# ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

CPA 47
Methane Recovery and Power Generation Project

Ref. No. 5979-0018
CPA-47 Methane Recovery and Combustion with Renewable Energy Generation from Anaerobic Animal Manure Management Systems under the Land Bank of the Philippines' Carbon Finance Support Facility

June 2019

## LIST OF ABBREVIATIONS

| | |
|---|---|
| BOD | Biological Oxygen Demand |
| BUSECO | Bukidnon Second Electric Cooperative, Inc |
| CDM | Clean Development Mechanism |
| CFSF | Carbon Finance Support Facility |
| CMR | Compliance Monitoring Report |
| CSR | Corporate Social Responsibility |
| DENR | Department of Environment and Natural Resources |
| DNA | Designated National Authority |
| DO | Dissolved Oxygen |
| DOE | Designated Operational Entity |
| DP | Discharge Permit |
| ECC | Environmental Compliance Certificate |
| EMB | Environmental Management Bureau |
| EMF | Environmental Monitoring Fund |
| EPMD | Environmental Program and Management Department |
| ERPA | Emissions Reduction Purchase Agreement |
| ESMP | Environmental and Social Management Plan |
| ESSF | Environmental and Social Safeguards Framework |
| LBP | Land Bank of the Philippines |
| MOA | Memorandum of Agreement |
| MRF | Methane Recovery Facility |
| MSDS | Materials Safety Data Sheet |
| PCO | Pollution Control Officer |
| P.D. | Presidential Decree |
| PoA | Program of Activity |
| PPE | Personal Protective Equipment |
| PTO | Permit to Operate |
| R.A. | Republic Act |
| SMR | Self-Monitoring Report |
| SPA | Subproject Agreement |
| TSD | Treatment / Storage / Disposal |
| TSS | Total Suspended Solids |
| WTF | Water Treatment Facility |

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## PURPOSE OF THE DOCUMENT

This Environmental and Social Management Plan (ESMP) is prepared as part of the requirements of the Safeguards Framework for Clean Development Mechanism (CDM) projects implemented under the Carbon Finance Support Facility (CFSF) of the Land Bank of the Philippines (LBP). The Environmental and Social Safeguards Framework (ESSF) was developed to ensure the establishment of protection, compliance, and mitigation measures for relevant environmental and social aspects of projects under the CDM program which covers the Methane Recovery and Power Generation of CPA 47.

### Scope

Since the Methane Recovery and Power Generation Project is a key component of the CPA 47's wastewater treatment facility (WWTF) – which handles the primary waste (manure) produced by its operations – this ESMP thus encompasses the operations of the entire farm described herein.

## 1 PROJECT SUMMARY

The Methane Recovery and Power Generation Project of CPA 47 is an initiative developed under LANDBANK's CFSF. Its goal is to capture greenhouse gases, particularly methane from piggery wastewaters that would otherwise dissipate into the atmosphere, and convert them into electrical energy.

### 1.1 Proponent Profile

| | |
|---|---|
| Proponent: | CPA 47 |
| Business Address: | Manolo Fortich, Bukidnon, Philippines |
| Project Site: | Bukidnon, Philippines |
| Project Type: | Livestock Project |
| Philippine Standard Industrial Classification: | 0145 - Hog Farming |

Contact Persons

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## 1.2 The Pig Farm

| | |
|---|---|
| Farm area: | 46,250 $m^2$ |
| Production: | Breeding, Farrow-to-Finish (Nucleus Farm) |
| Housing type: | Conventional, open-sided |
| Capacity: | 360 sow level |
| Start of operation: | December 2002 |
| No. of Employees: | 20 |
| Operating hours: | 24 |

CPA 47 is a sole proprietorship, accredited multiplier breeder farm of PIC Philippines. It is currently licensed (as per its Environmental Compliance Certificate) to house a maximum of 360 sows. The site layout in Figure 1 shows the basic facilities of the Farm.

The Farm is entirely powered by a grid of a local concessionaire, Bukidnon Second Electric Cooperative, Inc. (BUSECO) but will soon utilize electricity from biogas through the Project. Water for the Farm's operations is sourced from three deep wells within its premises.

