PROJECT DESIGN DOCUMENT

Onyx Alexandria Landfill Gas Capture and Flaring Project

CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT

BORG EL ARAB AND EL HAMMAM LANDFILLS
ALEXANDRIA, EGYPT

Version 2

-

November 2005

CLEAN DEVELOPMENT MECHANISM

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

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SECTION A. General description of project activity

A.1 Title of the project activity:

Onyx Alexandria Landfill Gas Capture and Flaring Project, November 2005, version 2

A.2. Description of the project activity:

This project includes two recently constructed municipal waste landfills in Alexandria, Egypt which are part of the **global waste management system** initiated by the Alexandria Governorate. The comprehensive waste management system was initiated in 2000 and is intended to improve the quality of life for the city's 5 million residents.

Onyx Alexandria was selected by the Alexandria Governorate for the multi-service contract for a 15-year period. Onyx Alexandria is a wholly owned subsidiary of Veolia Propreté (previously named Onyx), the waste management division of Veolia Environnement. Veolia Propreté is ranked 1st in Europe and 2nd worldwide in the field of solid waste collection and treatment. Veolia Propreté operates in 33 countries around the world with 71,000 employees.

The area served under the contract includes 18 districts within the city covering a total area of 7,200 km^2. The services provided under the contract include :

- Street Cleaning Program : daily manual and mechanical sweeping covering over 12,000 km of city streets and roadways.
- Household waste collection : collection of 1 million tonnes of waste per year
- Waste Transfer : Three (3) transfer stations have been put in service to limit the number of vehicles transporting waste from the city to the treatment centers.
- Landfills : As noted above, two (2) modern landfills have been constructed.
- Composting : Three (3) composting centres are operated and produce over 120,000 tonnes of compost per year.

The **project objective** is to maximise the capture of landfill gas (LFG) from the two new landfill sites. In addition to reducing the potential local impacts of odours and explosion or fire hazard associated with landfill gas, the project is aimed at reducing the fugitive emissions of methane, a greenhouse gas which contributes to global warming and climate change.

The **project activity** includes the installation of enhanced landfill gas extraction and flaring equipment for the destruction of the landfill methane that is collected from the existing and future disposal areas instead of releasing it to the atmosphere.

The **global waste management system** implemented for Alexandria has numerous positive contributions to sustainable development. This innovative initiative is the first of its kind in this region. The contract covers the full spectrum of waste management activities from street cleaning to collection and treatment of all the household and commercial waste generated in the city. The global system employs many of the latest technologies in this field.

Environmental Benefits:
The local environmental benefits are significant as a result of the transformation of waste management practices and infrastructure. Below are just a few key benefits :

- Preservation of water resources – Uncontrolled dumps have been replaced by engineered modern landfills with fully lined disposal areas for leachate (wastewater produced by the landfill) containment.
- Fight against desertification and depleted soil – The local production of compost provides much needed organic soil amendments.

Social benefits:

- Improvement of public health – the street cleaning activities and collection services initiated throughout the city have contributed to improved sanitary conditions in Alexandria.
- Employee training – An Africa-Middle East training institute has been established for all Onyx Alexandria personnel. This center is to be used for the Alexandria workforce as well as other employees working in the Middle East.
- Public participation – a public awareness programme has been implemented to describe the waste management practices being implemented in Alexandria and therefore the environment protection; these efforts are provided to the local population and school children.

Economical benefits:

- Employee – this contract resulted in the creation of 4000 job opportunities
- Quality Standards – Onyx Alexandria has obtained an ISO 9001 certificate in December 2004 and the ISO 14001 (Environment) and 18001 (Safety) in August 2005.
- Investment - 45 Million Euros have been invested to develop the global waste management system.

The **project activity** will contribute to continued environmental, social and economical improvements by providing infrastructure to reduce greenhouse gas emissions from the landfill sites : Flaring of the collected LFG does not only destroy methane, but will also destroy compounds in the LFG such as volatile organic compounds and ammonia. This project will prevent the following risks associated with landfill gas at uncontrolled landfills:

- Risk of explosion
- Risk of fire
- Unpleasant odours nuisances
- GHG emissions effects
- Potential atmospheric pollution
- Damage to vegetation by asphyxia

The impacts are and will continue to be mitigated by the installations proposed in this project.

Figure 1 : Onyx Alexandria Landfill site (Borg El Arab)

Figure 2 : Vent system in cell 2 of El Hammam landfill

The Borg El Arab Landfill was originally designed for the disposal of waste collected from Alexandria, operating on a year round basis. In 2003, the Governorate of Alexandria requested ONYX Alexandria to open a second landfill in El Hammam, 30km south of Borg El Arab commencing in July 2003. Approximately 13 million tonnes of waste will be deposited in the 2 landfills over the contract term.

As noted, the latest waste management standards are applied to Borg El Arab and El Hammam landfills. A composite liner system (geomembrane / clay) and leachate collection system will be installed as landfilling progresses. Final cover soils will be placed on areas as they reach their final elevation. The completed sections of the landfill will be revegetated. Furthermore, additional landfill gas (LFG) recovery equipment will be installed which is not common in Egypt and, according to the local regulator, active LFG recovery is not practised at any other landfill site in the country. As described below, Onyx Alexandria will use proven technology, including a piping and well network, blowers, and flaring systems.

In 2003, it was decided by the project participants to install an onsite evaporator at the Borg El Arab facility. The evaporator technology uses the collected landfill methane as a fuel to evaporate the leachate collected from the existing and future lined disposal areas. The recovered landfill gas will mainly be used for the evaporation process. The excess landfill gas will be flared. One of the reasons for selecting this technology was that it contributes to greenhouse gas emission reductions.

Greenhouse gas emission reductions will result from the combustion of the recovered methane contained in the landfill gas. It is estimated that this project will generate 3 700 000 CER's within a 10-year period (2006-2016).

Technology transfer:
The project will support efforts aimed at facilitating the dissemination of design and operational experience gained at Borg El Arab and El Hammam landfills for possible use throughout the country or region. The following activities will be funded by the project activity and implemented by Onyx Alexandria:

1. Development of information tools : brochures describing the CDM project and the impact of good practice at a landfill site to minimise its impact on Climate Change;
2. Routine onsite meetings will be held with Government agencies, Officials, Associations, and other stakeholders to explain the operation of these sites and the CDM project activities.

View of project Participants:

GOVERNORATE OF ALEXANDRIA :
The Secratary-General of Alexandria Governorate states :
"Alexandria Gorvenorate is aware that Onyx Alexandria is developing a Clean Development Mechanism Project at Borg El Arab and El Hammam Landfills. We fully support this project as it will allow for the installation of enhanced landfill gas collection and flaring equipment, which will contribute to the reduction of the greenhouse gas emissions from the sites."

VEOLIA PROPRETÉ :
Gary Crawford, Vice President of Veolia Propreté's Environment and Quality Department declares: " Veolia Propreté is proud to be part of this project in partnership with the Governorate of Alexandria. The global waste management system initiated in Alexandria has contributed to many local environmental and social benefits. The implementation of a CDM project at the two new landfills will continue the environmental improvements and will make a positive contribution to the global issue of climate change by reducing greenhouse gas emissions".

ONYX ALEXANDRIA LANDFILL SITE:
Yannick Morillon, General Director, Onyx Alexandria, declares:
"The success of this project is important in order to promote safe and environmentally friendly waste management technology in this area. The project, with the support of the CDM, will become an example for the Middle East and prove that it is possible to achieve a high standard of waste management practices in these countries."

A.3. Project participants:

Project participants are described below. For full contact details, please, refer to Annexe 1 of this document.

