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:

>> Olavarría Landfill Gas Recovery Project.

This is Version 2 of the PDD. (Version 1 of the PDD was elaborated under small-scale modalities and procedures).
Date of Version 2 of the PDD: 30 September 2005.

A.2. Description of the project activity:

>> The main objectives of this project are: (1) to contribute to the ultimate goal of the Convention on Climate Change (UNFCCC) by reducing the greenhouse gas emissions currently generated at Olavarría's landfill, and (2) to assist Argentina move towards sustainable development by demonstrating the potential for better municipal solid waste management practices supported through the Clean Development Mechanism (CDM).

More specifically, the proposed project activity will capture and destroy methane that is currently generated at Olavarría's municipal landfill. The town of Olavarría has a population of 100,000 and is located at the center of Buenos Aires Province, 350 km from Argentina's capital, the city of Buenos Aires.
The proposed activity will reduce greenhouse gas emissions, thereby generating certified emission reductions (CERs). The income generated from the CER sales will make it possible to eliminate the barriers preventing the implementation of this project.
The project will also deliver local community benefits related to the creation of new jobs during the construction, operation and maintenance stages of the LFG recovery plant and to the possibility of using the captured LFG as renewable energy resource in future economic enterprises.
Besides, the replication of the project activities in other towns around the country will trigger environmental awareness related to waste management, renewable energy resources and climate change in the involved communities.

One of the unique aspects of this project is its social component. Part of the income from the selling of CER will be used by the Municipality to install a safe and reliable potable water distribution system in the rural village of Espigas, 80 km from Olavarría. The 550 inhabitants of this village, which is within the jurisdiction of the Municipality of Olavarría, lack a potable water supply network, using shallow and often contaminated wells to meet water needs. Gastrointestinal diseases related to contaminated water are one of the major health problems in Espigas.

The recovery and destruction of methane from landfills are targeted under Argentina's National Strategy for Climate Change and the related National Programs developed by the Secretary of Environment and Sustainable Development of the Ministry of Health. These programs deal with Climate Change Impact (Resolution 1125/01), Renewable Energy and Fuels (Resolution 166/01), and Biofuels (Resolution 1076/01). However, at present, these programs are far from being fully implemented.

In accordance with the national policy, a Letter of Approval for the Olavarría Landfill Recovery Project has already been signed by the Secretary of Environment and Sustainable Development and submitted to the CDCF on November 2004 after being reviewed and signed by the Argentine Office for the Clean Development Mechanism (OAMDL), the Designated National Authority of the CDM.

A.3. Project participants:

>>

Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Argentina (host)	**- Municipality of Olavarría:** Sponsor of the project **- College of Engineering of the National University of the Center of Buenos Aires Province:** Developer of the project	No
Spain (Government of)	- **International Bank for Reconstruction and Development** as the Trustee of the Community Development Carbon Fund (CDCF)	Yes

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

>>

A.4.1.1. Host Party(ies):

>>Argentina

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

>>Province of Buenos Aires

A.4.1.3. City/Town/Community etc:

>>Olavarría

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

>> The proposed CDM project activity is the capture and destruction of the methane that is currently vented to the atmosphere at Olavarría's municipal landfill, located 9 km from the center of the town. The town of Olavarría has a population of 100,000 and is located at the center of Buenos Aires Province, 360 km from Argentina's capital, the city of Buenos Aires (Figure 1).

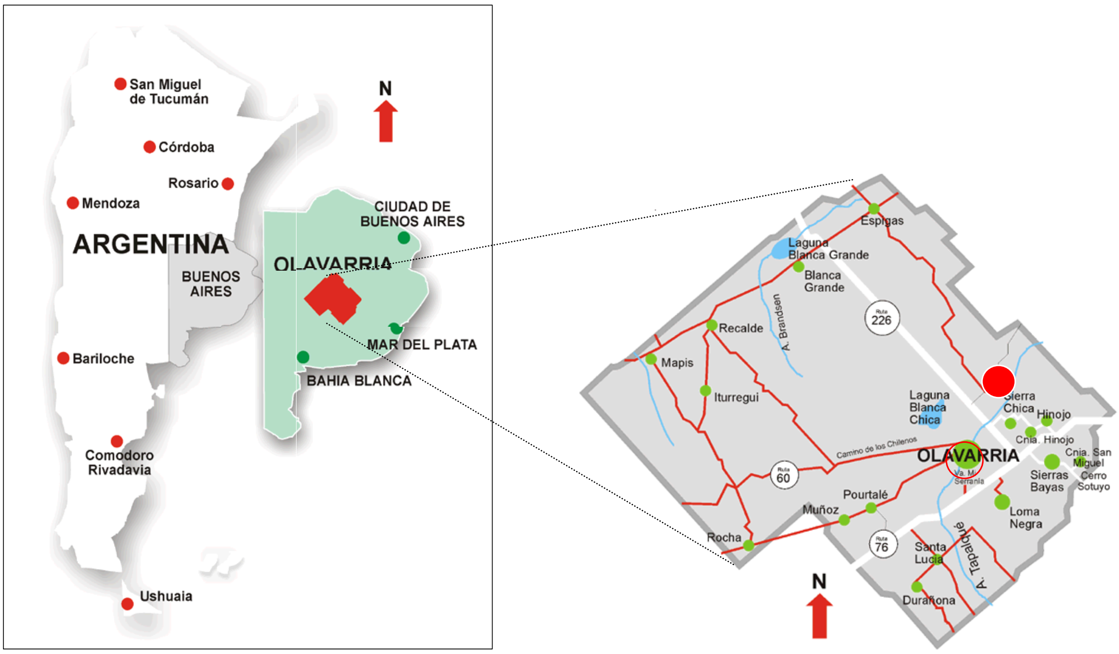

Figure 1. Location of Olavarría and the landfill site (red dot)

The current sanitary landfill has been in operation since November 1999 and is owned by the Municipality of Olavarría. The landfill site has a total area of 33 hectares and a total waste disposal capacity of approximately 30 years. The landfill is divided into cells with a total capacity of six cells. Currently, approximately 180,000 tons of municipal solid waste (MSW) are disposed in the first cell that was recently closed. In March 2005 the second cell was opened for the disposition of MSW.

The current access to the landfill site is a gravel road in fairly good conditions. The landfill site is connected to the main electrical grid but not to the natural gas distribution network. The landfill has been designed and constructed under sanitary engineering rules. According to previous hydro-geological studies, the site was selected in order to prevent groundwater contamination. The landfill has been insulated using a low permeability soil along with a synthetic liner. It has a leachate treatment system with a stabilization pond and recirculation pumps and piping.

The municipal landfill is being operated by a private concessionaire supervised by the Department of Public Works of the Municipality of Olavarría. The construction as well as the operation and maintenance of the LFG recovery plant will be performed by private companies selected through bidding processes.

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

>>The proposed project activity of *landfill gas capture and flaring* may be included in the Sectoral Scope 13: Waste handling and disposal.

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

>> The technology that will be used to capture and destroy the methane currently generated at Olavarría's municipal landfill consists of an active LFG collection system, the most effective means of LFG collection. This technology is being used in a number of landfills all over the world, but not in Argentina, where the first project of this type will be the hereby-proposed project.
The basic operation principle is the application of vacuum in the waste mass to extract the gas. The main components of the active collection system to be installed are the *gas extraction wells and collection piping*, the *gas pumping equipment* represented by mechanical blowers, the *gas treatment unit* including the condensate and flare systems, and the *monitoring and control system*.

- The LFG *extraction wells and collection piping* will be installed around the perimeter and in the center of the landfill. Gas extraction wells will be connected to a master pipe that will carry the LFG to the blower facility.
- The LFG *pumping equipment* will include pipeline header system and blowers. A pipeline header system conveys the flow of collected LFG from the well system to the blower facility. The blowers to be installed will be single-stage centrifugal type.
- The LFG *treatment unit* will consist of condensate and flare systems. A knockout vessel will be used to remove gas condensate. A closed flare will be installed to burn the LFG in a controlled environment to destroy methane and other harmful constituents and discharging them safely to the atmosphere.
- The *monitoring and control system* will be used to measure actual LFG flow and composition to avoid the intrusion of ambient air into the extraction wells and thereby optimize the extraction of gas.

It is important to mention that the gas extraction wells and collection piping will be installed in successive steps, beginning at the current landfill cell and then as new cells are opened. The other components of the system will be procured and installed at the beginning of the construction of the plant. The construction of the LFG recovery plant, including the purchasing of components and equipment, will be realized through a bidding process.

In this project, LFG will be combusted with no energy recovery. However, the utilization of the LFG will be analyzed in the future in the light of the actual recovery LFG rate obtained and other economic factors. This analysis is not included in this document.