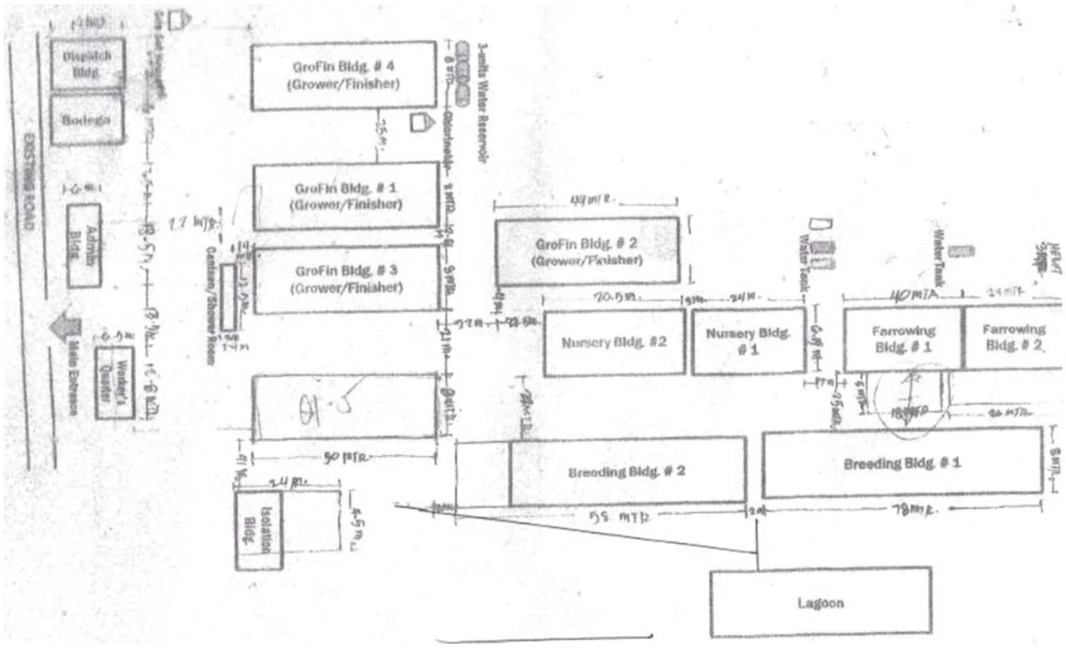


Figure 1. Site layout of CPA 47

## 1.3 Project Description

The Project covers the installation and operation of an anaerobic digester and its ancillary facilities, including post-treatment wastewater lagoons and a biogas-fueled electricity generation system. The Project will replace CPA 47's open anaerobic manure management system.

### 1.3.1 Components and Design

CPA 47's wastewater treatment process will feature three phases:

- *Pre-Treatment,* which involves removal of indigestible materials and relatively large digestible particles in wastewaters prior to entering the reactors;
- *Anaerobic digestion,* or the disintegration of biodegradable materials in the wastewaters through biological processes facilitated by microbes which thrive in the conditions provided by the reactor; and
- *Post-Treatment* of the by-products of anaerobic digestion – biogas, effluent, and sludge.

The WWTF will mainly be consisted of a covered earthen lagoon and a series of clarifying lagoons. The MRF basically will be consisted of biogas generator sets. However, the farm management has yet to finalize a design for their WWTF. The farm has communicated their intent to install an anaerobic digester system with a plan for the system to be operational by 2020. Details and specifications for the said system will be provided upon finalization of the system design.

Overall, the anaerobic digester system will be accommodating wastes generated by up to more than the maximum number of pigs the farm could house (4,000 heads).

### 1.3.2 Operation

Wastewaters from pig sheds will be conveyed through concrete drains into the anaerobic digester. They will remain in the chamber until they are displaced by newly flushed influent. From the biodigester, partially treated wastewaters will flow into a series of clarifying lagoons where they will be stored prior to being reused in the farm for cleaning or until they evaporate.

Biogas produced in the anaerobic digester will be propelled towards a generator set (using a motor) for conversion to electricity that will be used in the Farm.

Sludge will be removed from the anaerobic chambers through gravity release pipes. It will be piled on a concrete bed for drying. Dried sludge will be used as fertilizer.

Figure 2 illustrates the processes involved and the project components employed in the wastewater treatment and power generation process in CPA 47. Once the construction of the WWTF is completed, an assessment of the system's performance will be undertaken to determine its operational parameters and outputs. Results will be presented in the succeeding version of this ESMP.