Name of Party involved (*) ((host) indicates a host party)	Private and/or public entity(ies), project participant (*) (as applicable)	Kindly indicate if the party involved wishes to be considered as a project participant (Yes/No)
Egypt	Onyx Alexandrie	No
Spain	World Bank	Yes
France	Veolia Propreté	No
(*) In accordance with the CDM modalities and procedures new methodology (forms CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the party(ies) involved is required.		

The name and contact details of the Annex 1 Party willing to be involved within this project will be communicated in due course to the Executive Board, as mentioned in decision 57 of the eighteenth meeting report.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Egypt

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

Alexandria Governorate

A.4.1.3. City/Town/Community etc:

Borg El Arab and El Hammam cities

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

Borg El Arab landfill is located 50 Km west of Alexandria city on the southern side of the international coastal highway, while El Hammam landfill is located 30 km south of Borg El Arab Landfill, as shown on Figure 4. Borg El Arab landfill occupies a rectangular shaped area of length 3 km and width 250 m with a total area of 75 ha.

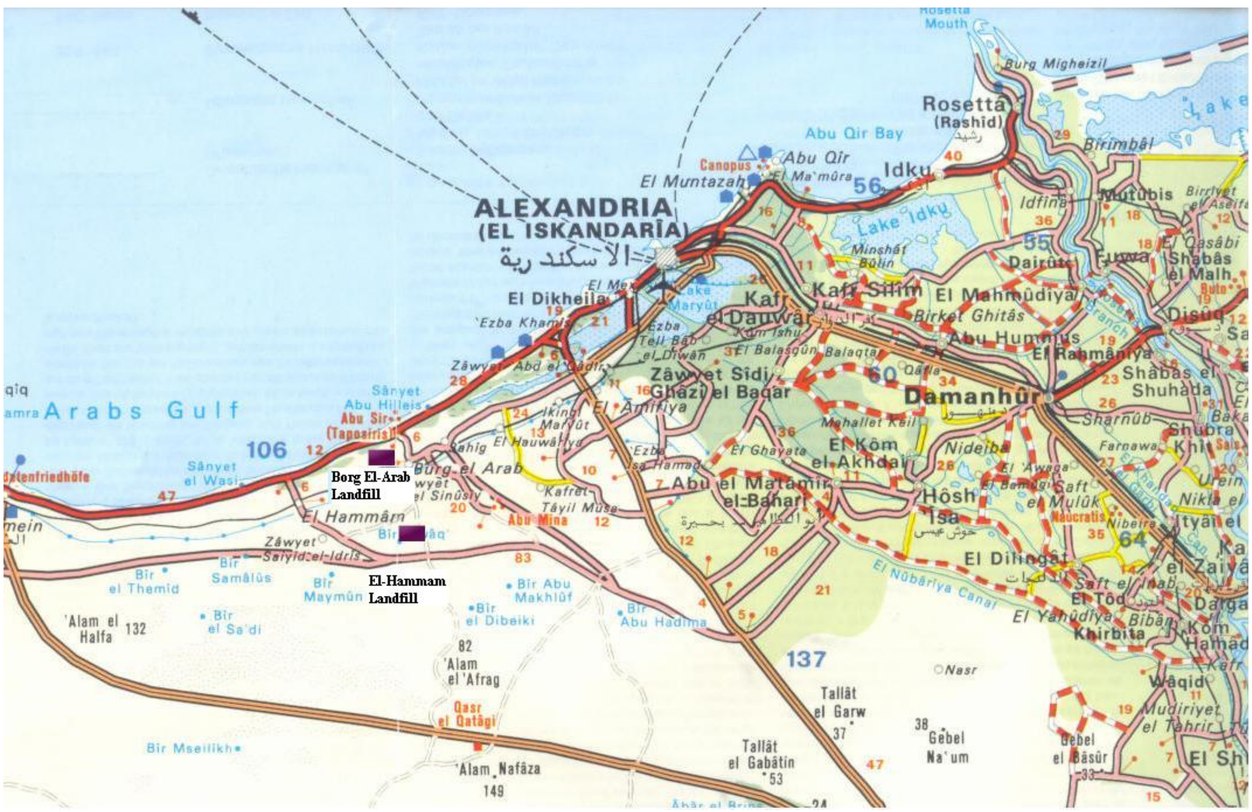


Figure 3 : Location of Borg El Arab and El Hammam Landfills

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

Waste Handling Disposal

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

Currently, the leachate generated from the landfilled waste is transported offsite to the nearest wastewater treatment facility. Part of the project activity is to commission an onsite evaporator (the BGVAP-K8lT system) at the Borg EL Arab Landfill.
This technology has been used in many landfill sites operated by Veolia Propreté. Currently, no landfill in Egypt employs such technology and therefore this project will help transfer the knowledge and know-how of this treatment technology into this country.

Below is a brief summary of the equipment and technology proposed for this project:

The landfill gas collection system consists of the following components:

- Progressive vertical wells

In order to allow for the possibility to collect landfill gas prior to the completion of a disposal area progressive vertical wells are installed. This type of wells consists of a perforated pipe encircled by a concrete ring. They are mounted as waste filling progress.

- Vertical wells

When necessary, wells will also be drilled into the landfill once areas reach their final elevation and final cover has been applied. The vertical wells consist of a pipe perforated in its lower part, placed in a drilled borehole in the waste, backfilled with gravel and sealed at the surface.

Both well types will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.

- Leachate Pumping Systems

Submersible leachate pumps will be installed in the LFG extraction wells as part of this project. Pumping of the accumulated leachate increases LFG well collection efficiency.

- Collection Piping

A high-density polyethylene collection piping system will be installed to convey the landfill gas from the well network to the blower/flare/evaporator station. The layout of the future systems will be implemented in order to minimise the low points which could disturb or prevent the gas collection (due to condensate blockage).

The landfill gas combustion system consists of the following equipment:

- Leachate Evaporator

This system functions by evaporating the leachate in an evaporator and directing the evaporated leachate to a flaring unit where it is burned at a very high temperature (ranging from 900-1100 ^{o}C). One evaporator and flaring unit (see description below) utilize part of the LFG generated from the landfill as the combustion fuel. The evaporator and flaring units have already been installed at the Borg El Arab landfill. The leachate evaporator has not yet been commissioned.

- Enclosed Flare

The project entails the installation of additional flaring units for the destruction of the captured LFG that is not utilized by the leachate treatment system. Currently, there is no flaring unit installed at the El Hammam Landfill.

- *Controls*

The flares will be equipped with automatic safety and monitoring controls (operator interface, air-fuel ratio, chamber temperature, UV sensor, emergency shut down, etc.)

- *Blower*

A centrifugal blower is used to create the required vacuum in the collection network to extract the LFG. The project entails the installation of additional capacity.

By implementing these technology approaches at the Borg El Arab and El Hammam Landfills, Veolia Propreté will transfer its expertise and experience with these systems to the local team who install and operate them. Numerous training programs have been and will be provided to our local staff . Technical support is always available to help resolve any difficulties.

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:

In Egypt, most of domestic waste goes either to illegal dumps or landfills with minimal or no environmental controls. At these sites the quality of the waste is not properly monitored and leachate is not contained and is leaking into the groundwater and surface water. Inevitably, the natural process of anaerobic degradation of the organic fraction of the deposited waste will occur releasing directly to atmosphere a gas containing an average of 50% methane.

The proposed project activity is aimed at reducing fugitive methane emissions by, using the latest development in terms of LFG extraction and flaring systems. The collection and flaring of LFG will convert its methane content into CO_2, a less harmful gas in terms of greenhouse gas effect.
The project activity will contribute to the development of the first “state of the art” landfills in Egypt. To date, these practices are not employed in Egypt.