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:

>> Greenhouse gas emissions from Olavarría's municipal landfill will be reduced through the collection of the landfill gas and the subsequent destruction of the methane in a closed flare, as described in Section A.4.3. The emission reductions (ERs) to be achieved with the proposed project activity will be directly measured according to the Monitoring Plan described in Section D of this document. The estimated annual average ERs for the proposed project activity are **18.688** ton CO_2e/year over the 21-year crediting period starting in 2006 (see Section E).

The emission reductions would not occur in the absence of the project activity because of the current legislation that does not required LFG capture, the lack of economic benefits to develop this type of projects, and several barriers that are described in Section B.3.

In fact, there are two pieces of legislation at a national level related to waste management: Law No. 25612, passed in 2002, related to industrial waste and therefore not relevant for this project, and Law No. 25916, passed in 2004, that establishes a set of standards related to solid waste management to be accomplished by municipalities throughout the country. These standards do not include LFG capture requirements.

In the Province of Buenos Aires, the so-called Integral Law of Environment No. 11723 (Chapter VII, Articles 65 and 66), passed in 1995, establishes that municipal solid waste management is responsibility of the municipality within which the waste is being generated. Law No. 11723 also gives general recommendations on waste management although does not set legal bound for landfill gas capture.
In 2002, the Secretary of Environmental Policy endorsed the Resolution No. 1143 that sets technical standards for landfill construction and operation. This Resolution requires passive LFG vent systems, but not methane capture and destruction.

Since the current legislation does not enforce the construction and operation of landfills as final disposal sites, open dumps are still common practice in most cities and towns around the country. Noticeably, LFG recovery is not required under the current legislation established in Argentina.

In addition to legal matters, for the proposed project activity there is no economic incentive for the capturing and combustion of methane from landfill gas since there will be no revenues from sources such as tax credits or the selling of electricity or thermal energy. Therefore, it is clear that without the income from the sale of CERs, the project activity would not be carried out.

Based on the previous considerations, the existing municipal solid waste management in Olavarría is assumed as the baseline scenario. This baseline scenario includes MSW collection, disposal in the landfill, compaction and daily cover, leachate collection and treatment, and the release of the LFG to the atmosphere through vent ducts without any treatment.

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

>>

Year	Annual estimation of emission reductions in tonnes of CO_2 e
First 7-year crediting period	
2006	9.424
2007	10.647
2008	11.798
2009	12.883
2010	13.910
2011	14.884
2012	15.813
Second 7-year crediting period	
2013	16,701
2014	17,552
2015	18,372
2016	19,164
2017	19,932
2018	20,679
2019	21,408
Third 7-year crediting period	
2020	22,122
2021	22,823
2022	23,514
2023	24,196
2024	24,873
2025	25,544
2026	26,213
Total estimated reductions (tonnes of CO_2 e)	392,452
Total number of crediting years	21
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	18.688

The details of the emission reductions estimation are given in Section E.

A.4.5. Public funding of the project activity:

>> No public funding from Annex I parties is 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 applied baseline methodology is the approved consolidated baseline methodology ACM0001: "Consolidated baseline methodology for landfill gas project activities".

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

>> The selected methodology ACM0001 is applicable to "landfill gas capture project activities where the baseline scenario is the total release of the landfill gas to the atmosphere", including the situation of the flaring only, as in the proposed project activity.

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

>> According to the adopted methodology ACM0001, "the methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared…"

In the proposed project activity, the actual methane destroyed will be obtained from direct measurements of key parameters that in turn will allow calculating the emission reductions.

Following the chosen methodology ACM0001, the emission reductions achieved by the project activity during a given year "y" (ER_y) will be calculated as the difference between the amount of methane actually destroyed during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed during the year in the absence of the project activity ($MD_{reg,y}$), times the approved Global Warming Potential value for methane (GWP_{CH4}).

$$ER_y = (MD_{project,y} - MD_{reg,y}) \cdot GWP_{CH4}$$

where:

ER_y emission reductions [ton CO_2e/year]
$MD_{project,y}$ is the methane destroyed by flaring [ton CH_4/year]
$MD_{reg,y}$ is the methane that would have been destroyed during the year in the absence of the project activity, that is zero [ton CH_4/year], as explained in Section A.4.4.
GWP is the Global Warming Potential value for methane 21 [ton CO_2e/ton CH_4]

The methane destroyed by the project activity $MD_{project,y}$ during a year is determined by monitoring the quantity of methane actually flared:

$$MD_{project,y} = MD_{flared,y}$$

$$MD_{flared,y} = LFG_{flared,y} \cdot w_{CH4,y} \cdot D_{CH4} \cdot FE$$

where:

$MD_{flared,y}$ is the quantity of methane destroyed by flaring [ton CH_4/year]
$LFG_{flared,y}$ is the quantity of landfill gas flared during the year (see Table D.2.2.1, *ID 1*)
$w_{CH4,y}$.is the methane fraction of the landfill gas (see Table D.2.2.1, *ID 5*)
D_{CH4} is the methane density (see Table D.2.2.1, *ID 4*)
FE is the flare efficiency (see Table D.2.2.1, *ID 6*)

Details of how the ACM0001 methodology is applied in the context of the proposed project activity as well as the Monitoring Plan are fully described in Section D.

No leakage effects need to be accounted under this methodology.

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:

>> Greenhouse gas emissions from Olavarría's municipal landfill will be reduced below those that would have occurred in the absence of the registered CDM project activity through the collection of the landfill gas and the subsequent destruction of the methane in a closed flare, as technically described in Section A.4.3.

The emission reductions (ERs) to be achieved with the proposed project activity will be directly measured and then calculated according to the Monitoring Plan described in Section D of this document.

The details of the methodology applied to calculate the emission reductions are described in Section D.2.4. According to this methodology the estimated annual average **emission reductions** for the proposed project activity are **18,688** ton CO_2e/year over the 21-year crediting period starting in 2006. Details of this estimation are described in Section E.5.

In order to demonstrate that the proposed project activity will reduce GHG emissions below those that would have occurred in the absence of the project and therefore that the proposed project activity is additional, the *Tool for the Demonstration and Assessment of Additionality* published by the CDM EB on October 2004 will be followed.

Step 0: Preliminary screening based on the starting date of the project activity

This step is not applicable since the project participants do not wish to have the crediting period starting prior to the registration of their project activity.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1.a.: Define alternatives to the project activity

Since the proposed project activity will not deliver commercial goods or services (i.e. electricity generation or thermal energy) and no other incentives will be obtained for the capturing and destroying of the methane contained in the LFG, and taking into account that the legislation in Argentina does not set legal bound for landfill gas capture, the current landfill management in Olavarría -with the LFG passively release to the atmosphere- would continue.

From this analysis, no alternative project to the proposed project activity is identified.

Sub-step 1.b.: Enforcement of applicable laws and regulations

Not applicable since there is no alternative project to the proposed project activity.

Step 2: Investment analysis

Sub-step 2.a.: Determine appropriate analysis method and Sub-step 2.b. Option I: Apply simple cost analysis

The proposed project activity will capture and destroyed landfill gas without producing commercial goods or services, such as electricity or thermal energy, therefore it will not generate economic benefits other than CDM related income.

Step 3: Barrier analysis

Sub-step 3.a.: Identify barriers that would prevent the implementation of type of the proposed project activity
Several institutional, financial and technological barriers hinder the development of this project. These barriers are described below.

First, lack of information about LFG technology, international climate change mitigation efforts, and carbon markets among the public and municipal governments in Argentina is a major barrier. It is envisaged that the development of this project, which is facilitated by the CDCF, will allow for fast dissemination of information in the region about the potential for LFG recovery and other types of activities, such as renewable energy and energy efficiency, and more generally the CDM. The project was already presented in several forums during 2003, 2004 and 2005. Since then, the project has drawn the attention of the local and regional media, and several municipalities from the region have enquired to both the developer and the sponsor about technical, economical and financial issues related to LFG potential, carbon market and CDM.
Second, a prohibitive financial barrier exists due to the significant investment required for the realization of the project and the inability of the Municipality of Olavarría to afford all the capital investment, operation and maintenance costs of the LFG recovery plant. Evidently, the lack of financing due to the country's current economic crisis aggravates the financial barrier. However, the sale of the CERs generated by the proposed project will help overcome the financial barrier. Carbon finance will help to cover the construction, operation and maintenance costs of the LFG recovery plant during the first years of operation.
Third, there exists a technological barrier due to the lack of experience in the construction, operation and maintenance of LFG recovery plants. The revenues from CERs will support training programs for the LFG plant operator and other parties involved in the construction.
Finally, although LFG capture technology is being used in a number of landfills all over the world, it is not used in Argentina, where the first project of this type will be the hereby-proposed project.

