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:

>> "Methane capture and combustion from swine manure treatment for Corneche and Los Guindos"

A.2. Description of the project activity:

>> In December 2000, Agricola 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. This commenced with the construction and operation of the Peralillo anaerobic digester, in 2000, at the VI Region of Chile.

The anaerobic and aerobic digestion technology is being phased in 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. This Project Design Document focuses on the systems of Corneche and Los Guindos, two not-heated anaerobic digesters, that just like Peralillo, have an important potential in GHG emission reductions.

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 project consists of an advanced improvement to the common practice of swine waste treatment in the country, reducing an important amount of greenhouse gases. The technology implementation is based on the use of anaerobic digesters. The technology has been proved to be applicable at Agrosuper´s swine farms and therefore owns the facilities of this project. This Project Design Document considers that the CDM project boundaries may be extended in order to include an upgrade of a supplementary or exclusive aerobic treatment unit, such as an activated sludge plant. Those upgrades will take place according to methodology AM0006.

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.
Such upgrade implementations, through an activated sludge plant construction either after or in replace of the existing digester, are only to happen when new farms and extension of production capacity with new farms (barns).

The expected result from this project activity will be a significant reduction in the volume of methane (CH4) emissions compared to those emissions that would otherwise occur in a scenario with traditional swine manure treatment systems.

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 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: "Methane capture for swine manure treatment for Corneche and Los Guindos":

CHILE

Project developer: Agricola Super Limitada, private company engaged in the swine and poultry business.

Chile ratified the Kyoto Protocol on August 26, 2002

JAPAN

The Tokyo Electric Power Company, Incorporated.

Japan ratified the Kyoto Protocol on June 4, 2001.

CANADA

Transalta Corporation

Canada ratified the Kyoto Protocol in December, 2002

Agrosuper: The Company

The "**Methane capture and combustion from swine manure treatment**" 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.

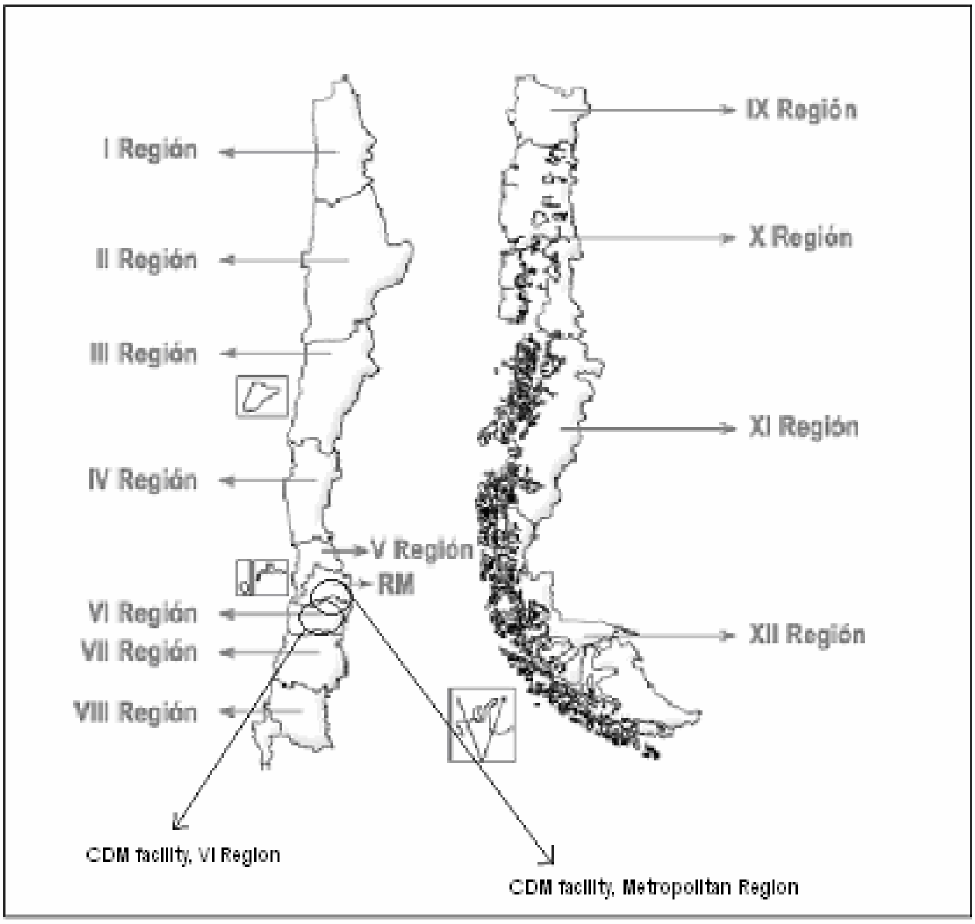
Agrosuper complies with all Chilean environmental regulations. In addition, the swine production department and all farms are certified with quality and environmental management systems under ISO 9001:2000 and ISO 14001:1996, respectively.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

>> The project is located in Central Chile, South America

Figure 1 Project Location



A.4.1.1. Host Party (ies):

>> The host party identified for this project is Agricola Super Ltda. (Agrosuper).

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

>> **Corneche** Advanced Waste Management System: Metropolitan Region, Province of Melipilla.

Los Guindos Advanced Waste Management System: Metropolitan Region, Province of Melipilla.

A.4.1.3. City/Town/Community etc:

>> **Corneche** Advanced Waste Management System: Community of San Pedro.

Los Guindos Advanced Waste Management System: Community of Melipilla.