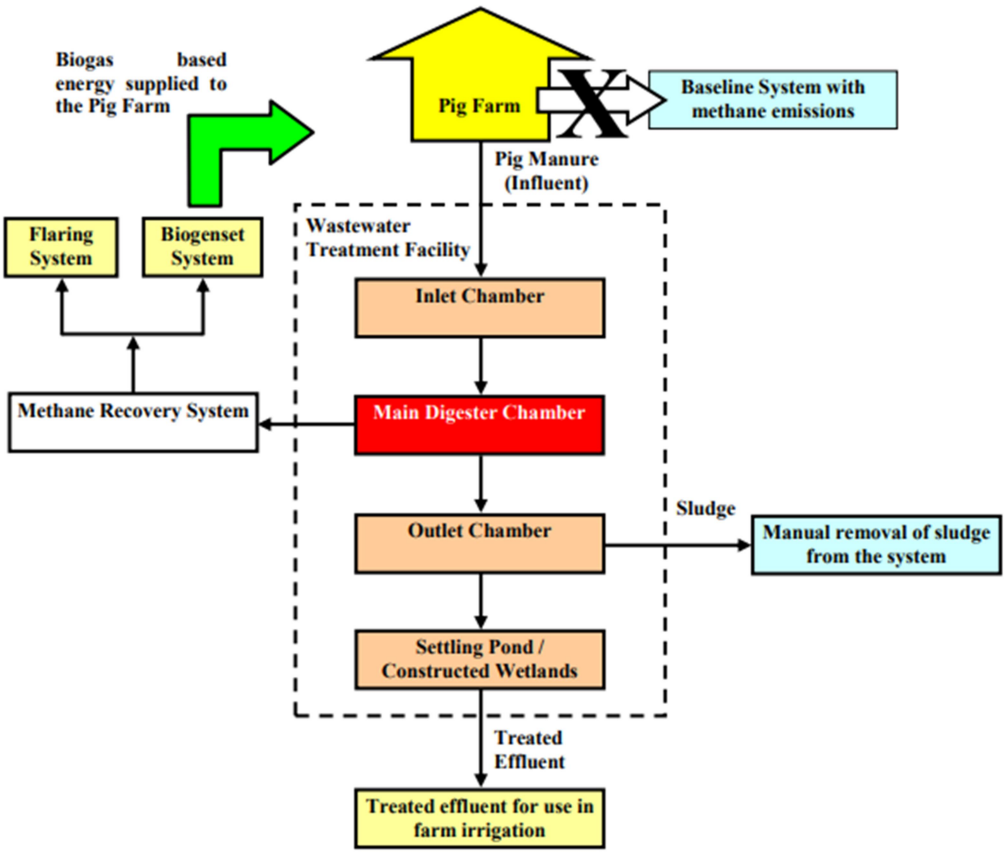


Figure 2. Wastewater treatment and power generation process in CPA 47

## 1.4 Exisitng Environmental Conditions

The Project will be built within the premises of CPA 47, a 4.6250-ha property located in Manolo Fortich, Bukidnon. Bukidnon is in the northern portion of the island of Mindanao in the Philippines.

### 1.4.1 Land Classification and Use

The Farm's location was initially intended for a sanitary landfill proposed by the local government of Manolo Fortich. When this project was deferred, the Zoning Administrator of the municipality permitted the Proponent to establish buildings for agro-industrial purposes in the site. Lands planted with high-value crops surround the property.

### 1.4.2 Climate

Köppen-Geiger system classifies the climate in Manolo Fortich as Tropical Rainforest.[1] The town receives significant rainfall all year round. It has an average annual temperature of 23.8 °C and an average annual precipitation of 2227 mm.[1] Typhoons are barely an occurrence in the Bukidnon.[2]

### 1.4.3 Topography and Soil

The Farm is relatively isolated by Pulog Hill on its west and a deep trench 350 m on its east (see Fig 3). Its ground very gradually drops from west to east. It is mainly made of limestone covered with clay loam soil. Terrains beyond the Farm have rolling topography.

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### 1.4.4 **Water Resources**

At the bottom of above mentioned trench (see Fig 3) is a tributary of Tagoloan River (probably the Dicklum River) which is about 5.5 km northeast of the Farm.

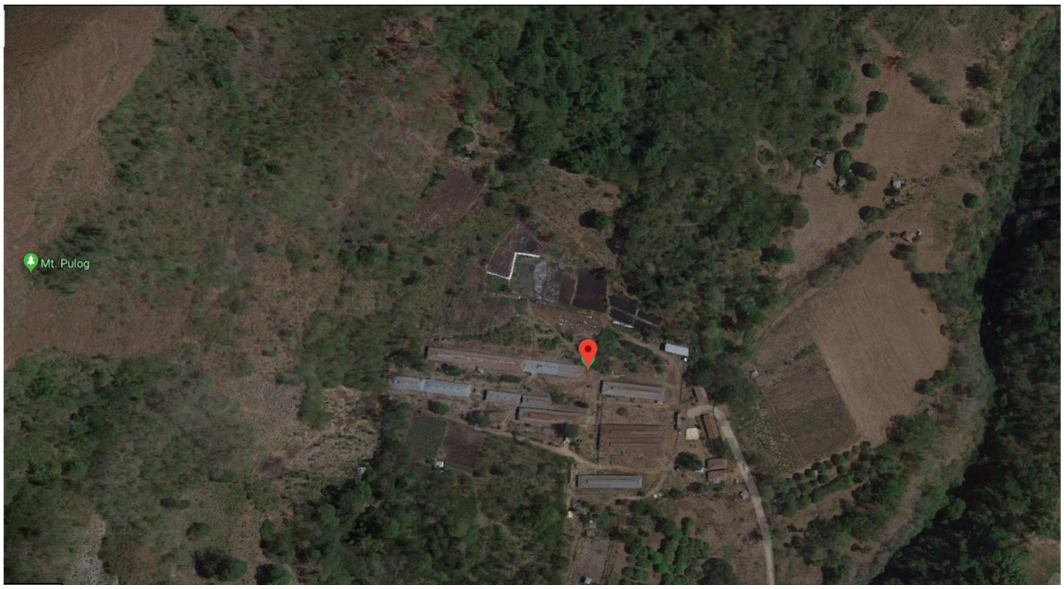


Figure 3. Satellite image of the CPA 47 and its vicinity (*Google Maps*)

### 1.4.5 **Natural Hazards**

The Farm is not vulnerable to flooding[3] due its elevation and sloping grounds. It is however susceptible to landslides and flash flooding and is moderately prone to earthquakes[2,3].

### 1.4.6 **People and Communities**

The Farm is situated at a road's end and is virtually isolated from communities (Fig 3). The neighborhoods closest to it are low density residential areas 2 to 2.5 km away, near the national highway.