The barriers described above have prevented this type of projects from being developed and implemented in Argentina.

Sub-step 3.a.: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)
Not applicable.

Step 4: Common practice analysis
Sub-step 4.a.: Analyze other activities similar to the proposed project activity
Since the current legislation does not enforce the construction and operation of landfills as final disposal sites, open dumps are still common practice in most cities and towns around the country. Noticeably, LFG recovery is not required. Even though the LFG capture technology is being used in a number of landfills all over the world, the first project of this type in Argentina will be the hereby-proposed project activity.

Step 5: Impact of CDM registration
The proposed activity will reduce greenhouse gas emissions, thereby generating certified emission reductions (CERs). The income generated from the CER sales will make it possible to eliminate the barriers preventing the implementation of this project.
The project will also deliver local community benefits related to the creation of new jobs during the construction, operation and maintenance stages of the LFG recovery plant and to the possibility of using the captured LFG as renewable energy resource in future economic enterprises.

Besides, the replication of the project activities in other towns around the country will trigger environmental awareness related to waste management, renewable energy resources and climate change in the involved communities.
By participating in the carbon market through the CDM enables the project to overcome these barriers.

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

>> According to the consolidated baseline methodology ACM0001, the project boundary is the site of the project activity where the gas is captured and destroyed. The baseline scenario of the project activity shall cover the landfill site.

Figures 2 shows the basic operations involved in the MSW management in Olavarría, including the proposed project activity. The dashed line defines the project boundary.

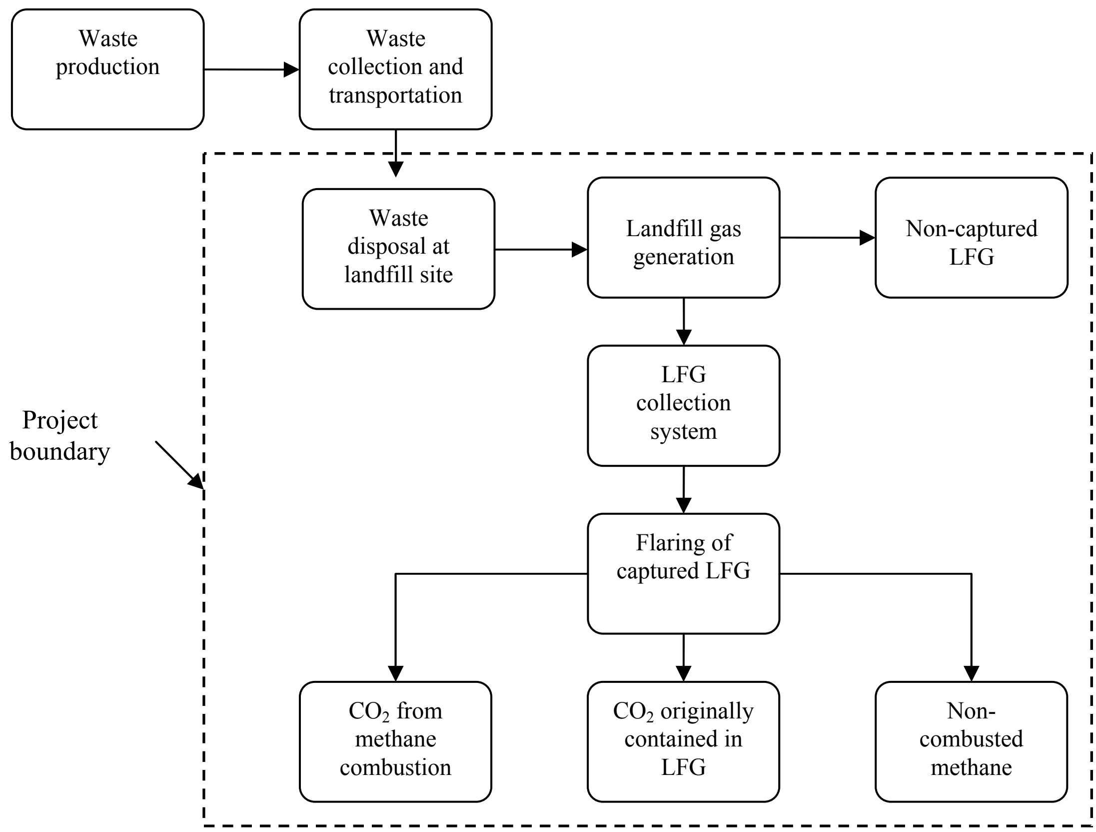

Figure 2. MSW operations, project activity and project boundary for Olavarría Landfill Gas Recovery Project

According to the approved consolidated baseline methodology ACM0001 under the title Project Boundary, CO_2 emissions from the combustion of the methane shall not be accounted for as well as the emissions of CO_2 originally contained in LFG.

Baseline emissions –emissions that would happen in the absence of the project activity- were estimated using the First Order Decay model (described in Chapter 5 of the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories elaborated by the Intergovernmental Panel on Climate Change IPCC, 1996), based on information about municipal solid waste in Olavarría and other technical parameters related to the landfill site (details are described in Annex 3). As a result of applying the FOD model, an average of 610 cubic meters per hour of LFG would be released to the atmosphere through the current passive vent system and landfill cover during the 21-year crediting period starting in 2006. This estimated value corresponds to **40,138** ton CO_2e/year and represents the **baseline emissions** in the project boundary.

CO_2 emissions resulting from electricity used by LFG pumping equipment were estimated based on the electricity consumption (42 MWh/year, based on a 5-kW blower running 96% of the time) and the emission factor of the electricity grid (0.57 ton CO_2/MWh); calculations yield 24 ton CO_2e/year. These emissions are approximately 0.1 % of the estimated emission reductions and therefore they will not be taken into account.

The methodology to determine the baseline scenario and baseline emissions for the project activity are given in Annex 3.

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:

>> Details to determine the baseline scenario and baseline emissions are given in Annex 3.

The date of completion of the baseline study was June 2005.

The College of Engineering of the National University of the Center of Buenos Aires Province has determined the baseline. The entity is also the developer of the project (not a project participant) and is listed in Annex 1.

Contact persons:

Gabriel Blanco gblanco@fio.unicen.edu.ar
Estela Santalla esantall@fio.unicen.edu.ar

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>> Starting date of project activities regarding CERs crediting period is 01/01/2006.

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

>> 21 years

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:

>> 01/01/2006

C.2.1.2. Length of the first crediting period:

>> 7 years

C.2.2. Fixed crediting period:

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 Monitoring Plan (MP) for the Olavarría Landfill Gas Recovery Project was developed according to the approved consolidated monitoring methodology ACM0001: "Consolidated monitoring methodology for landfill gas project activities".

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

>> The selected methodology ACM0001 is applicable to "landfill gas capture project activities where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include the situation of flaring the captured gas". This is the case for the proposed project activity.
The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform.
The Monitoring Plan for the proposed project activity provides for direct measurement of the quantity and quality of LFG flared.

The main variables that need to be determined are the quantity of methane actually captured ($MD_{project,y}$) and the quantity of methane flared ($MD_{flared,y}$).

To determine these variables, the following parameters will be monitored:

- The amount of landfill gas fed to the flare ($LFG_{flare,y}$) will measured continuously using a continuous flowmeter.
- The fraction of methane in the landfill gas ($w_{CH4,y}$) will be measured with periodical measurements, at a 95% confidence level, using a calibrated portable gas analyzer and taking a statistically valid number of samples.
- Temperature (T) and pressure (p) of the landfill gas will be measured to determine the density of methane in the landfill gas.
- The flare efficiency (FE), measured as the fraction of time in which the gas is combusted in the flare multiplied by the efficiency of the combustion process. This combustion efficiency is initially assumed at 97% and will be periodically verified through laboratory analysis to determine the methane content in the flare emissions.

Please, refer to Table D.2.2.1. for detailed data measurement and recording frequency.

The quantities of electricity to operate the LFG pumping equipment are negligible and therefore they will not be considered (see Section B.4.).

With regard to changes in the baseline scenario due to changes in the legislation, no legal enforcing LFG recovery is foreseen in the near future.

D.2.1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

>> Option 1 is not applicable. Option 2: *Direct monitoring of emission reductions from the project activity* is applied.

