic treatment	mg/L	Measured	Monthly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon and guarantee the effective operation days of the second component of the treatment system.
D.2-7	Concentration	Total Nitrogen content in second phase plant effluent.	mg/L	Measured	Monthly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon and guarantee the effective operation days of the second component of the treatment system.
D.2-8	Temperature	Temperature of manure in second phase plant effluent.	ºC	Measured	Monthly	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon and guarantee the effective operation days of the second component of the treatment system.

D.2-9	Flow rate	Biogas flow extracted by digester	Cubic meters	Measured	Every working day	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	This parameter shows the performance of the digester and gas recovery indicating operation*.
D.2-10	Percentile	CO2 concentration in gas flow	%	Measured	Every working day	100%	Paper and electronic	At least two years from completion of authorisation period or last CERs issued	This parameter shows the performance of anaerobic digestion*.
D.2-11	Percentile	Flare efficiency	%	Default values from design	-	100%	Paper and electronic	Duration of the crediting period	This parameter will not be monitored because the efficiency combustion of candlestick flares cannot be measured. Design combustion efficiency, provided by Perennial Energy (designers of equipment).

*: Either monitoring of biogas flow rate or carbon dioxide concentration on gas flow can be an evidence of the correct performance from the anaerobic digester.

Note: All variables collected under this monitoring plan, will be filed and stored for the crediting period + two years.

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>> For the purpose of emission quantification the baseline is considered as anaerobic lagoon, as stated in chapter B.
The formula to quantify the emissions for the baseline scenario has been described in **D.2.1.2.**

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E):

Not applicable

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
-								
-								

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

>> Not applicable. In chapter B it has been shown that the second phase of the project activity does not consider anaerobic conditions for sludge management.

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>> Not applicable. In chapter B it has been shown that the second phase of the project activity does not consider anaerobic conditions in sludge management.

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D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>> Not applicable. In chapter B it has been shown that the second phase of the project activity does not consider anaerobic conditions in sludge management.

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
D 2-1	Low	QA/QC procedures are established; this data will be used as basis for calculating emission reductions
D 2-2	Low	QA/QC procedures are established; this data will be used as basis for calculating emission reductions
D 2-3	Low	QA/QC procedures are established regarding the use of representative default data and adequate calculation of this variable as a function of the average animal weight.
D 2-4	Low	QA/QC procedures are established regarding the use of representative default data and adequate calculation of this variable as a function of the average animal weight.
D 2-5	Low	QA/QC procedures are established; this data will be used as basis for calculating emission reductions. The monitoring of required parameters in the aerobic treatment is part of the normal quality control in an aerobic wastewater treatment facility
D 2-6	Low	QA/QC procedures are established; this data will be used as basis for calculating emission reductions. The monitoring of required parameters in the aerobic treatment is part of the normal quality control in an aerobic wastewater treatment facility
D 2-7	Low	QA/QC procedures are established; this data will be used as basis for calculating emission reductions. The monitoring of required parameters in the aerobic treatment is part of the normal quality control in an aerobic wastewater treatment facility
D 2-8	Low	QA/QC procedures are established; this data will be used as basis for calculating emission reductions. The monitoring of required parameters in the aerobic treatment is part of the normal quality control in an aerobic wastewater treatment facility

D 2-9	Low	QA/QC procedures are established. This is supported by the control of temperature, pH and the variability of the gas flow rate
D 2-10	Low	QA/QC procedures are established. This is supported by the control of temperature, pH and the variability of the gas flow rate
D 2-11	Low	This parameter is not monitored, so QA/QC procedures rely on design values.

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

>>The emission reductions achieved for this project are calculated upon monitored values, rather than directly monitored. In order to implement a precise and representative monitoring plan, Agrosuper has established a continual registration of each monitoring parameter as part of its Environmental Management System and its Quality Management System.