## 2 ENVIRONMENTAL MANAGEMENT

### 2.1 Impacts

#### 2.1.1 Positive Impacts

*Environment*

The Project will be built to improve CPA 47's method of handling and disposing pig manure and liquid waste. Anaerobic digestion will help ensure that the Farm's effluents meet regulatory quality standards. Foul odors emanating from stored effluents are anticipated to be significantly abated, improving working conditions for workers and the general envronment for the Farm's neighboring communities and livestock.

By providing a mechanism to capture methane and use it as a renewable source of energy, the Project will help lower the Farm's overall carbon footprint – through preventing release of greenhouse gases into the atmosphere and decreasing its consumtion of conventional fuels (for power).

*Economy*

Using biogas-generated electricity will lessen the Farm's reliance on the grid, translating to savings for the piggery business. Selling sludge from the WWTF as soil amendment presents an opportunity to generate additional income. Further savings may also be gained from reusing treated effluent.

Having been being registered as a component project activity (CPA) in the CDM Program, CPA 47 has an opportunity to earn monetary incentives by selling carbon credits to World Bank. It may also opt to trade its carbon credits in the wider carbon market after the Program.

Lastly, CPA 47 provides employment opportunities to residents of Manolo Fortich and of nearby provinces. It also generates revenue for the local government.

#### 2.1.2 Negative Impacts

Certain aspects of the pig farms' and the project's operations inevitably result in potential harm to the environment, including generation wastewaters; hazardous and non-hazardous wastes; air pollutants; foul odors, noise, dust and other nuisance; and depletion of natural resources. These pose inherent risks to environmental quality and natural ecosystems and to health and safety of workers, communities, and livestock.

A. *Wastewater Generation*
   Wastewaters saturated with dissolved manure and feed materials are primarily generated from raising pigs through intensive farming methods.

B. *Solid Wastes Generation*
   Pig manure, sludge from wastewater treatment, and carcasses make up the bulk of solid wastes generated in the Farm.

C. *Hazardous Wastes Generation*
   Generation of potentially hazardous wastes mainly result from veterniary activities and use of various chemicals for cleaning and for maintenance of machineries. Biological materials from diseased pigs also pose significant risks to the health of workers and livestock.

D. *Generation of Air Pollutants*
   Emssions from diesel- and biogas- fueled generator sets which supplement the grid for the Farm's power requirements are the main sources of air pollutants in the Farm.

*E. Risks to Environmental Quality*

- Pollution. The inadvertent release to the environment (through breaches and leaks) of the wastes listed above, especially of nutrient-rich meterials, may cause serious damage to the quality of affected soil and aquatic resources.

  The Project site features a steep hill side with slopes that drain onto a trench. Runoff that streams through the Farm may carry pollutive materials into the river below. Long periods of heavy rainfall could overtop open wastewater lagoons and wash off improperly contained sludge piles.

- Global warming. Large amount of biogas, mostly composed of potent greenhouse gases, are produced during the anaerobic decomposition pig manure and other organic compounds. If allowed to escape to the atmosphere, these gases will contribute to the furthering of the deteriorating effects of global warming. Use of power from the grid consumes non-renewable fuels which generate greenhouse gases when processed for electricity production.

- Resource depletion. Intensive farming demands for significant volume of freshwater. Neglectful sourcing and use of water in the Farm could deplete water resources.

*F. Health and Safety (Methane Recovery Facility)*

Biogas is a mixture of gases produced during anaerobic digestion. It is mainly composed of methane and carbon dioxide, but other gases (nitrogen, hydrogen, hydrogen sulphide, ammonia, etc.) may also be present at lower concentrations.

- Fire and Explosion. The MRF presents a major fire and explosion hazard in the farm owing to the high concentrations of biogas (primarily consists of methane which is highly flammable and combustible) that it is designed to capture and process. Risk of explosion is elevated in areas where biogas is compressed for storage.

- Asphyxiation and Poisoning. Methane and carbon dioxide are asphyxiants, substances that cause suffocation by displacing oxygen in the ambient air. Furthermore, carbon dioxide and hydrogen sulfide are considered poisonous when inhaled at high concentrations. In the farm, risks of asphyxiation and gas poisoning are high in the areas associated with the MRF and in confined spaces and poorly ventilated areas where fugitive biogas may collect.

- Infection and Infestation. Handling and processing of manure, wastewaters, and sludge expose workers to various pathogens and parasites.

*G. Health and Safety (General Operations)*

Various elements and situations in the Farm could compromise the health and safety of workers and livestock. The comfort and convenience of surrounding communities may also be affected by impacts not contained by the Farm's boundaries.

- Odor, Noise, Dust. Fould odors are typically emitted from manure drains and storage and unclean pig houses. Loud noises may be produced by pigs (especially during feeding) and farm machines. Dust is generated from handling feeds and other dusty materials and by movement of vehicles on unsealed roads.

- Pests and vermin. Pests and vermin are attracted to foul odors and sources of food in the Farm (improperly disposed biodegradable wastes and Inadequately contained food and feed materials).

- Diseases and Injuries. Livestock, pathological materials, and excretions likely harbor harmful organims. Various injuries could result from accidents, particularly when handling pigs, operating machineries, and using toxic substances.

## 2.2 Due Diligence

CPA 47 commits to undertake environmental due diligence in its dealings and operations through compliance with relevant regulatory safeguards and implementation of the measures provided in the environmental management and monitoring plan in Table 3 and of other relevant provisions herein.