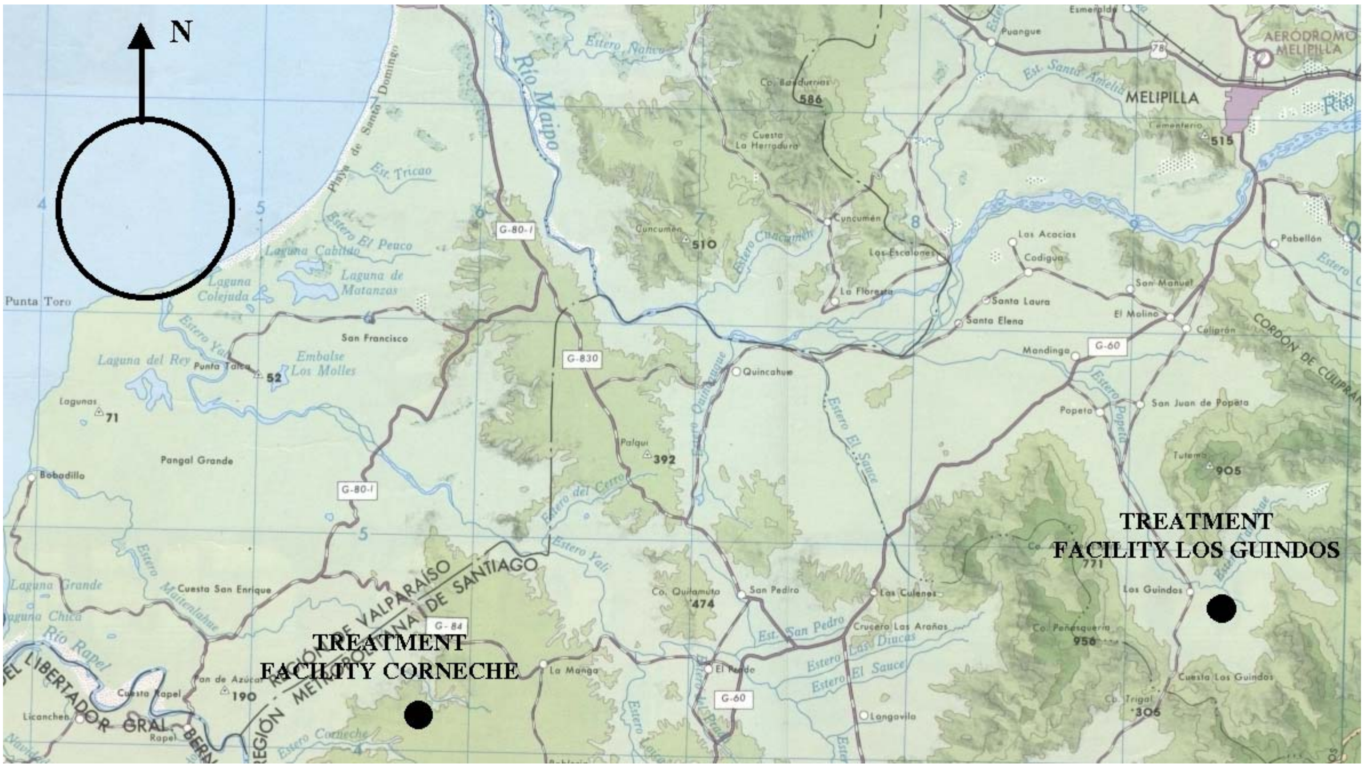
A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

>> The next table presents the Universal Transversal Mercator (UTM) co-ordinates for each waste management initiative:

Table A.1

Name of the advanced waste management system	Farm name	Nearest location	North (UTM)	East (UTM)
Corneche	Corneche	Corneche	6,242,007	257,670
Los Guindos	Tantehue	Los Guindos	6,246,500	295,400

Figure 2: Project Activity Location



The next table summarises the current Project Activity's characteristics:

Table A.2

Initiative	Treatment system type	Size of treatment system, volume (m^3)	Irrigation project	Starting date of the treatment system
Corneche	Ambient Temperature	31,000	Yes	May 2002
Los Guindos	Ambient Temperature	60,000	Yes	May 2002

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 *"Methane Recovery and waste handling and disposal"* 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 in the digester, and the 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. Any additional or exclusive aerobic treatment in the manure management system, will consider a default decay of nitrogen content via nitrification-denitrification, and an additional decay in the CH_4 generation from treated manure.

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

>> **Anaerobic Digestion**

The project is based on anaerobic digestion in two ambient temperature complete-mix digesters.

Figure 3: Methane combustion at Digester's Flare

Figure 4: Corneche's Digester Overview

An anaerobic digester is a reactor sized both to receive a daily volume of organic waste and to grow and maintain a steady-state population of methanogenic bacteria for degradation. Methanogenic bacteria are slow-growing, environmentally sensitive that grow without oxygen 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**.