In order to quantify the emission reductions in the validation process, the only data that relies on default parameters will be the volatile solids and nitrogen content in raw manure. The reason for not monitoring parameters in raw manure is because in Ramirana the manure management system has a discontinuous wastewater flow rate and also several entrances to the treatment process. The flow rate measurement would require a high cost of implementation and create operating problems, such as pumps and flow meter obstruction, due to the high solids content in the wastewater stream. Default values of volatile solids, nitrogen content in raw manure, and decay of each of these parameters, are referenced in Annex 3 of this PDD. To quantify emission reductions for wastewater treatment systems that include an aerobic component, the only data that will rely on default parameters will be the volatile solids content and nitrogen content in raw manure.

The following description details the operational and management structure developed for monitoring the emission reductions after each validation and verification process:

DATA VARIABLE	DATA UNIT	DATA ORIGIN	COMMENTS
Animal Population	Heads	Daily animal Stock and inlet program of pigs (Net inlet considering mortality). Information managed by Agrosuper	The counting of swine heads is part of the production schedule. The responsibility of monitoring this parameter relies on each barn's operators, and its register is part of the Quality Management System implemented by Agrosuper.
Average Weight of Animals	kg	Pavilion test and growing tendency curves. Information managed by Agrosuper	This parameter is sampled in special barns adapted for this purpose. It is also part of the production schedule and registered as part of the Quality Management

			System implemented by Agrosuper.
Manure Flow After Aerobic Treatment Stage	m^3/day	This parameter is calculated with total inlet flow minus sludge volume.	
Manure Flow Before Aerobic Treatment	m^3/day	This parameter is monitored from a flow meter installed before the activated sludge.	The Environmental Management System of Agrosuper has in schedule these monitoring, as considered by internal procedures based on this PDD's monitoring plan.
Flow of Sludge from Aerobic Treatment	m^3/day	Referential volume from sludge transportation requirements. Information managed by a third party.	
5 days BOD in Manure after Aerobic Treatment Stage	mg/L	Activated Sludge monitoring registers, managed by a third party.	These parameters are provided from laboratory analysis, and are also registered as part of the Environmental Management System implemented by Agrosuper. These parameters are monitored and analyzed by accredited laboratories.
Total Nitrogen Content in Manure after Aerobic Treatment Stage	mg/L	Activated Sludge monitoring registers, managed by a third party..	
Temperature of Manure after Aerobic Treatment Stage	ºC	Activated Sludge monitoring registers, managed by a third party..	The Environmental Management System of Agrosuper has in schedule these monitoring, as considered by internal procedures based on this PDD's monitoring plan.
Biogas Flow Extracted by Digester	SCFM	Registers from the CLP. Information managed by Agrosuper	These parameters are controlled as part of the Environmental Management System implemented by Agrosuper. The responsibility of monitoring and registration relies on operators in charge of the Manure Treatment Technology's operation. These daily registers are informed weekly to the swine production department of Agrosuper. The only purpose for monitoring the biogas flow is to confirm the correct functioning of the digester. Biogas extraction rate and CO2 percentage concentration do not have any influence in the emission reduction calculation; they solely guarantee the continuity in the digester's gas extraction capacity. For that reason, the registration of data is controlled periodically, jointly along with parameters like temperature and pH. Either monitoring of biogas flow rate or carbon dioxide concentration on gas flow can be an evidence of the correct performance from the anaerobic digester. The internal automatic control program of the digester regulates and optimizes the extraction, re-use and burn of the gas, based upon the pressure differential and the internal gas temperature. This internal automatic control program is known as controlled logical program (CLP), its purpose is to manage the digester operation as well as the distribution of gas to the boiler or to the flare. Flow sensors based on the pressure differentials and transmitted to the CLP as an electric signal measure the daily gas flow.
CO2 Concentration in Gas Flow	%	Registers from the CLP. Information managed by Agrosuper	
Flare Efficiency	%	Design Combustion Efficiency, Provided by Perennial Energy	

D.5 Name of person/entity determining the monitoring methodology:

