VALIDATION REPORT

"Corpus/Araúna – Landfill Biogas Project" in Brazil

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VALIDATION REPORT

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Client: ARAUNA – Energia e Gestão Ambiental Ltda.	Client ref.: Mauricio Maruca

Project Name: "Corpus/Araúna – Landfill Biogas Project"
Country: Brazil
Methodology: ACM0001
Version: 11
GHG reducing Measure/Technology: Landfill gas capture and flare/utilization
ER estimate: Annual average of 48 448 tCO_2e during its 7 year renewable crediting period
Size
☒ Large Scale
☐ Small Scale
Validation Phases:
☒ Desk Review
☒ Follow up interviews
☒ Resolution of outstanding issues
Validation Status
☒ Corrective Actions Requested
☒ Clarifications Requested
☒ Full Approval and submission for registration
☐ Rejected

This validation report summarizes the findings of the validation. In summary, it is DNV's opinion that the Corpus/Araúna – Landfill Biogas Project in Brazil, as described in the PDD of 2 March 2010, meets all relevant UNFCCC requirements for the CDM and all relevant host Party criteria and correctly applies the baseline and monitoring methodology ACM0001 version 11. DNV thus requests the registration of the project as a CDM project activity.
Prior to the submission of the validation report to the CDM Executive Board, DNV will have to receive the written approval of voluntary participation from the DNA of Brazil, including the confirmation by the DNA of Brazil that the project assists it in achieving sustainable development.

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Corpus/Araúna – Landfill Biogas Project in Brazil

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Abbreviations

AMS	Automated Measuring System
ANP	Petroleum National Agency
BM	Build Margin
BEN	National Energetic Balance
BNDES	Brazilian Development Bank / *Banco Nacional de Desenvolvimento Econômico e Social*
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CEF	Carbon Emission Factor
CER	Certified Emission Reduction
CETESB	São Paulo State Environmental Agency
CH_4	Methane
CL	Clarification request
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DNV	Det Norske Veritas
DNA	Designated National Authority
GHG	Greenhouse gas(es)
GWP	Global Warming Potential
IBGE	Statistics and Geosciences Brazilian Institue / *Instituto Brasileiro de Geografia e Estatística*
IGP-M	Brazil´s Market Price Index / *Indice Geral de Preços do Mercado*
IPCC	Intergovernmental Panel on Climate Change
IPT	Technological Research Institute / *Instituto de Pesquisa Tecnologica*
LFG	Landfill gas
MCT	Ministry of Science and Technology
MME	Ministry of Mines and Energy
MP	Monitoring Plan
NGO	Non-governmental Organisation
NPV	Net Present Value
ODA	Official Development Assistance
OM	Operating Margin
ONS	Electric System National Operator / *Operador Nacional do Sistema Elétrico*
PDD	Project Design Document
SIN	Brazilian National Interconnected System/Grid / *Sistema Interligado Nacional*
UNFCCC	United Nations Framework Convention on Climate Change

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1 EXECUTIVE SUMMARY – VALIDATION OPINION

Det Norske Veritas Certification AS (DNV) has performed a validation of the Corpus/Araúna – Landfill Biogas Project, located in the city of Indaiatuba, São Paulo State, Brazil. The validation was performed on the basis of UNFCCC criteria for CDM project activities and relevant Brazilian criteria, as well as criteria given to provide for consistent project operations, monitoring and reporting.

The project participants are Arauna – Energia e Gestão Ambiental Ltda. and Corpus Saneamento e Obras Ltda. of Brazil. The Party involved, i.e. Brazil, meets the requirements to participate in the CDM.

The objective of the project is to capture and flare the biogas generated through the decomposition of the waste in the landfill of Indaiatuba city. Also, there is the possibility to use the biogas to generate electricity.

By improving the environmental conditions for waste disposal in landfills, the project is in line with the current sustainable development priorities of Brazil.

The project applies the approved baseline and monitoring methodology ACM0001, i.e. "Consolidated baseline and monitoring methodology for landfill gas project activities" (version 11). The baseline methodology has been correctly applied and the assumptions made for the selected baseline scenario are sound. It is sufficiently demonstrated that the project is not a likely baseline scenario and that emission reductions attributable to the project are additional to any that would occur in the absence of the project activity.

The monitoring methodology has been correctly applied. The monitoring plan sufficiently specifies the monitoring requirements of the main project indicators.

By capturing and destroying biogas from a landfill, the project results in reductions of CO_2 emissions that are real, measurable and give long-term benefits to the mitigation of climate change. Emission reductions are directly monitored and calculated ex-post, using the approach given in ACM0001 (version 11). The ex-ante estimation of emission reductions and the projected biogas generation from the landfill was determined using the first order decay model.

In summary, it is DNV's opinion that the Corpus/Araúna – Landfill Biogas Project, as described in the revised project design document of 2 March 2010, meets all relevant UNFCCC requirements for the CDM and all relevant host Party criteria and correctly applies the baseline and monitoring methodology ACM0001 (version 11). Hence, DNV will request the registration of the Corpus/Araúna – Landfill Biogas Project as a CDM project activity.

Prior to the submission of the validation report to the CDM Executive Board, DNV will have to receive the written approval of voluntary participation from the DNA of Brazil, including the confirmation by the DNA of Brazil that the project assists it in achieving sustainable development.

2 INTRODUCTION

ARAUNA – Energia e Gestão Ambiental Ltda. has commissioned Det Norske Veritas Certification AS (DNV) to perform a validation of the Corpus/Araúna – Landfill Biogas Project located in the city of Indaiatuba, São Paulo State, Brazil (hereafter called "the project"). This validation report summarises the findings of the validation of the project, performed on the basis of UNFCCC criteria for the CDM, as well as criteria given to provide for consistent project operations, monitoring and reporting. UNFCCC criteria refer to Article 12 of the Kyoto Protocol, the CDM modalities and procedures and the subsequent decisions by the CDM Executive Board.

2.1 Objective

The purpose of a validation is to have an independent third party assess the project design. In particular, the project's baseline, monitoring plan, and the project's compliance with relevant UNFCCC and host Party criteria are validated in order to confirm that the project design, as documented, is sound and reasonable and meets the identified criteria. Validation is a requirement for all CDM projects and is seen as necessary to provide assurance to stakeholders of the quality of the project and its intended generation of certified emission reductions (CERs).

2.2 Scope

The validation scope is defined as an independent and objective review of the project design document (PDD). The PDD is reviewed against the criteria stated in Article 12 of the Kyoto Protocol, the CDM modalities and procedures as agreed in the Marrakech Accords, and the relevant decisions by the CDM Executive Board, including the approved baseline and monitoring methodology ACM0001(version 11) Consolidated baseline methodology for landfill gas utilization project activities /33/. The validation was based on the recommendations in the Validation and Verification Manual /39/.

The validation is not meant to provide any consulting towards the project participants. However, stated requests for clarifications and/or corrective actions may have provided input for improvement of the project design.

3 METHODOLOGY

The validation consisted of the following three phases:

I a desk review of the project design documents

II follow-up interviews with project stakeholders

III the resolution of outstanding issues and the issuance of the final validation report and opinion.

The following sections outline each step in more detail.

3.1 Desk Review of Project Documentation

The following table lists the documentation that was reviewed during the validation:

/1/ ARAUNA – Energia e Gestão Ambiental Ltda.: *Project Design Document for the* Corpus/Araúna – Landfill Biogas Project. Version 3 of 5 May 2009.

/2/ ARAUNA – Energia e Gestão Ambiental Ltda.: *Project Design Document for the* Corpus/Araúna – Landfill Biogas Project. Version 4 of 2 March 2010.

/3/ Corpus/Araúna – Landfill Biogas Project spreadsheet (CER – CorpusAraúna – Landfill Biogas Project version 14)

/4/ Previous License (# 000266 – Process # SMA 13651/99 – from 30/12/1999),
Installation License (# 36000255 – Process # 36/00257/00 – from 26/06/2000),
Working License (# 36000678 – Process # 36/00257/00 – from 20/03/2002),
Installation License (# 36002945 – Process # 36/00251/09 – from 30/06/2009)

/5/ Notifications from the Brazilian Post Office that stakeholders received a letter communicating the start of the project:

Interministerial Commission for the Global Climate Change on 30 April 2009;

CETESB - São Paulo State Environmental Agency 30 April 2009;

Brazilian Forum of NGO´s on 30 April 2009;

Brazilian Forum of Climate Change on 30 April 2009;

Federal Public Prosecution Office on 10 July 2009;

São Paulo State Public Prosecution Office on 30 April 2009;

Inadaiatuba City Hall on 2 June 2009 and Indaiatuba City Council on 4 June 2009.

/6/ Previous landfill assessment study by Corpus Saneamento e Obras Ltda. on April 2009

/7/ Contract between Arauna – Energia e Gestão Ambiental Ltda. and Corpus Saneamento e Obras Ltda. of 6 January 2009

/8/ Generation producer especification (Cummins – 1750 kW – model 1750 GQPB – April 2008)

/9/ Enclosed flare proposal (CARRER Elétrica e Automação of 28 March 2009)

/10/ Flare Analyser Unit (FAU & AEMS) proposals (LANDTEC of 3 November 2008)

/11/ LFG Extraction Net proposals: Plastolândia (20 October 2008), SYBS (22 October 2008), RIMAR (22 October 2008), Metal Canindé (22 October), Perfurasolo (20

October 2008)

/12/ Topography service proposal (CARRER Elétrica e Automação of 27 March 2009)

/13/ System operation and Energy consumption costs sorces: spreadsheet "Operadores.xls"

/14/ LFG Genset proposal (Cummins Power Generation of 8 June 2009)

/15/ Energy operation maintenance: Cummins Power Generation Proposal of 8 June 2009, item 4.3

/16/ 7th electricity auction of new energy held on 30 September 2008 (CCEE – Câmara de Comercialização de Energia Elétrica – Eletric Energy Chamber of Commerce (accessed on March 2010):
http://www.ccee.org.br/cceeinterdsm/v/index.jsp?vgnextoid=9c3225accdb7c110VgnVCM1000005e01010aRCRD

8th electricity auction of new energy held on 27 August 2009 (CCEE – Câmara de Comercialização de Energia Elétrica – Eletric Energy Chamber of Commerce (accessed on April 2010):
http://www.ccee.org.br/cceeinterdsm/v/index.jsp?vgnextoid=39c02d85c2753210VgnVCM1000005e01010aRCRD

/17/ BNDES (Brazilian Development Bank / *Banco Nacional de Desenvolvimento Econômico e Social*) website (accessed on March 2010):
www.bndes.gov.br

BNDES (Brazilian Development Bank / *Banco Nacional de Desenvolvimento Econômico e Social*) lending rate to environmental projects (accessed on March 2010):
http://www.bndes.gov.br/social/saneamento.asp

BNDES (Brazilian Development Bank / *Banco Nacional de Desenvolvimento Econômico e Social*) - TJLP value (accessed on March 2010):
http://www.bndes.gov.br/produtos/custos/juros/tjlp.asp

/18/ Lanfill energy invoices: CPFL Energia (CPFL Energy) invoices from June 2008 to June 2009

/19/ Study of the waste composition by Unicarbo of 25 May 2009

/20/ Tax of methane recovered: Paper "**Biogás de aterro para geração de eletricidade e Iluminação.** *USP"* (Landfill biogás to electricity generation). Available at (accessed on March 2010):
http://cenbio.iee.usp.br/download/projetos/aterro.pdf

/21/ Destruction efficiency of the baseline system by Landtec on April 2009

/22/ Burning efficiency in the enclosed flare (Proposal of CARRER – Elétrica e Automação – 28 March 2009)

/23/ Generator specification (Cummins Power Generator – 1750 kW – model 1750 GQPB – April 2008)

/24/ National Grid Emission Factor by the Brazilian DNA, available at (accessed on March 2010):
www.mct.gov.br/clima

/25/ Blower performace test curve: spreadsheet LFG.xls – by Robuschi (271477 C ver 01)

/26/ Report of technical losses – ANEEL (National Agency of Eletric Energy) of 20 August 2007. Available at (accessed on March 2010):
http://www.aneel.gov.br/aplicacoes/audiencia/arquivo/2007/035/documento/anexo_v_-_nt_251_2007_perdas_tecnicas_cpfl_piratininga__ap_.pdf

/27/ Norma Ambiental Environmental Lawyer Office: Brazilian Environmental Legislation colleting of 2009 - Legis Ambiental

/28/ Brazilian National Interconnected System (Grid), available at (accessed on March 2010):
http://www.ons.org.br/conheca_sistema/mapas_sin.aspx#

/29/ São Paulo state inventary of solid waste – 2008 (Cetesb), available at (accessed on March 2010): http://www.cetesb.sp.gov.br/Solo/publicacoes.asp

/30/ IBGE (Statistics and Geosciences Brazilian Institue / *Instituto Brasileiro de Geografia e Estatística*) study regarding destination of collected waste in Brazil (2000), available at (accessed on March 2010):
http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/pnsb/lixo_coletado/lixo_coletado109.shtm

/31/ Common practice survey by Arauna, 22 February 2010

/32/ Indaiatuba city Mean Annual Temperature (MAT) available at (accessed on March 2010):
www.indaiatuba.sp.gov.br/cidade/aspectos-fisicos/
Indaiatuba city Mean Annual Precipitation (MAP) available at (accessed on March 2010):
http://www.saae.sp.gov.br/saae_tratamento.htm

/33/ CDM-EB: Approved Consolidated Baseline and Monitoring Methodology ACM0001 Consolidated baseline methodology for landfill gas utilization project activities Version 11 http://cdm.unfccc.int/UserManagement/FileStorage/UJBDVFYLQKSEWCM73XG14Z692TRHO0

/34/ CDM-EB: Tool for the demonstration and assessment of additionality Version 5.2 Annex 10 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf

/35/ CDM-EB: Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site Version 4 Annex 10
http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v4.pdf

/36/ CDM-EB: Tool to calculate the emission factor for an electricity system Version 2 Annex 12 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf

/37/ CDM-EB: Tool to calculate baseline, project and/or leakage emissions from electricity consumption Version 01 Annex 7
http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf

/38/ CDM-EB: Tool to determine project emissions from flaring gases containing methane Annex 13 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf

/39/ CDM Executive Board: Validation and Verification Manual version 1.1
http://cdm.unfccc.int/Reference/Manuals/accr_man01.pdf

/40/ CDM Executive Board: Guidelines on the demonstration and assessment of prior consideration of the CDM. Version 3 EB 49
http://cdm.unfccc.int/Reference/Manuals/accr_man01.pdf

/41/ IGPM – Indice Geral de Preços do Mercado (Brazil´s Market Price Index) available at

(accessed on March 2010):
http://www.portalbrasil.net/igpm.htm

/42/ ONS – Electric System National Operator / Operador Nacional do Sistema Elétrico website (accessed on March 2010):
www.ons.org.br
Brazilian National Interconnected System (Grid) SIN available at:
http://www.ons.org.br/conheca_sistema/mapas_sin.aspx#
Brazilian DNA defining the Brazilian Grid as unique: Resolution nr. 8 issued on 26 May 2008

3.2 Follow-up Interviews with Project Stakeholders

On 29 May 2009, DNV performed a site visit and interviews with project stakeholders to confirm selected information and to resolve issues identified in the document review. Fabiana Philipi and Luis Filipe Tavares conducted the site visit. The main topics of the interviews and the project stakeholders are summarized in the table below.

	Date	Name	Organization	Topics
/43/	**29/05/2009**	**Alexandre Sorroche**	**Corpus Saneamento e Obras Ltda.**	• **Project's system components and equipments in the facility** • **Investment Analysis;** • **Monitoring, reporting and QA/QC procedures** • **Training of personnel;** • **Local stakeholders Consultation;** • **Operational Licenses and Environmental Impacts;** • **Additionality and CDM evidence**
/44/	**29/05/2009**	**Nuno Barbosa**	**Arauna – Energia e Gestão Ambiental Ltda.**	
/45/	**29/05/2009**	**André Paternostro**	**CDM Energy**	

The main changes from the PDD version 3 of 5 May 2009 /1/ which was published for 30 days stakeholders commenting period and the final PDD version 4 of 2 March 2010 which is submitted for registration are:
- Financial analysis: it was adequated to the project life time, input were updated according evidencies provided, values were included/excluded in order to represent correctly the scenarios;
- ACM0001 version 11 is adopted in PDD version 4 while PDD version 3 adopted an earlier methodology version (ACM0001 version 10);
- The PDD is revised according to the resolutions of raised CAR's and CL's;
- Revised the description of CDM consideration and project's starting date;
- Revised emission reductions estimate and monitoring plan;
- Revised financial analysis.

3.3 Resolution of Outstanding Issues

The objective of this phase of the validation was to resolve any outstanding issues which needed to be clarified prior to DNV's positive conclusion on the project design. In order to ensure transparency a validation protocol was customised for the project. The protocol shows in a transparent manner the criteria (requirements), means of verification and the results from validating the identified criteria. The validation protocol serves the following purposes:

- It organises, details and clarifies the requirements a CDM project is expected to meet;
- It ensures a transparent validation process where the validator will document how a particular requirement has been validated and the result of the validation.

The validation protocol consists of three tables. The different columns in these tables are described in the figure below. The completed validation protocol for the "Corpus/Araúna – Landfill Biogas Project" is enclosed in Appendix A to this report.