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

>>

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

>>

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

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*
1. $LFG_{flared,y}$	Flow of LFG flared	Flowmeter	m^3/h	m	Continuously	100%	electronic/paper	Data will be aggregated monthly and yearly
2. T	Temperature of LFG	Temperature sensor	°C	m	Daily	100%	electronic/paper	Data will be used to calculate the methane density.
3. P	Pressure of LFG	Pressure Sensor	kPa	m	Daily	100%	electronic/paper	Data will be used to calculate the methane density.
4. D_{CH4}	Methane density in LFG	Calculation	ton CH4/m3 CH4	c	Daily	100%	electronic/paper	To be used to calculate the methane destroyed.
5. $w_{CH4,y}$	Methane fraction in LFG	Gas analyzer	m^3 CH_4/m^3 LFG	m	Daily	Sample	electronic/paper	To be used to calculate the methane destroyed

6. *FE*	Combustion efficiency	Estimation	%	e	Annually verified	100%	electronic/paper	The estimated combustion efficiency will be verified annually through lab analysis to determine the methane content in the exhaust gas
	Flare availability	Timer	%	m	Continuously	100%	electronic/paper	Data will be aggregated monthly and yearly

* All archived data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

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

>> Not applicable. In this project and according to ACM0001, project emissions will not be monitored nor measured, instead emission reductions will be directly measured, as explained in Section D.2.4.

D.2.3. Treatment of leakage in the monitoring plan

>>No leakage will be considered for the project activity

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

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

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

>> Not applicable

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.)

>> According to the chosen methodology ACM001, the emission reductions achieved by the project activity during a given year "y" (ER_y) will be calculated as the difference between the amount of methane actually destroyed during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed during the year in the absence of the project activity ($MD_{reg,y}$), times the approved Global Warming Potential value for methane (GWP_{CH4}).

$$ER_y = (MD_{project,y} - MD_{reg,y}) \cdot GWP_{CH4} \quad (1)$$

where:

ER_y emission reductions [ton CO_2e/year]
$MD_{project,y}$ is the methane destroyed by flaring [ton CH_4/year]
$MD_{reg,y}$ is the methane that would have been destroyed during the year in the absence of the project activity, that is zero [ton CH_4/year], as explained in Section A.4.4.
GWP is the Global Warming Potential value for methane 21 [ton CO_2e/ton CH_4]

The methane destroyed by the project activity $MD_{project,y}$ during a year is determined by monitoring the quantity of methane actually flared:

$$MD_{project,y} = MD_{flared,y} \quad (2)$$

$$MD_{flared,y} = LFG_{flared,y} \cdot w_{CH4,y} \cdot D_{CH4} \cdot FE \quad (3)$$

where:

$MD_{flared,y}$ is the quantity of methane destroyed by flaring [ton CH_4/year]
$LFG_{flared,y}$ is the quantity of landfill gas flared during the year (see Table D.2.2.1, *ID 1*)
$w_{CH4,y}$.is the methane fraction of the landfill gas (see Table D.2.2.1, *ID 5*)
D_{CH4} is the methane density (see Table D.2.2.1, *ID 4*)
FE is the flare efficiency (see Table D.2.2.1, *ID 6*)

In order to calculate the quantity of landfill gas flared during the year ($LFG_{flared,y}$) the estimated methane to be generated in the landfill in that year ($CH_{4,y}$) is divided by the methane content in the LFG (w_{CH4}) and multiplied by the LFG recovery efficiency (RE) assumed at 50 % for this project.

Multiplying $LFG_{flared,y}$ by the methane content in LFG ($w_{CH4,y}$), the methane density (D_{CH4}) and the flare efficiency (FE), the methane destroyed by flaring ($MD_{flared,y}$) is obtained. This value constitutes a measurable and verifiable amount that will be determined according to the modalities and procedures of the

Monitoring Plan described in Annex 4.

In order to calculate the emission reductions (ER_y) in tons of CO_2e, the quantity of methane destroyed by flaring $MD_{flared,y}$ is multiplied by the Global Warming Potential (GWP) for methane.

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.
Table D.2.2.1. ID.1	Low	Flowmeter will be subject to regular maintenance according to the technical specifications from the manufacturers to ensure accuracy and good performance.
Table D.2.2.1. ID.2-3	Low	Temperature and pressure sensors will be subject to regular maintenance according to the technical specifications from the manufacturers to ensure accuracy and good performance.
Table D.2.2.1. ID.5	Low	Gas analysers (LFG quality) will be subject to regular maintenance and calibration procedures according to the technical specifications from the manufacturers to ensure accuracy and good performance.
Table D.2.2.1. ID.6	Medium	Regular maintenance will ensure optimal operations of the flare. Flare efficiency will be checked annually to verified deviation from the estimated value.
Table D.2.2.1. ID.6	Low	Timer device will be subject to regular maintenance to ensure accuracy.

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

>> In order to monitor emission reductions, the project operator will follow the Monitoring Plan and the procedures established in the Operation Manual, as described in Annex 4.

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

>> The entity that determined the Monitoring Plan and methodology is the College of Engineering of the UNCPBA, project developer and listed in Annex 1.

Contact persons:

Gabriel Blanco gblanco@fio.unicen.edu.ar

Estela Santalla esantall@fio.unicen.edu.ar

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

>> The anthropogenic emissions that would occur within the boundary of the project when the project activities (LFG capture and destruction) are in operation can be described as follow:

1. methane emissions due the non-captured LFG
2. methane emissions in the flare due to the flare efficiency.
3. CO_2 emissions in the flare due to the CO_2 contained in the captured LFG that remain unchanged during the combustion process.
4. CO_2 emissions in the flare due to the combustion of methane.

The last two sources of emissions (3 and 4) are part of the natural CO_2 biological cycle and considered neutral to the atmosphere; therefore these CO_2 emissions are not considered in this project.

CO_2 emissions resulting from electricity used by LFG pumping equipment were estimated based on the electricity consumption (42 MWh/year) and the emission factor of the electricity grid (0.57 ton CO_2/MWh); calculations yield 24 ton CO_2e/year. These emissions are approximately 0.1 % of the estimated emission reductions and therefore they will not be taken into account.

The emissions of GHG by sources within the project boundary are the methane emissions due the non-captured LFG (1) and the methane emissions in the flare due to the flare efficiency (2). Both sources of anthropogenic GHG are defined as the project emissions (PE_y) and can be estimated from de following equation:

$$PE_y = CH_{4,y} \cdot D_{CH4} \cdot (1-RE) \cdot GWP_{CH4} + CH_{4,y} \cdot D_{CH4} \cdot RE \cdot (1-FE) \cdot GWP_{CH4}$$

Where the first term of the right member of the equation represents the non-captured LFG due to recovery efficiency (in ton CO_2e/year) and the second term represents the amount of non-combusted methane due to flare efficiency (in ton CO_2e/year).
$CH_{4,y}$ is the total methane generated at the landfill (in m^3 of CH_4 per year), and is obtained by using the FOD model explained in Annex 3.

Assuming a LFG recovery efficiency (*RE*) of 50%, a flare efficiency (*FE*) of 93.1%, the methane density at 15°C and 101 kPa, a methane content of 52%, and a Global Warming Potential (GWP) for methane of 21, the estimated annual average **project emissions** (*PE*) are **21,450** ton CO_2e/year over the 21-year period starting in 2006.

E.2. Estimated leakage:

>> No leakage was considered for the project activity.

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

>> The chosen baseline methodology ACM001 directly calculates the emission reductions but for a first estimation, as E.2 is zero E.3 is equal to E.1, that is 21.450 ton CO_2e/year over the 21-year period.

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

>> The GHG emissions by sources of the baseline are represented by the amount of methane contained in the landfill gas ($CH_{4,y}$) that is currently release to the atmosphere (see Section B.5.)

Olavarría generates a daily average that ranges between 85-90 tons of MSW. At this moment, a total of 180,000 tons of MSW have already been disposed at the municipal landfill. A field study carried out by the College of Engineering of the local UNCPBA shows that almost 79% of this MSW consists of organic matter: 63% food residues and 16% paper and cardboard in non-recyclable conditions. The same field study yielded a methane content in LFG varying between 49 and 53%; these values were confirmed with the 52.8% of methane content obtained through theoretical calculations based on the waste composition.

Using the First Order Decay (FOD) model as a theoretical tool to predict the LFG generation rate at the landfill, an average of 610 cubic meters per hour of LFG is estimated that will be released to the atmosphere during the 21-year crediting period starting in 2006. This estimated value corresponds to an annual average of **40,138** ton CO_2e/year and represents the **baseline emissions**.

Details of the baseline emissions estimation are given in Annex 3.

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

>> In this project and according to the chosen methodology ACM0001, the emissions reductions (ERs) will be measured directly at the landfill site once the LFG recovery plant is installed and operating, as described in the Monitoring Plan in Section D.

However, a preliminary estimation of ERs has been performed by using the baseline emissions, the formulae given in Section D.2.4., and assuming values for several parameters that will be actually measured and monitored during project operations (see Section D.2.)
The parameters are:

- the recovery efficiency (*RE*) of the LFG collection system was estimated from previous experiences reported in the literature and values recommended by specialized research institutions. Considering that Olavarría´s landfill has not been originally designed for LFG recovery purposes, a conservative recovery efficiency RE of 50% was assumed. In fact, this recovery efficiency is smaller than that of most LFG recovery project currently in place and other recommended values.