>> Rodrigo García P. and Alfonso Guijon B.
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3838 Renato Sánchez, Santiago
Chile
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Note: Poch Ambiental S.A. is not project participant of this project activity

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

>>

Detail for each source:

Table E.1 Detailed Project Emissions (tCO2eq/year)

Emission components	At present, 2005	2006 and subsequent years
Digester's Losses and Leakage	749	3,425
Aerobic Treatment	5.99	27
Lagoon CH_4	16.87	68.42
Lagoon N_2O	2.02	8.18
Total Project Emissions	**774**	**3,529**

E.2. Estimated leakage:

>>The project does not envisage significant emissions generated outside the project boundary attributable to changes in liquid manure treatment. The project already includes the potential fugitive emissions related to the digester, as emissions in the project boundary.

In chapter B it has been shown that the present initiatives do not consider anaerobic conditions in sludge management, for there will be no leakages produced from this source. The volume of sludge from an aerobic treatment can be used as fertiliser in land application programs outside the project boundaries or converted as compost, minimizing emissions of green-house gases.

The digester's power consumption is of 0.001 MW (100 kW), that would not be consumed in the baseline scenario. Although emissions due to energy consumption are insignificant in terms of CO2eq, we have chosen to consider them for the purposes of our main calculations. If we take an emission factor of 0,5 ton CO_2eq/MWh, representative for the Chilean grid (as referenced from La Higuera's PDD), and consider 8760 hours in a year, we have an equivalent of :

0.001 MW x 8760 hours/year x 0,5 tonCO2eq/MWh = **4.38 ton CO2eq/year** as the resultant leakage for the digester component.

The consumption of energy due to the implementation of a wastewater treatment upgrade that relies in activated sludge technology does not carry relevant emissions. These potential emissions are generated outside the project boundaries, although they come from energy consumption inside the project boundaries. The range of energy consumption for the mechanical aeration of this system has a range of **19 to 39 KWh/$10^3$$m^3$** (Project specific data & Metcalf & Eddy). In order to quantify the potential leakage, it will be considered a treatment flow rate equal to 1200 m^3/day and a residential time of 20 days. If we relate energy consumption from the dispatch system to an emission factor, we can recognize the relevance of leakage in the emission analysis. If we take an emission factor of 0,5 tCO_2eq/MWh, representative for the Chilean grid (as referenced from La Higuera's PDD), and a full-year functioning of aerobic treatment, there is a representative emission of **4.2 to 8.5 tCO2eq/year.** Although this is a marginal emission in comparison to potential emission reduction for this type of projects, a leakage of **8.5 tCO2eq/year** will be counted as part of the project emissions, for the aerobic treatment component.

The total value of leakage from energy consumption will be considered as **12.9 tCO2eq/year**.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

>> Leakage considered for this project activity has been included. The following table synthesize these results:

Detail for each source:

Table E.2 Detailed Project Emissions (tCO2eq/year)

Emission components	At present, 2005	2006 and subsequent years
Digester's Losses and Leakage	749	3,425
Aerobic Treatment	5.99	27
Lagoon CH_4	16.87	68.42
Lagoon N_2O	2.02	8.18
Leakages	12.9	12.9
Total Project Emissions	**786.6**	**3,542**

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

>>Detail for each source:

Table E.3 Detailed Baseline Emissions (tCO2eq/year)

Emission components	At present, 2005	2006 and subsequent years
Lagoon CH_4	13,479.18	61,649.9
Lagoon N_2O	512.14	577.6
Total Baseline Emissions	**13,991**	**62,228**

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

>> The following table represents the emission reductions results of the project activity for the years 2005 and further on:

Table E.4 Total Emission Reductions (tCO2eq/year)

	At present, 2005	2006 and subsequent years
TOTAL EMISSION REDUCTIONS(tCO_2eq)/year	13,204	58,686

E.6. Table providing values obtained when applying formulae above:

>> The following table represents the emission reductions results of the project activity for the years 2005 and further on:

Table E.5 Total Emission Reductions (tCO2eq/year)

Years	**Estimation of project activity emission reductions (tonnes of CO2e)**	**Estimation of baseline emission reductions (tonnes of CO2e)**	**Estimation of leakage (tonnes of CO2e)**	**Estimation of emission reductions (tonnes of CO2e)**
Since October 2005	774	13,991	12.9	13,204
2006	3,529	62,228	12.9	58,686
2007	3,529	62,228	12.9	58,686
2008	3,529	62,228	12.9	58,686
2009	3,529	62,228	12.9	58,686
2010	3,529	62,228	12.9	58,686
2011	3,529	62,228	12.9	58,686
Until October 2012	2,755	48,237	12.9	45,469
Total (tonnes of CO2e)	**24,703**	**435,596**	**103.2**	**410,790**

SECTION F. Environmental impacts

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

>> The construction of barns and the respective waste treatment must be submitted to the Environmental Impact Assessment System, in order to comply with the Chilean Environmental Legislation. Agrosuper following that procedure, and in accordance with Chilean Law, submitted an Environmental Impact Statement to the National Commission for the Environment (CONAMA) that approved and authorized the construction of the barns with a traditional waste treatment system. Nevertheless, and in addition to what was approved by CONAMA, Agrosuper improved these waste treatment systems by including digesters and aerobic treatment systems, reducing potential impacts to the environment.

All these affirmations will be confirmed by the endorsement of the project given by the Designated National Authority (CONAMA), in its Host country approval process.

The fact that CH_4 has a global warming potential (21) that exceeds greatly the global warming potential of CO_2 (1), determines the relevance of the CDM projects related to biogas capture. The project activity can be stated as a relevant improvement for sustainable development, distressing local (odours) and global environmental pressures. This advanced system (anaerobic digester and aerobic treatment) minimizes the release of odours related to swine manure management, because organic matter is stabilized inside a hermetically closed reactor.

The substitution of traditional manure waste treatment (stabilization lagoon) by this advanced treatment also creates environmental benefits related to effluent quality. In the advanced treatment, this effluent has a low organic matter content that does not imply a potential risk of groundwater or river contamination. This digester also leads to a lower volume of sludge from effluent. In addition, this anaerobic treatment component doesn't require the transport or management of solid manure, because this is part of the substrate for the anaerobic fermentation in the digester.

In the traditional system, average temperature is a key parameter. In contrast, the digester component of the project activity uses the re-circulation of heated water to raise the internal operation temperature up to an optimal level for bacterial life.

The environmental impacts due to the development of this project can be summarized as ancillary benefits:

a) Odour is greatly reduced by gas recovery systems and aerobic treatment

b) Pathogen and vector control

c) Achieve the effective recuperation of wastewater as a resource for crops irrigation

d) The potential use of the biogas collected as an energetic resource for power generation

F.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:

>> In accordance to Chilean environmental legislation, specifically article 10 of Law 19.300 and Supreme Decree No. 95 of 2001 that modifies Supreme Decree No.30 of 1997, if an activity can cause significant

impact to the environment it has to present an Environmental Impact Study. If, on the contrary, it has very low impact to the environment or it does not cause any impact at all, the activity has to present an Environmental Impact Statement. Since the Project was required to present only an Environmental Impact Statement, it is possible to assume, as the Chilean legislation does, that the Project does not have any relevant impact on local or global environment.

Environmental Impact Statements:

- Ramirana's digester: approved on November 20, 2001, by resolution Nº161/2001 of the Regional Commission for the Environment (6th Region)

- Ramirana's activated sludge system: approved on April 26, 2005, by resolution Nº63/2005 of the Regional Commission for the Environment (6th Region)

SECTION G. Stakeholders' comments

>>

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

>> Agrosuper launched its first Biodigester in 2001, being the first CDM project of the company. In that event the presence of a Minster of State and the Executive Director of CONAMA and other regional authorities, was considered as a very important support to the efforts done by Agrosuper. The local news and even CNN published information about this new project of the company. At that time all comments made reference to the major environmental improvement done by the company by incorporating this first Digester.