A corrective action request (CAR) is raised if one of the following occurs:

(a) The project participants have made mistakes that will influence the ability of the project activity to achieve real, measurable additional emission reductions;

(b) The CDM requirements have not been met;

(c) There is a risk that emission reductions cannot be monitored or calculated.

A clarification request (CL) is raised if information is insufficient or not clear enough to determine whether the applicable CDM requirements have been met.

A forward action request (FAR) is raised during validation to highlight issues related to project implementation that require review during the first verification of the project activity. FARs shall not relate to the CDM requirements for registration.

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Validation Protocol Table 1: Mandatory Requirements for CDM Project Activities		
Requirement	***Reference***	***Conclusion***
The requirements the project must meet.	*Gives reference to the legislation or agreement where the requirement is found.*	*This is either acceptable based on evidence provided (**OK**), a **Corrective Action Request (CAR)** of risk or non-compliance with stated requirements or a request for **Clarification (CL)** where further clarifications are needed.*

Validation Protocol Table 2: Requirement checklist				
Checklist Question	***Reference***	***Means of verification (MoV)***	***Comment***	***Draft and/or Final Conclusion***
The various requirements in Table 2 are linked to checklist questions the project should meet. The checklist is organised in different sections, following the logic of the large-scale PDD template, version 03 - in effect as of: 28 July 2006. Each section is then further sub-divided.	*Gives reference to documents where the answer to the checklist question or item is found.*	*Explains how conformance with the checklist question is investigated. Examples of means of verification are document review (DR) or interview (I). N/A means not applicable.*	*The section is used to elaborate and discuss the checklist question and/or the conformance to the question. It is further used to explain the conclusions reached.*	*This is either acceptable based on evidence provided (**OK**), or a c**orrective action request (CAR)** due to non-compliance with the checklist question (See below). A request for clarification (CL) is used when the validation team has identified a need for further clarification.*

Validation Protocol Table 3: Resolution of Corrective Action and Clarification Requests			
Draft report clarifications and corrective action requests	***Ref. to checklist question in table 2***	***Summary of project owner response***	***Validation conclusion***
If the conclusions from the draft Validation are either a CAR or a CL, these should be listed in this section.	*Reference to the checklist question number in Table 2 where the CAR or CL is explained.*	*The responses given by the project participants during the communications with the validation team should be summarised in this section.*	*This section should summarise the validation team's responses and final conclusions. The conclusions should also be included in Table 2, under "Final Conclusion".*

Figure 1: Validation protocol tables

3.4 Internal Quality Control

The validation report underwent a technical review before requesting registration of the project activity. The technical review was performed by a technical reviewer qualified in accordance with DNV's qualification scheme for CDM validation and verification.

3.5 Validation Team

				Type of involvement					
Role/Qualification	*Last Name*	*First Name*	*Country*	**Desk review**	**Site visit / Interviews**	**Reporting**	**Supervision of work**	**Technical review**	**Expert input**
CDM validator / Technical team leader	Tavares	Luis Filipe	Brazil	x	x		x		
GHG auditor	Philipi	Fabiana	Brazil	x	x	x			
Technical reviewer (draft)	Sharma	Anjana	India					x	
Technical reviewer (final, applicant)	Wong	Simon	Malaysia					x	
Technical reviewer (final)	Brinks	Hendrik	Norway					x	

The qualification of each individual validation team member is detailed in Appendix B to this report.

4 VALIDATION FINDINGS

The findings of the validation are stated in the following sections. The validation criteria (requirements), the means of verification and the results from validating the identified criteria are documented in more detail in the validation protocol in Appendix A.

The validation findings relate to the project design as documented and described in the revised and resubmitted project design documentation, version 4 of 2 March 2010.

4.1 Participation Requirements

The project participants are Arauna – Energia e Gestão Ambiental Ltda. and Corpus Saneamento e Obras Ltda. of Brazil. There is no Annex I Party defined yet.

Prior to the submission of the validation report to the CDM Executive Board, DNV will have to receive the written approval of voluntary participation from the DNA of Brazil, including the confirmation by the DNA of Brazil that the project assists it in achieving sustainable development. The project's contribution to the sustainable development of the country shall be confirmed through the written Letter of Approval to be issued by the Brazilian DNA.

The project does not involve any public funding and the validation did not reveal any information that indicates that the project can be seen as a diversion of ODA funding towards Brazil.

4.2 Project Design

The "Corpus/Araúna – Landfill Biogas Project" consists of the installation of a forced exhaustion system of the landfill gas (LFG), an enclosed flare and equipments for electricity generation. The project is located in the city of Indaiatuba, São Paulo State, Brazil, operated by Corpus Saneamento e Obras Ltda. The project coordinates are: 23°05'25" S latitude 47°13'05" W longitude. The LFG is generated through the decomposition of the organic waste deposited in the landfill. The main component of the LFG is methane (CH_4), a Greenhouse gas (GHG) according to the Kyoto Protocol. Flare and electricity generation from LFG involves the destruction of CH_4, which leads to GHG emissions reduction. Electricity generation from LFG will also create additional GHG emissions reductions, as a consequence of CO_2 emission avoidance that would have been produced if the electricity was generated from a non renewable source. The landfill currently uses a passive venting with occasional flaring, thus most of the LFG produced escapes to the atmosphere. The leachate is stored in aerobic lagoons at the site and exported to a private wastewater treatment plant.

The landfill started operation in 2002 and the end of operation is expected to be in 2017. The waste filled in 2002 was 113 tonnes/day /6/, and it is expected to increase to 250 tonnes/day from 2010 /4/. The project activity is expected to generate a maximum of 11 566 MWh /3/ and therefore a generator with 1.75 MW of installed capacity will be implemented. The installed capacity was calculated considering the yearly methane generation, its electric potential, 87% of LFG produced that is addressed to energy generation and 37.1% LFG to electricity conversion efficiency /23/.

The project design engineering reflects good practice for the collection of LFG, flaring of LFG and utilization of LFG for electricity generation. The technology to be used in the project activity is available in the Brazilian market, consisting basically of a vertical and/or

horizontal drain system interconnected to blower. These materials and equipments are available in Brazil, with the exception of the generation equipment.

A 7-years renewable crediting period is selected (with the potential of being renewed) starting on 1 September 2010, or on the date of the registration of the CDM project activity, whichever is later. The starting date of the project activity is 1 September 2010 (an estimated date, since DNV verified during the site visit that project implementation has not started and according PDD /2/ the construction of the LFG capture and destruction system should be started when registered or until 15 days after the registration of the CDM project at UNFCCC) and the expected operation lifetime of the project activity is 14 years (from 2010 to 2023). DNV has verified through the CER calculus spreadsheet /3/ estimates that after the 14th year the amount of biogas reduces considerably and thus is not worth continuing to operate the project.

The project description is to the consideration of DNV complete and accurate.

4.3 Baseline Determination

The project applies the approved consolidated baseline methodology ACM0001 "Consolidated baseline methodology for landfill gas utilization project activities" version 11 /33/. This methodology is applicable to the project as this project consists of the installation of a forced exhaustion system of the landfill gas, a enclosed flare and equipments for electricity generation from the LFG generated through the decomposition of the organic waste deposited in the landfill. The project meets the methodology's applicability criteria since:

- the captured gas is flared; and
- the captured gas is used to produce energy.

The project boundary is the site of the project activity where the gas captured, destroyed and used, and all the power generation sources connected to the grid to which the project activity is connected.

The selected baseline scenario is the total atmospheric release of the landfill gas. The selection of the baseline scenario is in compliance with the requirements of ACM0001 version 11, which includes the following steps:

Step 1: Identification of alternative scenarios.

The identified alternative scenarios are:

LFG1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity;
LFG2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.
Since it is not mandatory to flare the landfill gas in Brazil (according Brazilian environmental laws and regulations /27/ and environmental licenses /4/, that do not foresees landfill gas flaring between the mandatory activities) and flaring does not give any income to compensate for the costs involved, flaring of landfill gas is not a realistic option. LFG1 is therefore only limited to mainly use of landfill gas for electricity generation.

Also, all the power generation realistic and credible alternatives were considered:
P1: Power generated from landfill gas undertaken without being registered as CDM project activity;
P2: Existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant;
P3: Existing or construction of a new on-site or off-site renewable based cogeneration plant;
P4: Existing or construction of a new on-site or off-site fossil fuel fired captive power plant;
P5: Existing or construction of a new on-site or off-site renewable based captive power plant;
P6: Existing and/or new grid-connected power plants; if LFG is used to generate electricity, this energy will be sent to grid.

Cogeneration plants are not realistic alternatives to the project since there is no need for heat in the site or nearby facilities. Thus, alternatives P2 and P3 for cogeneration are excluded. The construction of a captive power plant is not a realistic alternative, since the average annual consumption of energy is low and does not justify the deployment of a captive power plant at the landfill. DNV has assessed the landfill energy invoices /18/ and concluded that the savings due in electricity consumption (6 146 Euro per year) are not enough to justify the implementation of a captive plant. Therefore, alternatives P4, P5 for captive power plant were excluded.

Also, all heat generation realistic and credible alternatives were considered:
H1: Heat generated from landfill gas undertaken without being registered as CDM project activity;
H2: Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant;
H3: Existing or Construction of a new on-site or off-site renewable based cogeneration plant;
H4: Existing or new construction of on-site or off-site fossil fuel based boilers, air heaters or other heat generating equipment (e.g. kilns);
H5: Existing or new construction of on-site or off-site renewable energy based boilers, air heaters or other heat generating equipment (e.g. kilns);
H6: Any other source such as district heat; and
H7: Other heat generation technologies (e.g. heat pumps or solar energy).
Cogeneration plants are not realistic alternatives to the project since there is no need for heat in the site or nearby facilities. Thus, the the heat generation alternatives, from H1 to H7 were excluded.

The realistic and credible alternatives left are:

- LFG1+P1 (project activity)

- LFG2+P6 (continuation of pre-project scenario)

DNV considers the list of realistic and credible alternatives to be complete.

There are no policies or regulations in Brazil including mandatory landfill gas capture or destruction requirements because of safety issues or local environmental regulations /27/, the environmental licences /4/ granted by the environmental agency to the project activity do not mention landfill gas capture and/or destruction between their mandatory applicability conditions. The obligation of flaring biogas is not a condition to obtain the environmental licence by the Environmental Entity CETESB (Environmental Sanitation Technology Company) /27/.

Step 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable:
There will be no extra use of fossil fuel in the project activity that was not used in the baseline scenario. The project participants did not use any fossil fuel before implementation of the project activity, electricity is provided by the national grid /28/, which was verified through the landfill electricity invoices /18/.
As the used electricity comes from the Brazilian grid, it does not fit to accomplish a choice of the fuel, because the emission factor is determined as per "Tool to calculate the emission factor of an electric system".

Step 3: Step 2 and/or Step 3 of the "Tool for the demonstration and assessment of additionality" version 5.2.

Since the project activity (LFG1+P1) has a negative internal rate of return (IRR), cf. Section 4.4, realistic alternative scenario for implementation of the project activity is LFG2 (Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns) and P6 (existing and/or new grid-connected power plants) The selected baseline scenario was selected as per the methodology.

***Step 4*: Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario.**

There is only one credible and plausible alternative to the project activity which is the continuation of the current operation conditions of the landfill (LFG2+P6). The credible and plausible alternative to the project activity complies with the methodology applicability since:

a) The most plausible baseline scenario for the landfill gas is identified as the atmospheric release of landfill gas;
b) The most plausible baseline scenario for the energy component of the baseline scenario is the electricity is obtained from the grid.

This baseline scenario is in line with the applicability criterion of the methodology.

Emission sources and gases included in the project boundary are:

	GHGs involved	*Description*
Baseline emissions	***CH_4***	***Methane in the LFG produced in the anaerobic decomposition of the organic waste deposited in the landfill***
	CO_2	***Electricity consumption from the grid***
Project emissions	***CO_2***	***Project activity electricity consumption during the first year of operation***
Leakage	***N/A***	***There are no leakages that need to be considered in applying* ACM0001 *methodology.***

The selected sources and gases are justified for the project activity.

4.4 Additionality

In accordance with the methodology ACM0001 Consolidated baseline methodology for landfill gas utilization project activities version 11, the additionality of the project is demonstrated through the Tool for the demonstration and assessment of additionality version 5.2.

4.4.1 CDM consideration and continued action to secure CDM status.

Since there is no commitment to financial expenditure yet, the starting date of the project activity is estimated to be 1 September 2010. Therefore the CDM consideration, that is the start of the validation process (when PDD was made publicly available on UNFCCC website from 7 May 2009 to 5 June 2009) /40/ is before the project starting date. According PDD, the project activity construction has to be started when registered or until 15 days after the registration of the CDM project at UNFCCC.

A contract between Araúna – Energia e Gestão Ambiental Ltda., the responsible for the construction, capture and destruction of the LFG and/or electricity generation from the LFG, and the owner of Indaiatuba city landfill, Corpus Saneamento e Obras Ltda, was signed on 6 January 2009, mentions the Kyoto Protocol and the CERs that will be generated from the project implementation and therefore is another proof of the CDM consideration /7/. This contract does not commit to any financial expenditure and was established in order to determine Araúna – Energia e Gestão Ambiental Ltda. as the CDM project developer and in charged of the project activity implementation.

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

As mentioned in Section 4.3 (Baseline determination), there are only two realistic alternatives that need to be further addressed:

- LFG1 + P1: The project activity; collection of landfill gas mainly for electricity generation and the rest being flared.
- LFG2 + P6: Most of the landfill gas being vented and the electricity produced by other power plants in the national grid.

4.4.3 Investment analysis: Choice of approach

As the project activity installed with power plant generates revenues from the sale of electricity and the alternative does not involve investments for the project participants, benchmark analysis has been adopted to demonstrate that the alternative LFG1 + P1 is not feasible.

4.4.4 Benchmark

The benchmark adopted is the_BNDES (Brazilian Development Bank / *Banco Nacional de Desenvolvimento Econômico e Social*) lending rate._A bank lending rate is an adequate

benchmark. BNDES rate is a public bank which mission is to provide the national development considering social and environmental actions and which rates are the lower in the market, therefore conservative to be used as benchmark /17/. DNV has assessed that the BNDES landing rate to environmental projects is composed by a long term rate (TJLP) which value has been 6.25% in the last 3 years, BNDES remuneration 0.9%, risk rate 3.57%, resulting in an annual rate of 10.72% as benchmark /17/. Project-IRR before tax was chosen as the appropriate financial indicator.

4.4.5 Investment analysis: Input parameters

Investment costs

The LFG genset of 1.75 MW was estimated to cost 1.044 million Euro, which was verified from the proposal from Cummins /14/.

The enclosed flare cost of 224 019.93 Euro was verified from the proposal of Carrer Elétrica e Automação /9/, the flare analyser unit (FAU & AEMS) value was verified from the Landtec proposals /10/, the landfill gas extraction net value 159 265.37 Euros was verified from the Plastolândia, Sybs, Rimar, Metal Canindé, Perfurasolo proposals /11/ (value described is the sum of values of each proposal).

Pre-operational costs

The topography services value 12 757 Euro was cross checked with proposal of Carrer Elétrica e Automação /12/. DNV has assessed that since the company that runs the landfill does not perform topography as part of current landfill operations, a specific topography will have to be done in order to plan the gas extraction network.

Operational Costs

The capture and flaring system operation cost 45 898 Euros/year was verified by a spreadsheet /13/ that considered the salary paid to the team that will be working in the landfill net implementation of the project during the operation and the waste received. The energy consumption value 5 537 Euro in the first year before the electricity generation system is in operation was cross checked with the landfill energy tariff in the invoices from June 2008 to June 2009 /18/. It is anticipated that the project activity will generate renewable electricity for own consumption starting from the second year when the LFG genset is expected to be commisioning, hence operational costs from the purchase of grid electricity to operate the parasitic consumption will be incurred during the first year. This has been correctly reflected in the IRR calculation spreadsheet.

The energy system maintenance value 23 Euros/MWh was cross checked with the Cummins Power Generation Proposal, item 4.3 /15/. The energy system operation cost 48 448 Euros/year was verified by a spreadsheet /13/ that considered the salary paid to the team that will be working in the electricity generation system. Also, DNV has verified that some energy generators have lower prices but higher O&M costs. In order to assess the values presented, DNV compared them with the project activity already registered “Gorai Landfill closure and Gas Capture Project, Mumbai, India” (project number 2944). The “Gorai Landfill closure and Gas Capture Project, Mumbai, India” project activity is the implementation of a gas extraction system and a flare/energy generation system in India, with 3 MW of installed capacity.

According PDD information, the 3 MW generator cost was 1.34 million Euros (85.5 million Indian rupee). Also, the average yearly O&M costs regarding the generator operation is 311 thousand Euros/year. This value implies an O&M expenditure per year around 23.6% of the generator total cost. The present project has a similar O&M expenditure per year around 22.56% of the generator total cost. However, cheaper generators costs are compensated by higher O&M cost. Through this analysis and based on the generator and O&M costs evidences provided, Cummins proposals /14//15/, it is DNV opinion that the values applied in the financial analysis are adequate.

Income

The income is the electricity generation times the electricity tariff. The electricity generation was estimated from the methane generation potential, collection efficiency and electricity generation efficiency to an average value of 8 136 MWh from 2011 to 2023. The tariff was cross checked against the 7th electricity auction of new energy held on 30 September 2008 (price for energy from bagasse from sugar cane was 48.17 Euro /16/). This is the last electricity auction that happened in Brazil and involves renewable sources. The electricity sale will generate a revenue of 5.095 million Euros in the 13 years of generation, an average of 391 933 Euros/year.