There are no national or regional requirements in Egypt to capture and treat LFG. A few sites have installed passive landfill gas vents. This type of passive venting system has been approved by the local Governorate. To date, these systems represented the best practice in Egypt. Studies have shown that these passive venting systems have a collection efficiency below 20%.

The baseline emissions have been determined taking into account Onyx Alexandria’s contractual requirements as well as current practices and requirements in Egypt:

Onyx Alexandria’s contract requires the treatment of LFG generated from the landfill without mandating a specific quantity to be collected or flared. The primary concern is to capture the landfill gas to reduce the onsite risk of fire or explosion. As there is no specific volume or percentage of landfill gas to be captured and treated in the contract, a value of 20% of the captured LFG is assumed in the baseline calculation.

The value of 20% is higher than what is currently collected from the site. With the actual installation on the first disposal area, 15% of the methane that would have been captured by the project activity is captured and flared as explained in section B2. As noted in the attached letter from the Alexandria Governorate, the current installation fulfils the contract requirements.

As previously mentioned, the goal of the project activity is to maximise the capture of landfill gas from the sites. The CDM project activity will increase the overall capture rate to at least 70% by installing the necessary infrastructure.

Assuming collection and destruction of 20% of the captured LFG as a baseline is extremely conservative as there are **no other** landfills at this level in Egypt.

The baseline reflects what would occur in the absence of the project activity. Moreover, the installation of the additional collection and flaring equipment to maximise greenhouse gas emission reductions will result in supplemental costs are not compensated by additional revenues. Therefore, the approval and registration of the project as a CDM project will offer an economic incentive to the project participants to implement the project.

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

It is estimated that the enhanced collection and flaring capacity envisioned by the project activity will result in the yearly capturing and combustion of approximately 70% of the produced LFG . The estimate of total emission reductions to be realised are 3 715 266 tCO_{2eq} over the crediting period starting the 1st January 2006 ending the 31st December 2015 included**.** Expected Emission Reductions are described in the table below

Year	**Annual estimation of emission reductions in tonnes of CO_{2e}**
2006	210 665
2007	248 490
2008	285 431
2009	321 553
2010	356 913
2011	391 570
2012	425 578
2013	458 990
2014	491 854
2015	524 222
Total Estimated reductions (tonnes of CO_{2e})	3 715 266
Total Number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO_{2e})	371 526

A.4.5. Public funding of the project activity:

In this project no public funding is involved.

SECTION B. Application of a baseline methodology

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

"Consolidated baseline methodology for landfill gas project activities" – ACM0001-version 02.

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

This methodology is applicable to LFG capture project activities, where the baseline scenario is the partial atmospheric release of the landfill gas and the project activity include the following situations:

- The gas is captured and flared. Some of the LFG can be used to produce thermal energy to evaporate the collected leachate. No emission reductions are claimed for displacing or avoiding energy from other sources.
- There exists a contract between Alexandria Governorate and Onyx Alexandria for the collection, treatment and final disposal of solid waste. The contract makes the operator, Onyx Alexandria, responsible for all aspects of the landfill design, construction, operation, maintenance, and monitoring.
- The contract was awarded to Onyx Alexandria through a competitive bidding process.
- The contract specifies that Onyx Alexandria should treat the LFG generated from the landfill without mandating a specific quantity to be flared. As noted above an adjustment factor of 20% is being applied to this project activity.

The approved monitoring methodology ACM0001 ("consolidated monitoring methodology for landfill gas project activities") will be used in conjunction with this baseline methodology.

In conclusion, the conditions for use of the methodology ACM0001 are met.

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

As described in the methodology ACM0001, in cases where regulatory or contractual requirements do not specify the amount of methane to be destroyed an adjustment factor shall be used and justified taking into account the project context.

In this case and in order not to rely on theoretical value the following formulae will be used:

$$MD_{reg,y} = MD_{project,y} * AF$$

Whereas,
$MD_{reg,y}$ is the methane (in tCO_{2eq}) that would have been destroyed in the absence of the project (emission baseline).$MD_{project,y}$ is the methane (in tCO_{2eq}) destroyed by the project activity

AF is the adjustment factor.

Emissions will be determined ex post by metering the actual quantity of methane captured and destroyed once the project activity is operational.

The core business of ONYX Alexandria at the Borg El Arab and El Hammam landfill sites is environmentally sound disposal and management of municipal and industrial waste. The Borg El Arab site started to receive waste the 1st October 2001.

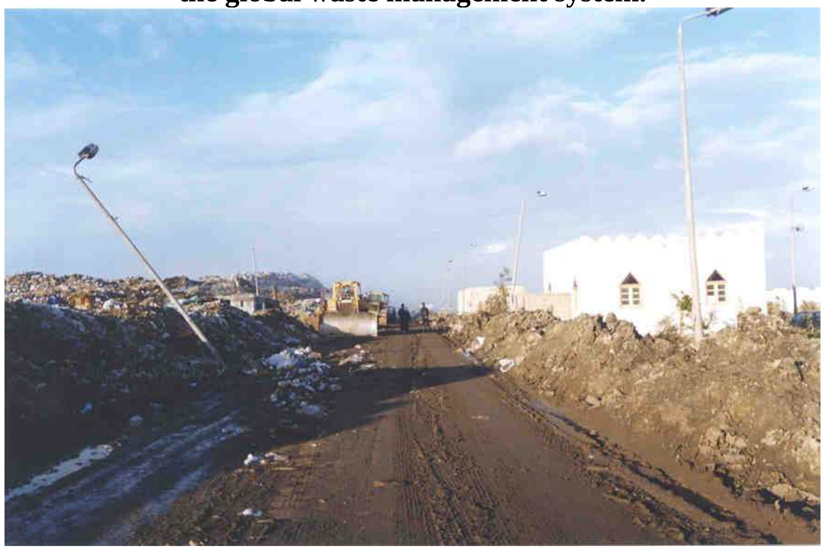
Landfill gas extraction equipment was installed in the first disposal area at the Borg El Arab Landfill in July 2003. The LFG is collected and flared at the onsite evaporator / flare station. Based on the site monitoring data for 2004 an average of 77 m^3/hr of methane was captured. In 2004, only Cell 1 was connected to the extraction system. If the project activity had been implemented, the estimated amount of methane captured would have been 520 m3/hr (using the referenced model and considering a maximum collection efficiency of 70%).. Therefore, the site flares 15% of what it should theoretically produced. This onsite measurement confirms the conservative assumption of 20 % used as an adjustment factor. The current equipment is recognised by the Governorate of Alexandria to be sufficient to respond to the contractual obligation.

The following steps describe the methodology used in order to define the ACM0001 methodology:

Step 1: Assessment of legal requirements
The Egyptian legislation does not require landfill operators to flare or to treat LFG. Whereas there is no regulatory obligation, there is a contract in place between Onyx Alexandria and the Governorate of Alexandria stating, without specifying any level, that the landfill gas should be treated.

The Governorate of Alexandria is the most advanced in Egypt in terms of waste management practices. Most waste in Egypt and in neighbouring countries in the region are disposed in uncontrolled sites with limited or no environmental controls. With the inception of the contract in Alexandria, two uncontrolled sites ceased to receive waste and they are currently being rehabilitated.

Figure 4 : An uncontrolled landfill in Alexandria operated prior to the implementation of the global waste management system.



There are no regulations governing flaring and/or combustion of landfill gas and no regulation is expected over the next decade.

As noted, Onyx Alexandria has a contract with the Governorate of Alexandria stating that landfill gas should be treated. It has been demonstrated that 20% of flared gas is a reasonable and conservative obligation considering the absence of existing local standards.