As stated in Section F, the Project went through the Environmental Impact Statement procedure. As a publicity measure to maintain the community duly informed, the National or Regional Environment Commission, as corresponds, shall publish every month on the first working day, in the Official Gazette and in a national or regional journal, a list of the projects and activities that were submitted to the Chilean Environmental Impact Assessment System during the previous month. Additionally, the relevant Commission shall deliver a copy of the list to the municipalities of the places where the works or activities envisaged in the project under evaluation are to be carried out.

The presence of Agrosuper, in seminars and workshops in Chile, to present the relevant aspects of the CDM project was requested by the National Environmental Authorities many times. Agrosuper went to all those events to explain the main characteristics of the CDM project.

Moreover, the CDM Project activity was announced in Agrosuper's web page for many months, during December 2002 until 2004.

In order to show their facilities and the technological improvements done in the last years, Agrosuper has a program in which invites the neighbouring community of the Project areas to visit their plants.

Moreover, in mid of 2004, Agrosuper announced publicly the finalization of negotiations of two important contracts with companies from Canada and Japan in order to sell emission reductions from their CDM projects. That announcement had a very important international coverage, specially also at the national level. News shows and newspapers did an extensive coverage of this important transaction in Chile.

Agrosuper has developed two promotional films in this field: one regards the CDM and Agrosuper's projects involvement and a second more didactic, about the treatment components for an Agrosuper's

waste management system. Both of these films are available in the Agrosuper web site (www.agrosuper.com), since 2004.

The private sector and especially the Chilean Government have been using the Agrosuper projects as a model to develop the emission reduction market in Chile, giving them an extensive coverage.

G.2. Summary of the comments received:

>> The only comments received were during the environmental impact assessment procedure, by different authorities with respect to different aspects of the project. Those comments were more related to clarifications of the project, rather than to objections to the project itself.

During the time the project was announced on the web, no comments were received.

In Seminars and workshops, all comments received were positive, highlighting the leadership of Agrosuper in its business sector and in the CDM field.

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

>> All clarifications done by the authorities were clarified and incorporated in due time. This allowed the environmental approval of the project, as stated in Section F.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Agrícola Super Limitada (Agrosuper)
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Not applicable. There is no public funding for the Project.

Annex 3

BASELINE INFORMATION

The following section includes the references used for calculating emissions in the baseline and project scenarios.

Calculations were based on information obtained by Agrosuper, default values of the model and additional information. The following scenarios were analysed:

- Baseline Scenario**: Barns → Anaerobic Lagoon → Use of effluents on site**
- Project Scenario: **Barns → Anaerobic digester → Aerobic Treatment → Storage lagoon→ Use of effluents on site**

The changes through time in the monitored parameters will determine the time-dependence of the emissions calculation for each scenario.

3.1 General Data

The following table presents the main standpoints since the beginning of the Ramirana digester's operation:

Table 1: Main Standpoints in Ramirana's operation

Date *DD/MM/YYYY*	**01/02/2002**	
Standpoints	Activated sludge component commencing construction	

The project implementation relies greatly on the values presented in this annex. The only data that relies on default parameters are the volatile solids content and nitrogen content in raw manure.

Table 2: General Characteristics of Ramirana's Operation

	2005	**2006**
Number of swine heads	24,631	30,058
Average Swine weight	175.00	161.72
Effective Operation days	90	365

Source: Specific hog operations data from Agrosuper.

In order to quantify ex-ante results of emission reductions for the year 2006, the same monitored and corrected default data of 2005 was used, considering a continuous operation of 365 days a year.

The importance of monitoring the number of swine heads relies in the calculation of VS content and nitrogen excretion in total manure.