The electricity saving (avoided costs from electricity purchases) was estimated through the average energy consumption in one year (50 MWh /18/) and the average energy tariff in one year, from June 2008 to June 2009 (0.10953 Euro/kWh /18/), resulting in 79 902 Euros in the 13 years of electricity generation.

4.4.6 Investment analysis: Calculation and conclusion

The financial analysis spreadsheet /3/ was assessed considering the 14 years of project life time. The input parameters, assumption and calculations were confirmed to be correct. The resulting project-IRR is negative IRR (-1.48%) which is much lower than the benchmark 10.72%, and therefore the alternative LFG1+P1 is not financially attractive.

4.4.7 Sensitivity Analysis

A sensitivity analysis was carried out for parameters contributing more than 20% to revenues or costs in order to check the robustness of the financial analysis. Reasonable variations of the energy selling price, electricity generator price and electricity generator maintenance costs were checked by calculating the variation necessary to reach the benchmark and then discussing the likelihood for that to happen. None of the parameters in the sensitivity analysis are considered to have any significant positive correlation.

DNV was able to verify that the project IRR will touch the benchmark only if the above mentioned parameters change by values as mentioned below:

Energy selling price	Electricity generator price	Electricity generator maintenance costs
+35.7%	-82%	-78%

Energy: A variation of 35.7% in the price of energy sold (energy price of 65.37 Euros) would lead to an IRR of the benchmark. The electricity price adopted (48.17 Euros /16/) is from the

last energy auction that happened in Brazil regarding renewable sources. DNV has assessed the auctions happened in 2009 and 2010 and has verified that the higher energy tariff regarding an auction of new energy was 50.07 Euros (the 8th auction of new energy held on August 2009), 4% higher than the electricity price adopted 48.17 Euros /16/. Thus the probability to have such increase in the energy price is very low.

Electricity generator LFG genset: A decrease of 82% in the generator price would lead to an IRR of the benchmark. As the generator price adopted (1 043 930 Euros) is from the proposal provided by Cummins on June 2009 /14/ such a decrease is highly unlikely.

Generator maintenance: A decrease of 78% in the generator maintenance price would lead to to an IRR of the benchmark. The generator maintenance price adopted (23 Euros/MWh) is from the proposal provided by Cummins on June 2009 /15/, and such a decrease is highly unlikely.

The financial analysis and sensitivity analysis demonstrate that without the income from CERs sales, the project is not a financially attractive option.

4.4.8 Common practice analysis

The environmental entity CETESB (São Paulo State Environmental Agency) does not require the landfills to capture and flare the biogas produced /27/. This activity is not a condition to a landfill to get any of the environmental licences during all the phases: previous licence, installation licence and operation licence.

DNV has assessed that there are 1 452 sanitary landfills in Brazil, from the total 8 381 final destinations of collected waste, and 5 993 open dump landfills /30/, and that the sanitary landfills have no obligation to capture and flare the biogas. There are only 30 sanitary landfills CDM projects registered or under validation at UNFCCC. The Cetesb (São Paulo State Environmental Agency) efforts now a day is to close dumps and force municipalities to give proper destination to the waste /29/.

The project participant has performed a survey in order to assess if landfills in the same region (São Paulo state) and that receive a similar amount of waste per day (from 160 to 250 tonnes) capture and flare/generate energy with the biogas and are not CDM projects /31/. DNV has assessed that based on the São Paulo state inventary of solid waste /29/, 11 landfills with the description above were identified: 3 implemented/are implemented a CDM project (projects “Terrestre Ambiental Landfil Project”, “Landfill Gas to Energy Project at Lara Landfill, Mauá, Brazil” and “Alto Tiete Landfill Gas Project”); 4 are not under operation any more and have no CDM projects implemented/under implemention (São José do Rio Preto, Carapicuíba, Piracicaba and Mogi da Cruzes); 4 do not capture and burn/generate energy with the biogas (Franca, Limera, Suzano and Itu).

It is DNV opinion that the LFG capture and flare/use to generate energy is not a feasible scenario without the CDM incentive and therefore the project activity is additional.

4.5 Monitoring

The proposed project applies the approved monitoring methodology ACM0001 version 11. The selected monitoring methodology is applicable for the project.

Details of the data to be collected, frequency of data recording, and the project management responsibilities have been defined in the monitoring plan of the PDD. The monitoring plan is

in accordance with the monitoring methodology. The monitoring plan will give opportunity for real measurements of achieved emission reductions. It is DNV opinion that the project participant has sufficient condition of implementing and operating the monitoring plan described bellow.

According to ACM0001 version 11, the monitoring consists of direct measurement of the amount of methane flared/used to generate electricity, and concerning leakage, no sources of emission were identified.

4.5.1 Parameters monitored ex-ante

Baseline emission estimations are correct and transparently documented in the spreadsheet /3/. The following parameters are made available *ex-ante*:

According ACM0001 version 11:

- DNV has assessed that regulatory requirements relating to landfill gas projects are according the CETESB regulation /27/;
- The GWP_{CH4} (Global Warming Potential - GWP) of methane is correctly applied according to IPCC2006 values;
- The methane density is correctly applied according ACM0001 /11/;
- The $BE_{CH4,SWDS,y}$ (Methane generated by the landfill in the absence of the project activity in the year y), correctly calculated through the daily amount of waste dumped (previous landfill assessment study until 2008 /6/ and after it was used the amount of waste allowed by the environmental licence (250 t/day /4/) and the waste composition (study of the waste composition ($p_{n,j,x}$) was presented to DNV /19/);

According Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4 /35/:

- The φ (model correction factor to account for model uncertainties), the value correctly applied 0.9 according to the Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4;
- OX (Oxidation factor), value correctly applied 0.1 for solid waste disposal sites that are covered with oxidizing material such as soil or compost, DNV has verified during the site visit that it is covered with soil;
- F (fraction of methane in the SWDS gas), the value correctly applied 0.5 according Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4;
- DOC_f (Fraction of degradable organic carbon (DOC) that can decompose), the value correctly applied 0.5 according to the Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4;
- MCF (methane correction factor), value correctly applied 1.0 is used for anaerobic managed solid waste disposal sites. DNV has verified during the site visit that waste is covered and there is mechanical compacting;
- DOC_j (fraction of degradable organic carbon (by weight) in the waste type *j*), value correctly applied according Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4;
- k_j (decay rate for the waste type j), value correctly applied according mean annual temperature = 22 °C /32/ and tropical climate mean annual precipitation = 1 283 mm –

Wet climate /32/.

All the parameters are according methodology and tools described above. All values adopted are according determined by methodology and tools described above, or evidence presented and considered in a conservative way (please see section 4.6 to find parameters evidences).

4.5.2 Parameters monitored ex-post

The monitoring plan allows for collection and archiving of the following key parameters related to the determination of emission reductions resulting from the project activity:

According ACM0001 version 11:

- AF: parameter will be determined ex-post as the ε_{PR} has to be monitored at least for the first year. Value applied 2.72% was calculated *ex-ante*, ε_{BL} = 2% (considering that alternative b) was used to calculate it and it was measured as 1.82% /21/); ε_{PJ} = 75% x 98% = 73.50% (75% extraction rate /44/ with a burning efficiency in the enclosed flare of 98% /22/), AF = ε_{BL}/ ε_{PJ} = 2.72%.
- LFGTotal,y: Total amount of landfill gas captured, on-site measured by a specific flow meter to measure only this parameter, it will be calibrated as per manufacturer recommendations by IPT (Technological Research Institute - Instituto de Pesquisa Tecnologica). It will be used as reference the following standard conditions: Temperature, 273.15 K and pressure of 10^5 Pa. Measured continuously by a flow meter and data will be aggregated monthly and yearly. It will be used a flow meter with +/- 1% of accuracy;
- $LFG_{Flare,y}$: Amount of landfill gas flared, on-site measured by a specific flow meter to measure only this parameter, it will be calibrated as per manufacturer recommendations by IPT (Technological Research Institute - *Instituto de Pesquisa Tecnologica*). It will be used as reference the following standard conditions: Temperature, 273.15 K and pressure of 10^5 Pa. Measured continuously by a flow meter and data will be aggregated monthly and yearly. It will be used a flow meter with +/- 1% of accuracy;
- $LFG_{electricity,y}$: Amount of landfill gas combusted in power plant, on-site measured by a specific flow meter to measure only this parameter, it will be calibrated as per manufacturer recommendations by IPT (Technological Research Institute - *Instituto de Pesquisa Tecnologica*). It will be used as reference the following standard conditions: Temperature, 273.15 K and pressure of 10^5 Pa. Measured continuously by a flow meter and data will be aggregated monthly and yearly. It will be used a flow meter with +/- 1% of accuracy;
- $PE_{flare,y}$: Project emissions from flaring of the residual gas stream in year y, the approach the temperature of the exhaust gas of the flare and the flow rate of residual gas at the inlet of the flare will be monitored. The temperature measurements will be done continuously. The measure will be done by a Type N thermocouple. The readings of temperature will be made by a computer based system, with continuous storage;
- w_{CH4}: Methane fraction in the landfill gas, measured by an on-site gas analyzer continuously;

- T: Temperature of the landfill gas. Despite the fact that standard conditions (temperature 273.15 K and pressure of 10^5 Pa) will be used and it is not necessary to monitor parameter, project participant decided to monitor it;
- P: Pressure of the landfill gas. Despite the fact that standart conditions (temperature 273.15 K and pressure of 10^5 Pa) will be used and it is not necessary to monitor parameter, project participant decided to monitor it;
- EL_{LFG}: Net amount of electricity generated using LFG, the measurement instruments will be subject the maintenance and periodic tests in agreement with the supplier appropriate patterns;
- $CEF_{elec,y,BL,y}$: Carbon emission factor of electricity;
- Operation of the energy plants: Operation of the energy plant, measurement by the genset operation hours, data are measured and archived electronically, and recorded annually;
- $PE_{ec,y}$: Project emissions from electricity consumption by the project activity during the year y.

According the Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4:

- $MG_{PR,y}$: Amount of methane generated during year *y*, according the Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4;
- $p_{n,j,x}$: Weight fraction of the waste type *j* in the sample *n* collected during the year *x*, sampling will be undertaken four times per year*;*
- f: Fraction of methane captured at the SWDS and flared, combusted or used in another manner, monitored annualy ;
- GWP_{CH4}: Global Warming Potential (GWP) of methane, valid for the relevant commitment period, according IPCC value;
- W_x: Total amount of organic waste prevented from disposal in year *y*, measured continuously, aggregated at least annually;
- z: Number of samples collected during the year *y* or the first year of the project activity, measured continuously, aggregated annually.

According with Tool to determine project emissions from flaring gases containing methane Annex 13:

- $fv_{i,h}$: Volumetric fraction of component *I* in the residual gas in the hour *h* where *i*=CO_2, CO, O_2, H_2, N_2 and CH_4;
- $FV_{RG,h}$: Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*;
- $T_{O2,h}$: Volumetric fraction of O_2 in the exhaust gas of the flare in the hour h;
- $fv_{CH4,FG,h}$: Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h;
- T_{flare}: Temperature in the exhaust gas of the flare.

It is assumed that 75% of the LFG generated will be collected /20/ (13% will be flared and 87% used to energy generation), and a 98% default value /22/ for the flare efficiency is

considered for the *ex-ante* estimations of emission reductions. However the efficiency of the flare will be continuously monitored (*ex post* and the value of 98% used for the estimation of the emission reductions will not be taken into account) when the equipment is installed.

According the Tool to calculate baseline, project and/or leakage emissions from electricity consumption version 01 /37/:

- $TDL_{j,y}$: Average technical transmission and distribution losses for providing electricity to source *j* in year *y*. Annually update (in the absence of data from the relevant year, most recent figures should be used, but not older than 5 years).

All the parameters are according methodology and tools described above. All values adopted are according determined by methodology and tools described above, or evidence presented and considered in a conservative way (please see section 4.6 to find parameters evidences).

4.5.3 Management system and quality assurance

Responsibilities and authorities for project management, monitoring and reporting activities, measurement, training and reporting techniques and QA/QC procedures are being defined and will be implemented until the date of commencement of the project activity/first verification.

In addition, the monitoring of parameters will be carried out electronically on a fully automated system, and all the monitoring data will be backed up on a daily basis to 2 different sites and be kept for the full crediting period, plus two years.

Operational procedures will be implemented in order to assure adequate operation and monitoring.

Arauna – Energia e Gestão Ambiental Ltda. has two others project activities register under the CDM program, the project "Embralixo/Araúna - Bragança Landfill Gas Project" (reference number 1179) and "URBAM/ARAUNA - Landfill Gas Project (UALGP)" (reference number 1247). Thus, they have experience regarding implementation and monitoring of landfill projects.

4.6 Estimate of GHG Emissions

Emission reductions are directly monitored and calculated *ex-post*, using the approach indicated in the methodology ACM0001 version 11.

Baseline emissions are estimated as the sum of amount of methane that would have been destroyed/combusted during the year in project scenario and the net quantity of electricity produced using LFG times CO_2 emissions intensity of the baseline source of electricity displaced. No thermal energy is produced.

- $\mathbf{BE_y = (MD_{project,y} - MD_{BL,y})*GWP_{CH4} + EL_{LFG,y}*CEF_{elec,BL,y} + ET_{LFG,y}*CEF_{ther,BL,y}}$

$MD_{project,y}$ – it was estimated annually according the Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4. All parameters were checked by DNV and found to be in accordance with the tool. The annual estimation is presented in the spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – Baseline CH_4- The annual amount of waste was estimated using the previous landfill assessment study until 2008 /6/ and after it was used the amount of waste allowed by the environmental licence (250 t/day /4/). The landfill started operation on 2002 and will end

operation on 2017. A study of the waste composition ($p_{n,j,x}$) was presented to DNV /19/. The adopted collection efficiency is estimated to be 75% /20/. The destruction efficiency of the baseline system ε_{BL} was measured 1.82%. DNV considers that alternative b) is the most adequate to this project (the PP hired a company – Landtec - to measure the destruction efficiency of the baseline system ε_{BL} and this value has been used in the project). According to the methodology, if no system for collection and destruction of methane is implemented prior to the project and/or no measurements of the amount of methane that is destroyed are available, then the destruction efficiency of the system mandated by regulatory or contractual requirements (ε_{BL}) should be assumed to be equal to the theoretical efficiency of the specific system for collection and destruction of methane that is defined in the regulation or contract. Since in Brazil there is no regulation regarding it /27/, the value adopted would be zero, but conservatively the PP measured it and find out 1.82% as the destruction efficiency of the baseline system. Conservatively 2% was adopted. The burning efficiency in the enclosed flare was adopted as 98% /22/.

$MD_{BL,y}$ - it was calculated multiplying the $MD_{project,y}$ by the AF (adjustment factor) calculated 2.72% (ε_{BL} divided by flare flare efficiency times 75% of the LFG collection efficiency /20/). Project participant has not yet defined if $MD_{project,}$ will be the one during the first year of project activity (option 1) or during the year y of the project activity (option 2).

$EL_{LFG,y}$ – it was calculated considered the amount of methane generated yearly in MWh /3/. It was considered that 87% of the biogas collected will be utilized to generate energy and that the generator efficiency to transform biogas to electricity is 37.1%.

$CEF_{elec,y,BL,y}$ – Brazilian grid emissions factor, combined margin, consisting of the average of the operating margin (OM) and build margin (BM) for the Brazilian interconnected grid system/Grid SIN. The combined margin emission coefficient for the Brazilian grid is determined *ex-post* and it will be updated during the verification process in accordance with Tool to calculate the emission factor for an electricity system version 2 /36/.

The dispatch data analysis was the option selected for the calculation of the operating margin. The PDD was published on 5 May 2009 and in order to estimate the emissions reductions, the baseline emission factor estimate of 0.4766 tCO_2e/MWh was determined based on available data of 2008 /3/, which is the latest available at the time of PDD webhosting.

The build margin (BM) emission factor, will also be determined *ex-post* during the verification process. Based on 2008 data it was estimated to 0.1458 tCO_2e/MWh.

As a result, the combined margin (CM) emission factor used for estimating purposes of the emission reductions in the PDD is 0.3112 tCO_2e/MWh, based on 1:1 weighing between OM and BM emission factor.

Project emissions: $PE_{EC,y}$ – it is calculated considering the Tool to calculate baseline, project and/or leakage emissions from electricity consumption version 01 spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – PE Elec:

- $\boldsymbol{PE_{EC,y} = \sum EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y})}$

It considers the amount of methane produced yearly, the amount of biogas produced yearly (0.45 is the methane rate in the biogas), the blower energy consumption of 0.0001 MWh/m^3

biogas (from the blower performace test curve /25/, the grid emission factor ($CEF_{elec,y,BL,y}$) and the average technical transmission and distribution losses $TDL_{j,y}$ 5.606% /26/. It is considered just in the first year, when the grid energy will be used, but after the first year on the energy will be produced with the biogas.

No leakage effects need to be accounted under the methodology used.

In summary, the selection of the parameters and GHG calculations is complete and transparent. The accuracy of the calculations has been verified. The emission estimates can be replicated using the data and parameter values provided in the PDD and supporting files submitted for registration. The data sources mentioned have been verified by DNV.