### 2.2.1 Legal Framework

CPA 47 operates in the context of laws prescribing the regulatory safeguards in the tables below:

**Table 1.** Environmental documents and statutory requirements regulating the operation of CPA 47

| DOCUMENT | PARTICULARS | |
|---|---|---|
| Environmental Compliance Certificate (ECC) | Reference No. | 10(13)02 10-28 3072-12130 |
| | Issuing Agency | EMB Region 10 |
| | Date of Issuance | October 28, 2002 |
| | Valid Until | - no expiration - |
| | Conditions | ・ area of operation: 4.6250 ha<br>・ maximum population: 360 sow level<br>・ creation of EMF |
| Discharge Permit (DP) for Water Pollution Source / Control Facilities | Reference No. | 2016-DP-J-1013-753 |
| | Issuing Agency | EMB Region 10 |
| | Date of Issuance | September 14, 2015 |
| | Valid Until | September 20, 2021 |
| | Conditions | ・ permits reuse of wastewater for irrigation<br>・ effluent wastewater flow rate: 11,552.25 $m^3$/yr<br>・ submission of SMR |
| Safe Re-use of Wastewater | Reference No. | ・ BAF 09-2016 |
| | Issuing Agency | ・ Department of Agriculture Region 10 |
| | Date of Issuance | ・ September 20, 2016 |
| | Valid Until | ・ September 20, 2021 |
| | | ・ compliance with |
| Permit to Operate (PTO) Air Pollution Source Control Installations | Reference No. | 2018-POA-G-1013-1131 |
| | Issuing Agency | EMB Region 10 |
| | Date of Issuance | June 4, 2018 |
| | Valid Until | July 21, 2023 |
| | Conditions | ・ For the following equipment:<br>- (1 unit) 50 HP / 37.3 kW “LESTER” diesel engine stand generator set |
| Hazardous Waste Generator ID | Registration No. | GR-R10-13-00085 |
| | Approving Agency | EMB Region 10 |
| | Date of Approval | July 1, 2016 |
| | Valid Until | - no expiration - |
| | Conditions | ・ For the following wastes:<br>- mercury and mercury compounds (D407)<br>- waste oils (I101)<br>- lead compounds (D406)<br>・ submission of SMR |
| PCO (Pollution Control Officer) Accreditation Certificate | Accreditation No. | 2015-PCO-1013-00230 |
| | Issuing Agency | EMB Region 10 |
| | Date of Issuance | - |
| | Valid Until | November 19, 2018 (For Renewal) |

EMB Environmental Management Bureau
EMF Environmental Monitoring Fund
SMR Self-Monitoring Report

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**Table 2.** Permits ensuring the safety of CPA 47's facilities and operation

| DOCUMENT | PARTICULARS | |
|---|---|---|
| Business Permit | Permit No. | AVAILABLE AND UP-TO-DATE |
| | Issuing Agency | Office of the Mayor - Manolo Fortich |
| | Date of Issuance | 2019 |
| | Valid Until | December 31, 2019 |
| | Prerequisites | Compliance to:<br>Building Permit<br>Occupancy Permit<br>Locational Clearance<br>Fire Safety Inspection Certificate<br>Sanitary Permit |
| Occupancy | Reference Nos. | CO-13-06-303-BP (June 7, 2013) |
| | | CO-051000133-BP (October 18, 2005) |
| Locational Clearance | Reference No. | Decision No. CZC-02-0142 |
| | Approving Agency | Office of the Municipal Zoning Administrator – Manolo Fortic |
| | Date of Issuance | November 27, 2002 |
| Fire Clearance | Reference No. | AVAILABLE |
| | Issuing Agency | Bureau of Fire Protection |
| | Date of Issuance | January 2019 |
| | Valid Until | December 31, 2019 |
| | Prerequisites | • compliance with R.A. 9514 (Revised Fire Code) |
| Sanitary Permit | Permit No. | AVAILABLE |
| | Issuing Agency | Municipal Health Office – Manolo Fortich |
| | Date of Issuance | January 2019 |
| | Valid Until | December 31, 2019 |
| | Prerequisites | • compliance with P.D. 522 ('Sanitation Requirements'), P.D. 856 (Code on Sanitation), and pertinent local ordinances |

### 2.2.2 **Environmental Management and Monitoring Plan**

Table 3 summarizes the measures intended to address the environmental impacts and risks identified in Section 2.1.2. Adequate training will be given to concerned employees to ensure that the content of this environmental management plan will be properly carried out.