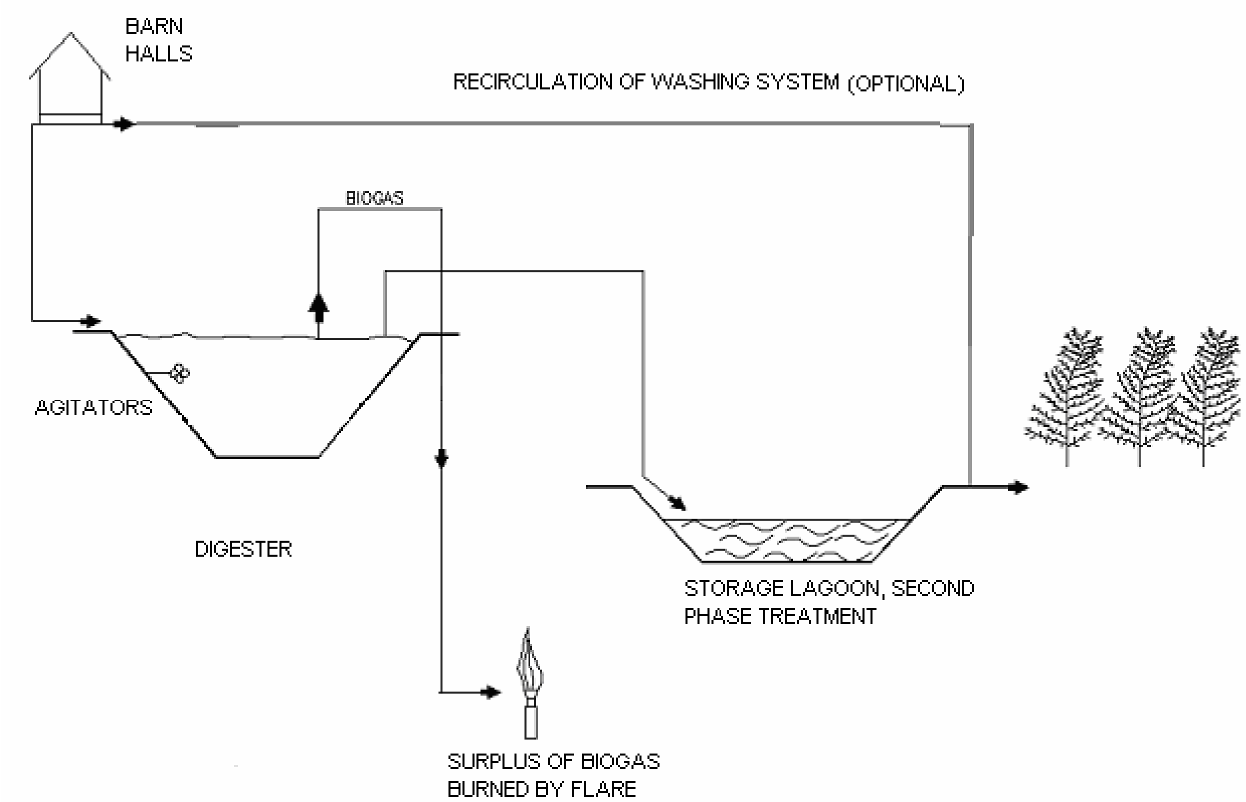
The digester technology includes a cover of high-density polyethylene HDPE 40-60 mils, (1–1.5 mm) which is floated over the primary lagoon of a two lagoon system. The primary lagoon is maintained as a constant volume treatment lagoon and the second cell is used to provide storage of treated effluent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

The digester is a complete-mix reactor that anaerobically decomposes animal manure under a constant volume and mixing. Mixing is accomplished by mechanical mixers. A complete-mix digester can be designed to maximise biogas production as an energy source 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 are 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.

Figure 5: Flowchart of Treatment System



The emission reduction achievement is based on the transformation of CH_4 to CO_2 through combustion, thereby avoiding fugitive CH_4 emissions.

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 in the storage lagoon.

The present project considers aerobic and controlled conditions for solids removed from the storage lagoon's bottom, on a land application programs for soil recover. 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. Methane and nitrous oxide emissions are considered negligible, because there are no anaerobic conditions in each of the final 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. Corneche's and Los Guindos swine waste management program began in May 2002, with the operation of two anaerobic digesters

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.
These projects may incorporate an upgrade in its manure treatment system, such as an activated sludge plant either supplementary to or replacing the existing digester, in order to improve the treatment capacity and, specially, improve also the final wastewater quality.

Baseline (Anaerobic Lagoon):

Approximately 50% of the companies in Chile (including Agrosuper) have introduced the open lagoon system, in the 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 of 1999. 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 commencement 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 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 methods 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 implemented the anaerobic lagoon system for all of its facilities and then has gone even further by installing digesters like in Corneche and Los Guindos that have a continuous operation since May 2002.

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 Corneche and Los Guindos project activity through the crediting period:

Table A.3 Emission Reductions, Corneche & Los Guindos

Emission Reduction (tCO2eq)/year	2002	2003	2004	2005 & subsequent years
Corneche	25,439	53,665	52,009	52,009
Los Guindos	25,370	28,870	39,038	39,038
TOTAL Emission Reductions	50,809	82,536	91,047	91,047

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 project 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 in 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 operationalise this approach in the form of 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 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, on a cost-benefit evaluation.

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

>>

B.2.1. Application of Baseline Methodology

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 – Storage Lagoon – Land Application
7) Solid Separation – Composting – Land Application

The dry lot system has been excluded because is not applicable to the conditions of 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 solids 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 not 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 blown out of 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. 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, and so, a smaller lagoon. This makes this alternative a potential baseline scenario.

6) Digester – Storage Lagoon – Land Application: Most of the barriers of 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 – Storage Lagoon – Land Application

Step 3: Economic Comparison

The following economic comparison between each waste management scenario, will exclude 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.1.1 Economic Comparison (Corneche)

Baseline I (US$)	**Year 1**	**Year 2**	**Year n**	**Year n+1**
WASTE TREATMENT STAGE I: PRESS + ANAEROBIC LAGOON				
Equipment costs (specify the equipments needed)	-	-	-	-
Installation costs (considering press)	-395,121	0	0	0
Maintenance costs (drying solids, solids removal and land incorporation)	-175,436	-63,510	-63,510	-63,510
Additional costs (**Press** Operation, consultancy, engineering, **irrigation costs**)	-1,965	-1,965	-1,965	-1,965
TOTAL BASELINE	**-572,522**	**-65,475**	**-65,475**	**-65,475**
NPV (US$) (discount rate = 10 %)	**-$ 668,498**			