The forecasted emission reductions of annual average of 48 448 tCO_2e over its first 7 year renewable crediting period starting from 2010 to 2016 are deemed within reasonable limits. However, experiences with other landfills have shown that the methane generation and collection efficiency of the landfills projected by the first order decay model has an inherent uncertainty of almost 50% and hence the amount of CERs, which will be monitored *ex-post*, might vary from the projected amount. No other project emission or leakage sources contributing more than 1% and not mentioned by the methodology have been found.

	$(MD_{project,y} - MD_{BL,y})*GWP_{CH4}$	$EL_{LFG,y}*CEF_{elec,BL,y}$	$PE_{EC,y}$	ER_y
2010	11 106	0	17	11 089
2011	38 295	874	38	39 131
2012	42 110	2 883	0	44 993
2013	45 104	3 088	0	48 192
2014	47 510	3 253	0	50 763
2015	49 488	3 388	0	52 876
2016	51 147	3 502	0	54 649
2017	35 044	2 399	0	37 444
Total (tCO_2e)	319 804	19 388	55	339 137

4.7 Environmental Impacts

No significant negative environmental impacts are expected from the implementation of the project activity. CORPUS SANEAMENTO E OBRAS LTDA. has been granted an Installation License number 36000255 – Process # 36/00257/00 – from 26 June 2000 and the Installation Licence number 36002945 – Process # 36/00251/09 – from 30 June 2009 (increasing the amount of waste received to 250 t/day) issued by the São Paulo state environmental entity CETESB (Environmental Sanitation Technology Company), of which a copy was made available for DNV /4/.

4.8 Comments by Local Stakeholders

Local stakeholders, such as Interministerial Commission for the Global Climate Change, CETESB - São Paulo State Environmental Agency, Brazilian Forum of NGO´s, Brazilian Forum of Climate Change, Federal Public Prosecution Office, São Paulo State Public Prosecution Office, Inadaiatuba City Hall and Indaiatuba City Council, and such entities are

in accordance with the requirements of Brazilian Global Climate Change Inter-ministerial Commission Resolution #7, from 5 March 2008.

DNV has received copies of letters sent to the local stakeholders and notification from the Brazilian Post Office that stakeholders described above received a letter communicating the start of the project /5/. No comments from stakeholders were received. It is DNV opinion that the local stakeholder consultation performed is adequately.

4.9 Comments by Parties, Stakeholders and NGOs

The PDD version 3 of 5 May 2009 was made publicly available on UNFCCC website (http://cdm.unfccc.int/Projects/Validation/DB/XRCDRQ6VTVP6B8NFCCTH92OZI9D6B7/view.html) and Parties, stakeholders and NGOs were through the CDM website invited to provide comments during a 30 days period from 7 May 2009 to the 5 June 2009.

No comments were received.

APPENDIX A

CDM VALIDATION PROTOCOL

Table 1 Mandatory Requirements for Clean Development Mechanism (CDM) Project Activities

Requirement	Reference	Conclusion
About Parties		
1. The project shall assist Parties included in Annex I in achieving compliance with part of their emission reduction commitment under Art. 3.	Kyoto Protocol Art.12.2	No participating Annex I Party is identified yet.
2. The project shall assist non-Annex I Parties in contributing to the ultimate objective of the UNFCCC.	Kyoto Protocol Art.12.2.	OK
3. The project shall have the written approval of voluntary participation from the designated national authority of each Party involved.	Kyoto Protocol Art. 12.5a, CDM Modalities and Procedures §40a	Prior to the submission of the validation report to the CDM Executive Board, DNV will have to receive the written approval of voluntary participation from the DNA of Brazil, including the confirmation by the DNA of Brazil that the project assists it in achieving sustainable development.
4. The project shall assist non-Annex I Parties in achieving sustainable development and shall have obtained confirmation by the host country thereof.	Kyoto Protocol Art. 12.2, CDM Modalities and Procedures §40a	OK Prior to the submission of the validation report to the CDM Executive Board, DNV will have to receive the written approval of voluntary participation from the DNA of Brazil, including the confirmation by the DNA of Brazil that the project assists it in achieving sustainable development.

Requirement	Reference	Conclusion
5. In case public funding from Parties included in Annex I is used for the project activity, these Parties shall provide an affirmation that such funding does not result in a diversion of official development assistance and is separate from and is not counted towards the financial obligations of these Parties.	Decision 17/CP.7, CDM Modalities and Procedures Appendix B, § 2	The validation did not reveal any information that indicates that the project can be seen as a diversion of ODA funding towards Brazil.
6. Parties participating in the CDM shall designate a national authority for the CDM.	CDM Modalities and Procedures §29	The DNA of Brazil is the Inter-ministerial Commission on Global Climate Change (CIMGC – Comissão Interministerial de Mudança Global do Clima).
7. The host Party and the participating Annex I Party shall be a Party to the Kyoto Protocol.	CDM Modalities §30/31a	Brazil has ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 28 February 1994, and the Kyoto Protocol on 23 August 2002.
8. The participating Annex I Party's assigned amount shall have been calculated and recorded.	CDM Modalities and Procedures §31b	NA No participating Annex I Party is yet identified.
9. The participating Annex I Party shall have in place a national system for estimating GHG emissions and a national registry in accordance with Kyoto Protocol Article 5 and 7.	CDM Modalities and Procedures §31b	NA No participating Annex I Party is yet identified.
About additionality		
10. Reduction in GHG emissions shall be additional to any that would occur in the absence of the project activity, i.e. a CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity.	Kyoto Protocol Art. 12.5c, CDM Modalities and Procedures §43	Table 2, Section B.3.1

Requirement	Reference	Conclusion
About forecast emission reductions and environmental impacts		
11. The emission reductions shall be real, measurable and give long-term benefits related to the mitigation of climate change.	Kyoto Protocol Art. 12.5b	Table 2, Section B.4 to B.7
For large-scale projects only		
12. Documentation on the analysis of the environmental impacts of the project activity, including transboundary impacts, shall be submitted, and, if those impacts are considered significant by the project participants or the Host Party, an environmental impact assessment in accordance with procedures as required by the Host Party shall be carried out.	CDM Modalities and Procedures §37c	Table 2, Section D.
About stakeholder involvement		
13. Comments by local stakeholders shall be invited, a summary of these provided and how due account was taken of any comments received.	CDM Modalities and Procedures §37b	Table 2, Section E.
14. Parties, stakeholders and UNFCCC accredited NGOs shall have been invited to comment on the validation requirements for minimum 30 days, and the project design document and comments have been made publicly available.	CDM Modalities and Procedures §40	The PDD version 3 of 5 May 2009 was made publicly available on UNFCCC website (http://cdm.unfccc.int/Projects/Validation/DB/XRCDRQ6VTVP6B8NFCCTH92OZI9D6B7/view.html) and Parties, stakeholders and NGOs were through the CDM website invited to provide comments during a 30 days period from 7 May 2009 to 5 June 2009. No comments were received.
Other		
15. The baseline and monitoring methodology shall be previously approved by the CDM Executive Board.	CDM Modalities and Procedures §37e	Table 2, Section B.1.1

Requirement	Reference	Conclusion
16. A baseline shall be established on a project-specific basis, in a transparent manner and taking into account relevant national and/or sectoral policies and circumstances.	CDM Modalities and Procedures §45c,d	Table 2, Section B.2
17. The baseline methodology shall exclude to earn CERs for decreases in activity levels outside the project activity or due to force majeure.	CDM Modalities and Procedures §47	Table 2, Section B.2
18. The project design document shall be in conformance with the UNFCCC CDM-PDD format.	CDM Modalities and Procedures Appendix B, EB Decision	The project design document conforms to version 03 of the CDM-PDD.
19. Provisions for monitoring, verification and reporting shall be in accordance with the modalities described in the Marrakech Accords and relevant decisions of the COP/MOP.	CDM Modalities and Procedures §37f	OK.

Table 2 Requirements Checklist

CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
A. General Description of Project Activity *The project design is assessed.*					
A.1. Project Boundaries *Project Boundaries are the limits and borders defining the GHG emission reduction project.*					
A.1.1. Are the project's spatial boundaries (geographical) clearly defined?	/1/	DR	The project Corpus/Araúna – Landfill Biogas Project is located in the city of Indaiatuba, São Paulo State, Brazil. The geographical coordinates are: -23° 05' 25'' South latitude and 47° 13' 05'' West longitude.		OK
A.1.2. Are the project's system boundaries (components and facilities used to mitigate GHGs) clearly defined?	/1/	DR	Project boundary is the site of the project activity where the gas captured, destroyed and used, and all the power generation sources connected to the grid to which the project activity is connected. Since the project has not been implemented, it is not possible to state the equipments specification. But basically it consists of the installation of a forced exhaustion system of the landfill gas, an enclosed flare and equipments for electricity generation from the LFG generated through the decomposition of the organic waste deposited in the landfill.		OK
A.2. Participation Requirements *Referring to Part A, Annex 1 and 2 of the PDD as well as the CDM glossary with respect to the terms Party, Letter of Approval, Authorization and Project*					

* MoV = Means of Verification, DR= Document Review, I= Interview

CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
Participant.					
A.2.1. Which Parties and project participants are participating in the project?	/1/	DR	The project participants are Arauna – Energia e Gestão Ambiental Ltda. and Corpus Saneamento e Obras Ltda., both of Brazil. The host country Brazil is a Non-Annex I country and it meets all relevant participation requirements.		OK
A.2.2. Have all involved Parties provided a valid and complete letter of approval and have all private/public project participants been authorized by an involved Party?	/1/	DR	Prior to the submission of the validation report to the CDM Executive Board, DNV will have to receive the written approval of voluntary participation from the DNA of Brazil, including the confirmation by the DNA of Brazil that the project assists it in achieving sustainable development.	–	--
A.2.3. Do all participating Parties fulfil the participation requirements as follows: - Ratification of the Kyoto Protocol - Voluntary participation - Designated a National Authority	/1/	DR	Yes. Brazil has ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 28 February 1994, and the Kyoto Protocol on 23 August 2002. The DNA of Brazil is the Inter-ministerial Commission on Global Climate Change (CIMGC - Comissão Interministerial de Mudança Global do Clima).		OK
A.2.4. Potential public funding for the project from Parties in Annex I shall not be a diversion of official development assistance.	/1/	DR	The project does not involve any public funding and the validation did not reveal any information that indicates that the project can be seen as a diversion of ODA funding towards Brazil.		

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
A.3. Technology to be employed *Validation of project technology focuses on the project engineering, choice of technology and competence/ maintenance needs. The validator should ensure that environmentally safe and sound technology and know-how is used.*					
A.3.1. Does the project design engineering reflect current good practices?	/1/	DR	The project consists of the installation of a forced exhaustion system of the landfill gas, an enclosed flare and equipments for electricity generation. The project design engineering reflects good practice for the collection of LFG, flaring of LFG and utilization of LFG for electricity generation. The technology to be used in the project activity is available in the Brazilian market, consisting basically of a vertical and/or horizontal drain system interconnected to blower. These materials and equipments are available in Brazil, with the exception of the generation equipment.		OK
A.3.2. Does the project use state of the art technology or would the technology result in a significantly better performance than any commonly used technologies in the host country?	/1/	DR	Despite the fact that LFG capture and treatment is not mandatory by Brazilian regulation (DNV requests evidence that there is no legislation in the project city/country obligating the landfill to destroy methane), the technology to be used in the project activity is available in the Brazilian market.	~~CL 1~~	OK
A.3.3. Does the project make provisions for meeting training and maintenance needs?	/1/	DR	Despite the PDD states that no technical documentation on monitoring and maintenance plan has been developed at this	~~**CL 26**~~	OK

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			time and that monitoring of the variables of the process indicated on section B.7.1 will be carried out electronically on a fully automated system (and also does not determine that they will be developed and implemented until the first verification), the QA/QC for all parameters are clearly defined. The PDD does not mention: - persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed; - procedures for emergency preparedness; - procedures for review of data.	~~CL 27~~	OK
A.4. Contribution to Sustainable Development *The project's contribution to sustainable development is assessed.*					
A.4.1. Has the host country confirmed that the project assists it in achieving sustainable development?	/1/	DR	Prior to the submission of the validation report to the CDM Executive Board, DNV will have to receive the written approval of voluntary participation from the DNA of Brazil, including the confirmation by the DNA of Brazil that the project assists it in achieving sustainable development.	~~–~~	--
A.4.2. Will the project create other environmental or social benefits than GHG emission reductions?	/1/	DR	DNV requests evidence from all social benefits stated in PDD that the project	~~CL 2~~	OK

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			activity is suppose to bring to the local community (cooperation in Educational Environmental Activities, promoting activities with the local neighbors and visitors at the landfill, encourage research in local schools and intensification of recycling of the waste received at the landfill, contribution to the improvement of the environmental conditions at the neighborhood of the landfill, contribution for the recovering of vegetation and fauna).		
B. Project Baseline *The validation of the project baseline establishes whether the selected baseline methodology is appropriate and whether the selected baseline represents a likely baseline scenario.*					
B.1. Baseline Methodology *It is assessed whether the project applies an appropriate baseline methodology.*					
B.1.1. Does the project apply an approved methodology and the correct version thereof?	/1/ /33/	DR	The project applies the approved baseline methodology ACM0001 version 11 /33/ and the steps for the identification of the baseline scenario of the approved Tool for the demonstration and assessment of additionality version 5.2.		OK
B.1.2. Are the applicability criteria in the baseline methodology all fulfilled?	/1/ /33/	DR	The project meets the methodology's applicability criteria: • the captured gas is flared; and • the captured gas is used to produce energy.		OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
B.2. Baseline Scenario Determination *The choice of the baseline scenario will be validated with focus on whether the baseline is a likely scenario, and whether the methodology to define the baseline scenario has been followed in a complete and transparent manner.*					
B.2.1. What is the baseline scenario?	/1/ /33/	DR	Baseline scenario has been defined as the continuation of the current situation (total atmospheric release of the landfill gas), that are the alternatives: For the disposal/treatment of the waste: LFG2: atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns; For power generation: P6: existing and/or new grid-connected power plants. The alternative for power generation P6 described in the PDD - section B.4 - does not correspond with the one described in the methodology ACM0001 version 11. Step 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable: Demonstrate that the identified baseline fuel is available in abundance in the host country and there is no supply constraint. According PDD, there will be no	~~CAR 1~~ ~~CAR 2~~	OK OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			extra use of fossil fuel in the project activity that was not used in the baseline scenario. DNV requires the project proponent to explain better how no extra fossil fuel will be used. DNV has found some issues regarding baseline determination that will be stated in sections B.2.2, B.2.4 and B.2.5. Project developer is requested to combine the different baseline options and scenarios in line with the methodology to arrive at a single situation which clearly represents the scenario in the absence of project activity.	~~CL 3~~	OK
B.2.2. What other alternative scenarios have been considered and why is the selected scenario the most likely one?	/1/ /33/	DR	Step 1: Identification of alternatives to the project activity consistent with current laws and regulations Sub-Step 1a: All the alternatives for the disposal/treatment of the waste in the absence of the project activity were considered: LFG1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity; LFG2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns. Also, all the power generation realistic and		

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			credible alternatives were considered: P1: Power generated from landfill gas undertaken without being registered as CDM project activity; P2: Existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant; P3: Existing or construction of a new on-site or off-site renewable based cogeneration plant; P4: Existing or construction of a new on-site or off-site fossil fuel fired captive power plant; P5: Existing or construction of a new on-site or off-site renewable based captive power plant; P6: Existing and/or new grid-connected power plants. Cogeneration plants are not realistic alternatives to the project since there is no need for heat in the site or nearby facilities. Thus, alternatives P2 and P3 for cogeneration are excluded. The construction of a captive power plant is not a realistic alternative, because the national grid is actually connected to the landfill site. Therefore, alternatives P4, P5 for captive power plant were excluded. Also, all heat generation realistic and credible alternatives were considered: H1: Heat generated from landfill gas		

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			undertaken without being registered as CDM project activity; H2: Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant; H3: Existing or Construction of a new on-site or off-site renewable based cogeneration plant; H4: Existing or new construction of on-site or off-site fossil fuel based boilers, air heaters or other heat generating equipment (e.g. kilns); H5: Existing or new construction of on-site or off-site renewable energy based boilers, air heaters or other heat generating equipment (e.g. kilns); H6: Any other source such as district heat; and H7: Other heat generation technologies (e.g. heat pumps or solar energy). Cogeneration plants are not realistic alternatives to the project since there is no need for heat in the site or nearby facilities. Thus, the the heat generation alternatives, from H1 to H7 were excluded. The realistic and credible alternatives left are: LFG1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity; LFG2: Atmospheric release of the landfill		

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			gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns. P1: Power generated from landfill gas undertaken without being registered as CDM project activity; P6: Existing and/or new grid-connected power plants. Project developer is requested to combine the different baseline options and scenarios in line with the methodology to arrive at a single situation which clearly represents the scenario in the absence of project activity Sub-Step 1b: Consistency with mandatory laws and regulations: The methodology determines that relevant policies and regulations related to the management of landfill sites should be taken into account. Such policies or regulations may include mandatory landfill gas capture or destruction requirements because of safety issues or local environmental regulations. DNV requested evidence that there is no legislation in the project city/country obligating the landfill to destroy methane. The scenarios LFG2 and P6 are the current situation and the scenarios LFG1 and P1 are expected to not be feasible according the Tool for the demonstration and assessment of	~~CL 3~~ ~~CL 1~~	OK OK