Step 2: Assessment of economic attractive courses of action

The following three alternatives could be identified:

1. Reference scenario LFG is flared as defined within the contract. The rest of LFG is emitted into the atmosphere.

2. Extract and use the LFG as a fuel for a separate leachate evaporation installation and flare excess LFG

3. Extract and use the LFG as a fuel for a separate gas engine facility to export electricity.

Alternative 1

As required by the contract some LFG is collected and flared. A maximum of 20% will be collected in the absence of the project activity to satisfy the contractual obligations to reduce the risk of fire and / or explosion. The investment required for this alternative includes the cost for the wells, limited piping and flare capacity.

Alternative 2

Under this alternative ONYX ALEXANDRIA will invest in an improved LFG and leachate extraction system on top of the alternative 1 equipment, as described in Section A.4.3 above. The additional investment for this infrastructure, compare to Alternative 1, is estimated to be **3.1 million dollars (USD)**. The economic lifespan of the equipment is set for 15 years. The investment will not generate any revenue and for the purpose of proving the additionality the potential CER revenues are left out of this calculation.

The installation of the enhanced extraction system will maximise LFG capture. The LFG will be used in an onsite evaporator or flared. Leachate generated onsite is currently hauled to a nearby wastewater treatment plant. Operating the evaporation unit for the leachate generated onsite results in numerous environmental benefits, however, it is not the least expensive option. The cost of offsite treatment at this local plant is lower than the cost to operate the evaporator.

The results of the financial analysis clearly shows that the implementation of the project activity is not the economically most attractive course of action.
Consequently, we can show that this alternative has a negative Internal Rate of Return.

Alternative 3
Using LFG as an alternate fuel source for a gas engine to produce electricity can be in some cases an attractive scenario to recover LFG. This third alternative consists of the installation of LFG engines to generate and export electricity onto the national grid was considered.

As these landfills are the first of their kind in this country there is no prior experience with the development of landfill gas to energy projects. It is also too early in the operating lives of these installations to determine the technical feasibility of a LFG to energy project.

In addition, as the gas engine distribution network is relatively modest, it appears difficult to install, at the moment, such maintenance intensive equipment.
It is envisaged to study the opportunity of developing such system when the technical information will be sufficient on this type of waste. Consequently, this scenario is not, at the moment, economically attractive due to these uncertainties.

Clearly Alternative 1 is the least cost option for the Borg El Arab and El Hammam landfill sites. Therefore, the CDM project is additional.

Step 3: Assessment of barriers and common practice

Although Veolia Propreté has worldwide experience in waste management, Egypt is a challenging country to develop such high standards technology.
The landfill site of Borg El Arab was the first site operated by the group in Egypt. On a daily basis our operations team works to find the optimum methods to deal with the Egyptian waste which is very different from the waste type in other countries. The design and operation must be adapted to the local context. The latest technology has been implemented at the two landfill sites. Composite lined disposal areas are prepared in advance. These cells are equipped with leachate collection systems. The incoming waste is weighed and controlled upon entry to the site. The placed waste is compacted using waste compactors. The active workface is kept to a minimum to reduce nuisances.

It has been seen that the waste received at the Alexandria landfills contains a high organic fraction. This waste will typically produce high LFG volumes due to the high organic content. However, it has been observed that the compacted Alexandria waste is more challenging from a LFG collection standpoint than western European waste. As part of this project, Onyx Alexandria will conduct studies to determine the most effective and adapted extraction system design using the elements described in Section A.4.3 above.

Operating the first site with this level of equipment and control requires a strong training commitment. This adaptation and development work creates additional costs that Onyx Alexandria shall bear.

As an example, Onyx Alexandria, as part of the project activity, plans to employ a gas technician in order to manage and control the extraction system and infrastructure. As it is a new activity in Egypt, a person will be hired locally and then trained by internal experienced technicians in France.

A CDM project will be, for the local area, an example to demonstrate that such pro-environmental project can be developed in North Africa and Middle East Region.

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:

The baseline emissions are determined based on the contractual requirements. Also, the contract was awarded to Onyx Alexandria through a competitive bidding process. No regulations exist for the collection and destruction of LFG. Solid waste contractors have submitted requests for approval to the Egyptian Environmental Affairs Agency for passive venting systems which has a maximum collection efficiency of 20%. For conservativeness, it will be assumed that this 20% will be flared or used for leachate evaporation system as part of the baseline. Thus the baseline reflects what would occur in the absence of the project activity.

Moreover, the installation of the additional collection and flaring equipment will require increased costs without any expected additional revenues. Therefore, the approval and registration of the project as a CDM project will offer an economic incentive to the project participants from the revenue generated by the CERs which will encourage the implementation of the project.

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 is the physical boundary of Borg El Arab and El Hammam landfills. Emissions calculated in the baseline are methane emissions within the landfill boundaries. Two sources of emissions exist during project activity: methane emissions from landfills and carbon dioxide emissions from electricity generated to pump the excess methane that will be flared. The landfill emissions during project activity occur within the project boundary. Electricity used to pump the methane will be generated from the on-site diesel generator which is also within the project boundary, although its emission are negligible compare the overall project .

The following emissions were not taken into account:
Emissions from the transport of waste to the site are excluded from the project boundaries, as they are not affected by the implementation of the proposed CDM activity.

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 completion: 01/03/2005

The entity defining the baseline is the project Participant described in the Annexe 1: ONYX Alexandria.

Technical assistance on the preparation of the Baseline Study was provided by :
Veolia Propreté - Environment and Quality Department
169 Avenue Georges Clémenceau
92735 Nanterre Cedex
Gary Crawford, Vice President, Environment / Quality, Gary.Crawford@veolia-proprete.fr
Lionel Bondois, Carbon Credit Manager, Lionel.Bondois@veolia-proprete.fr

The baseline scenario is defined in the Annexe 3 ‘Baseline information’.

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:

The starting date of the project activity is July 2003.

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

The contract between Onyx Alexandria and the Governorate of Alexandria is valid until the October 2016. The Governorate has the possibility to renew the contract at the end of the period. The operational lifetime of the equipment with the proper maintenance program is 15 years.

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

A fixed crediting period will be used.

C.2.1. Renewable crediting period

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

Not Applicable

C.2.1.2. Length of the first crediting period:

Not Applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

1st January 2006

C.2.2.2. Length:

10 years

SECTION D. Application of a monitoring methodology and plan

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

“Consolidated monitoring methodology for landfill gas project activities” ACM001-version 2.

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

Thus approved monitoring methodology is applicable for the project activity since the project reduces greenhouse gas emissions through landfill gas capture and flaring where the baseline is established by a public concession contract.

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
Not applicable	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
Not applicable	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

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

>> Not applicable.