Baseline II (US$)	**Year 1**	**Year 2**	**Year n**	**Year n+1**
WASTE TREATMENT STAGE I: ANAEROBIC LAGOON				
Equipment costs (specify the equipments needed)	-	-	-	-
Installation costs	-218,816	0	0	0
Maintenance costs (drying solids, solids removal and land incorporation)	-139,908			
Additional costs (Operation, consultancy, engineering, irrigation costs)	-1,965	-1,965	-1,965	-1,965
SUBTOTAL	**-360,689**	**-1,965**	**-1,965**	**-1,965**
TOTAL BASELINE	**-360,689**	**-1,965**	**-1,965**	**-1,965**
NPV (US$) (discount rate = 10 %)	**-$ 332,340.51**			

Project (US$)	**Year 1**	**Year 2**	**Year n**	**Year n+1**
WASTE TREATMENT STAGE I: DIGESTER				
Equipment costs (Gas handling skid (GHS) consisting of blower system, PLC, heat exchange system, boiler and flare system).	-94,384			
Installation costs	-337,158	0	0	0
Maintenance costs	-30,000	-30,000	-30,000	-30,000
Additional costs (Operation, consultancy, engineering)	-44,714	-44,714	-44,714	-44,714
SUBTOTAL	**-506,256**	**-74,714**	**-74,714**	**-74,714**
WASTE TREATMENT STAGE II: STORAGE LAGOON				
Equipment costs				
Installation costs	-72,912	0	0	0
Maintenance costs (drying solids & solids removal)	-27,008			
Additional costs (Operation, consultancy, engineering, irrigation costs)	-926	-926	-926	-926
SUBTOTAL (US$/year)	**-100,846**	**-926**	**-926**	**-926**
TOTAL PROJECT (US$/year)	**-607,102**	**-75,640**	**-75,640**	**-75,640**
NPV (US$) (discount rate = 10 %)	**-$ 722,916.16**			

IRR (%)	Undefined	

Table B.1.1 Economic Comparison (Los Guindos)

Baseline I (US$)	**Year 1**	**Year 2**	**Year n**	**Year n+1**
WASTE TREATMENT STAGE I: PRESS + ANAEROBIC LAGOON				
Equipment costs (specify the equipments needed)				
Installation costs (considering press)	-293,137	0	0	0
Maintenance costs (drying solids, solids removal and land incorporation)	-235,406	-63,510	-63,510	-63,510
Additional costs (**Press** Operation, consultancy, engineering, **irrigation costs**)	-1,561	-1,561	-1,561	-1,561
TOTAL BASELINE	**-530,104**	**-65,071**	**-65,071**	**-65,071**
NPV (US$) (discount rate = 10 %)	**-$ 629,024.47**			

Baseline II (US$)	**Year 1**	**Year 2**	**Year n**	**Year n+1**
WASTE TREATMENT STAGE I: ANAEROBIC LAGOON				
Equipment costs (specify the equipments needed)				
Installation costs	-163,999	0	0	0
Maintenance costs (drying solids, solids removal and land incorporation)	-214,869			
Additional costs (Operation, consultancy, engineering, irrigation costs)	-1,561	-1,561	-1,561	-1,561
SUBTOTAL	**-380,430**	**-1,561**	**-1,561**	**-1,561**
TOTAL BASELINE	**-380,430**	**-1,561**	**-1,561**	**-1,561**
NPV (US$) (discount rate = 10 %)	**-$ 349,375.58**			

Project (US$)	**Year 1**	**Year 2**	**Year n**	**Year n+1**
WASTE TREATMENT STAGE I: DIGESTER				
Equipment costs (Gas handling skid (GHS)	-104,487			

consisting of blower system, PLC, heat exchange system, boiler and flare system).				
Installation costs	-482,376	0	0	0
Maintenance costs	-30,000	-30,000	-30,000	-30,000
Additional costs (Operation, consultancy, engineering)	-43,392	-43,392	-43,392	-43,392
SUBTOTAL	**-660,255**	**-73,392**	**-73,392**	**-73,392**
WASTE TREATMENT STAGE II: STORAGE LAGOON				
Equipment costs				
Installation costs	-137,123	0	0	0
Maintenance costs (drying solids & solids removal)	-42,200			
Additional costs (Operation, consultancy, engineering, irrigation costs)	-1,158	-1,158	-1,158	-1,158
SUBTOTAL (US$/year)	**-180,480**	**-1,158**	**-1,158**	**-1,158**
TOTAL PROJECT (US$/year)	**-840,735**	**-74,549**	**-74,549**	**-74,549**
NPV (US$) (discount rate = 10 %)	**-$ 932,844.02**			
IRR (%)	Undefined			

There are no potential revenues involved in any of these scenarios. The analysis shown has considered assumptions and parameters for the project activity chosen in a conservative way.

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, between scenarios.

The following table presents the NPV of each scenario analyzed:

Table B.2. NPV Comparison for Corneche & Los Guindos

NPV (US$) (discount rate = 10 %)	Press (solid separation)-Anaerobic- Land application	Anaerobic Lagoon-Land application	Digester-Storage Lagoon-Land application
Corneche	**-$ 668,498.12**	**-$ 332,340.51**	**-$ 722,916.16**
Los Guindos	**-$ 629,024.47**	**-$ 349,375.58**	**-$ 932,844.02**

Because there are no positive cash flows involved, a cost-effective economic comparison is adequate to recognize the best waste 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. Both phases of the project initiative have 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 an anaerobic Digester 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".

In order to include a supplementary aerobic unit to the wastewater treatment system, this technological upgrade requires an even higher investment compared to the anaerobic system, such additional activated sludge treatment would make the project NPV even more negative because of the higher investment costs when compared to the baselines scenario, and also in the case of only activated sludge treatment (no digester), the project NPV is still more negative than the baseline NPV.