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			additionality version 5.2. There are some issues regarding the additionality that will be stated in section B.3.		
B.2.3. Has the baseline scenario been determined according to the methodology?	/1/ /33/	DR	Yes, the baseline determination follows the methodology ACM0001 version 11 and the Tool for the demonstration and assessment of additionality version 5.2.		OK
B.2.4. Has the baseline scenario been determined using conservative assumptions where possible?	/1/	DR	The baseline scenario has been determined using the investment analysis. During the site visit DNV will be able to verify if values applied in PDD version 3 and spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 were using conservative assumptions. .	~~CL 4~~	OK
B.2.5. Does the baseline scenario sufficiently take into account relevant national and/or sectoral policies, macro-economic trends and political aspirations?	/1/	DR	DNV requests evidence that there is no legislation in the project city/country obligating the landfill to destroy methane.	~~CL 1~~	OK
B.2.6. Is the baseline scenario determination compatible with the available data and are all literature and sources clearly referenced?	/1/	DR	See B.2.4.		
B.2.7. Have the major risks to the baseline been identified?	/1/	DR	No major risks to the baseline were identified.		OK
B.3. Additionality Determination *The assessment of additionality will be validated with focus on whether the project itself is not a likely baseline scenario.*					

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
B.3.1. Is the project additionality assessed according to the methodology?	/1/ /3/ /33/ /34/	DR	Yes, the methodology ACM0001 version 11 recommends the use of the latest version of the Tool for the demonstration and assessment of additionality, that is version 5.2. *Step 1: Identification of alternatives to the project activity consistent with current laws and regulations* *Sub-step 1a: Define alternatives to the project activity:* The outcomes from this step are the scenario alternatives LFG1, LFG2, P1 and P6 (already discussed in section B.2.2). *Sub-step 1b. Enforcement of applicable laws and regulations:* The PDD states that there is no obligation for an efficient treatment of the LFG in Brazil, neither a national model governing landfill practices. DNV requested evidence that there is no legislation in the project city/country obligating the landfill to destroy methane. *Step 2: Investment analysis* Alternative LFG1: *Sub-step 2a. Determine appropriate analysis method:* Since it does not have any income other than the CERs revenue, the Option I Simple Cost Analysis is applicable. *Sub-step 2b. – Option I: Simple cost analysis:* Since the only alternative applicable to this method is the LFG1 (the project activity	~~CL 1~~ ~~CAR 3~~	OK OK

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			undertaken without being registered as a CDM project activity), that is an alternative for the disposal/treatment of the waste in the absence of the project activity and do not consider power generation, the costs regarding CDM activities and power generation should not be considered. Alternative P1: *Sub-step 2a. Determine appropriate analysis method:* Option II (investment comparison analysis **)** or Option III **(**benchmark analysis **)** *Sub-step 2b:* It is not clear if the Option II (investment comparison analysis) is being used. According the "Tool for demonstration and assessment of additionality" version 5.2, if the CDM project activity and alternatives identified generate financial or economic benefits other than CDM related income, the investment comparison analysis (Option II) or the benchmark analysis (Option III) should be used. Also, according to the Annex: Guidance on the Assessment of Investment Analysis (version 2), the benchmark approach is therefore suited to circumstances where the baseline does not require investment. Thus, the Option II is not indicated to this project activity. Project developer is required to clarify how the selected investment analysis approach is applicable to the alternatives identified in	~~CL 5~~	OK

CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			step 1. PDD needs to be revised to incorporate the discussion regarding the same. *Sub-step 2c. – Calculation and comparison of financial indicators:* the project IRR (4.69%) is compared with the benchmark for the abstraction of resources of the national market is the National Bank of Economic and Social Development – BNDES – 10.79%. Also, the Net Present Value (NPV) will be applied presuming that it will support the result indicated by the IRR. *Sub-step 2d. – Sensitivity analysis:* project activity option P1 does not have revenue from CER's and thus sensitivity analysis applied in the CER´s can not be considered. If the indicator chosen to analyze the investment is the project internal return rate (IRR) and the benchmark adopted is a commercial lending rate (BNDES rate), the sensibility analysis should measure the impact from the parameters variation over the same indicator (IRR) of the project, and not over the NPV. Project developer is requested to consider all parameters that contribute more than 20% of either project cost or project revenues need to be considered for sensitivity analysis. Discussion in the PDD needs to be revised to	~~**CAR 4**~~	OK

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			include this. *Step 4. Common Practice Analysis,* *Sub-step 4a:* the item "b" from this Sub-step does not match with the information provided by the source "Diagnóstico do Manejo de Resíduos Sólidos Urbanos, table 6.16, page 81". *Sub-step 4b:* Since Araúna is Project Proponent of the "Corpus/Araúna – Landfill Biogas Project", it is necessary to analyse others landfills and not just those from Araúna in order to satisfy this sub-step.	~~CL 11~~ ~~CAR 5~~	OK OK
B.3.2. Are all assumptions stated in a transparent and conservative manner?	/1/ /3/	DR	The PDD 3 and spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 assumptions evidence will be checked during the site visit.	~~CL 4~~	OK
B.3.3. Is sufficient evidence provided to support the relevance of the arguments made?	/1/ /3/	DR	DNV requires evidences from the values of the benchmarks described (BNDES rate and IMA-S return) and further explanation from both. DNV requires evidence from the energy auctions and further explanation why the biomass energy price from June 2007 was adopted. DNV requires evidences from the CERs price and exchange rate adopted. DNV requires evidence from the Project without CDM IRR (4.69%) and NPV	~~CL 6~~ ~~CL 7~~ ~~CL 8~~ ~~CL 9~~	OK OK OK OK

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			(356,977 Euros). *Step 4. Common Practice Analysis, Sub-step 4a:* DNV requires evidence from the value 157,708 tons of waste per day, 1.35 kg/inhabitant/day and 2.35% (amount of landfills in Brazil that use/flare the gas disregarding CDM projects). The graphic 3 (Colected Waste Final Disposal in Brazil) was not provided in the PDD Corpus/Araúna – Landfill Biogas Project version 3.	~~**CL 10**~~	OK
B.3.4. If the starting date of the project activity is before the date of validation, has sufficient evidence been provided that the incentive from the CDM was seriously considered in the decision to proceed with the project activity?	/1/	DR	According the EB 41 meeting report, the start date of a CDM project activity is the earliest date at which either the implementation or construction or real action of a project activity begins and thus the date of the the signature of the contract between the responsible for the construction, capture and destruction of the LFG and/or electricity generation (6 January 2009) can't be considered. DNV requests the project proponent to present the proof of serious consideration of CDM revenues for the decision to go ahead with the project, that is the contract signed between CORPUS SANEAMENTO E OBRAS LTDA. and ARAUNA. According PDD the construction of the LFG capture and destruction system should be started until 15	~~**CAR 6**~~ ~~**CL 24**~~	OK OK

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			days after the registration of the CDM project at UNFCCC.		
B.4. Calculation of GHG Emission Reductions – Project emissions *It is assessed whether the project emissions are stated according to the methodology and whether the argumentation for the choice of default factors and values – where applicable – is justified.*					
B.4.1. Are the calculations documented according to the approved methodology and in a complete and transparent manner?	/1/ /3/ /33/ /35/ /36/ /37/ /38/	DR	No. DNV considers that is not very well stated in PDD how the final emissions reductions were calculated, regarding project emissions. DNV requires the project proponent to give further information. CER – CorpusAraúna – Landfill Biogas Project version 14 – PE Flare: DNV considers that according the methodology ACM0001 version 11, the project emission from flaring of the residual gas stream is not considered in the ex ante estimation, since it is related to the $MD_{project}$ formula used during the project activity, with parameters monitored during the project activity. DNV understands that if the emission factor from the national grid will be used to calculate the Project Emission of electricity consumption (spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – PE Elec) the TDL of the grid	~~**CAR 9**~~ ~~**CAR 11**~~	OK OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			should be used.		
B.4.2. Have conservative assumptions been used when calculating the project emissions?	/1/ /3/ /33/ /35/ /36/ /37/ /38/	DR	See B.4.1.		
B.4.3. Are uncertainties in the project emission estimates properly addressed?	/1/ /3/ /33/ /35/ /36/ /37/ /38/	DR	See B.4.1.		
B.5. Calculation of GHG Emission Reductions – Baseline emissions *It is assessed whether the baseline emissions are stated according to the methodology and whether the argumentation for the choice of default factors and values – where applicable – is justified.*					
B.5.1. Are the calculations documented according to the approved methodology and in a complete and transparent manner?	/1/ /3/ /33/ /35/ /36/	DR	No. DNV considers that is not very well stated in PDD how the final emissions reductions were calculated, regarding baseline. DNV requires the project proponent to give further information. DNV requests evidence from the proportion	~~**CAR 9**~~ ~~**CL 13**~~	OK OK

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	/37/		of waste type $p_{n,j,x}$ adopted.		
	/38/		DNV requests evidence from the followings (described in the PDD and in the spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – Input data): amount of waste per day (from past years and 2010 on), extraction rate (73%), LFG collection and destruction (1.82%), methane rate in biogas (45%), flare efficiency (98% agreed in contract), temperature (the source provided indicates 20.5°C).	~~CL 14~~	OK
			According the spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – Baseline CH4, the amount of waste accumulated from 2002 to 2017 is 921 268 tonnes and the estimated amount in the PDD for the same period is 491 461 tonnes.	~~CL 15~~	OK
			DNV requires evidence from the landfill gas blower energy consumption 0.01 kWh/m3.	~~CL 16~~	OK
			CER – CorpusAraúna – Landfill Biogas Project version 14 – Baseline Energy: DNV requires evidence from methane calorific value, further explanation of the conversion from CH4 tones to MWh and evidence from the conversion efficiency (50%).	~~CL 22~~	OK
			CER – CorpusAraúna – Landfill Biogas **Project version** 14 – Baseline Energy: - if just 73% from the gas is captured, the value considered shouldn't be divided by 73%;	~~CAR 10~~	OK

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			- If the generator capacity estimation is higher than 1MW, why the generator capacity is just 1MW? If not all the 90% from LFG is used to generate energy, the amount of gas flared should increase. CER – CorpusAraúna – Landfill Biogas Project version 14 – CER: The 73% methane extraction factor was already applied in the Baseline CH4 sheet and thus it has been applied twice. The methane destroyed formula does not follow the methodology ACM0001 version 11.	~~CAR 12~~	OK
B.5.2. Have conservative assumptions been used when calculating the baseline emissions?	/1/ /3/ /33/ /35/ /36/ /37/ /38/	DR	See B.5.1.		OK
B.5.3. Are uncertainties in the baseline emission estimates properly addressed?	/1/ /3/ /33/ /35/ /36/	DR	See B.5.1.		OK

CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
	/37/ /38/				
B.6. Calculation of GHG Emission Reductions – Leakage *It is assessed whether leakage emissions are stated according to the methodology and whether the argumentation for the choice of default factors and values – where applicable – is justified.*					
B.6.1. Are the leakage calculations documented according to the approved methodology and in a complete and transparent manner?	/1/ /33/	DR	As per the methodology ACM0001 version 11, leakage is not to be considered.		OK
B.6.2. Have conservative assumptions been used when calculating the leakage emissions?	/1/ /33/	DR	See B.6.1.		OK
B.6.3. Are uncertainties in the leakage emission estimates properly addressed?	/1/ /33/	DR	See B.6.1.		OK
B.7. Emission Reductions *The emission reductions shall be real, measurable and give long-term benefits related to the mitigation of climate change.*					
B.7.1. Are the emission reductions real, measurable and give long-term benefits related to the mitigation of climate change.	/1/ /33/	DR	The project is expected to reduce CO_2 emissions to the extent of Annual average of 48 448 tCO_2e (46,527 tCO_2e/year on average) during the first renewable **Error! Reference source not found.** crediting period. The CERs estimation in the PDD does not	~~**CL 28**~~	OK

* MoV = Means of Verification, DR= Document Review, I= Interview

CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			correspond with the CERs estimation in the spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – CER.		
B.8. Monitoring Methodology *It is assessed whether the project applies an appropriate monitoring methodology.*					
B.8.1. Is the monitoring plan documented according to the approved methodology and in a complete and transparent manner?	/1/	DR	The PDD version 3 states that as the project activity did not started yet, no technical documentation on monitoring and maintenance plan has been developed at this time. It is not described in PDD that technical documentation on monitoring and maintenance plan (CDM project manual measurement procedures) and electronic automated system of monitoring will be developed and implemented until the first verification. The PDD does not mention: - persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed; - procedures for emergency preparedness; - procedures for review of data.	~~CL 26~~ ~~CL 27~~	OK OK
B.8.2. Will all monitored data required for verification	/1/	DR	All data will be kept until two years after the		OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
and issuance 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?			end of the crediting period.		
B.9. Monitoring of Project Emissions *It is established whether the monitoring plan provides for reliable and complete project emission data over time.*					
B.9.1. Does the monitoring plan provide for the collection and archiving of all relevant data necessary for estimation or measuring the greenhouse gas emissions within the project boundary during the crediting period?	/1/ /33/	DR	The monitoring plan allows for collection and archiving of the following key parameters related to the determination of emission reductions resulting from the project activity (the monitoring of the variables of the process indicated on PDD section B.7.1 will be carried out electronically on a fully automated system): - **$LFG_{Total,y}$**: Total amount of landfill gas captured. On-site measured by a flow meter at normal conditions. Flow meter will be calibrated yearly, according to the Brazilian standard *NBR 10396.* Data to be aggregated monthly and yearly. Uncertainty level is low. - **$LFG_{Flare,y}$:** Amount of landfill gas flared. On-site measured continually by a flow meter at normal conditions. Flow meter will be calibrated yearly, according to the Brazilian standard *NBR 10396.* Data to be aggregated monthly and yearly. Uncertainty level is low. - **$LFG_{electricity,y}$:** Amount of landfill gas combusted in power plant at Normal Temperature and Pressure. On-site measured		OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			continually by a flow meter. Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy. Data to be aggregated monthly and yearly. - **$PE_{flare,y}$:** Calculated according the Tool to determine project emissions from flaring gases containing methane Annex 13. The temperature of the exhaust gas of the flare and the flow rate of residual gas at the inlet of the flare will be monitored. The temperature will be done continuously. The measure will be done by a Type N thermocouple. The readings of temperature will be made by a computer based system, with continuous storage. If the temperature read is below 500ºC for any particular hour, then the flare efficiency during that hour is zero. By the time of validation the flare was not installed. Thermocouples will be replaced or calibrated according with the manufacturer's specifications. - **w_{CH4}:** Methane fraction in the landfill gas. Measured by continuous gas quality analyzer. Methane fraction of the landfill gas to be measured on wet basis. All data are measured and archived electronically. The gas analyzer will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure accuracy. Calibration will be done either		

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			manually or automatically on a weekly basis. Once a year the gas analyzer will be calibrated by an independent company. Uncertainty level is low. - **T:** Temperature of the landfill gas. On site continuous measurement by thermocouples, on an electronic database. Thermocouples will be replaced or calibrated every year. Uncertainty level is low. No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters. - **P**: Pressure of the landfill gas. Continuous measurement by on-site manometer. All the data will be recorded continuously, on an electronic database. Uncertainty level is low. The pressure gauge will be calibrated as per manufacturer recommendations once a year. Also, will be subject to a regular maintenance, testing and calibration regime in accordance with manufacturer specifications to ensure accuracy. No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure. - **EL_{LFG}:** Net amount of electricity generated using LFG, sent to grid. The measurement instruments will be subject the maintenance and periodic tests in agreement with		

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			national/international appropriate patterns. - **$CEF_{elec,y,BL,y}$**: Carbon emission factor of electricity, calculated by the National Designated Authority according the Tool for the demonstration and assessment of additionality version 5.2. - **Operation of the energy plants:** Operation of the energy plant. On site measurement of the operating hours of the plant energy. All data are measured and archived electronically, and recorded annually. The meters will be calibrated regularly according to manufacturer's specifications. - **PEec,y:** Project emissions from electricity consumption by the project activity during the year y, calculated following the Tool to calculate baseline, project and/or leakage emissions from electricity consumption version 01. - **$MG_{PR,y}$**: Amount of methane generated during year *y*. Uses on-site measurement and plants records. Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4. - **F:** Fraction of methane captured at the SWDS and flared, combusted or used in another manner. Source of data used is plant records. - **W_x:** Total amount of organic waste prevented from disposal in year *y*. On-site		

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			measurement of the amount of the collected waste taken to the landfill through waste trucks. - Z: Number of samples collected during the year *y*. This parameter will not be monitored, once the monitoring will be realized through a continuous biogas analyzer. - **$fv_{i,h}$:** Volumetric fraction of component *I* in the residual gas in the hour *h* where *i*=CO_2, CO, O_2, H_2, N_2 and CH_4. It will be measured on site by continuous gas analyzer. Values to be averaged hourly or at a shorter time interval. Analyzers will be periodically calibrated according to the manufacturer's recommendation. As a simplified approach, project participants may only measure the methane content of the residual gas and consider the remaining part as N_2. - $FV_{RG,h}$: Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h.* Measured using a flow meter. Measure the volumetric fraction of all components in the residual gas (*fvi,h*) when the residual gas temperature exceeds 60 ºC. The monitoring will be realized hourly or at a shorter time interval. Flow meters are to be periodically calibrated according to the manufacturer's recommendation. - **$To_{2,h}$:** Volumetric fraction of O2 in the exhaust gas of the flare in the hour h.		