**Table 3.** Environmental Management and Monitoring Plan of CPA 47

| IMPACT | SOURCE / ACTIVITY | MEASURES | STATUS | | | MONITORING METHOD | FREQUENCY | PARAMETER / INDICATOR | RESPONSIBLE ENTITY | REPORTING TO | Cost^, Php |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Existing / Current Practice | To be Implemented / Under Construction | Adoption Under Review | | | | | | |
| **A. Wastewater** | | | | | | | | | | | |
| a.1 generation of wastewater | pig raising | water conservation strategies | ✓ | | | quantify wastewater production | monthly | volume of wastewater produced | Supervisors | Farm Manager > reported in SMR | (Project cost) |
| | | treatment of wastewater in WWTF | ✓ | | | | | | | | |
| a.2 generation of domestic wastewater | general farm activities | water conservation strategies | ✓ | | | check siphoning and hauling records | every 5 years | volume of sewage hauled | Supervisors | Farm Manager > reported in SMR | - |
| | | lined sewage septic tanks | ✓ | | | | | | | | |
| | | sewage disposal to treatment plant | | ✓ | | | | | | | |
| **B. Solid Waste** | | | | | | | | | | | |
| b.1 generation of manure, sludge | pig raising, feed wastage, WTF | minimize feed wastage | | ✓ | | quantify (dried) sludge produced | annually | amount of sludge produced | Supervisors | Farm Manager > reported in SMR | (Project cost) |
| | | treatment of manure in WWTF | ✓ | | | | | | | | |
| b.2 generation of (non-infectious) carcasses, blood | injuries, adverse environmental conditions, etc. | observe sound pig raising practices and biosecurity measures | ✓ | | | weigh disposed materials | daily | weight of materials disposed | Supervisors | Farm Manager > reported in SMR | - |
| | | regular inspection and preventive maintenance of equipment regulating pig environment | ✓ | | | | | | | | |
| | | carcass disposal in concrete vault | ✓ | | | | | | | | |
| b.3 generation of general solid wastes | general farm activities | waste segregation | ✓ | | | weigh solid wastes disposed of (recyclables and residuals) | every hauling | weight / details on wastes generated, stored, and disposed of | Supervisors | Farm Manager > reported in SMR | (cost of hauling and dumping) |
| | | adequate collection bins, proper storage | ✓ | | | | | | | | |
| | | reuse, recycling / selling of recyclables | ✓ | | | | | | | | |
| | | residuals hauled to the sanitary landfill | ✓ | | | | | | | | |
| | | composting | ✓ | | | | | | | | |
| **C. Hazardous Materials** | | | | | | | | | | | |
| c.1 generation of hazardous, toxic wastes | facilities' operation and maintenance | monitors resource usage to avoid expiration of chemicals | ✓ | | | quantify each type of hazardous waste produced / stored and disposed of (check hazardous waste manifests) | every hauling and disposal | quantity of each hazardous waste type stored and disposed | Supervisors | Farm Manager > reported in SMR | (cost of disposal through TSD) |
| | | disposal through accredited TSD | | ✓ | | | | | | | |
| | | reusing, recycling (for various construction and maintenance activities) | ✓ | | | | | | | | |
| c.2 generation of infectious, pathological wastes, carcasses | veterinary activities, infections, outbreaks | disposal in concrete vault | ✓ | | | | | | | | |
| **D. Air Pollution** | | | | | | | | | | | |
| d.1 generation of air pollutants | vehicles, stand-by generator sets (fossil fuel combustion) | operates equipent according to manufacturer's instruction | ✓ | | | review inspection and maintenance record | quarterly | number and details of machinery issues noted | Supervisors | Farm Manager | (cost of maintenance, including salaries) |
| | | regular inspection and preventive maintenance of equipment | ✓ | | | | | | | | |
| **E. Risk of Environmental Degradation** | | | | | | | | | | | |
| e.1 surface water and groundwater quality degradation, disruption of soil properties, contamination | e.1.1 wastewater collection, transport, treatment, disposal | WWTF constructed with durable materials | | ✓ | | effluent sampling and testing by an EMB-accredited laboratory | quarterly - more frequently during rainy seasons | effluent quality indicators: BOD, TSS, ammonia, phosphate (must meet standards for Class C effluent) | Supervisors | Farm Manager > reported in SMR | (cost of maintenance, including salaries)<br><br>50,000 / yr for effluent testing |
| | | operates WWTF as prescribed | | ✓ | | | | | | | |
| | | regular inspection and preventive maintenance of WWTF | | ✓ | | | | | | | |
| | | raised lagoon walls to prevent ingress of runoff | ✓ | | | | | | | | |
| | | adequate rainwater and wastewater separation | | ✓ | | | | | | | |
| | | adequate groundwater and wastewater separation | ✓ | | | | | | | | |
| | | establish vegetation (filter strips) around lagoons | ✓ | | | | | | | | |
| | | has and implements contingency response plan | ✓ | | | | | | | | |
| | e.1.2 sludge management, storage, leachate | regular inspection and preventive maintenance of drying bed | | ✓ | | review inspection and maintenance record | monthly - more frequent during rainy seasons | number and details of leak / breach incidents | Supervisors | Farm Manager | - |
| | | adequate separation of storage from surface/groundwater | | ✓ | | | | | | | |
| | | establish vegetation (filter strips) | ✓ | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | around drying bed and storage | | | | | | | | | |