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) 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, treat the water and reduce GHG emissions beyond the most economically attractive option, namely the anaerobic lagoon (which is also much less expensive than the CDM project activity).

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 are not commonly used in wastewater treatments for animal manure.

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

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, due to the significant investments required, without economic compensation.

The potential to sell CERs was the main factor that influenced the decision to implement the anaerobic digesters. 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.

B.2.2 Emission reductions calculation

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
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 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 (IPCC and US-EPA default values). Baseline data and additional information for emission reduction quantification can be found on Annex 3. The inclusion of a new aerobic wastewater management unit could provide monitored values to represent the emissions of the storage lagoon in the project scenario (such as long term BOD concentration and total nitrogen content).

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 used 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. The collected gas is flared and the 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.

In order to include a supplementary aerobic unit to the wastewater treatment system, and still represent a whole CDM project activity, it is acknowledged that

- The incorporation of this new wastewater treatment enables an extra management that reduces organic content and nitrogen concentration of the residue, achieving an even lower methane and nitrous oxide emission potential for the next treatment stages.
- This technological upgrade demands a major investment respect to the prevalent wastewater management practice, not obstructing the additionality condition of the advanced wastewater treatment system proposed originally as a CDM project activity.

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 a decision to continue the implementation of more digesters 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.

It is acknowledged that the CDM project boundaries can be extended in order to consider the incorporation of a supplementary aerobic unit and still represent a whole CDM project activity, as manure management systems may comprise several treatment stages. 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 (Corneche & Los Guindos)

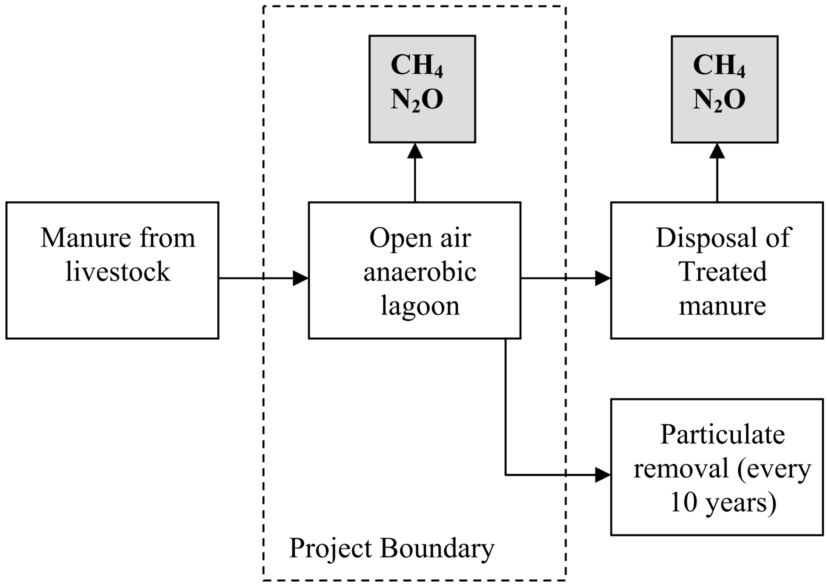
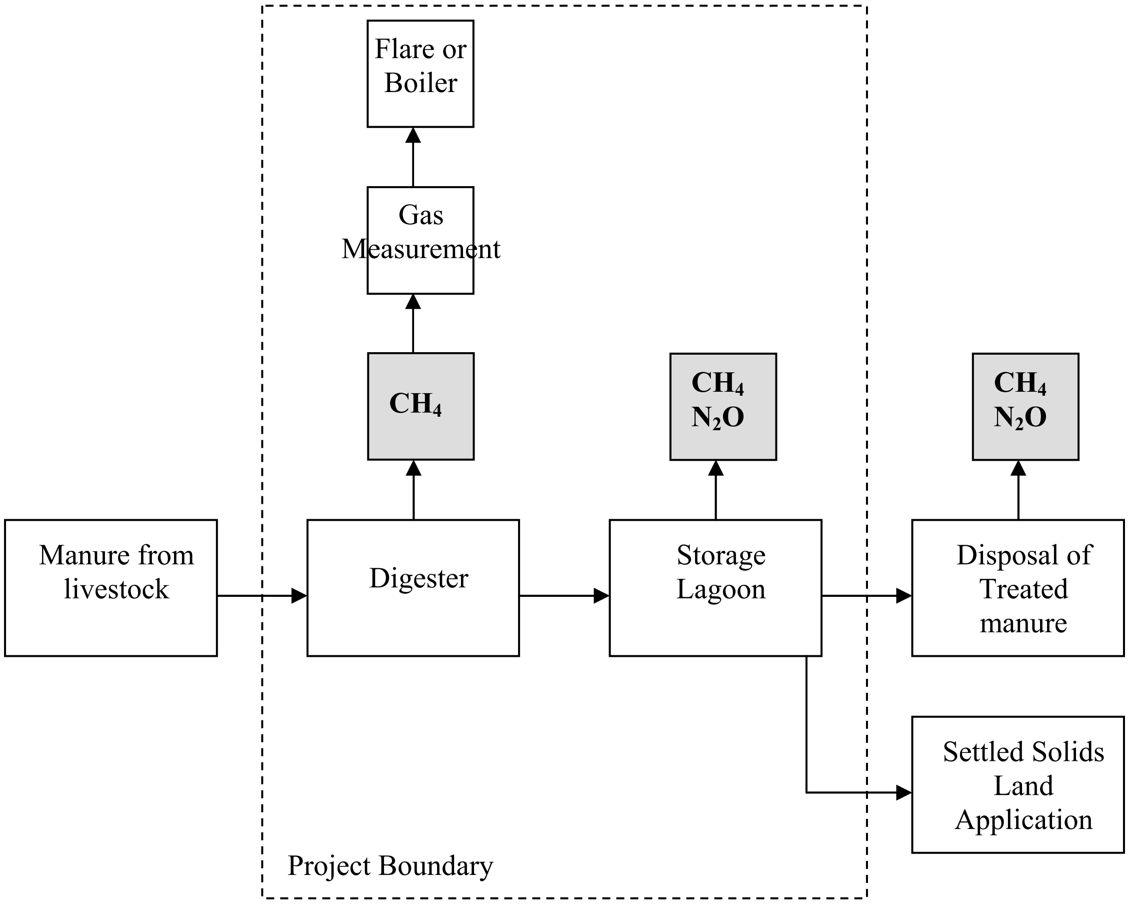