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
Not applicable	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
Not applicable	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

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

Not Applicable

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 *Use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data Unit	Measured (m) calculated © or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived ? (electronic : e/ paper : p)	For how long is archived data kept ?	Comments
1 LFG. **$_{total..y}$**	Total amount of landfill gas captured	Flowmeter	m^3	m	Continuously / periodically	100 %	Electronic	During the crediting period and two years after	Measured by a flow meter. Data to be aggregated monthly and yearly
1. LFG **$_{flare..y}$**	Amount of landfill gas flared	Flowmeter	m^3	m	Continuously / periodically	100 %	Electronic	During the crediting period and two years after	Measured by a flow meter. Data to be aggregated monthly and yearly
3. LFG **electricity..y**	Amount of landfill gas combusted in power plant	Flowmeter	m^3	m	Continuously / periodically	100 %	Electronic	During the crediting period and two years after	N/A
4. LFG **thermal..y**	Amount of methane combusted in boiler	Calculated flowmeter and gas analyser data	m^3	m	Continuously / periodically	100 %	Electronic	During the crediting period and two years after	Measured by a flow meter. Data to be aggregated monthly and yearly

5. FE	Flare /combustion efficiency, determined by the operation hours (1) and the methane content in the exhaust gas (2)	On-site measurement	%	m/c	(1) continuously (2) quarterly, monthly if unstable	n/a	Electronic	During the crediting period and two years after	(1)Periodic measurement of methane content of flare exhaust gas. (2) Continuous measurement of operation time of flare (e.g with temperature
6. W_{CH4}.y	Methane fraction in the landfill gas	Gas analyzer	M^3 CH_4/m^3 LFG	m	Continuously / periodically	100 %	Electronic	During the crediting period and two years after	Preferably measured by continuous gas quality analyser
7 T	Temperature of the landfill gas	Temperature gauge	°C	m	Continuously / periodically	100 %	Electronic	During the crediting period and two years after	Measured to determine the density of methane DCH_4
8 P.	Pressure of the landfill gas	Pressure gauge	Pa	m	Continuously / periodically	100 %	Electronic	During the crediting period and two years after	Measured to determine the density of methane DCH_4
9.	Total amount of electricity and/or other energy carriers used in the project for gas pumping and heat transport (not derived from gas)	Invoices of fuel	L	c	periodically	100%	paper	During the crediting period and two years after	The sites only used diesel generator to feed the blower which extract landfill gas.
10.	CO_2 emission intensity of the electricity	N/A	T CO_2/Mwh	c	N/A	N/A	N/A	N/A	Electricity is provided by an on site generator

	and /or other energy carriers in ID 9								
11.	Regulatory requirements relating to landfill gas projects	Official publication	Test	n/a	Annually	100 %	Electronic	During the crediting period and two years after	Required for any changes to the adjustment factor (AF) or directly $MD_{reg..y}$

All data will be archived during the crediting period and 2 years after.

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

Project emissions are directly monitored through the continuous monitoring device that will be installed. The total volume of methane that is flared for all days of the year is collected from the recorded values in m^3.
Electricity utilised by the collection system to extract the excess of methane will be generated from a diesel generator on-site. The generator will be utilizing diesel fuel (fuel #2).

The diesel fuel consumed for generating electricity to pump excess methane represent less than 1% of the project emission. Consequently, this emission are negligible over the scale of the project as shown below:.

The total amount flared in tons of methane is calculated from the following formula:

$$CH4_{project}\ (t\ CH_4) = CH_{4project}\ (m^3\ CH_4) * 0.0007168$$

The carbon dioxide emitted from electricity used to pump the methane represent less than 1% of the project emission. This can be demonstrated with the following formula, where it is adjusted for the excess methane share of electricity:

$$CO2_{project} = \left[CH4_{flared,y} - CH4_{baseline,y}\right] * Consump\ (t\ Fuel) * 3.17 \left(\frac{t\ CO2}{t\ Fuel}\right)$$

The consumption of this type of generator is approximately 0.022L per cubic meter of CH4 collected.
The density of diesel has been taken at 0.8450 kg/L (EN-ISO 3675).

Carbon content in diesel fuel in Egypt is approximately 86.3%. Therefore carbon dioxide emission factor can be estimated from the combustion equation of carbon as follows:

$C+0_2 \rightarrow CO_2$

For each mole of carbon, 1 mole of carbon dioxide is emitted. The molecular weight of Carbon is 12g/mol and for carbon dioxide 44 g/mole. There, each 12t of carbon results in 44 tons of CO_2 and hence each ton of carbon will result in 3.67 tons of carbon dioxide.
For each ton of diesel fuel combusted 0.863 tons of carbon is burned

0.863*3.67=3.17 tons of CO_2 are emitted per ton of diesel.

Therefore the emission factor of diesel fuel is 3.17 t CO_2 / t fuel.

To illustrate CO_2 emission are negligible compare to the emission of the project, the emission of the year 2005 are calculated for the site of Borg El Arab:

Emission reduction of the year 2005: 109413 tCO_2 from CH_4

Using the above formulae, the emission from electricity generation equal :
Baseline emission: 171.3 tCO_{2eq}
Project emission: 599.7 tCO_{2eq}
The emission of the electricity generation due to the project equals : 428 tCO_{2eq}.

This prove that the emission of electricity generation is less than 0.4% of the emission reduction. Compare to the conservativeness of the Adjustment Factor, these emissions are negligible.

The total project emissions of carbon dioxide equivalent are calculated from the following formula:

$CO2e_{project}$ ($t\ CO_{2e}$) = $CH_{4project}$ ($t\ CH_4$) * 21

D.2.3. Treatment of leakage in the monitoring plan **D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity**								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
Not Applicable	*Not Applicable*	*Not Applicable*	*Not Applicable*	*Not Applicable*	*Not Applicable*	*Not Applicable*	*Not Applicable*	*Not Applicable*

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.)

Emission reduction should be calculated from the following equations:

$$ER_Y = ER\_CH_{4y} * AF * GWP_{CH4}$$

$$ER\_CH_{4y} = MD_{project,y} - MD_{reg,y}$$

Where:
ER_y is the GHG reduction in t CO_{2e}

ER_CH_{4y} is the methane emission reduction in m^3
AF is a conversion factor from t CH_4 to m^3 CH_4 (0.0007168 tCH_4/m^3 CH_4)

GWP_{CH4} is the global warming potential for CH_4 (21)

$MD_{reg,y}$ is the amount of methane that would have been destroyed in the absence of the project activity , which equal the baseline scenario ($CH4_{baselinr,y}$)

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1-4 LFG_y	Low	Will be included in ISO 9001 and 14001 certification scope
5. FE	Medium	Will be included in ISO 9001 and 14001 certification scope
6. WCH_4	Low	Will be included in ISO 9001 and 14001 certification scope

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 project will be under the direct supervision of Yannick Morillon, Managing Director of Onyx Alexandria. David Denois, the Technical Manager of Onyx Alexandria is in charge of the implementation, maintenance of the equipment. He will also ensure the monitoring plan is followed.

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

Yannick Morillon, Onyx Alexandria, is one of the project participants

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

Landfill Emissions

According to the approved baseline methodology, emission reduction should be calculated from the following equations:

$$ER_Y = ER\_CH_{4y} * AF * GWP_{CH4}$$

$$ER\_CH_{4y} = MD_{project,y} - MD_{reg,y}$$

Where:

ER_y is the GHG reduction in t CO_{2e}

ER_CH_{4y} is the methane emission reduction in m^3

AF is a conversion factor from t CH_4 to m^3 CH_4 (0.0007168 tCH4/m^3 CH_4)

GWP_{CH4} is the global warming potential for CH_4 (21)

$MD_{reg,y}$ is the amount of methane that would have been destroyed in the absence of the project activity , which equal the baseline scenario ($CH_{4baselinr,y}$)
$MD_{project,y}$ is the amount of methane destroyed by the project activity.

The project consists on improving the gas collection system. Due to the waste type and its characteristics, it has been assessed that the project will improve the collection efficiency up to 70% of the amount theoretically produced. The table 1 below represents the estimated amount of methane flared by the project activity.

Year	Global Methane flared with the project activity (m^3CH_4/year)
2006	17 493 813
2007	20 634 808
2008	23 702 498
2009	26 702 057
2010	29 638 436
2011	32 516 379
2012	35 340 433
2013	38 114 953
2014	40 844 120
2015	43 531 945
Total (2006-2015)	**308 519 442**

Table 1 : Estimated amount of methane flare by the project activity at Borg EL Arab and El Hammam Landfills

Electricity Generation Emissions

As demonstrated in part D.2.2.2 "Description of the formulae used to calculate project emission (for each gas source, formulae/algorithm, emission units of CO_2 equ.)", the emission from the electricity generation are negligible compare to the emission of the project.