- the flare efficiency (*FE*) was calculated as the flare availability (fraction of time in which the gas is combusted) assumed at 96% multiplied by the combustion efficiency (fraction of methane actually destroyed). The standard combustion efficiency given by flare manufacturers is 99%; however, a conservative value of 97% is assumed for this project. Using these two figures the estimated flare efficiency is 93.1%. **Note**: During the project operations the flare availability will be continuously recorded and the combustion efficiency will be annually verified through lab analysis to determine the methane content in the exhaust gas.

- The methane content (w_{CH4}) in LFG obtained from the field tests varied between 49% and 53%. These figures confirmed the 52.8% obtained through theoretical calculations based on waste composition. A methane content in the LFG of 52% is assumed for this preliminary estimation. **Note**: During the project operations the methane content in LFG will be daily measured and recorded.

- The methane density (D_{CH4}) at 15°C and 101 kPa (average climate conditions in Olavarría): of 0.678 kg/m^3. **Note**: During the project operations the methane density of LFG will be daily calculated by measuring temperature and pressure.

- The Global Warming Potential (*GWP*) for methane of 21 tCO_2e/tCH_4 (according to Miscellaneous Parameters in ACM0001/Version 1 of the Approved consolidated monitoring methodology ACM0001 CDM, EB, 3 September 2004)

Thus, the estimated annual average **emission reductions** for the proposed project activity according the formulae given in Section D.2.4. are **18,688** ton CO_2e/year over the 21-year crediting period starting in 2006.

Figure 3 shows the evolution of baseline emissions and emission reductions within the boundary of the project over the crediting life in tons of CO_2 equivalent.

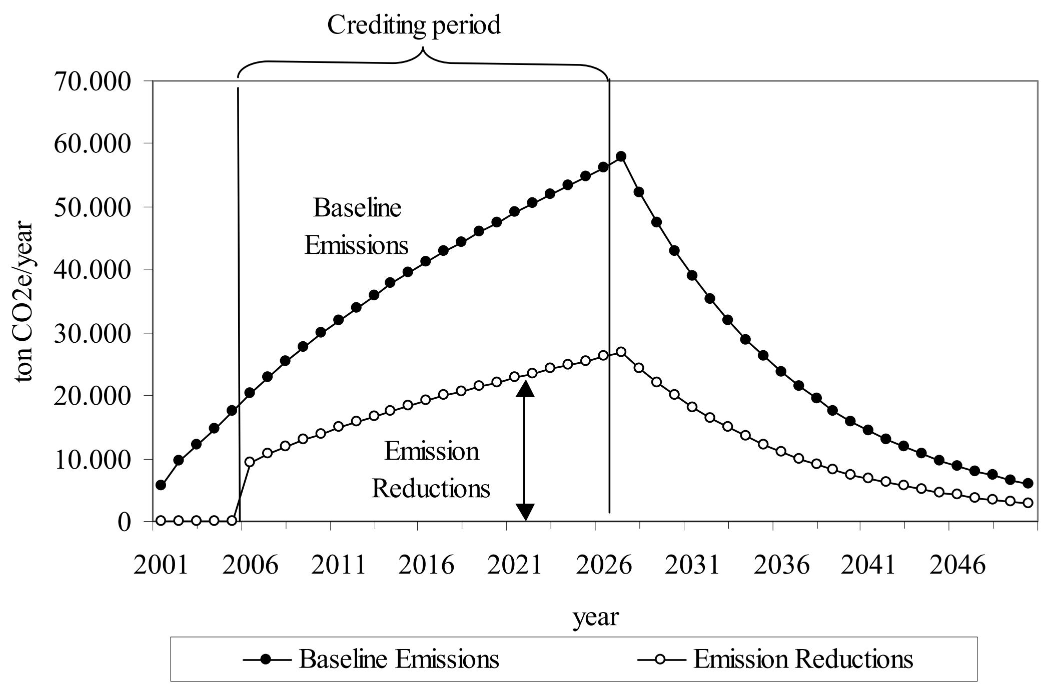

Figure 3. Evolution of baseline emissions and emissions reductions for Olavarría Landfill Gas Recovery Project

The **emission reductions** represent the amount of methane actually destroyed and constitute a measurable and verifiable amount that will be determined according to the Monitoring Plan developed in Section D.

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

>> Table 2 shows the estimated annual ERs during the crediting period of the project.

Table 2. Baseline emissions and emission reductions (in ton CO_2e)

year	Baseline Emissions	Cumulative Baseline Emissions	Emission Reductions	Cumulative Emission Reductions
2006	20.240	20.240	9.424	9.424
2007	22.868	43.107	10.647	20.071
2008	25.339	68.446	11.798	31.869
2009	27.669	96.116	12.883	44.751
2010	29.875	125.990	13.910	58.661
2011	31.968	157.958	14.884	73.545
2012	33.963	191.921	15.813	89.358
2013	35.869	227.790	16.701	106.059
2014	37.698	265.488	17.552	123.611
2015	39.459	304.947	18.372	141.984
2016	41.160	346.108	19.164	161.148
2017	42.809	388.917	19.932	181.080
2018	44.414	433.330	20.679	201.759
2019	45.979	479.310	21.408	223.167
2020	47.513	526.822	22.122	245.288
2021	49.019	575.841	22.823	268.112
2022	50.502	626.343	23.514	291.625
2023	51.968	678.312	24.196	315.822
2024	53.421	731.732	24.873	340.695
2025	54.863	786.596	25.544	366.239
2026	56.299	842.895	26.213	392.452
Annual average:	**40.138**		**18.688**	

Total emission reductions during the 21-year crediting life starting in 2006 are **392,452** ton CO_2e, and the annual average ERs for the same period are **18,688** ton CO_2e/year.

SECTION F. Environmental impacts

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

>> As part of the feasibility study for the Olavarría LFG recovery project, an environmental impact assessment (EIA) was performed. The objective of this EIA was to identify the effects of the project activities on both the biophysical components of the environment and the socio-economical aspects of Olavarría community, and to provide measures and procedures to mitigate the possible effects. The feasibility study as well as the EIA was carried out by the College of Engineering of the National University of the Center of Buenos Aires Province in 2002.

For further information about the EIA, please contact the project developer (see Annex 1).

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 conclusions of the EIA shows that the proposed project activity would have positive impacts on the biophysical components by reducing GHG emissions and destroying potentially harmful LFG, and on the socio-economical aspects by implementing new technologies and triggering climate change awareness in the community.

SECTION G. Stakeholders' comments

>>

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

>> The feasibility study carried out by the College of Engineering during 2002 about expanding and improving the current MSW management system in Olavarría launched the discussion about the future of MSW management in the city. The project sponsored by the Municipality focused the public attention on issues such as GHG mitigation, climate change, CDM and potential local impacts such as LFG technology and utilization and project replicability in the region.

During 2002, 2003 and 2004, several meetings have been organized by the College of Engineering to inform stakeholders about the project. Different aspects of the project, such as social, environmental, economical and technical issues were outlined during the meetings where risks and benefits were also addressed. Community members represented by NGOs, such as the environmental Fundación Nuevo Horizonte and the local chapter of Rotary Club, representatives of the municipal legislative body and industrial organizations actively participated in those meetings and made public their own opinion about the project.

Many local and regional media, such as newspapers, radio and TV stations have been the sources of information about the project in the community. The project is also published in the official website of the Municipality of Olavarría www.olavarria.gov.ar.

In March 2004, the project was declared of Public Interest by the Senate of the Province of Buenos Aires and by the Ministry of Infrastructure, Housing and Public Services of the Government of Buenos Aires.

The current landfill operator has also been informed about the proposed project activity. The landfill operator has facilitated the first field test works on the landfill site.

Informal MSW workers such as scavengers do not work in the landfill area and will not be affected by the proposed project activities.

G.2. Summary of the comments received:

>> Most of the stakeholders were interested in the social aspects of the project, especially those related to potential labor demand within the community.

During the meetings, most of the stakeholders showed interest in the possibility of implementing waste recycling programs. The high unemployment rate that has affected Argentina for the last several years has raised this concern among the community. Stakeholders were informed that recycling programs are not prevented from being implemented in the future in spite of the LFG recovery activities.

Stakeholders recognized their lack of information regarding issues such as global warming, climate change, the Clean Development Mechanism and carbon markets. In general, they were enthusiastic about the possibility to develop a new technology in the community through the installing of a LFG recovery plant.

In general, all interest groups that have been contacted agreed with the concept of the project and most of them emphasized the importance of the positive environmental impact that the project will bring about. No objection regarding the technical, environmental and social issues has been detected.