Figure 2: CDM Project Activity Boundary (Corneche & Los Guindos)



Potential Emissions outside the project's boundaries

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 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), as emissions in the project boundary.

The present project considers aerobic and controlled conditions for solids removed from the storage lagoon's bottom, on a land application programs for soil recover. 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. Methane and nitrous oxide emissions are considered negligible, because there are no anaerobic conditions in each of the final management process.

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):

23/07/2004

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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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:

>> The 1st of May of 2002 will be considered as the starting date of the Corneche and Los Guindos digesters operation.

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:

>>01/05/2002

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.

The parameters involved in the monitoring plan presented in this Project Design Document (PDD) include the parameters required for an anaerobic treatment and an aerobic treatment monitoring. Therefore, if an additional treatment stage is included, such as an activated sludge system, the monitoring plan must be adjusted accordingly to the requirements of the monitoring plan.

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)	Comment
D.2-1	Number	Daily Swine stock	Heads	Measured	Weekly	100%	Paper and electronic	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	Necessary for treatment stages with no monitored wastewater parameters available (Volatile solids, Nitrogen content, and biochemical oxygen demand).
D.2-3	Flow rate	Manure flow to the aerobic post-treatment	m^3/day	Measured	Monthly	100%	Paper and electronic	To be measured when aerobic treatment component is included.

D.2-4	Concentration	5 days Biochemical Oxygen Demand (BOD) in storage lagoon after aerobic treatment	mg/L	measured	Monthly	100%	Paper and electronic	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon in the second phase of the project. To be measured when an aerobic treatment component is included.
D.2-5	Concentration	Total Nitrogen content in second phase plant effluent.	mg/L	measured	Monthly	100%	Paper and electronic	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon in the second phase of the project. To be measured when aerobic treatment component is included.
D.2-6	Temperature	Temperature of manure in second phase plant effluent.	ºC	measured	Monthly	100%	Paper and electronic	Option A of the baseline methodology is chosen to represent emissions from the storage lagoon. To be measured when an aerobic treatment component is included.
D.2-7	Flow rate	Biogas flow extracted by digester	SCFM (standard cubic feet per minute)	Measured	Every working day	100%	Paper and electronic	This parameter shows the performance of digester and gas recovery indicating operation. To be measured when an anaerobic digester is included.
D.2-8	Percentile	CO2 concentration in gas flow	%	Measured	Every working day	100%	Paper and electronic	This parameter shows the performance of anaerobic digestion. To be measured when an anaerobic digester is included.

D.2-9	Percentile	Flare efficiency	%	Default values from design	-	100%	and electronic	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).

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 and the second as the storage lagoon. For any further inclusion of an additional unit relying in aerobic wastewater treatment, it will be considered that the second and third treatment stages are the activated sludge system and the storage lagoon, respectively. The tools for representing emission calculation for any wastewater treatment component in each scenario are available in Approved Methodology AM0006.

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 inclusion of an aerobic unit, 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, where monitored parameters of aerobic treatment outflow are available.

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.

MCF_{sl}: Methane conversion factor (MCF) for treatment of manure in the storage lagoon in per cent. Applicable for the inclusion of an aerobic wastewater treatment, or where wastewater monitored parameters exist.

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. For this project it will be considered the use of corrected default IPCC values.

R_{VS}: Relative reduction of volatile solids in the second 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 flow to the aerobic treatment stage, during the year y in m^3. Applicable for the inclusion of an aerobic wastewater treatment, or where wastewater monitored parameters exist.
$BOD_{lt,y}$: Long term biochemical oxygen demand of the manure flow to the storage lagoon treatment stage in mg/l, for year y. Applicable for the inclusion of an aerobic wastewater treatment.

N_2O Emissions equations from anaerobic lagoon & Storage losses

EQ. 4: $_2$O Emissions related to the storage lagoon treatment stage where there are no monitored values available

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

Where:

$E_{N2O,mm,1,y}$: Nitrous oxide emissions from the storage lagoon stage of the manure management systems 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: N_2O Emissions related to the storage lagoon treatment stage where there are monitored values available (for any further inclusion of an additional aerobic wastewater treatment**)**

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

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

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

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

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

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 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)	Comment
D.2-1	Number	Daily Swine stock	Heads	Measured	Weekly	100%	Paper and electronic	All of the pig barns have an exhaustive daily 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	
D.2-3	Flow rate	Biogas flow extracted by digester	SCFM/day (standard cubic feet meter/day)	Measured	Every working day	100%	Paper and electronic	This parameter indicates the level of performance of the digester and gas recovery system. This parameter will verify the correct anaerobic fermentation process in the baseline scenario (considering the effect of inhibitors). To be measured when an anaerobic digester is included.