The next table presents the GWP values for each GHG under consideration:

Table 3: Global Warming Potential

	Global Warming Potential (GWP)
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310

3.2 CH_4 Emissions from Manure Management Systems

VS = Volatile Solids rate in kg/day/head for a given stock of pigs. The IPCC provides a volatile solids rate in raw manure of 0.5 kg/day/head for developed countries (Table B-2 of IPCC Guideline, Reference Manual). This data (VS) is corrected by the mean swine weight from Agrosuper's data, in contrast with a representative weight of **82 kg/head** (IPCC). We can trust that the IPCC default value (for developed countries) represents the volatile solids content in raw manure for Agrosuper because every parameter involved in the next calculation, is consistent and similar to those presented in Appendix B of Chapter 4.2, of the IPCC Guidelines Reference Manual:

Equation 15 of the IPCC Guidelines Reference Manual

$$VS_{dm} \text{ (kg dm/day)} = \text{Intake (MJ/day)} \bullet (1 \text{ kg}/ 18.45 \text{ MJ}) \bullet (1 - DE\%/100) \bullet (1 - ASH\%/100)$$

Where:

VS_{dm} = VS excretion per day on a dry weight basis;

dm = dry matter;

Intake = the estimated daily average feed intake in MJ/day;

DE% = the digestibility of the feed in per cent;

ASH% = the ash content of the manure in per cent.

The energy density of feed intake is about 18.45 MJ per kg of dry matter. The next table presents the results given for the parameters that determine the volatile solids content in raw manure. These factors may be used when accurate site specific information is unavailable.

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Table 4 : Volatile Solids referential data

	Feed Digestibility	Energy intake	Feed intake	Ash content	VS
	%	MJ/hd/day	kg/hd/day	%	(kg/hd/day)
Developed Countries IPCC default value Appendix B Chapter 4.2, IPCC Guidelines Reference Manual	75	38	2.1	2	0.50
Agrosuper monitored data	78	44*	2.38*	2	0.514

* Average feed and energy intake in Agrosuper's barns.

The percentage decay of this parameter after the digester, is referenced in the "**Development Document for the Proposed Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations**" (EPA, 2001). This document assumes a **60 percent** reduction of VS due to the digester.

Bo = Maximum CH_4 production capacity from manure, per head for a given stock of pigs [m3/kg of volatile solids]. Default values can be obtained in the Table B-2 of the "IPCC Guidelines for National Greenhouse Gas Inventories, Revised 1996, Reference Manual". This parameter varies by species and diet, and for Agrosuper swine barns, it should be used the representative data for developed countries (swine: 0.45 m^3/kg).

MCF = Conversion factors of CH_4, for each manure management system and every regional weather. For the anaerobic lagoon (baseline) and the storage lagoon we consider MCF to be 90 % and 45% as a default reference from the IPCC, respectively. The MCF for activated sludge is 0.1%. For the purposes of quantifying indirect fugitive emissions in the digester, we consider a 5 % as a default reference from the IPCC. The next table summarises the different types of manure management systems involved in the project and baseline scenario, and their CH_4 conversion factors (MCFs).

Table 5: CH4 Conversion Factor in different emission sources

	MCF %	
Baseline	Anaerobic Lagoon*	90%
Project	Indirect fugitive emissions from digester*	5%
	Storage Lagoon**	45%

	Aerobic Treatment ***	0.10%

Source: * IPCC Guidelines (Reference Manual table 4-8 and table B-6) and ** IPCC Good Practice and uncertainty management (Table 4.10) and *** IPCC Good Practice and uncertainty management (Table 4.11), temperate climate.

3.3 Nitrous Oxide Emissions from Manure Management Systems

Nitrogen excretion rate : NEX = **20 kg/head/day** for developed countries, as stated in Table 4-20 of the 1996, IPCC Guidelines. This data (NEX) is corrected for the mean swine weight from Agrosuper's data (for each barn), in contrast with a representative IPCC default weight of **82 kg/head**.