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

>> All efforts made by the developer and the sponsor to inform the stakeholders and the general public were focused on the description of the project activities and their relation to global environmental issues. Special efforts were made to clarify that LFG recovery activities do not exclude the development of waste recycling programs in the future.

With respect to the request about the possibility to improve local labor demand, it was explained that the implementation of the LFG recovery plant would require specialized work skills for both the construction and O&M phases. It was also emphasized that LFG recovery opens the doors to future initiatives that can make a full use of the LFG captured.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Municipality of Olavarría
Street/P.O.Box:	Belgrano 2801
Building:	
City:	Olavarría
State/Region:	Buenos Aires
Postfix/ZIP:	7400
Country:	Argentina
Telephone:	54-2284-420368
FAX:	
E-Mail:	
URL:	http://www.olavarria.gov.ar
Represented by:	
Title:	Secretary of Public Works and Services
Salutation:	Mrs.
Last Name:	Arregui
Middle Name:	
First Name:	Margarita
Department:	Public Works and Services
Mobile:	
Direct FAX:	
Direct tel:	54-2284-420368
Personal E-Mail:	secobras@vaf.com.ar

Organization:	Facultad de Ingeniería de la Universidad Nacional del Centro de la Provincia de Buenos Aires
Street/P.O.Box:	Av. Del Valle 5737
Building:	
City:	Olavarría
State/Region:	Buenos Aires
Postfix/ZIP:	B7400JWI
Country:	Argentina
Telephone:	54 2284 451055
FAX:	54 2284 451055
E-Mail:	
URL:	www.fio.unicen.edu.ar
Represented by:	
Title:	Project developer
Salutation:	Mr/Mrs
Last Name:	Blanco/Santalla
Middle Name:	
First Name:	Gabriel/Estela
Department:	
Mobile:	
Direct FAX:	
Direct tel:	54-2284-451055 ext.261/279
Personal E-Mail:	gblanco@fio.unicen.edu.ar/esantall@fio.unicen.edu.ar

Organization:	Community Development Carbon Fund – The World Bank
Street/P.O.Box:	1818 H Street, NW
Building:	
City:	Washington
State/Region:	District of Columbia
Postfix/ZIP:	DC 20433
Country:	United States
Telephone:	
FAX:	1-202-522-7432
E-Mail:	
URL:	www.carbonfinance.org
Represented by:	Represented by:
Title:	Fund Manager of the Carbon Finance Unit of the World Bank
Salutation:	Mr
Last Name:	Knudsen
Middle Name:	
First Name:	Odin
Department:	Carbon Finance Unit
Mobile:	
Direct FAX:	1-202-522-7432
Direct tel:	1-202-458-5118
Personal E-Mail:	oknudsen@worldbank.org

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding from Annex I parties in this project.

Annex 3

BASELINE INFORMATION

The existing municipal solid waste management in Olavarría consists basically of urban solid waste collection, disposal in the landfill, compaction and daily cover, leachate collection and treatment, and the release of the LFG to the atmosphere through vent ducts without any treatment.
The emission reductions would not occur in the absence of the project activity because of the current legislation that does not required LFG capture, the lack of economic benefits to develop this type of projects, and several barriers that are described in Section B.3.
Based on the previous considerations, the existing municipal solid waste management in Olavarría is assumed as the baseline scenario. This baseline scenario includes MSW collection, disposal in the landfill, compaction and daily cover, leachate collection and treatment, and the release of the LFG to the atmosphere through vent ducts without any treatment.

Baseline emissions –emissions that would happen in the absence of the project activity- were estimated using the First Order Decay model (IPCC, 1996), based on the following information about municipal solid waste in Olavarría and other technical parameters related to the landfill site:

- the amount of waste disposed by year: this data is provided by the historical records of the current and the previous landfill management private concessionaires. An initial MSW generation rate of 31,300 tons per year with a projected annual increase of 2% during the 21-year crediting period was used. The projection of the MSW generation rate over the next 21 years takes into account the projected 6% annual Gross Domestic Product (GDP) growth for the next years in Argentina (Source: Argentina´s Ministry of Economy. (Table A3.1 in Annex 3 shows the projection expected.)

- the amount of methane contained in the landfill gas: this value has been directly measured at the site in the last two years through a field study carried out by the College of Engineering of UNCPBA. A methane content w_{CH4} of 52% was used for baseline emissions calculations.

- the methane generation potential of the waste was estimated from the MSW composition and the landfill management (IPCC, 1996). A methane generation potential L_o of 102 m^3 CH_4/ton MSW was used for baseline emissions calculations. (see Annex 3 for further details).

- the methane generation rate is the time taken for the degradable organic matter in waste to decay to half its initial mass. Based on waste characteristics and climate conditions at the landfill site, a half-life for the organic matter in the waste of 7 years was used, yielding a methane generation rate k of 0.099 (see Annex 3 for further details).

According to the FOD model, the formula used to estimate the total methane generated within the boundary of the project in a given year is as follows:

$$CH_{4,y} = \sum_x A \cdot k \cdot MSW_T(x) \cdot L_o \cdot e^{-k\cdot(y-x)} \qquad \text{(A3.1)}$$

where:

$CH_{4,y}$ = total methane generated at the landfill in year y [m^3 CH_4/year]

A = normalization factor [1-exp(-k)]/k
y = year of inventory
x = years for which input data should be added
k = methane generation rate [$year^{-1}$]
$MSW_T(x)$ = total municipal waste disposed at the landfill in year x [ton MSW/year]
L_o = methane generation potential [m^3 CH_4/ton MSW]

The methane generation potential L_o was calculated as follows:

$$L_o = MCF \cdot DOC \cdot DOC_F \cdot F \cdot \frac{16}{12} \quad \text{(A3.2)}$$

where:
MCF = methane correction factor
DOC = degradable organic carbon in [ton C/ton MSW]
DOC_F = fraction of DOC dissimilated
w_{CH4} = fraction by volume of CH_4 in landfill gas [m^3 CH_4/m^3 LFG]
16/12 = conversion from carbon to CH_4 [ton CH_4/ton Carbon]

IPCC (1996) gives default values for *MCF* according to the site management. For this project *MCF* = 0.8 was assumed.
DOC is given by IPCC as a function of waste composition. Taking into account the waste composition in Olavarría, a value of *DOC* = 0.175 [ton C/ton MSW] was calculated.
For DOC_F, a value of 0.7 is assumed (IPCC, 1996).
w_{CH4} was estimated based on waste composition and verified in the field. Calculations yielded a value of w_{CH4} = 0.52 [m^3 CH_4/m^3 LFG].
Introducing these values in Eq. (A3.2) above and considering the methane density of 0.678 kg/m^3 at 15°C and 101 kPa, calculations yield L_o = 102 [m^3 CH_4/ton MSW].

Total municipal solid waste disposed in a given year $MSW_T(x)$ is known from records archived since the beginning of the landfill operations in November 1999. In order to estimate a projection of the $MSW_T(x)$ for future years, the projected growth of Argentina's GDP of 6% per year for the next years was taking into account. Then, to define the baseline scenario, a MSW generation growth rate of 2% was assumed for the years of the project (2006-2026). Thus, the annual average of the municipal solid waste disposed at the landfill during the 21-year crediting period is 42,780 ton/year. Table A3.1 shows the disposal of MSW at Olavarría´s landfill since the beginning of the activity in 1999 and the projected MSW generation rate.

The methane generation rate k was estimated using the formula given by IPCC (1996). k is related to the time taken for the DOC in waste to decay to half its initial mass (the half-life or $t_{1/2}$) as follows:

$$k = \frac{ln(2)}{t_{1/2}} \quad \text{(3)}$$

For this project and following IPCC´s recommendations, a DOC half-life of 7 years was assumed considering both the high moisture conditions in Olavarría (annual precipitations higher than 1000 mm) and the large amount of rapidly degradable material in the waste (almost 70%). This half-life yields a value of k = 0.099 $year^{-1}$.

As a result of applying the First Order Decay model, an average of 610 cubic meters per hour of LFG would be released to the atmosphere through the passive vent system and landfill cover during the 21-year crediting period starting in 2006. This estimated value corresponds to **40,138** ton CO_2e/year and represents the **baseline emissions**. Table A3.1 shows the baseline emissions in tons of CO_2e per year during the crediting period.