D.2-4	Percentile	CO2 concentration in gas flow	%	Measured	Every working day	100%	Paper and electronic	This parameter indicates the level of performance of the digester and gas recovery system. To be measured when an anaerobic digester is included.
D.2-5	Percentile	Flare efficiency	%	Default values from design	-	100%	Paper and electronic	Methane content of flare exhaust gas. This parameter indicates the level of performance of the digester and gas recovery system. 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).

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

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: Not applicable. This project does not consider anaerobic conditions for treated manure management.

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. It has been shown that the project activity does not consider anaerobic conditions for solids removed from the storage lagoon's bottom.

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. It has been shown that the project activity does not consider anaerobic conditions for solids removed from the storage lagoon's bottom.

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; this data will be used as basis for calculating emission reductions
D 2-4	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 2-5	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 is supported by the control of temperature, pH and the variability of the gas flow rate

D 2-8	Low	QA/QC procedures are established. This is supported by the control of temperature, pH and the variability of the gas flow rate
D 2-9	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.

The reason for not monitoring parameters in raw manure is because in Corneche and Los Guindos, 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 caudalimeter 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

CO2 Concentration in Gas Flow	%	Registers from the CLP. Information managed by Agrosuper	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. 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.
Flare Efficiency	%	Design Combustion Efficiency, Provided by Perennial Energy	

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

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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, Corneche

Emissions (tCO2eq)/year	2002	2003	2004	2005
Digester's losses and Leakage	1,898	4,005	3,881	3,881
Lagoon CH_4	6,834	14,418	13,972	13,972
Lagoon N_2O	556	675	655	655
Total Project Emissions (Corneche)	**9,289**	**19,098**	**18,508**	**18,508**

Table E.2 Detailed Project Emissions, Los Guindos

Emissions (tCO2eq)/year	2002	2003	2004	2005
Digester's losses and Leakage	1,893	2,155	2,913	2,913
Lagoon CH_4	6,816	7,756	10,488	10,488
Lagoon N_2O	486	491	491	491
Total Project Emissions (Los Guindos)	**9,195**	**10,402**	**13,892**	**13,892**

In order to include the incorporation of a supplementary aerobic unit to the anaerobic wastewater treatment system, and still represent a whole CDM project activity, it is acknowledged that:

- the CDM project boundaries can be extended to consider the incorporation of the new treatment unit, as manure management systems may comprise several treatment stages, as established in AM0006.

- The tools for emission calculations in each scenario and emission reductions are available in Approved Methodology AM0006.

E.2. Estimated leakage:

>>The project does not envisage emissions generated outside the project boundary that are significant and reasonably 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.

The digester's power consumption is of 0.001 MW (100 kWh), that would not be consumed in the baseline scenario. Because emissions due to energy consumption are so insignificant in terms of CO2eq, we have chosen to disregard it for the purposes of our main calculations.

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

>> There are no leakage emissions considered for this project activity during the crediting period, so the results shown in table E.1 and E.2, are representative for emissions in the project scenario. The following table synthesize these results:

Detail for each source:

Table E.3 Detailed Project Emissions

Emissions Corneche (tCO2eq)/year	2002	2003	2004	2005
Digester's Losses and Leakage	1,898	4,005	3,881	3,881
Lagoon CH_4	6,834	14,418	13,972	13,972
Lagoon N_2O	556	675	655	655
Subtotal (Corneche)	**9,289**	**19,098**	**18,508**	**18,508**
Emissions Los Guindos (tCO2eq)/year	**2002**	**2003**	**2004**	**2005**
Digester's Losses and Leakage	1,893	2,155	2,913	2,913
Lagoon CH_4	6,816	7,756	10,488	10,488
Lagoon N_2O	486	491	491	491
SubTotal (Los Guindos)	**9,195**	**10,402**	**13,892**	**13,892**
Total Project Emissions	**18,484**	**29,500**	**32,401**	**32,401**

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

>>Detail for each source:

Table E.4 Detailed Baseline Emissions, Corneche & Los Guindos

Baseline Emissions Corneche(tCO2eq)/year	2002	2003	2004	2005
Lagoon CH_4	34,172	72,088	69,862	69,862
Lagoon N_2O	556	675	655	655
Subtotal (Corneche)	**34,729**	**72,763**	**70,517**	**70,517**
Baseline Emissions Los Guindos (tCO2eq)/year	**2002**	**2003**	**2004**	**2005**
Lagoon CH_4	34,079	38,781	52,439	52,439
Lagoon N_2O	486	491	491	491
Subtotal (Los Guindos)	**34,565**	**39,272**	**52,930**	**52,930**
Total Baseline Emissions	**69,294**	**112,035**	**123,447**	**123,447**

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 2002 to 2005:

Table E.5 Total Emission Reductions

Emission Reduction (tCO2eq)/year	2002	2003	2004	2005 & subsequent years
Corneche	25,439	53,665	52,009	52,009
Los Guindos	25,370	28,870	39,038	39,038
TOTAL Emission Reductions	50,810	82,536	91,047	91,047

It has been estimated that 25 – 30 % of additional emission reductions can be achieved if these wastewater treatment facilities include a technological upgrade as an aerobic treatment. This aerobic system does not envisage in relevant energy consumption that could be interpreted as leakage.