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			Measurement on-site by continuous gas analyzer. Values to be averaged hourly or at a shorter time Interval. Analyzers will be periodically calibrated according to the manufacturer's recommendation. - **$fv_{CH4,FG,h}$:** Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h. Measurement on-site by continuous gas analyzer. Analyzers will be periodically calibrated according to the manufacturer's recommendation. - **T_{flare}:** Temperature in the exhaust gas of the flare. On-site measurement of the temperature of the exhaust gas stream in the flare will be done using a Type N thermocouple. It will be registered continuously. Thermocouples should be replaced or calibrated every year. - **$TDL_{j,y}$**: Average technical transmission and distribution losses for providing electricity to source *j* in year *y*. Annually update. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.		
B.9.2. Are the choices of project GHG indicators reasonable and conservative?	/1/ /33/	DR	Yes. The choice of the GHG indicator is in line with the monitoring methodology.		OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
B.9.3. Is the measurement method clearly stated for each GHG value to be monitored and deemed appropriate?	/1/	DR	See B.9.1		OK
B.9.4. Is the measurement equipment described and deemed appropriate?	/1/ /33/	DR	The project is not implemented yet and thus technical specification from each is not defined. But in general the equipments described are appropriate to the measurement they are related to. There are two parameters that must be monitored according methodology ACM0001 version 11 and the project proponent will not monitor: $p_{n,j,x}$ and z. So DNV required further explanation how they will be obtained.		OK
B.9.5. Is the measurement accuracy addressed and deemed appropriate? Are procedures in place on how to deal with erroneous measurements?	/1/	DR	The measurements accuracy has been addressed for various parameters. The PDD does not mention procedures to deal with erroneous measurements neither intention to include in the CDM project manual measurement procedures regarding accuracy.	~~**CL 25**~~	OK
B.9.6. Is the measurement *interval* identified and deemed appropriate?	/1/	DR	See B.9.1		OK
B.9.7. Is the *registration, monitoring, measurement* and *reporting* procedure defined?	/1/	DR	Despite the project activity haven't started yet, it is not described in PDD that technical documentation on monitoring and maintenance plan (CDM project manual measurement procedures) and electronic	~~**CL 26**~~	OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			automated system of monitoring will be developed and implemented until the first verification. The PDD does not mention: - persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed; - procedures for emergency preparedness; - procedures for review of data.	~~CL 27~~	OK
B.9.8. Are procedures identified for *maintenance* of monitoring equipment and installations? Are the calibration intervals being observed?	/1/	DR	See B.9.7.		OK
B.9.9. Are procedures identified for day-to-day records handling (including what records to keep, storage area of records and how to process performance documentation)	/1/	DR	See B.9.7.		OK
B.10. Monitoring of Baseline Emissions *It is established whether the monitoring plan provides for reliable and complete baseline emission data over time.*					
B.10.1. Does the monitoring plan provide for the collection and archiving of all relevant data necessary for determining baseline emissions during the crediting period?	/1/ /35/ /36/ /37/ /38/	DR	See B.9.7.		OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
B.10.2. Are the choices of baseline GHG indicators reasonable and conservative?	/1/ /33/	DR	CH_4 and CO_2 is the only GHG indicator that needs to be accounted for in the baseline and it has been taken care of in the monitoring plan.		OK
B.10.3. Is the measurement method clearly stated for each baseline indicator to be monitored and also deemed appropriate?	/1/ /35/ /36/ /37/ /38/	DR	Yes, it will be possible to monitor the specified baseline indicators.		OK
B.10.4. Is the measurement *equipment* described and deemed appropriate?	/1/ /35/ /36/ /37/ /38/	DR	As the project activity hasn't started yet, no specification from measurement equipment has been provided. But an overall description was provided and is deemed appropriate.		OK
B.10.5. Is the measurement *accuracy* addressed and deemed appropriate? Are procedures in place on how to deal with erroneous measurements?	/1/	DR	The assurance level from almost all equipments was provided. Despite the project hasn't been implemented yet, the PDD does not mention procedures to deal with erroneous measurements neither intention to include in the CDM project manual measurement procedures regarding accuracy.	~~**CL 25**~~	OK
B.10.6. Is the measurement *interval* for baseline data identified and deemed appropriate?	/1/	DR	No. The monitoring of the variables of the process will be carried out electronically on a fully automated system that hasn't been implemented yet. It is not described in PDD that technical	~~**CL 26**~~	OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			documentation on monitoring and maintenance plan (CDM project manual measurement procedures) and electronic automated system of monitoring will be developed and implemented until the first verification.		
B.10.7. Is the registration, *monitoring*, *measurement* and *reporting* procedure defined?	/1/	DR	No. As the project activity did not started yet, no technical documentation on monitoring and maintenance plan has been developed at this time. It is not described in PDD that technical documentation on monitoring and maintenance plan (CDM project manual measurement procedures) and electronic automated system of monitoring will be developed and implemented until the first verification.	~~**CL 26**~~	OK
B.10.8. Are procedures identified for *maintenance* of monitoring equipment and installations? Are the calibration intervals being observed?	/1/	DR	The procedures have not been documented in a CDM project manual, but the PDD states the calibration interval regarding the equipment for each parameter. It is not described in PDD that technical documentation on monitoring and maintenance plan (CDM project manual measurement procedures) and electronic automated system of monitoring will be developed and implemented until the first verification.	~~**CL 26**~~	OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
B.10.9. Are procedures identified for day-to-day records handling (including what records to keep, storage area of records and how to process performance documentation)	/1/	DR	No. It is not described in PDD that technical documentation on monitoring and maintenance plan (CDM project manual measurement procedures) and electronic automated system of monitoring will be developed and implemented until the first verification.	~~CL 26~~	OK
B.11. Monitoring of Leakage *It is assessed whether the monitoring plan provides for reliable and complete leakage data over time.*					
B.11.1. Does the monitoring plan provide for the collection and archiving of all relevant data necessary for determining leakage?	/1/ /33/	DR	As per ACM0001 version 11, leakage is not to be considered.		OK
B.11.2. Are the choices of project leakage indicators reasonable and conservative?	/1/ /33/	DR	See B.11.1.		OK
B.11.3. Is the measurement method clearly stated for each leakage value to be monitored and deemed appropriate?	/1/ /33/	DR	See B.11.1.		OK
B.12. Monitoring of Sustainable Development Indicators/ Environmental Impacts *It is assessed whether choices of indicators are reasonable and complete to monitor sustainable performance over time.*					
B.12.1. Is the monitoring of sustainable development indicators/ environmental impacts warranted by legislation in the host country?	/1/ /33/	DR	The monitoring methodology ACM0001 version 11 does not require the monitoring of social and environmental indicators.		OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
B.12.2. Does the monitoring plan provide for the collection and archiving of relevant data concerning environmental, social and economic impacts?	/1/ /33/	DR	See B.12.1		OK
B.12.3. Are the sustainable development indicators in line with stated national priorities in the Host Country?	/1/ /33/	DR	See B.12.1		OK
B.13. Project Management Planning *It is checked that project implementation is properly prepared for and that critical arrangements are addressed.*					
B.13.1. Is the authority and responsibility of overall project management clearly described?	/1/	DR	No. The PDD does not mention: - persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed; - procedures for emergency preparedness; - procedures for review of data.	~~CL 27~~	OK
B.13.2. Are procedures identified for training of monitoring personnel?	/1/	DR	No. The PDD does not mention: - persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed;	~~CL 27~~	OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			- procedures for emergency preparedness; - procedures for review of data.		
B.13.3. Are procedures identified for emergency preparedness for cases where emergencies can cause unintended emissions?	/1/	DR	No. The PDD does not mention: - persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed; - procedures for emergency preparedness; - procedures for review of data.	~~CL 27~~	OK
B.13.4. Are procedures identified for review of reported results/data?	/1/	DR	No. The PDD does not mention: - persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed; - procedures for emergency preparedness; - procedures for review of data.	~~CL 27~~	OK
B.13.5. Are procedures identified for corrective actions in order to provide for more accurate future monitoring and reporting?	/1/	DR	No. The PDD does not mention: - persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed;	~~CL 27~~	OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
			- procedures for emergency preparedness; - procedures for review of data.		
C. Duration of the Project/ Crediting Period *It is assessed whether the temporary boundaries of the project are clearly defined.*					
C.1.1. Are the project's starting date and operational lifetime clearly defined and evidenced?	/1/	DR	According the EB 41 meeting report, the start date of a CDM project activity is the earliest date at which either the implementation or construction or real action of a project activity begins and thus the date of the the signature of the contract between the responsible for the construction, capture and destruction of the LFG and/or electricity generation (6 January 2009) can't be considered. DNV requires project proponent to provide documentary evidence confirming the 14 years expected for operational lifetime (from 2010 to 2023).	~~CAR 6~~ ~~CL 23~~	OK OK
C.1.2. Is the start of the crediting period clearly defined and reasonable?	/1/	DR	A 7-years renewable crediting period is selected (with the potential of being renewed) starting on 1 September 2010, or on the date of the registration of the CDM project activity, whichever is later.		OK
D. Environmental Impacts *Documentation on the analysis of the environmental impacts will*					

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
be assessed, and if deemed significant, an EIA should be provided to the validator.					
D.1.1. Has an analysis of the environmental impacts of the project activity been sufficiently described?	/1/	DR	No significant negative environmental impacts are expected from the implementation of the project activity. CORPUS SANEAMENTO E OBRAS LTDA. has been granted an Installation Licence issued by the São Paulo state environmental entity CETESB (Environmental Sanitation Technology Company), of which a copy was made available for DNV. The Installation License number provided does not correspond with the one described in the PDD.		OK
D.1.2. Are there any Host Party requirements for an Environmental Impact Assessment (EIA), and if yes, is an EIA approved?	/1/	DR	See D.1.1		OK
D.1.3. Will the project create any adverse environmental effects?	/1/	DR	The project will not affect the environment in any adverse way.		OK
D.1.4. Are transboundary environmental impacts considered in the analysis?	/1/	DR	There are no transboundary environmental impacts.		OK
D.1.5. Have identified environmental impacts been addressed in the project design?	/1/	DR	The project does not have any adverse environment impact.		OK
D.1.6. Does the project comply with environmental legislation in the host country?	/1/	DR	See D.1.1		OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
E. Stakeholder Comments *The validator should ensure that stakeholder comments have been invited with appropriate media and that due account has been taken of any comments received.*					
E.1.1. Have relevant stakeholders been consulted?	/1/	DR	Local stakeholders, such as Comissão Interministerial de Mudanças Globais do Clima, CETESB, Fórum Brasileiro de ONGs, FÓRUM BRASILEIRO DE MUDANÇAS CLIMÁTICAS, Ministério Público Federal, Ministério Público do Estado de São Paulo, Prefeitura Municipal de Indaiatuba, Câmara Municipal de Indaiatuba were invited to comment on the project, in accordance with the requirements of Brazilian Global Climate Change Inter-ministerial Commission Resolution #7, from the 5th March 2008. Not all the entities determined by the Brazilian Global Climate Change Inter-ministerial Commission Resolution #7 received the invitation. DNV requires the project proponent to translate to English the name of the entities invited for stakeholder consultation. DNV has received copies of letters sent to the local stakeholders, them notification from the Brazilian Post Office that stakeholders described above received a letter communicating the start of the project. No comments from stakeholders were received.	~~CL 21~~ ~~CL 20~~	OK OK

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CHECKLIST QUESTION	Ref.	MoV*	COMMENTS	Draft Concl.	Final Concl.
E.1.2. Have appropriate media been used to invite comments by local stakeholders?	/1/	DR	See E.1.1		OK
E.1.3. If a stakeholder consultation process is required by regulations/laws in the host country, has the stakeholder consultation process been carried out in accordance with such regulations/laws?	/1/	DR	See E.1.1		OK
E.1.4. Is a summary of the stakeholder comments received provided?	/1/	DR	No comments were received.		OK
E.1.5. Has due account been taken of any stakeholder comments received?	/1/	DR	See E.1.4.		OK

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Table 2b: Additional requirements checklist for VVM version 1 (EB 44)

A.5. Letter of approval					
A.1.1 Is the LoA received directly from the DNA or through the project participant?	/1/	DR	Prior to the submission of the validation report to the CDM Executive Board, DNV will have to receive the written approval of voluntary participation from the DNA of Brazil, including the confirmation by the DNA of Brazil that the project assists it in achieving sustainable development	--	--
A.6. Project design					
A.2.1 Does the PDD describe the CDM project activity with all relevant elements in a transparent and accurate way?	/1/		Yes, please see Table 2 A.3.1		OK
A.2.2 Has the CDM project activity at the start of the validation been constructed or does the CDM project activity use existing facilities or equipment?	/1/		No, the project activity hasn't been yet constructed. According the EB 41 meeting report, the start date of a CDM project activity is the earliest date at which either the implementation or construction or real action of a project activity begins and thus the date of the the signature of the contract between the responsible for the construction, capture and destruction of the LFG and/or electricity generation (6 January 2009) can't be considered. Please see Table 2 C.1.1	~~CAR 6~~	OK
A.2.3 Is the project a large scale project, a small scale project with average annual emission reductions above 15 000 tonnes or a bundled small scale project? Has on-site visit been carried out?			The proposed project activity represents a large scale CDM project. On 29 May 2009, as member of DNV validation team, Fabiana Philipi and Luis Filipe Tavares conducted a site visits to CORPUS office and landfill. In		OK

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			the context of these site visits interviews with representatives of project stakeholders were conducted to confirm selected information and to resolve issues identified in the document review.		
A.2.4 Does the project activity involved alteration of existing installations? If so, have the differences between pre-project and post-project activity been clearly described in the PDD?			No, the entire project will use new equipment. Please see Table 2 A.3.1.		OK
A.7. Project emissions not addressed by the methodology					
A.3.1 Does the methodology describe all project emission source for the project activity that contributes all 1% of the emission reductions? Sources that the methodology considers not to take into account are not relevant (e.g. cement and iron consumption for building hydropower plants).			While the project does not consume significant quantity of high energy and carbon intensive materials, all relevant project emissions are considered as required by ACM0001 methodology.		OK
A.8. Documentation of baseline emissions					
A.4.1 Documentation of the baseline determination: a. All assumptions and data used by the project participants are listed in the PDD and related document to be submitted for registration. The data are properly referenced. b. All documentation is relevant as well as correctly quoted and interpreted. c. Assumptions and data can be deemed reasonable d. Relevant national and/or sectoral policies and circumstances are considered and listed in the PDD. e. The methodology has been correctly applied to identify what would occurred in the absence of the proposed CDM project activity			Yes. See Table 2- B.1.1, B.2.1 and B.2.2 and B5.		OK

A.9. Documentation of the calculations					
A.5.1 Algorithms and/or formulae used to determine emission reductions • All assumptions and data used by the project participants are listed in the PDD and related document submitted for registration. The data are properly referenced • All documentation is correctly quoted and interpreted. • All values used can be deemed reasonable in the context of the project activity • The methodology has been correctly applied to calculate the emission reductions and this can be replicated by the data provided in the PDD and supporting files to be submitted for registration.			Yes. See Table 2 B.3, 2B.4 and 2B.5		OK
A.10. Implementation of the monitoring plan					
A.6.1 How were the plans for implementation of the monitoring plan, data management, QA/QC procedures assessed? To what extent can the emission reductions achieved by the project by monitored ex-post and verified later by a DOE?			Yes, please see Table 2 B.8, B.9 and B.10.		OK
A.11. CDM consideration prior to starting date					
A.7.1 The prior consideration of CDM for the project activity complies with EB41 annex 46			Yes, Pease see Table 2 B.3.4.		OK

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Table 3 Resolution of Corrective Action and Clarification Requests

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
CAR 1 **The alternative for power generation P6 (Existing and/or new grid-connected power plants) in the identification of alternatives scenarios does not correspond with the one described in the** ACM0001**, version** 11**.**	B.2.1	CAR 1 answered on Section B.4 of the PDD according to the methodology ACM0001.	The alternative for power generation P6 in the PDD version 4 corresponds with the methodology ACM0001 version 11. Therefore this CAR is closed.
CAR 2 Step 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable: Demonstrate that the identified baseline fuel is available in abundance in the host country and there is no supply constraint. According PDD, there will be no extra use of fossil fuel in the project activity that was not used in the baseline scenario. DNV requires the project proponent to explain better how no extra fossil fuel will be used.	B.2.1	CAR 2 answered as described bellow and included on Section B.4, Step 2 of the PDD.As the electricity is provided by the electricity gridso no other type of fuel is required. As a final remark we remind that all equipments that will be installed on the project are electrical. The electricity will be obtained from the same electricity line that provides electricity to the landfill, and sectoral policies for electricity supply require a minimum interruptions on its availability. Therefore PP choosed not to install a fossil fuel backup generator on the project.	Since the project uses electricity from the grid, there is no risk of supply constrains and variations in the use of fossil fuel can not be foreseing by PP. Therefore this CAR is closed.
CAR 3 *Sub-step 2b. – Simple cost analysis:* Since the only alternative applicable to this method is	B.3.1	Due to a mistake the CDM costs were included on the analysis. CAR 3 answered on Section B.4, Sub-step 2b	Spreadsheet was amended and evidences were provided. Therefore this CAR is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
the LFG1 (the project activity undertaken without being registered as a CDM project activity), that is an alternative for the disposal/treatment of the waste in the absence of the project activity and do not consider power generation, the costs regarding CDM activities and power generation should not be considered.		of the PDD: the costs regarding CDM activities and power generation were excluded. References were sent to DNV.	
CAR 4 *Sub-step 2d. – Sensitivity analysis:* project activity option P1 does not have revenue from CER's and thus sensitivity analysis applied in the CER´s can not be considered. If the indicator chosen to analyze the investment is the project internal return rate (IRR) and the benchmark adopted is a commercial lending rate (BNDES rate), the sensibility analysis should measure the impact from the parameters variation over the same indicator (IRR) of the project, and not over the NPV. Project developer is requested to consider all parameters that contribute more than 20% of either project cost or project revenues need to be considered for sensitivity analysis. Discussion in the PDD needs to be revised to include this.	B.3.1	CAR 4 answered, the sensitivity analysis applied to the project activity used the Internal Return Rate (IRR). It was included in the PDD the sensitivity analysis for the energy sale price, costs of the motogenerator and costs of maintenance. The sensitivity analysis was applied to obtain the IRR reference.	PDD was amended, considering all parameters that contribute more than 20% of either project cost or project revenues. Therefore this CAR is closed.
CAR 5	B.3.1	CAR 5 answered on Step 4. The quantity of landfills that exists in Brazil	Since there is no Brazilian legislation obligating landfills to flare the biogas and