Table A3.1. MSW generation rate and Baseline Emissions of project activity

Year	Annual tonnage of MSW	Cumulative tonnage of MSW disposed	Baseline Emissions ton CO2e
1999	8,758	8,758	
2000	33,638	42,396	
2001	34,364	76,760	
2002	27,008	103,768	
2003	28,636	132,404	
2004	31,777	164,181	
2005	34,160	198,341	
2006	34,843	233,185	20,240
2007	35,540	268,725	22,868
2008	36,251	304,975	25,339
2009	36,976	341,951	27,669
2010	37,715	379,667	29,875
2011	38,470	418,136	31,968
2012	39,239	457,376	33,963
2013	40,024	497,399	35,869
2014	40,824	538,224	37,698
2015	41,641	579,865	39,459
2016	42,474	622,338	41,160
2017	43,323	665,661	42,809
2018	44,190	709,851	44,414
2019	45,073	754,924	45,979
2020	45,975	800,899	47,513
2021	46,894	847,794	49,019
2022	47,832	895,626	50,502
2023	48,789	944,415	51,968
2024	49,765	994,179	53,421
2025	50,760	1,044,939	54,863
2026	51,775	1,096,715	56,299
Annual average:	**42,780**		**40,138**

crediting period (2006–2026)

It is relevant to point out some inevitable uncertainties underlying the baseline scenario. Among the most uncertain parameters that may affect baseline emissions are the MSW generation rate, the MSW composition, and the climate conditions. Changes in the MSW generation rate due to changes in the overall economic activity of the community may affect the baseline scenario as well as changes in consumption habits may alter MSW composition modifying the methane potential L_o. Finally, changes in the precipitation levels and overall climate conditions may affect the methane generation rate *k,* altering in turn the landfill gas emissions estimation (IPCC, 1996).

Despite these parameters were obtained by applying formulae given by the IPCC (1996) and based on actual municipal waste composition and local climate and landfill management conditions, a sensitivity analysis of the effect of potential variations of these parameters on the baseline emissions was realized. The results of this analysis are shown in Figure A3.1

- For the MSW, the annual generation growth rate was varied from 0% to 6% for the 21-year crediting life yielding annual average values of 34,160 and 65,055 ton MSW/year respectively.

- With respect to the methane generation potential L_o, a value of 102 [m^3 CH_4]/[ton MSW] was initially calculated. Deviations of 50% from this base value were considered to estimate the variation in baseline emissions. Then, the L_o was varied from 51 to 153 [m^3 CH_4]/[ton MSW].

- The same variation was applied to the methane generation rate *k* initially set at 0.099 $year^{-1}$. Then, *k* was varied from 0.05 to 0.15 $year^{-1}$.

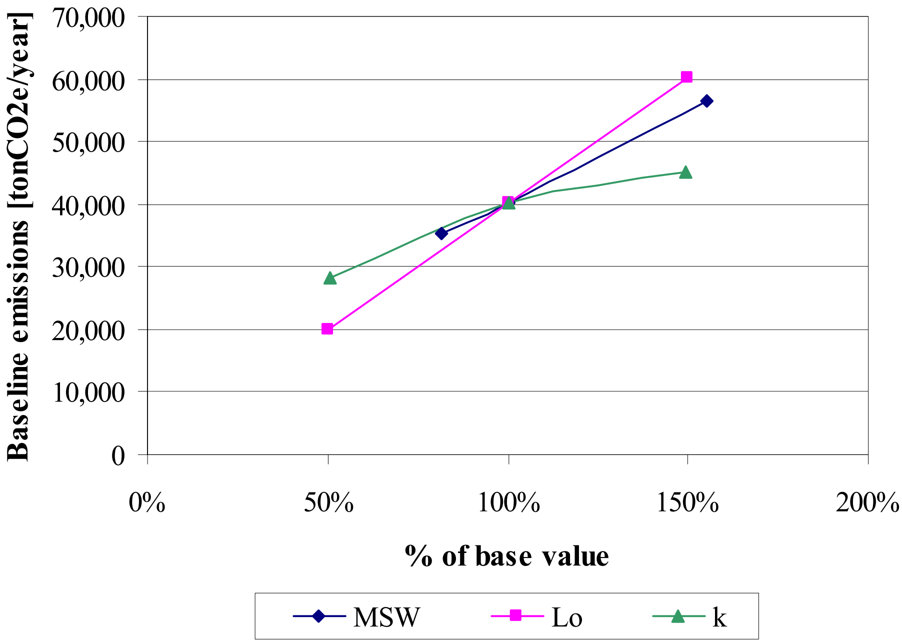

Figure A3.1. Sensitivity analysis of the baseline emissions in terms of MSW, L_o and k.

Methane generation potential L_o shows the strongest effect on baseline emissions relative to the other variables analyzed. A reduction of 50% in the base value of L_o yields a similar reduction in the baseline emissions. However, the value of L_o used (and calculated as explained above) to estimate the baseline emissions is already in the lower part of the range given in the literature. Therefore, it seems unlikely that such a reduction in the L_o value can be reached.

With regard to changes in the baseline scenario due to changes in the legislation, no legal enforcing LFG recovery is foreseen in the near future.

Annex 4

MONITORING PLAN

A4.1. Purpose of the Monitoring Plan

In the context of the Clean Development Mechanism (CDM) of the Kyoto Protocol, monitoring describes the systematic surveillance of a project's performance by measuring and recording performance-related indicators relevant to the project or activity. Verification is the periodic auditing of monitoring results, the assessment of achieved emission reductions (ER) and of the project's continued conformance with all relevant project criteria.

This document contains the Monitoring Plan (MP) for the Olavarría Landfill Gas Recovery Project. It describes the requirements for the collection, processing and auditing of data from the project for the purpose of calculating and verifying the ERs the project has produced.

A4.2. Overview

According to the approved consolidated monitoring methodology ACM0001 applied for this project activity, the monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform. The Monitoring Plan provides for direct measurement of the quantity and quality of LFG flared and the non-combusted methane in the flare.

Daily on-site measurements of both the LFG volumetric flow and the fraction of methane in the LFG will be performed to calculate the amount of methane in the LFG captured. LFG temperature and pressure will be daily measured and recorded in order to calculate the methane density and therefore mass flow. Finally, methane content in the exhaust gases will also be monitored to verify the flare efficiency and to correct the amount of methane actually destroyed by the project activity.

The amount of methane determined through direct monitoring and measurement of the captured LFG minus the non-combusted methane emitted in the flare represents the actual methane emissions avoided by the project activities, that is, the Emission Reductions (ERs) of this project.

A4.3. Monitoring and calculation of Emission Reductions

The emission reductions from the Olavarría Landfill Gas Recovery Project result from the avoided landfill methane emissions due to the collection and flaring (and conversion to CO_2) of the methane contained in the landfill gas.

The amount of methane recovered will be determined by on-site daily measurements from flow meters and gas analysers. These two measurements will be adjusted for the flare efficiency represented by the fraction of methane in LFG that is not combusted in the flare but emitted to the atmosphere. The flare efficiency will be annually verify through lab analysis to determine the methane content in exhaust gas.

Thus, the amount of methane in the exhaust gases will be discounted from the product of the LFG captured (flow meters) and the methane content (gas analyzers). The resulting amount of methane must

be multiplied by the methane density (ton/m^3) at the corresponding temperature and pressure to obtain the methane emission reductions of the project activities in tons of CH_4. In order to obtain the result in tons of CO_2 equivalent, the tons of CH_4 will be multiplied by the methane Global Warming Potential.
Finally, the time that the flare is in operation (flare availability) will be continuously recorded to calculate the amount of methane actually destroyed.

According to the applied methodology, leakage -defined as the net change of anthropogenic emissions by sources of GHG that occurs outside the project boundary that is measurable and attributable to the CDM project activity- will not be considered.

The performance indicators, key data needs, and monitoring procedures are described in Table A4.1. Figure A4.1 shows the basic scheme of the monitoring plan.