E.2. Estimated leakage:

Not applicable.

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

No leakage have been identified and emission from diesel generator being negligible, the emission reduction resulting from the destruction of methane can be calculated. Table 2 presents the avoided emissions in tCO_{2eq} expected from the project activity.

Table 2 : Avoided Emission in tCO_2eq resulting from the project activity

Year	Global emission resulting from project activity TCO_2eq
2006	263 331
2007	310 612
2008	356 789
2009	401 941
2010	446 141
2011	489 463
2012	531 972
2013	573 737
2014	614 818
2015	655 278
Total (2006-2015)	**4 644 082**

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

As per the methodology ACM0001, the amount of methane that would have been destroyed in the absence of the project activity ($MD_{reg,y}$) is defined by the following formula:

$$MD_{reg,y} = MD_{project,y} * AF$$

where
$MD_{project,y}$ is the amount of methane actually destroyed during the year by the project activity
AF is the adjustment factor (20%)

Table 3, shown below present the amount of methane that would have been destroyed in the absence of the project activity ($MD_{reg,y}$)

Table 3 : amount of methane that would have been destroyed in the absence of the project activity ($MD_{reg,y}$) in m^3 of CH_4/year as part of the Baseline scenario

Year	Emission reduction in the Baseline scenario for both sites (m^3 of CH_4/year)
2006	3 498 763
2007	4 126 962
2008	4 740 500
2009	5 340 411
2010	5 927 687
2011	6 503 276
2012	7 068 087
2013	7 622 991
2014	8 168 824
2015	8 706 389
Total (2006-2015)	61 703 890

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

Applying the formulae

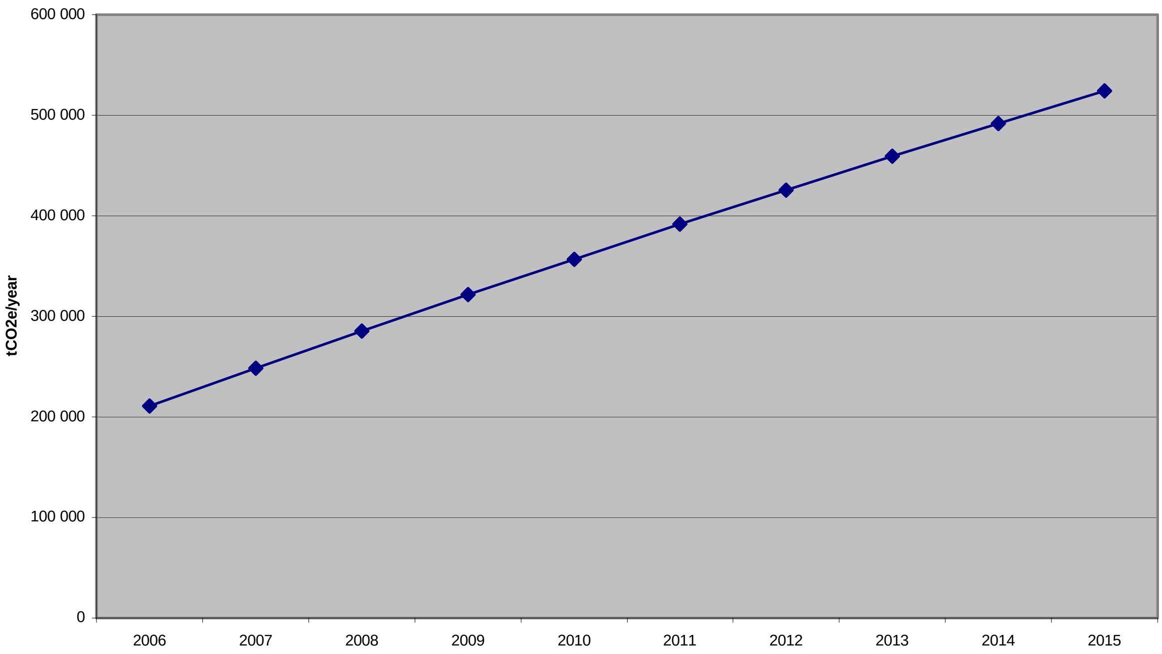
$$ER_y = (MD_{project,y} - MD_{reg,y)} * GWP_{CH4}$$

Where,

ER_y is the greenhouse gas emission reduction achieved (in tCO_{2eq}/year)by the project activity during a given year y
GWP_{CH4} is The global Warming Potential of the Methane (21)

The emission reduction of the project can be estimated as shown on figure 6

Figure 5 : Estimated Emissions Reductions of the project activity (ER_y)



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

Table 4, shown below, presents the Estimated Emissions Reductions of the project activity (ER_y)obtained when applying formulae above.

Table 4 : Emissions Reduction of the project activity in $tCO_{2e}q$/year

Year	Estimation of project activity emission reductions (tonnes of CO_{2e})	Estimation of baseline emission reductions (tonnes of CO_{2e})	Estimation of Leakage (Tonnes of CO_{2e})	Estimation of Emission Reduction (tonnes CO_{2e})
2006	263 331	52 666	0	**210 665**
2007	310 612	62 122	0	**248 490**
2008	356 789	71 358	0	**285 431**
2009	401 941	80 388	0	**321 553**
2010	446 141	89 228	0	**356 913**
2011	489 463	97 893	0	**391 570**
2012	531 972	106 394	0	**425 578**
2013	573 737	114 747	0	**458 990**
2014	614 818	122 964	0	**491 854**
2015	655 278	131 056	0	**524 222**
Total (2006-2015)	**4 644 082**	**928 816**	**0**	**3 715 266**

SECTION F. Environmental impacts

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

This project will have no detrimental effects on the environment. In fact the project is planned in order to enhance the environmental performance of this landfill. The project will allow for optimum landfill gas extraction. Flaring of the collected LFG does not only destroy methane, but will also destroy compounds in the LFG such as volatile organic compounds and ammonia. This project will prevent the following risks associated with landfill gas at uncontrolled landfills:

- Risk of explosion
- Risk of fire
- Unpleasant odours nuisances
- GHG emissions effects
- Potential atmospheric pollution
- Damage to vegetation by asphyxia

The impacts are and will continue to be mitigated by the installations proposed in this project.

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:

An environmental impact assessment was carried out. It shows there is no significant negative impacts from the project activities.

SECTION G. Stakeholders' comments

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

Two public hearing meetings were held for concerned stakeholders. The first meeting, held on Tuesday 13th of December 2005 while the second was held on the 21st of December 2005.

Stakeholders attending the meeting included:

· **General Mohamed Ahmed Bassiouni**- General Secretary of Alexandria Governate
· **Dr. Ezz El Din EL Raii**, Professor in Alexandria University
· **Mr Mohssen Al Diwani**, Director of the affairs of the Environment Department
· **Dr Mona Gamal El Din**, Consultant of the Environment, Representative of the NGOs and member of the "Friends of the Environment" Society
· **Mr Said Mattar**, General Manager of the Financial and Administrative Affairs-Alexandria Governorate
· **Mr Mahmoud Hamed**, Director of the Control & Environmental Follow-up department - Alexandria Governorate

Onyx Alexandria personnel attending the included :

· **Mr Yannick Morillon**, Delegated member of the Board and General Manager of Onyx Alexandria.
· **Mr David Denois**, Director of the treatment department – Onyx Alexandria.
· **Mr Hassan Abaza**, Business Development Director- Onyx Alexandria.