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

>> The following tables present the values obtained with the equations from section D:

CORNECHE

	2002		2003		2004		2005	
Ton CO2eq/yr	BASELINE	PROJECT	BASELINE	PROJECT	BASELINE	PROJECT	BASELINE	PROJECT
EQ 1	34,172	1,898	72.088	4.005	69,862	3,881	69,862	3,881
EQ 2		6,834		14.418		13,972		13,972
EQ 3	556	556	675	675	655	655	655	655
EQ 4	0.37	0.37	0,39	0,39	0.38	0.38	0.38	0.38
EQ 5	14.8	14.8	15,4	15,4	15.3	15.3	15.3	15.3

LOS GUINDOS

	2002		2003		2004		2005	
Ton CO2eq/yr	BASELINE	PROJECT	BASELINE	PROJECT	BASELINE	PROJECT	BASELINE	PROJECT
EQ 1	34,079	1,893	34,079	1,893	52,439	2,913	52,439	2,913
EQ 2		6,816		6,816		10,488		10,488
EQ 3	486	486	486	486	491	491	491	491
EQ 4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
EQ 5	53.9	53.9	53.9	53.9	53.9	53.9	53.9	53.9

SECTION F. Environmental impacts

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

>> According to the Chilean legislation, the implementation of an anaerobic digester in existing facilities does not require a specific Environmental Impact Study, although a voluntary submission to the Environmental Impact System is allowed. Notwithstanding the previous, the construction of barns and the respective waste treatment does require this specific authorization and study. The National Commission for the Environment (CONAMA) did approved and authorized the construction of the barns with a traditional waste treatment system. Nevertheless, Agrosuper improved the system including digesters and aerobic treatment systems reducing potential impacts to the environment. Those changes do not require an additional Environmental Impact Evaluation, apart from the respective sectoral permits, which were obtained in due time by the company. In case of future upgrades, those permits will be obtained in accordance to the Chilean legislation and informed in due time to the DOE and Chilean DNA.

All these affirmations are confirmed by the endorsement of the project given by the Designated National Authority (CONAMA), in its Host country approval process (Letter of approval is attached). In that instance the DNA reviewed all the different environmental permits related to the project and found them to be in accordance with all national environmental regulations.

The fact that CH4 has a global warming potential (21) that exceeds greatly the global warming potential of CO2 (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 (odors) and global environmental pressures. This advanced system (anaerobic digester and aerobic treatment) minimizes the odors 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, the advanced system 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 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 advanced waste management systems 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:

>> The impacts are very low or not existent. .

The project participants don't recognize any relevant impact on local or global environment due to the project. It has been stated that this project contributes to sustainable development in the region. However, the construction of barns and waste treatment systems, do require an environmental impact assessment, according to article 10 of the Law 19.300[1] and Supreme Decree Nº 30 of 1997.[2]

Host country approval for the project activity was granted by the CONAMA, the Chilean Designated Authority (DNA), on July 01, 2003 (letter and unofficial translation is attached).

Environmental Impact Assessments related to the swine waste management project activity:

- Corneche: First approved on June 28, 2001, by resolution Nº350 of the Regional Commission for the Environment (Metropolitan Region), and afterwards modified and approved on July 25, 2002, by the resolution Nº 424 of the same Regional Commission.

- Los Guindos: First approved on October 19, 2000, by resolution Nº461 of the Regional Commission for the Environment (Metropolitan Region), and afterwards modified and approved on June 20, 2002, by the resolution Nº361 of the same Regional Commission.

SECTION G. Stakeholders' comments

>>

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

>> As stated in Section F, the Project went through the Environmental Impact Assessment procedure. In the case of an Environmental Impact Statement, 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, as applicable, a list of the projects and activities subject to an Environmental Impact Statement that were submitted 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 Agrosupers' web page for many months, during December 2002 until the present.

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[1] Law 19,300 "General Environmental Framework" Official Gazette 04.09.94.

[2] Supreme Decree Nº 30 of 1997 of the General Secretariat of the Presidency, Regulation of the Environmental Impact Assessment System. Official Gazette 04.03.97

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 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

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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 → 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 project's implementation relies greatly on the values presented in this annex, like the ones presented in the following table:

Table 2: General Characteristics of the project's operation

Corneche	**2002**	**2003**	**2004**
Number of swine heads	77,187	90,017	87,530.4
Average Swine weight	60.67	63.14	62.93
Effective Operation days	210	365	365
Los Guindos	**2002**	**2003**	**2004**
Number of swine heads	18,487	18,700	18,704.5
Average Swine weight	221.06	221.06	221.06
Effective Operation days	240	270	365

Source: Specific hog operations data from Agrosuper.

In order to quantify ex-ante results of emission reductions for the year 2005, the same monitored and corrected default data of 2004 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} (kg dm/day) = Intake (MJ/day) • (1 kg/ 18.45 MJ) • (1 - DE%/100) • (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 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.

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 after the digester (project), we consider MCF to be 90 %, as a default reference from the IPCC. 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%

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

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	2002	2003	2004
Volatile Solids Excretion Rate (Corneche)	Medium	Kg/head/day	0.37	0.39	0.38
Nitrogen Excretion Rate (Corneche)	Medium	Kg/head/year	14.80	15.40	15.35
Volatile Solids Excretion Rate (Los Guindos)	Medium	Kg/head/day	1.35	1.35	1.35
Nitrogen Excretion Rate (Los Guindos)	Medium	Kg/head/year	53.92	53.92	53.92

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:

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 (if applicable).
Manure Flow Before Aerobic Treatment	Low	m^3/day	This parameter is monitored from a flow meter installed before the activated sludge (if applicable).
Flow of Sludge from Aerobic Treatment	Low	m^3/day	Referential volume from sludge transportation requirements. Information managed by third party (if applicable).
5 days BOD in Manure after Aerobic Treatment Stage	Low	mg/L	Activated Sludge monitoring registers, managed by third party (if applicable).
Total Nitrogen Content in Manure after Aerobic Treatment Stage	Low	mg/L	Activated Sludge monitoring registers, managed by third party (if applicable).
Temperature of Manure after Aerobic Treatment Stage	Low	ºC	Activated Sludge monitoring registers, managed by third party (if applicable).
Biogas Flow Extracted by Digester	Low	SCFM	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