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
Step 4. Common Practice Analysis, Sub-step 4b: **Since Araúna is Project Proponent of the "**Corpus/Araúna – Landfill Biogas Project**", it is necessary to analyse others landfills and not just those from Araúna in order to satisfy this sub-step.**		was analyzed, and also which of them have the benefits of the CDM project activity.	that the activity requires a massive investment, all the projects implemented in Brazil are part of CDM programme. Therefore this CAR is closed.
CAR 6 According the EB 41 meeting report, the start date of a CDM project activity is the earliest date at which either the implementation or construction or real action of a project activity begins and thus the date of the the signature of the contract between the responsible for the construction, capture and destruction of the LFG and/or electricity generation (the 6th January 2009) can not be considered.	B.3.4 C.1.1	CAR 6 answered according to the the EB41, the start date is 01/05/2010, wich seems a reasonalble amount of time (1 year after the PDD being publicly available) to validate and register the PDD at the UNFCCC.	Since the project has not started yet, an estimation of the starting date was presented in PDD version 4. The date 01/05/2010 is one year after the date when PDD was made publicly available in UNFCCC website (05/05/2009). This period is adequate considering that project should be started until 15 days after the registration of the CDM project at UNFCCC. Therefore this CAR is closed.
CAR 7 **Data and parameters not monitored: AF: this parameter is not listed in the methodology** ACM0001 **version** 11**. It will be calculated.**		CAR 7 answered and the parameter was excluded from the section B.7.1.	AF is not listed like a parameter monitored from PDD version 4. Therefore this CAR is closed.
CAR 8 Data and parameters not monitored: the parameters MD_{Hist} and MG_{Hist} are missing according methodology ACM0001 version 11.		CAR 8 answered and the parameters were included on the Section B.6.2 of the PDD.	MD_{Hist} and MG_{Hist} were included in PDD version 4. Therefore this CAR is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
CAR 9 DNV considers that is not very well stated in PDD how the final emissions reductions were calculated, regarding baseline and project emissions. DNV requires the project proponent to give further information.	B.4.1	CAR 9 answered to recalculate the final emission reductions with further information in the PDD.	The PDD has been amended, presenting the calculus used and the final result from each calculus. Therefore this CAR is closed.
CAR 10 CER – CorpusAraúna – Landfill Biogas Project version 14 **– Baseline Energy:** **B.1.3. if just 73% from the gas is captured, the value considered shouldn't be divided by 73%.** B.1.4. if the estimation of LFG results in a generator capacity higher than 1MW, the generator capacity adopted must be more than just 1MW. If not all the 90% from LFG is used to generate energy, the amount of gas flared should increase.	B.5.1	CAR 10 answered, the values of biogas distribution sent to the flare and for power generation have been resized to meet the specifications of the project.	The new spreadsheet provided was corrected. Therefore this CAR is closed.
CAR 11 CER – CorpusAraúna – Landfill Biogas Project version 14 – PE Flare: DNV considers that according the methodology ACM0001 version 11, the project emission from flaring of the residual gas stream is not considered in the ex ante estimation, since it is related to the $MD_{project}$ formula used during the project	B.4.1	CAR 11 answered, PDD corrected.	The PDD has been amended, and the project emission from flaring of the residual gas stream was not considered. Therefore this CAR is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
activity, with parameters monitored during the project activity.			
CAR 12 CER – CorpusAraúna – Landfill Biogas Project version 14 – CER: The 73% methane extraction factor was already applied in the Baseline CH4 sheet and thus it has been applied twice. The methane destroyed formula does not follow the methodology ACM0001 version 11.	B.5.1	Correction made: The Baseline CH4 sheet was corrected, the methane extraction factor is not being applied twice anymore.	The PDD has been corrected and the 73% methane extraction factor was applied once. Therefore this CAR is closed.
CL 1 **DNV requests evidence that there is no legislation in the project city/country obligating the landfill to destroy methane.**	A.3.2 B.2.2 B.2.5 B.3.1	Besides othere references stated in the PDD, pelase check the non existence of legislation/obligation in the Project city/country to flare the LFG in the landfill operation licence.	The environmental license granted by the São Paulo State Environmental Agency does not require the capture and flare of the landfill biogas. Therefore this CL is closed.
CL 2 DNV requests evidence from all social benefits stated in PDD that the project activity is suppose to bring to the local community (cooperation in Educational Environmental Activities, promoting activities with the local neighbors and visitors at the landfill, encourage research in local schools and intensification of recycling of the waste received at the landfill, contribution to the improvement of the environmental conditions at the neighborhood of the landfill,	A.4.2	The social project was change to a more suitable social project adequated to the CDM project size..	The social benefits were changed in the PDD version 4 and are suitable to the project. Therefore this CL is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
contribution for the recovering of vegetation and fauna).			
CL 3 **Project developer is requested to combine the different baseline options and scenarios in line with the methodology to arrive at a single situation which clearly represents the scenario in the absence of project activity.**	B.2.1 B.2.2	The identified baseline scenario, according to the methodology ACM0001 v.11, establishes the scenario LFG2 for methane emission and P6 for energy consumption.	The PDD has been amended and represents different baseline options and scenarios in line with the methodology. Therefore this CL is closed.
CL 4 **DNV requests evidence from all project costs considered in the simple cost analysis and benchmark analysis, that were considered in the spreadsheet** CER – CorpusAraúna – Landfill Biogas Project version 14 **– REVENUE AND EXPENDITURE.**	B.2.4 B.3.2	Please verify budgets attached. Please verify budgets attached. The booster and construction real values were excluded because they were already included on the proposal of the flare.	Evidences were provided and spreadsheet corrected according them. Therefore this CL is closed.
CL 5 It is not clear if the Option II (investment comparison analysis) is being used. According the "Tool for demonstration and assessment of additionality" version 5.2, if the CDM project activity and alternatives identified generate financial or economic benefits other than CDM related income, the investment comparison analysis (Option II) or the benchmark analysis (Option III) should be	B.3.1	Option II is no longer used for that analysis, instead it´s used Option III to identify the indicator to be used, and the one that was chosen was the IRR.	The comparison analysis (Option II) was removed from PDD version 4. Also, PDD version 4 states that simple cost analysis (Option I) suits to the scenario that does not generate any financial or economic benefit other than CDM related income and investment comparison analysis (Option III) suits to the scenario that create financial or economic benefits in addition to those

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
used. Also, according to the Annex: Guidance on the Assessment of Investment Analysis (version 2), the benchmark approach is therefore suited to circumstances where the baseline does not require investment. Thus, the Option II is not indicated to this project activity. Project developer is required to clarify how the selected investment analysis approach is applicable to the alternatives identified in step 1. PDD needs to be revised to incorporate the discussion regarding the same.			related to the CDM activity. Therefore this CL is closed.
CL 6 **DNV requires evidences from the values of the benchmarks described (BNDES rate and IMA-S return) and further explanation from both.**	B.3.3	Please find evidence of the benchmark IMA-S attached. This indicator was used as benchmark since it is based on a fixed interest application (risk free). The objective of using this index as a benchmark is to evaluate the difference between applying the money required to build this project to build the project or to applying it on a risk free application.	The IMA-S rate adoped considers some bonds from the Brazilian government in the last 12 months, and it is lower than the government risk free rate Selic. Therefore this CL is closed.
CL 7 **DNV requires evidence from the energy auctions and further explanation why the biomass energy price from June 2007 was adopted.**	B.3.3	CL 7 answered and the reference of the 7th energy auction was changed in the PDD, which occurred on September 30th of 2008, according to CCEE (Brazilian Chamber of Energy Trading) web site.	Evidences of both auctions were provided and the price from the most recent one was adoped. Therefore this CL is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
CL 8 **DNV requires evidences from the CERs price and exchange rate adopted.**	B.3.3	Please find evidence attached of the exchange rates adopted based on official Central Bank exchange rates.	Evidence has been provided. Therefore this CL is closed.
CL 9 DNV requires evidence from the Project without CDM IRR (4.69%) and NPV (356 977 Euros).	B.3.3	CL 9 answered, please find evidence attached in spreadsheet CashflowLFG1 P1.	Evidences were provided. Therefore this CL is closed.
CL 10 *Step 4. Common Practice Analysis, Sub-step 4a:* DNV requires evidence from the value 157,708 tons of waste per day, 1.35 kg/inhabitant/day and 2.35% (amount of landfills in Brazil that use/flare the gas disregarding CDM projects). The graphic 3 (Colected Waste Final Disposal in Brazil) was not provided in the PDD Corpus/Araúna – Landfill Biogas Project version 3.	B.3.3	Evidence sent to DNV about the source of the data used.	The PDD version 4 was corrected and all evidences are adequate. Therefore this CL is closed.
CL 11 *Step 4. Common Practice Analysis, Sub-step 4a:* the item "b" from this Sub-step does not match with the information provided by the source "Diagnóstico do Manejo de Resíduos Sólidos Urbanos, table 6.16, page 81".	B.3.1	The information now matches the data provided by the source. All the sources will be send to DNV.	This item was removed from PDD version 4. Therefore this CL is closed.
CL 12 Regarding the Tool to determine project emissions from flaring gases containing		CL 12 answered and Step 6 was changed in the PDD to adequate to	In the section B.6.1 (Explanation of methodological choices) of PDD version 4, regarding the Project

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
methane Annex 13, first in the PDD is described that the project activity will use an enclosed flare and continuous monitor the destruction efficiency of the flare, but in the Step 6, it is described that a default value will be used.		continuous monitoring.	Emissions (Tool to determine project emissions from flaring gases containing methane Annex 13), continuous monitoring will be used in step 6. Therefore, this CL is closed.
CL 13 DNV requests evidence from the proportion of waste type $p_{n,j,x}$ adopted.	B.5.1	Please find evidence of the composition of the waste attached, based on landfill information.	Evidence has been provided. Therefore this CL is closed.
CL 14 DNV requests evidence from the followings (described in the PDD and in the spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – Input data): amount of waste per day (from past years and 2010 on), extraction rate (73%), LFG collection and destruction (1.82%), methane rate in biogas (45%), flare efficiency (98% agreed in contract), temperature (the source provided indicates 20.5°C).	B.5.1	Please find evidence attached. The evidence was sent to DNV, it is a report from Landtec.	Evidences were provided. Therefore this CL is closed.
CL 15 According the spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – Baseline CH4, the amount of waste accumulated from 2002 to 2017 is 921 268 tonnes and the estimated amount in the	B.5.1	Corrected.	The PDD has been amended with the right waste amount. Therefore this CL is closed.

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PDD for the same period is 491 461 tonnes.			
CL 16 DNV requires evidence from the landfill gas blower energy consumption 0.01 kWh/m3.	B.5.1	The blower performance curve was provided as basis for the calculation.	The blower performance test curve of producer was provided. Therefore this CL is closed.
CL 17 Data and parameter monitored: $LFG_{Total,y}$: DNV requires evidence from the Brazilian standard NBR 10396 – Medidores de vazão de fluidos and from the flow mater accuracy of +/-1%.		Evidence sent to DNV. The evidence was sent to DNV, it is the flow rate flyer, on Feature 4, page 8.	Evidence was provided. Therefore CL is closed.
CL 18 Data and parameter monitored: $TDL_{j,y}$: DNV requires evidence from the value applied (sources in PDD and spreadsheet do not match).		Corrected.	The source from data applied for technical transmission and distribution losses (TDL) was provided in PDD version 4 and is adequate. Therefore this CL is closed.
CL 19 The PDD "Corpus/Araúna – Landfill Biogas Project" section E do not follow the "GUIDELINES FOR COMPLETING THE PROJECT DESIGN DOCUMENT (CDM-PDD)**"** EB41 Annex12.		The invitation letters were sent to comply with the Resolution #7.	The PDD has being amended. Therefore this CL is closed.
CL 20 DNV requires the project proponent to translate to English the name of the entities invited for stakeholder consultation.	E.1.1	CL 19 answered on Section E of the PDD, by changing the names to English.	The names of all entities are in English in PDD version 4. Therefore this CL is closed.
CL 21	E.1.1	The invitation letters were sent to	The invitation letters were sent to all

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
The stakeholder invitations to comment should follow the Brazilian Global Climate Change Inter-ministerial Commission Resolution #7, from the 5th March 2008. Not all the entities determined by the Brazilian Global Climate Change Inter-ministerial Commission Resolution #7 received the invitation.		comply with the Resolution #7.	entities determined by the Brazilian Global Climate Change Inter-ministerial Commission Resolution #7. Therefore this CL is closed.
CL 22 CER – CorpusAraúna – Landfill Biogas Project version 14 – Baseline Energy: DNV requires evidence from methane calorific value, further explanation of the conversion from CH4 tones to MWh and evidence from the conversion efficiency (50%).	B.5.1	The efficiency of the conversion of CH4 to MWh is determined by the motogenerator manufacturer´s specification. Evidence will be send to DNV. The evidence is at 2006 IPCC Guideline, Chapter 1: Introduction, page 19, Table 1.2, Fuel type English description, Gas Biomass, Landfill Gas.	Evidences were provided. Therefore this CL is closed.
CL 23 DNV requires project proponent to provide documentary evidence confirming the 14 years expected for operational lifetime (from 2010 to 2023).	C.1.1	Please see biogas production estimative spreadsheet, provided by the landfill.	The operation life time is different from the CDM project activity duration. The CER calculus spreadsheet estimates that after 2023 the amount of biogas reduces considerably and thus is not worth developing a CDM project. Therefore this CL is closed.
CL 24 DNV requests the project proponent to present the proof of serious consideration of CDM revenues for the decision to go ahead	B.3.4	The contract signed between CORPUS and ARAUNA was sent to DNV.	A hard copy from the contract stating the importance of CDM to the implementation of the project was sent to DNV.

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with the project. This proof is the contract signed between CORPUS SANEAMENTO E OBRAS LTDA. and ARAUNA that mention the importancy of the CDM to the project activity.			Therefore this CL is closed.
CL 25 The PDD does not mention procedures to deal with erroneous measurements neither intention to include in the CDM project manual measurement procedures regarding accuracy.	B.9.5	The manual measurement procedures is been developed and it will be ready at the start date of the project activity. These procedures were included in PDD.	This information was included in PDD. Therefore this CL is closed.
CL 26 It is not described in PDD that technical documentation on monitoring and maintenance plan (CDM project manual measurement procedures) and electronic automated system of monitoring will be developed and implemented until the first verification.	B.8.1 B.9.7	The technical documentation on monitoring and maintenance plan is being developed and it will be ready at the start date of the project activity. These procedures were included in PDD.	This information was included in PDD. Therefore this CL is closed.
CL 27 The PDD does not mention: B.7.2. persons involved in the operation and maintenance of the project activity or training to deal with the new technology installed; B.7.3. procedures for emergency preparedness; B.7.4. procedures for review of data.	B.8.1 B.9.7 B.13.1 B.13.2 B.13.3 B.13.4 B.13.5	The operational plan is being developed and it will be ready at commercial operation. These procedures were included in PDD.	This information was included in PDD. Therefore this CL is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
CL 28 The CERs estimation in the PDD does not correspond with the CERs estimation in the spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14 – CER.	B.7.1	Corrected.	The PDD version 4 and spreadsheet present the same CER estimation. Therefore this CL is closed.
CL 29 The PDD does not mention how the waste water/leachate generated will be handled. Project participant is requested to address in PDD how wastewater/leachate will be handled (aerobically or anaerobically).		The leachate is stored in aerobic lagoons at the landfill, and exported to a private wastewater treatment plant. This information was included in PDD.	Information was added to PDD, leachate is stored in aerobic lagoons at the site, and exported to a private wastewater treatment plant. Therefore this CL is closed.
CL 30 Considering that there maybe cost savings due to internal generation from the LFG gensets, project participant is requested to add to PDD information regarding the viability of project scenario alternative P5 (Existing or construction of a new on-site or off-site renewable based captive power plant).		The average annual consumption of energy is low, around 56MWh/year. The revenue generated from the landfill biogas represents an estimated annual value of € 2,703, for a total of € 35,143 during the whole period of crediting, which does not justify the deployment of a captive power plant at the landfill. Thus the P5 option is not a realistic option for the project. Included in the PDD.	Information was added to PDD, the savings due energy production are not enough to justify the implementation of a captive plant. Therefore this CL is closed.
CL 31 Project participant is requested to explain why the benchmark IRR adopted in PDD version 3 was 10.79% and in PDD version 4 is 12.67%.		The benchmark adopted in PDD version 4 was IMA-S, which was more appropriate to reflect the risks of the investment. Although it will be used the	The BNDES landing rate was considered as benchmark and DNV opinion is that it is adequate considering a project cash flow.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
		benchmark of BNDES, which is 10,72%, in order to be more conservative in the analysis.	Therefore this CL is closed.
CL 32 Pre-operational costs: Topography services: Project participant is requested to explain if the activity described is not part of the landfill operation and would be done in compliance with local regulations.		The landfill owner does not perform topography as part of current landfill operations, therefore a specific topography will have to be done in order to plan the gas extraction network.	Since topography is not part of landfill operation activities, it is DNV opinion that it must be considered in order to implement the gas network. Therefore this CL is closed.
CL 33 Project participant is requested to include like a revenue the avoided costs from electricity purchases been considered in the IRR analysis.		It is to be included the costs savings from the consumed energy from the blower. The costs were included in the line 19 in the cash flow.	The cost savings were added to the financial analysis, considering the energy tariff of the invoices. Therefore this CL is closed.
CL 34 Operational costs: - Project participant is requested to explain why O&M turns out to be 16% of the investment. O&M cost for managing the current (baseline) landfill (maintenance cost, operation cost, human resources etc.) are not be included. Only the incremental cost of methane collection, flaring, combustion engine (proposed project) should be included.		The cost shown in the project reflects the strategy of the manufacturer selected, that has a lower cost to purchase and higher cost of operation of the motorgenerator.	Regarding the capture and flaring of the biogas, the system operation value 45 898.21 Euros/year was cross checked with the spreadsheet “Operadores” /13/, and considers the salary paid to the team that will be working in the landfill net implementation during the landfill operation, considering that the landfill receives waste daily. It is DNV opinion that the value applied is adequate, considering that daily activties and work is necessary due to the LFG extraction process.