During the first meeting technical details of the project were explained and the contribution of the project to achieving sustainable development goals was presented. A copy of the Project Design Document and the Environmental Impact Assessment of the project site were distributed for the consideration of stakeholders. Also, Arabic translations for the two documents were forwarded to all attending stakeholders as per their request. A form was distributed during the first meeting and different stakeholders were asked to provide their comments after examining the relevant documents.

During the second meeting, stakeholders provided feedback and comments on the project.

G.2. Summary of the comments received:

The main comments received from stakeholders are described below:

1. What are the other benefits for the Alexandria communities in addition to those already mentioned within the PDD?

2. How will other gas emissions be monitored?

3. Will Onyx Alexandria explore other options for the utilization of the landfill gas?

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

A summary of how comments are taken into account is presented below.

1. Onyx Alexandria, as requested by the Egyptian Designated National Authorities' procedures, will contribute 6% of the revenue generated from the sale of the CERs to the Egyptian Environmental Protection (EPF) fund for sustainable development projects. In addition, Onyx Alexandria will also contribute 19% of the CER's revenue to the Governorate of Alexandria for local sustainable development projects, among others, the project regarding street scavengers in Alexandria was mentioned.

2. Gas emissions will be monitored according to the monitoring plan specified in the monitoring methodology and the environmental impact assessment of the project. Flare standards are according to European Standards guaranteeing the full combustion of the gas at a high temperature. The CDM project reinforced the procedure already in place to monitor and control gas emissions from the site. The site has been certified according to ISO 14001 and ISO 9001.

3. Onyx Alexandria with the commissioning of the leachate evaporator will already utilize part of the landfill gas as a fuel. Electric generation from landfill gas will be considered in the future when the available landfill gas volume will be sufficient and when it can be shown that there are no other barriers .

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Represented by:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the project.

Annex 3

BASELINE INFORMATION

Main Data

Factor (t CO2e / t CH4)	Period Applicable	Source
21	1996-2012	Revised IPCC guidelines for National Greenhouse Gas Inventories

Factor (t CH4 / m^3 CH4)	Period Applicable	Source
0.0007168	Default	

Calculation of the baseline

The first step in applying the methodology is to estimate the volume of methane that is expected to be generated from the landfill during the project lifetime. This estimated quantity of methane is calculated based on the amount of waste that is expected to be disposed of in the landfill according to the contract between Onyx Alexandria and Alexandria Governorate. The contract, signed in September 2000, specifies that Onyx Alexandria is responsible for the collection of 2,700 tons of waste on a daily basis with an annual increase of 2%. The waste stream data consist of the measured disposed waste between 2001 and 2004. For years from 2005 to 2015, an annual increase of 2% compare to the value of 2004 was assumed according to the contract.

Estimation of Methane Generated From Landfill

The first order decay model presented in the approved methodology was used to estimate methane emissions from both landfills. The model is as follows:

$$CH4_{\text{Projected, y}} = k * L_o * \sum_{t=0,y} WASTE_{\text{contract, t}} * e^{-k(y-t)}$$

Where:

$CH4_{projected,y}$ is the quantity of methane estimated to be generated (m^3)

k is the methane generation rate constant (1/yr)

L_o is the methane generation potential (m^3 CH4 / t Waste)

$Waste_{contract,t}$ is the waste input at year y

t is the year where methane production is calculated

y is the year where the waste was input to the landfill

Assumption of k

The estimation of methane generated form the landfill is highly sensitive to the assumption of the methane generation rate constant value, k. k value depends on the moisture content in the landfill, temperature in the anaerobic zone, pH, and nutrient availability. According to the US EPA landfill gas to energy development handbook, values of k should be assumed to be between 0.1 and 0.02. It has been observed on site that the gas production is low. In line with the US EPA recommendation and the site observation, the k value has been selected at 0.05.

Estimation of Methane Generation Potential (L_o)

According to IPCC guidelines, methane generation potential is estimated from the following equation:

$Lo = MCF*DOC*DOC_f*F*(16/12)$

Where:
Lo is the methane generation potential of the waste (t CH4 / t Waste)

MCF is the methane correction factor

DOC is the degradable organic carbon in the waste (fraction)

DOC_f is the fraction of organic carbon dissimilated (fraction)

F is the fraction of CH_4 in the landfill gas (fraction)

Estimating MCF

According to IPCC, MCF is assumed according to the types of sites shown in table 5.

Table 5 : Methane Correction Factor

Type of Site	Methane Correction Factor (MCF)
Managed Landfill	1
Unmanaged – deep (≥ 5m waste)	0.8
Unmanaged – shallow (< 5m waste)	0.4
Default value – uncategorized SWDSs	0.6

MCF was assumed to have a value of 1 since the landfill is a well managed landfill. According to IPCC guidelines, well managed landfills should have controlled placement of waste and a degree of control of scavenging activities and control of fires should be in place. Both landfills satisfy this criteria for the following reasons:

- Placement of waste is well planned in previously designed cells. The bottom of each cell is lined with 75 cm of compacted clay and the bottom and sides of the cell are lined with a 2mm HDPE geomembrane liner protected by two layers of 600 g/m^2 geotextiles.
- The landfill is protected with a fence that surrounds it from all sides and no scavenging activities are allowed inside the landfill.
- After the placement of each layer of waste (2 to 2.5 m), the waste is covered by a 15 to 20 cm sand layer which prevents any possible self ignition of the waste.

Estimating DOC

Degradable organic fraction is based on the composition of the waste. DOC is estimated from a weighted average of the carbon content of various components of the waste stream. IPCC guidelines gives default values for the carbon content for various waste types. These values are presented in table 6, shown below.

Table 6 : Degradable Organic Carbon For Major Waste Streams

Waste Stream	Percent DOC by Weight
A. Paper and textiles	40%
B. Garden and park waste, and other (non-food) organic putrescibles	17%
C. Food wastes	15%
D. Wood and straw waste	30%

If the composition of the percentage of each type of waste is known, the weighted average of the degradable organic carbon can be estimated as follows:

% DOC (by weight) = 0.4(A) + 0.17(B) + 0.15(C) + 0.30(D)

Where:
A is the percent paper and textiles in the waste
B is the percent garden and park waste, and other non-food organics
C is the percent food waste
D is the percent wood and straw waste

Table 7, shown below, presents the composition of waste in Egypt. This composition was used to estimate the degradable organic fraction of the Egyptian waste.

Table 7 : Composition of Egyptian Waste

Waste Type	Percentage
Food	50-60%
Paper	10-25%
Plastics	3-12%
Glass	1-5%
Metals	1.5-7%
Textiles	1.2-7%
Others	11-30%

An average value was assumed for each waste stream. Yard waste was assumed at 5% of the total waste while wooden waste was assumed at 2%. The weighted average for the degradable organic carbon was estimated as follows:

% DOC = 0.4(0.22) + 0.17(0.05) + 0.15(0.55) + 0.3(0.02) = 0.19

The default value given in the IPCC guidelines for wastes in Egypt is 0.21 which shows that the estimated value for DOC is a conservative assumption.

Estimating DOC_f

Fraction dissimilated DOC is the portion of the degradable organic carbon that is converted to landfill gas. IPCC guidelines present the following equation to estimate DOC_f:

$DOC_f = 0.014T + 0.28$

Where:
DOC_f is the fraction dissimilated degradable organic carbon
T is the temperature in the anaerobic zone

The temperature in the anaerobic zone was assumed at 35 °C. Therefore, the DOC_f was estimated as follows:

$DOC_f = 0.014(35) + 0.28 = 0.77$

Estimating F

The default value for the fraction of methane in landfill gas is 0.5 as given by IPCC. Field measurements at Borg El Arab landfill at well head showed that methane fraction is in the range of 50-60%. F was assumed at 50% for the sake of conservativeness. It is important to note that the methane content of the landfill gas that is used to treat the leachate decreases due its dilution with air at well head during the collection process. When estimating methane emissions from the waste, the methane content at well head is the value that should be used.