| | | has and implements contingency response plan | ✓ | | | | | | | | |
| | e.1.3 pathological wastes, carcass disposal, leachate | disposal in concrete vault | ✓ | ✓ | ✓ | review inspection and maintenance record | monthly<br>- more frequent during rainy season | number and details of leak / breach incidents | Supervisors | Farm Manager | - |
| | | create diversion banks, drains around disposal site | | ✓ | | | | | | | |
| | | establish vegetation (filter strips) around disposal site | ✓ | | | | | | | | |
| | | has and implements contingency response plan | ✓ | | | | | | | | |
| | e.1.4 handling, transport, storage, disposal of hazardous and infectious materials | use materials according to registered use / manufacturer's instruction | ✓ | | | review inspection and maintenance record | weekly | number and details of leak / breach incidents | Supervisors | Farm Manager | (cost of signage cost)<br><br>(cost for TSD disposal) |
| | | MSDS available and consulted | | ✓ | | | | | | | |
| | | proper and secured storage | ✓ | | | | | | | | |
| | | spill kits available | | ✓ | | | | | | | |
| | | appropriate signage, warnings in place | | ✓ | | | | | | | |
| | | regular inspection of storage, disposal facilities | | ✓ | | | | | | | |
| | | has and implements contingency response plan | ✓ | | | | | | | | |
| | | adequate training on handling hazardous materials | | ✓ | | | | | | | |
| | e.1.5 natural hazards | raised lagoon walls | | ✓ | | review inspection and maintenance record | monthly<br>- more frequently during rainy seasons | details of inspection report | Supervisors | Farm Manager | (cost of slope protection) |
| | | adequate runoff channels | | ✓ | | | | | | | |
| | | slope protection measures | | ✓ | | | | | | | |
| | | plant / maintain vegetation along / on sloping areas | ✓ | | | | | | | | |
| e.2 (release of GHGs) | e.2.1 anaerobic digestion, biogas collection and utilization, fugitive biogas | biogas sequestered using biodigester | | ✓ | | review inspection and maintenance record | monthly | number and details of leak / breach incidents (odor detection) | Supervisors | Farm Manager | (cost of maintenance, including salaries) |
| | | MRF constructed with durable materials | | ✓ | | | | | | | |
| | | operate MRF as prescribed | | ✓ | | | | | | | |
| | | regular inspection and preventive maintenance of MRF | | ✓ | | | | | | | |
| | | has and implements contingency response plan | | ✓ | | | | | | | |
| | | has flare | | | ✓ | | | | | | |
| | e.2.2 use of electricity from grid | energy conservation strategies | ✓ | | | review billing statement | monthly | kWh consumption | Supervisors | Farm Manager >reported in SMR | - |
| | | uses renewable fuel (biogas from MRF) | | ✓ | | | | | | | |
| | | uses energy-efficient equipment | ✓ | | | | | | | | |
| e.3 groundwater depletion | pig raising, general farm activities | water conservation strategies | ✓ | | | quantify volume of freshwater consumption | monthly | volume of freshwater consumed | Supervisors | Farm Manager >reported in SMR | (flow meter cost) |
| | | effluent recycling | | ✓ | | | | | | | |
| | | rainwater harvesting | | | ✓ | | | | | | |
| **F. Health and Safety – Anaerobic Digester System** | | | | | | | | | | | |
| f.1 explosion, fire hazard | biogas collection, storage, combustion | WWTF-MRF constructed with durable materials | | ✓ | | review inspection and maintenance records, incident reports, complaints register | monthly | number and details of explosion, fire incidents | Supervisors | Farm Manager | (signage cost)<br><br>(cost of fire protection equipment)<br><br>(cost of maintenance, including salaries) |
| | | operates WWTF-MRF according to design | | ✓ | | | | | | | |
| | | regular monitoring of pressure within the MRF system | | ✓ | | | | | | | |
| | | regular inspection and preventive maintenance of MRF | | ✓ | | | | | | | |
| | | restricts access to MRF | | ✓ | | | | | | | |
| | | prohibits ignition sources near MRF | | ✓ | | | | | | | |
| | | 'no smoking' policy / designated smoking area | ✓ | | | | | | | | |
| | | appropriate signage, warnings in place | | ✓ | | | | | | | |
| | | fire protection equipment on site | ✓ | | | | | | | | |
| | | adequate training on biogas safety | | ✓ | | | | | | | |
| f.2 asphyxiation, | biogas | appropriate signage, warnings in | | ✓ | | review incident reports | monthly | number and details of | Supervisors | Farm Manager | (cost of PPE) |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| poisoning | | place | | | | | | asphyxiation, poisoning incidents | | | (signage cost) |
| | | adequate training on biogas safety | | ✓ | | | | | | | |
| | | pull-plug system for draining and desludging WWTF | | | ✓ | | | | | | |
| | | use of appropriate PPE | | ✓ | | | | | | | |
| f.3 infection, infestation | wastewater, sludge | appropriate signage, warnings in place | | ✓ | | review incident reports | monthly | number and details of infection, infestation incidents | Supervisors | Farm Manager | (cost of PPE) |
| | | adequate training on handling infectious materials | | ✓ | | review results of health checks | annually | | | | (cost of employees' health checks) |
| | | uses appropriate PPE | | ✓ | | | | | | | |
| **G. Health and Safety – General Farm Operations** | | | | | | | | | | | |