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			Regarding the energy operation, the system operation value 48 448.11 Euros/year was cross checked with the spreadsheet "Operadores" /13/, and considers the salary paid to the team that will be working in the generation station. It is DNV opinion that the value applied is adequate, since daily activities and works will be necessary due the electricity generation. The maintenance value 23 Euros/MWh, was cross checked with the Cummins Power Generation Proposal, item 4.3 /15/. Also, DNV has verified that some energy generators have lower prices but higher maintenance costs. In order to assess the values presented, DNV compared them with the the last Brazilian project activity registered of landfill gas capture and energy generation "Feira de Santana Landfill Gas Project" (project number 1626) and the project activity already registered "Gorai Landfill closure and Gas Capture Project, Mumbai, India" (project number 2944). The "Feira de Santana Landfill Gas Project" project activity is the implementation of a gas

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
			extraction system and a flare/energy generation system in Brazil, with 1 MW of installed capacity. According PDD information, the 1 MW generator cost was 0.719 million Euros (0.98 million American dollars), 0.719 million Euros per MW of installed capacity. Considering the Corpus/Araúna – Landfill Biogas electricity generator cost (1.044 million Euros /14/) and its installed capacity of 1.75 MW, it is 0.596 million Euros per MW of installed capacity, what asures that it is a cheaper generator. The "Feira de Santana Landfill Gas Project" project activity average annual O&M costs regarding electricity production were 0.135 million Euros (0.184 million American dollars), which results in an O&M expenditure per year around 18.78% of the generator total cost. Considering the Corpus/Araúna – Landfill Biogas electricity generator cost (1.044 million Euros /14/) and the average yearly O&M cost (235.6 thousand Euros/year /15/), the O&M expenditure per year is around 22.56% of the generator total cost, what asures

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
			that cheaper generators have higher O&M costs. The "Gorai Landfill closure and Gas Capture Project, Mumbai, India" project activity is the implementation of a gas extraction system and a flare/energy generation system in India, with 3 MW of installed capacity. According PDD information, the 3 MW generator cost was 1.34 million Euros (85.5 million Indian rupee). Also, the average yearly O&M costs regarding the generator operation is 311 thousand Euros/year (20.2 million Indian rupee per year). This value implicates in an O&M expenditure per year around 23.6% of the generator total cost. Considering the Corpus/Araúna – Landfill Biogas electricity generator cost (1.044 million Euros /14/) and the average yearly O&M cost (235.6 thousand Euros/year /15/), the relation between generator cost and installed capacity of Corpus/Araúna – Landfill Biogas project (1.044 million Euros and 1.75 MW, 0.596 million Euros/MW) is higher than the relation between generator cost and installed capacity of

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
			Gorai Landfill closure and Gas Capture Project, Mumbai, India (1.34 million Euros and 3 MW, 0.446 million Euros/MW). On the other hand, the yearly O&M cost of Corpus/Araúna – Landfill Biogas compared with the generator cost (average yearly O&M of 235.6 thousand Euros/year, generator cost of 1.044 million Euros, which results in an O&M expenditure per year around 22.56% of the generator total cost) are lower than the yearly O&M cost of Gorai Landfill closure and Gas Capture Project, Mumbai, India when compared with the generator cost (O&M of 311 thousand Euros/year, generator cost of 1.34 million Euros, which result in between 23.6% per year of the generator cost). Thus, cheaper generators costs are compensated by higher O&M cost. Through this analysis and based on the generator and O&M costs evidences provided, Cummins proposals /14//15/, it is DNV opinion that the values applied in the financial analysis are adequate. Therefore this CL is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
CL 35 Spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 14, tab CASHFLOW LFG1+P1: Project participant is requested to employ the correct nomenclature regarding installed capacity and energy generation.		The nomenclature has changed in Spreadsheet CER – CorpusAraúna – Landfill Biogas Project version 143, tab CASHFLOW LFG1+P1.	The nomenclature was corrected (installed capacity is 1.75 MW and energy produced is MWh, then 48.17 Euros/MWh). Therefore this CL is closed.
CL 36 Project participant is requested to provide a survey of the common practice regarding landfill biogas use. Non-CDM project need to be considered.		Regarding this CL the PP conducted a study, landfills in the same geographical area, the São Paulo state, that receive 160 to 250 tons per day of waste (10 landfills were identified) similar to the CORPUS landfill. Three questions were asked on a phone interview : 1. Is there a CDM LFG flaring project at the landfill? (to exclude CDM landfills) 2. Is the LFG flared at an eclosed flare? (to determine if under non CDM landfills the LFG flaring is common practice) 3. What is the amount of waste deposited per day? (to check if the information of the deposited waste per day was correct) The result of the phone interviews clearly demonstrates that the LFG flaring on non CDM landfills is not common practice. 7 out of 10, or 11 if we include the Itu landfill (also contacted since the Itu landfill	A common practice survey was added to PDD. Therefore this CL is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
		is a similar private landfill) do not perform LFG flaring. The 3 landfills that perform LFG flaring do it under a CDM project. PP believe that this survey demonstrates that under non CDM landfills, LFG flaring is not common practice.	
CL 37 The CEF parameter must be listed in PDD section B.6.2 as parameter monitored ex-ante. The AF must be be listed in PDD section B.7.1 as parameter monitored ex-post.		AF included in B.7.1	AF was included in PDD section B.7. Therefore this CL is closed.
CL 38 It must be clearly stated in PDD that the project will have three flow meters (for the total LFG, for the LFG flared and for the LFG used in the electricity generation).		Included in B.7.1 for each parameter. "On-site measured by a specific flow meter to measure only this parameter."	Information stating that it will be implemented one flow meter to measure each parameter was included in PDD. Therefore this CL is closed.
CL 39 The PDD should state clear information on the calibration frequency and also the calibration entity.		The calibration frequency will depend on the supplier chosen, which although defined at this time, might be changed due to the considerable time that takes to register a CDM project. Project participants would not like to commit to a specific supplier. The calibration entity will be IPT (Instituto de Pesquisas Tecnológicas).	Since project activity will just be implemented if project get registered, the project participant has not defined yet the equipment that will be used. The calibration entity was defined as IPT. Therefore this CL is closed.
CL 40 The project participant states that the flow		The CL is correct. It is not necessary to monitor pressure. But project	The standard Pressure and Temperature information was added to PDD.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
will be expressed in standard cubic meters per hour, therefore no monitoring of Pressure and Temperature is required. But PDD section B.7.1 states that it temperature will be continuously measured by thermocouples and pressure will be continuously measured by manometer. Also, the project participant is requested to state the standard Pressure and Tempreature in their respective values/units in Section B.7.1 as definitions of standard references conditions may vary in different region.		participants will do so since LFG pressure is an important parameter to define the gas extracion behaviour and therefore to maximize LFG extraction. Informations regarding measurement procedures and monitoring frequency were included in both parameters of section B.7.1, as follows:As reference the following standard conditions: Temperature, 273.15 K (°C) and pressure of 10^5 pascals qill be used, based on. IUPAC recommendation that the former use of the pressure of 1 atm as standard pressure (equivalent to 1.01325×10^5 Pa) should be discontinued.IUPAC was formed in 1919 by chemists from industry and academia. Over nearly eight decades, the Union has succeeded in fostering worldwide communications in the chemical sciences and in uniting academic, industrial and public sector chemistry in a common language. IUPAC has long been recognized as the world authority on chemical nomenclature, terminology, standardized methods for measurement, atomic weights and many other	Therefore this CL is closed.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
		critically evaluated data.	
CL 41 AF (Adjustment Factor) and ε_{BL} (Destruction efficiency of the baseline system): The PDD states *"In cases where a specific system for collection and destruction of methane is mandated by regulatory or contractual requirements, the ratio of the destruction efficiency of that system to the destruction efficiency of the system used in the project activity shall be used"* and that a company was hired to study the actual efficiency of the LFG collection and destruction. DNV could not identify witch alternative - a), b) or c) of the methodology Guidance on estimating AF – was used. Project participant is requested to clarify it.		To determine AF and ε_{BL}, since there is no collection system installed, PP hired a study to determine the destruction efficiency on the baseline and adopted that value on the PDD. The valued adopted is conservative as there is no obligation to destroy LFG, the chosen value could be zero.	Analyzing the ACM0001 version 11 alternatives to calculate destruction efficiency of the baseline system - alternatives a), b) or c) - DNV considers that alternative b) is the most adequate to this project (the PP hired a company – Landtec - to measure the destruction efficiency of the baseline system ε_{BL} and this value has been used in the project). According it, if no system for collection and destruction of methane is implemented prior to the project and/or no measurements of the amount of methane that is destroyed are available, then the destruction efficiency of the system mandated by regulatory or contractual requirements (ε_{BL}) should be assumed to be equal to the theoretical efficiency of the specific system for collection and destruction of methane that is defined in the regulation or contract. Since in Brazil there is no regulation regarding it, the value adopted would be zero, but conservatively the PP measured it and find out 1.82% as the destruction efficiency of the baseline system.

Draft report clarifications and corrective action requests by validation team	Ref. to checklist question in table 2	Summary of project owner response	Validation team conclusion
			Therefore this CL is closed.
CL 42 Investment analysis: project participant is requested to define what is the project scenario, LFG capture and flare or LFG capture and flare/energy generation. The PDD should present the investment analysis of the defined project activity scenario and not of the possible alternatives.		The project will be power generation, carrying LFG1 + P1. Information concerning the analysis of investment have been changed in the PDD	The PDD presents just the scenario LFG1 + P1 and thus the benchmark analysis is adequate. Therefore this CL is closed.

APPENDIX B

CERTIFICATES OF COMPETENCE

CERTIFICATE OF COMPETENCE

Filipe Tavares

Qualification in accordance with DNV's Qualification Scheme CDM/JI (ICP-8-1-CDMJI-i1)

GHG Auditor:		**Yes**				
Technical Area		*CDM Validator*	*CDM Verifier*	*Sector Knowledge*	*Sector Expert*	*Technical Reviewer*
Landfill gas		**Jan 2009**	**Jan 2009**	**Nov 2009**		
Renewables	***Hydro power***	**Jan 2009**	**Jan 2009**			
	Wind power		**Sept 2009**			
	Other renewable		**Sept 2009**			
Biomass		**Mar 2009**	**Mar 2009**			
Grid connection of isolated system			**Sept 2009**			
Cement						
Waste-heat / waste-gas recovery		**Jan 2009**			**Nov 2009**	
Efficiency of thermal power plants						
Coal mine methane						
Fuel switch		**Jan 2010**	**Jan 2010**		**Nov 2009**	
Manure management		**Jan 2009**	**Jan 2009**		**Jan 2009**	
Waste / wastewater treatment		**Jan 2009**	**Jan 2009**		**Jan 2009**	
Energy efficiency						
N_2O						
HFCs						
Flare reduction						
PFCs						
Charcoal			**Sept 2009**			
CO_2 recovery						
Transport						
Non-renewable biomass			**Sept 2009**			
Biofuel						
Pipeline leakage reduction						
SF_6						

Høvik, 12 January 2010

Michael Lehmann

Michael Lehmann
Technical Director, Climate Change Services

CERTIFICATE OF COMPETENCE

CERTIFICATE OF COMPETENCE

Fabiana Philipi

Qualification in accordance with DNV's Qualification Scheme CDM/JI (ICP-8-1-CDMJI-i1)

GHG Auditor:		**Yes**				
Technical Area		*CDM Validator*	*CDM Verifier*	*Sector Knowledge*	*Sector Expert*	*Technical Reviewer*
Landfill gas						
Renewables	***Hydro power***					
	Wind power					
	Other renewable					
Biomass						
Grid connection of isolated system						
Cement						
Waste-heat / waste-gas recovery						
Efficiency of thermal power plants						
Coal mine methane						
Fuel switch						
Manure management						
Waste / wastewater treatment						
Energy efficiency						
N_2O						
HFCs						
Flare reduction						
PFCs						
Charcoal						
CO_2 recovery						
Transport						
Non-renewable biomass						
Biofuel						
Pipeline leakage reduction						
SF_6						

Høvik, 25 January 2010

Michael Lehmann

Michael Lehmann
Technical Director, Climate Change Services

CERTIFICATE OF COMPETENCE

CERTIFICATE OF COMPETENCE

Anjana Sharma

Qualification in accordance with DNV's Qualification Scheme CDM/JI (ICP-9-8-i1-CDMJI-i1

GHG Auditor:		**Yes**				
Technical Area		*CDM Validator*	*CDM Verifier*	*Sector Expert*	*Methodology Expert*	*Technical Reviewer*
Landfill gas					**Jan 2009**	**Jan 2009**
Renewables	***Hydro power***	**Jan 2009**				
	Wind power				**Jan 2009**	**Jan 2009**
	Other renewable					
Biomass						
Grid connection of isolated system						
Cement						
Waste-heat / waste-gas recovery						
Efficiency of thermal power plants						
Coal mine methane						
Fuel switch						
Manure management						
Waste / wastewater treatment						
Energy efficiency						
N_2O						
HFCs						
Flare reduction						
PFCs						
Charcoal						
CO_2 recovery						
Transport						
Non-renewable biomass						
Biofuel						
Pipeline leakage reduction						
SF_6						

Høvik, 9 January 2009

Michael Lehmann

Michael Lehmann
Technical Director, Climate Change Services

CERTIFICATE OF COMPETENCE

Yon Sing (Simon) Wong

Qualification in accordance with DNV's Qualification Scheme CDM/JI (ICP-8-1-CDMJI-i1)

GHG Auditor:		**Yes**				
Technical Area		*CDM Validator*	*CDM Verifier*	*Sector Knowledge*	*Sector Expert*	*Technical Reviewer*
Landfill gas						
Renewables	***Hydro power***	**Jan 2010**				
	Wind power					
	Other renewable					
Biomass						
Grid connection of isolated system						
Cement						
Waste-heat / waste-gas recovery						
Efficiency of thermal power plants						
Coal mine methane						
Fuel switch						
Manure management		**Aug 2009**				
Waste / wastewater treatment		**Jan 2009**		**Nov 2009**		
Energy efficiency						
N_2O						
HFCs						
Flare reduction						
PFCs						
Charcoal						
CO_2 recovery						
Transport						
Non-renewable biomass						
Biofuel						
Pipeline leakage reduction						
SF_6						

Høvik, 7 January 2010

Michael Lehmann

Technical Director, Climate Change Services

CERTIFICATE OF COMPETENCE

Hendrik Brinks

Qualification in accordance with DNV's Qualification Scheme CDM/JI (ICP-8-1-CDMJI-i1)

GHG Auditor:		**Yes**				
Technical Area		*CDM Validator*	*CDM Verifier*	*Sector Knowledge*	*Sector Expert*	*Technical Reviewer*
Landfill gas		**Jan 2009**				**Jan 2009**
Renewables	***Hydro power***					**Jan 2009**
	Wind power					
	Other renewable					
Biomass						**Jan 2009**
Grid connection of isolated system						
Cement						
Waste-heat / waste-gas recovery						**Jan 2009**
Efficiency of thermal power plants						
Coal mine methane						**Jan 2009**
Fuel switch						
Manure management						
Waste / wastewater treatment						**Jan 2009**
Energy efficiency						**Jan 2009**
N_2O						
HFCs						
Flare reduction						**Aug 2009**
PFCs						
Charcoal						**Aug 2009**
CO_2 recovery						
Transport						**Aug 2009**
Non-renewable biomass						
Biofuel						
Pipeline leakage reduction						
SF_6						

Høvik, 24 August 2009

Michael Lehmann

CERTIFICATE OF COMPETENCE

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