The digester anaerobic process (complete mix) does not have an effect on the nitrogen content of manure, as stated in the "**Development Document for the Proposed Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for CAFO**" (EPA, 2001). This document also gives a reference of **75 %** decay of nitrogen content due to the aerobic treatment, via nitrification-denitrification.

Conversion Factor – N_20 N TO N: For reporting purposes the conversion is performed using the following equation

$$N_2O_{(mm)} = (N_2O - N)_{(mm)} \bullet 44/28$$

44/28 =1.57

The next table presents the relevant emission factor involved in the emission reduction of nitrous oxide.

Table 6: Emission Factor involved in the N20 emission calculations for each scenario.

Parameter	Value	Units	Description	Reference
EF3	0.001	kg N_2O-N/kg of Nitrogen excreted	N_2O emission factor for Manure Management System	Table 4-22 IPCC Guidelines and Table 4-13 IPCC Good Practice Guidance Document

3.4 Corrected IPCC default data

The following table presents the information used to represent the volatile solids content and nitrogen in raw manure.

Table 7: Corrected IPCC default data for emission calculation

DATA VARIABLE	UNCERTAINTY LEVEL	DATA UNIT	At present, 2005	2006 and subsequent years
Volatile Solids Excretion Rate	Medium	Kg/head/day	1.07	0.99

Nitrogen Excretion Rate	Medium	Kg/head/year	42.7	39.4

3.5 Additional monitored information for emission reductions calculation

Table 8: Monitored information based on the monitoring plan

DATA VARIABLE	DATA UNIT	At present, 2005	2006 and subsequent years
Manure Flow After Aerobic Treatment Stage	m^3/day	1436	1436
Manure Flow Before Aerobic Treatment	m^3/day	1445	1445
Flow of Sludge from Aerobic Treatment	m^3/day	9	9
5 days BOD in Manure after Aerobic Treatment Stage	mg/L	35	35
Total Nitrogen Content in Manure after Aerobic Treatment Stage	mg/L	50	50
Temperature of Manure after Aerobic Treatment Stage	ºC	19	19
Biogas Flow Extracted by Digester	m^3/day	-	-
CO2 Concentration in Gas Flow	%	28	28
Flare Efficiency	%	98%	98%

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Annex 4

MONITORING PLAN

The following table presents the monitoring plan followed by Agrosuper in order to achieve certified emission reductions, after each validation and verification process. The data collected will be archived during the complete crediting period and will be reserved two years after this period.

DATA VARIABLE	UNCERTAINTY LEVEL	DATA UNIT	DATA ORIGIN
Animal Population	Low	Heads	Daily animal Stock and inlet program of pigs (Net inlet considering mortality). Information managed by Agrosuper
Average Weight of Animals	Low	kg	Pavilion test and growing tendency curves. Information managed by Agrosuper
Manure Flow After Aerobic Treatment Stage	Low	m^3/day	This parameter is calculated with total inlet flow minus sludge volume.
Manure Flow Before Aerobic Treatment	Low	m^3/day	This parameter is monitored from a flow meter installed before the activated sludge.
Flow of Sludge from Aerobic Treatment	Low	m^3/day	Referential volume from sludge transportation requirements. Information managed by third party.
5 days BOD in Manure after Aerobic Treatment Stage	Low	mg/L	Activated Sludge monitoring registers, managed by third party.
Total Nitrogen Content in Manure after Aerobic Treatment Stage	Low	mg/L	Activated Sludge monitoring registers, managed by third party.
Temperature of Manure after Aerobic Treatment Stage	Low	ºC	Activated Sludge monitoring registers, managed by third party.
Biogas Flow Extracted by Digester	Low	m3/day	Registers from the CLP. Information managed by Agrosuper*
CO_2 Concentration in Gas Flow	Low	%	Registers from the CLP. Information managed by Agrosuper*

Flare Efficiency	Low	%	Design Combustion Efficiency, Provided by Perennial Energy

*: Either monitoring of biogas flow rate or carbon dioxide concentration on gas flow can be an evidence of the correct performance from the anaerobic digester.