Estimating L_o

Based on the estimation of different parameters needed, methane generation potential was estimated as follows:

$Lo = MCF*DOC*DOC_f*F*(16/12)$

Lo = 1*0.19*0.77*0.5*(16/12) = 0.098 Mg CH4 / Mg Waste = 136 m^3 CH4 / t Waste

IPCC guidelines states that the value of Lo may range from less than 100 to over 200 m3 CH4 / t Waste. This shows that the estimated values are within acceptable range.

Estimation of Waste Quantities

As previously mentioned, Borg El Arab landfill receives waste generated during all months of the year except for the duration of May to September. Projected waste starting from 2004 was estimated based on those received in the previous year with an assumed increase of 2%. Tables 8 presents the amount of solid waste that is projected to be disposed of during the project lifetime at Borg El Arab and El Hammam landfills.

The waste flows will be divided amongst the two sites. The repartition of waste does not affect the predicted methane generation

Table 8 : Projected Municipal Solid Waste Disposed in both landfills during Project Lifetime

Year	Waste Quantity (Tons)
2001	68 000
2002	738 000
2003	828 000
2004	790 715
2005	806 529
2006	822 660
2007	839 113
2008	855 895
2009	873 013
2010	890 474
2011	908 283
2012	926 449
2013	944 978
2014	963 877
2015	983 155
2016	1 002 818

Total Quantity of Methane Generated

Applying the approved model using the estimated parameters, the total quantity of methane generated from the landfill can be assessed. Figures 7 and 8, shown below, presents the total quantities of methane that are expected to be generated from both landfills during the period 2005 to 2016.

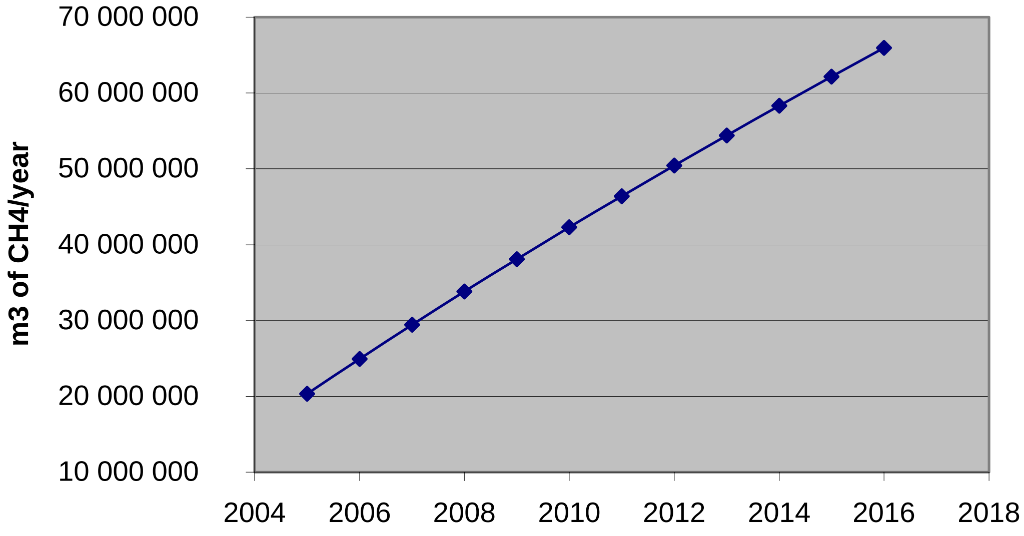

Figure 6 : Methane Generation from both sites

<u>Estimation of Baseline Emissions</u>

As stated in the approved baseline methodology ACM001, the amount of methane that would have been destroyed in the absence of the project activity ($MD_{reg,y}$) should be calculated from the following equation:

$$MD_{reg,y} = MD_{project,y} * AF$$

Where:

$MD_{project,y}$ is the amount of methane actually destroyed during the year by the project activity
AF is the adjustment factor (20%)

Conservativeness in Baseline Estimation

Conservative assumptions have been used to estimate the baseline according to the recommendations of the CDM Executive Board. Conservativeness was accounted for in the following:

- Estimation of methane generation potential (L_o) was estimated based on conservative assumptions for DOC which was estimated at a less value than the default value given in IPCC guidelines.
- A conservative assumption for the methane generation constant (k) was used at a value of 0.05.This value is the recommended value by the U.S. EPA.
- It should be noted that the impact of the landfill gas production model is not sensitive and will not be used in the verification phase. Emission Reduction Credit will only be issued based on on-site verifiable data. The model is used to provide an initial estimate of the potential Emission Reduction of the project.

Annex 4

MONITORING PLAN

Applied methodology

ACM001 Approved Monitoring Methodology "Consolidated monitoring methodology for landfill gas project activities" – Version 2.

1. Brief description of the methodology

As part of the Approved monitoring methodology, it is acceptable to assume that the volume of LFG actually recovered is an indication of the volume of gas that would have been emitted without the project. This will be monitored.

2. Data to be collected or used in order to monitor emissions from the project activity and how this data will be archived

The emission reductions are defined as the difference of emissions in the baseline situation and in the project situation. This means that all landfill gas emissions that are recovered and combusted lead to emission reductions.

Q_x= concentration *Q_c **(A4.1)**

Q_c = total landfill gas recovered in year x (m^3/yr)
Concentration = % of methane in landfill gas (measured
Q_x = total methane recovered in year x (m^3/yr)
To calculate the methane emissions expressed in ton per yr the following formula is used.

$$M = \frac{0.016 * Q_x}{22.4} \qquad \textbf{(A4.2)}$$

In which
M = methane recovered (ton/yr)
0.016 = molecular weight methane (ton/kmol)
22.4 = molecular volume at 0 °C and 1000 hPa (m^3/kmol)
Q_x = total methane recovered in year x (m^3/yr)

The greenhouse gas emission reductions are calculated as follows:
GHG = 21* M **(A4.3)**

In which
GHG = GHG emission reductions (ton CO_2e/yr)
21= GWP of methane (ton CO_2e/ton methane)[4]
M= methane recovered (ton/yr)

Instrumentation

Instrumentation will be calibrated as recommended by manufacturers.
Data will be monitored and archived as described in the AM0011 monitoring methodology.
As recommended data will be kept for two years after the end of the crediting period of the last issuance of CER's for this project activity whatever occurs the latest.

Data collection:

Some data are collected automatically through a data logger such as information on Flare, Evaporator, gas flow.

In case of a default of the evaporator, an alarm is automatically raised. In addition a daily visual inspection is carried out by an operator. During this visit the operator check the instrumentation and monitoring data such as gas quality.

During this daily visit the operator analyses the data and balance the landfill to the adequate suction of the landfill to maintain a steady gas quality. Gas quality and suction level are checked at each individual gas well on a daily basis. This monitoring plan allows maximising gas collection and maintaining the facility.

Data Analysis:

The data are analysed on a daily basis by the operator. In case of a drift of one parameter the operator can react quickly and fix any potential problems.

All data required for the emission reduction calculations will be kept in the onsite-monitoring database. This information will be reported to Veolia Propreté.

On a regular basis, all monitoring information are transferred to Veolia Propreté to analyse the Emission Reduction following the formulae provided within the approved methodology ACM001.

Management system:

The sites will follow the management system in place which have been certified via the international certification system ISO 9000, ISO 14000 and ISO 18000.