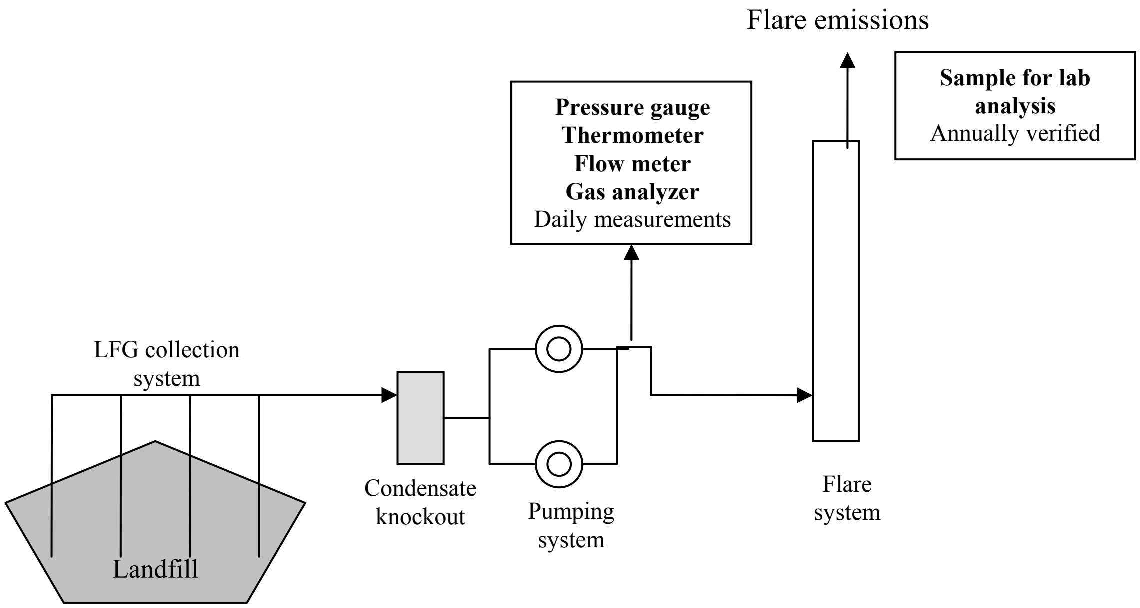

Figure A4.1. Basic scheme of the MP for Olavarría´s Landfill Gas Recovery Project

A4.3.1. Monitoring sampling points

The monitoring sampling points to measure the methane content in the LFG and in the flare emissions are shown in Figure A4.2. The point before the flare system will be daily monitored to record the landfill gas flow and the methane content in the flow. The LFG composition will also be monitored in the wellheads for technical purposes.
The flare emissions will be annually monitored through lab analysis to verify the amount of methane in exhaust gas.
In order to achieve a representative sample of the flare emissions, multiple monitoring ports along the flare are necessary due to the variability in the combustion gases emissions profile. According to the characteristics of the flare to be installed, two different planes across the perpendicular sections of the flare stack were defined. As given by the minimum recommendations of the Environment Agency of the United Kingdom, the sample plane must be at least 1 meter from the flare exit and without any flame near the sampling port to avoid uncertainties due the flame chemistry. Four sampling ports at each plane will

be arranged (Figure A4.3). The number of sampling ports was determined according to the minimum established by ISO 9096 and from the flare dimensions (approximately 1 meter diameter).

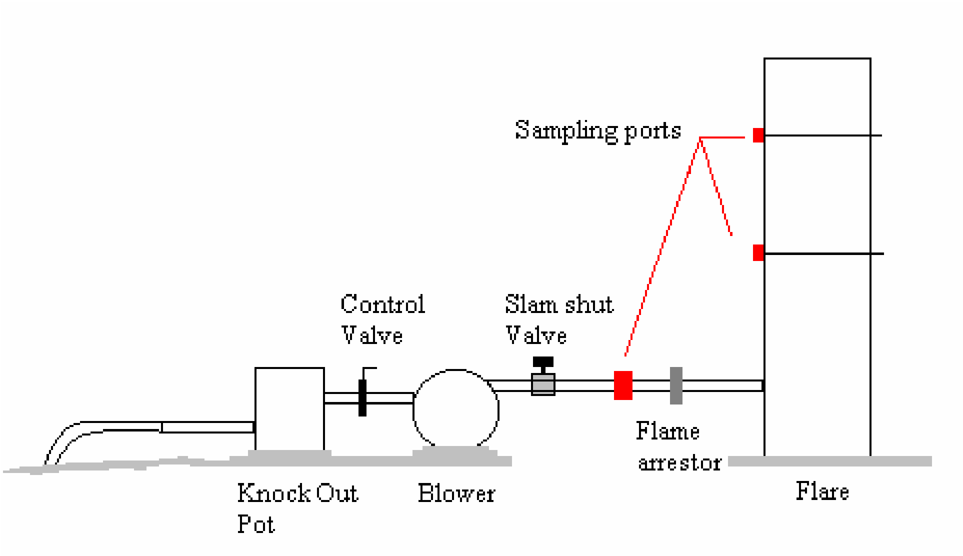

Figure A4.2. Sampling ports and basic arrangement of the flare system

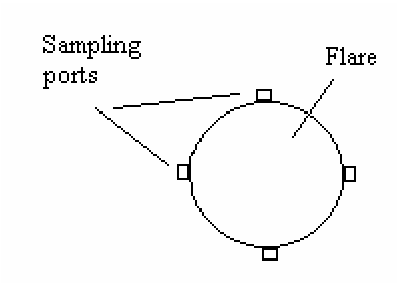

Figure A4.3. Sampling ports at each plane

The combustion efficiency in terms of the percentage of combusted methane will be determined by the difference between the amount of captured methane in LFG (before flare) and the non-combusted methane (from the sampling ports in the flare). This value will be annually adjusted.

A4.3.2. Data to be monitored

The information required for the Monitoring Plan of the Olavarría Landfill Gas Recovery project in the following Table A4.1.

Table A4.1. 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*
1. $LFG_{flared,y}$	Flow of LFG flared	Flowmeter	m^3/h	m	Continuously	100%	electronic/paper	Data will be aggregated monthly and yearly
2. T	Temperature of LFG	Temperature sensor	°C	m	Daily	100%	electronic/paper	Data will be used to calculate the methane density.
3. P	Pressure of LFG	Pressure Sensor	kPa	m	Daily	100%	electronic/paper	Data will be used to calculate the methane density.
4. D_{CH4}	Methane density in LFG	Calculation	ton CH4/m3 CH4	c	Daily	100%	electronic/paper	To be used to calculate the methane destroyed.
5. $w_{CH4,y}$	Methane fraction in LFG	Gas analyzer	m^3 CH_4/m^3 LFG	m	Daily	Sample	electronic/paper	To be used to calculate the methane destroyed
6. *FE*	Combustion efficiency	Estimation	%	e	Annually verified	100%	electronic/paper	The estimated combustion efficiency will be verified annually through lab analysis to determine the methane content in the exhaust gas
	Flare availability	Timer	%	m	Continuously	100%	electronic/paper	Data will be aggregated monthly and yearly

* All archived data will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

A.4.4. Monitoring Plan Management

The Monitoring Plan (MP) will be used by all parties involved in Olavarría Landfill Gas Recovery Project with responsibilities in the project implementation and verification activities:

The *project sponsor* (Municipality of Olavarría) will oversee the development of the project and will periodically carry out internal audits to assure that project activities are in compliance with operational and monitoring requirements.

The *project operator* (to be designated through a bidding process) will adopt the instructions given in the MP and accomplish all activities related to the implementation of the procedures given in the Operational Manual. The main responsibilities of the operator are related to:

- *Data handling*: maintaining an adequate system for collecting, recording and storing data according to the protocols determined in the MP, checking data quality, collection and record keeping procedures regularly.
- *Reporting*: preparing periodic reports that include emission reductions generated and observations regarding MP procedures.
- *Training*: assuring personnel training regarding the performance of the project activities and the MP.
- *Quality control and quality assurance*: complying with quality control and quality assurance procedures to facilitate periodical audits and verification.

An Operational Manual to be elaborated by the *project developer* (UNCPBA) will include procedures for training, capacity building, proper handling and maintenance of equipment, emergency plans and work safety.

A4.5. Quality control and quality assurance procedures

Regarding quality control and quality assurance procedures to be undertaken for the monitored data, the practices to be implemented in the context of the Olavarría Landfill Gas Recovery Project are as follows:

Gas field monitoring records:

- Daily readings of all field meters will be registered in paper worksheets. Data collected will be entered in electronic worksheets and stored.
- Periodic controls of the LFG field monitoring records will be carried out to check any deviation from the estimated ERs and according the Operational Manual for correction or future references.
- Recommendations on system and procedures improvements will be presented.
- Periodic reports to evaluate performance and assist with performance management will be elaborated.

Equipment calibration and maintenance:

- Flow meters, gas analyzers and other sensors will be subject to regular maintenance and testing regime according to the technical specifications from the manufacturers to ensure accuracy and good performance.
- Calibration of equipment will be performed periodically according to technical specifications and in agreement with recommendations given by the Instituto Argentino de Racionalización de Materiales (IRAM).

Corrective actions:

- Actions to handle and correct deviations from the Monitoring Plan and Operational Manual procedures will be implemented as these deviations are observed either by the operator or during internal audits.
- If necessary, technical meetings between the operator, the developer and the sponsor of the project will be held in order to define the corrective actions to be undertaken.

Site audits:

- The Municipality of Olavarría will make regular site audits to ensure that monitoring and operational procedures are being observed in accordance with the Monitoring Plan and the Operational Manual.

Training:

- The operator personnel will be trained in equipment operation, data recording, reports writing, and operation, maintenance and emergency procedures in compliance with the Operational Manual.

- - - - -