| g.1 odor - nuisance, discomfort, health issues | g.1.1 pig houses, manure | regular cleaning, disinfection | | ✓ | | review complaints register | every two weeks - more frequent during typhoon (windy) season | number and details of odor complaints | Supervisors | Farm Manager | (cost of cleaning materials) |
| | | plant / maintain buffer trees / vegetation | ✓ | | | | | | | | (cost of seedlings) |
| | | uses appropriate PPE | | ✓ | | | | | | | (cost of PPE) |
| | g.1.2 WTF, effluent, MRF | employs biodigester (traps odor and biogas) | | ✓ | | | | | | | (cost of maintenance) |
| | | adequate retention time of wastewaters in the biodigester | | ✓ | | | | | | | |
| | | regular inspection and preventive maintenance of WWTF-MRF | | ✓ | | | | | | | |
| | | prevent overtopping, spillage | ✓ | | | | | | | | |
| | | plant / maintain buffer trees / vegetation | ✓ | | | | | | | | |
| | | uses appropriate PPE | | ✓ | | | | | | | |
| | g.1.3 decomposing materials (sludge and organic solids) | sludge pile is well aerated, prevent waterlogging | ✓ | | | | | | | | |
| | | uses appropriate PPE | | ✓ | | | | | | | |
| | g.1.4 decomposing materials (placental materials and carcasses) | disposal in concrete vault | ✓ | | | | | | | | |
| | | prevent leachate leakage | ✓ | | | | | | | | |
| | | uses of appropriate PPE | | ✓ | | | | | | | |
| g.2 noise - nuisance, discomfort | g.2.1 pigs | uses appropriate PPE | | ✓ | | review complaints register | monthly | number and details of noise complaint | Supervisors | Farm Manager | (cost of PPE) |
| | | adequate spatial buffer from surrounding communities | ✓ | | | | | | | | (cost of seedlings) |
| | | plant / maintain buffer trees / vegetation | ✓ | | | | | | | | (cost of maintenance) |
| | g.2.2 vehicles, machineries | operates equipment according to manufacturer's instruction | ✓ | | | | | | | | |
| | | limits operation during day time | ✓ | | | | | | | | |
| | | regular inspection and preventive maintenance of machineries | ✓ | | | | | | | | |
| | | noise reduction equipment | | ✓ | | | | | | | |
| | | uses appropriate PPE | | ✓ | | | | | | | |
| g.3 dust - nuisance, discomfort, health issues | g.2.1 pig houses, feed handling | uses appropriate PPE | | ✓ | | review complaints register | quarterly - more frequent during typhoon (windy) season | number and details of dust complaints | Supervisors | Farm Manager | - |
| | g.2.2 composting areas, dried compost handling | limit dust-generating activities during day time, low wind movement | ✓ | | | | | | | | |
| | | uses of appropriate PPE | | ✓ | | | | | | | |
| | g.2.3 vehicles, machineries | limits vehiclular speed on unsealed roads | ✓ | | | | | | | | |
| | | limit dust-generating activities during day time | ✓ | | | | | | | | |
| | | uses of appropriate PPE | | ✓ | | | | | | | |
| g.4 pest and vermin proliferation / infestation - nuisance, health issues | decomposing materials, sources of odors | observes good houskeeping practices | ✓ | | | review inspection results records and complaints register | monthly - more frequent during rainy season | number and details of incidents, complaints | Supervisors | Farm Manager | (cost of pest control) |
| | | odor control measures | ✓ | | | | | | | | |
| | | pest, vermin control measures | ✓ | | | | | | | | |
| g.5 health hazards, (risk of) contracting infectious diseases, sustaining injuries, livestock outbreak | handling, transport, storage of hazardous and infectious materials, movement of carrier pests and | adequate training on handling of hazardous, infectious materials | | ✓ | | review incident reports, inspection records and complaints register, results of employees' regular health checks | monthly | number and details of illness, injury incidents, complaints | Supervisors | Farm Manager | (cost of PPE) |
| | | uses appropriate equipment (including PPE) for handling, storage of hazardous and infectious | | ✓ | | | | | | | (cost of supplies for biosecurity) |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | vermin, handling of ill pigs | materials | | | | | | | | | |
| | | enforce, observe biosecurity, health and safety protocols | ✓ | | | | | | | | |
| | | pest and vermin control measures | ✓ | | | | | | | | |
| g.6 drowning hazard | open ponds, lagoons, tanks | restricted access to WWTF | | ✓ | | review incident reports | monthly | number and details of drowning incidents | Supervisors | Farm Manager | (cost of signage) |
| | | appropriate signage and warnings | | ✓ | | | | | | | |

BOD Biological Oxygen Demand
MSDS Materials Safety Data Sheet
PCO Pollution Control Officer
PPE Personal Protective Equipment
SMR Self-Monitoring Report
TSD Treatment, Storage, Disposal
TSS Total Suspended Solids

^ Indicative cost

### 2.2.3 **Contingency Response**

The following is an overview of the Farm's current preparation and plan of action in response to certain emergency incidents (see also Appendix A):

a. Fire
   – Fire extinguishers are available at strategic locations around the farm. Pig houses are also equipped with water taps from which water for putting out fire can be sourced.

b. Earthquake
   - The open grounds inside the farm are designated as evacuation areas for when an earthquake occurs.

c. Outbreak
   - In the event of a livestock outbreak, quarantine measures are instinctively applied. Movement of humans and animals in and out of the farm is restricted and instructions from the farm's consultant veterinarian are carried out.

d. Power outage
   - Should there be power interruption, a diesel-fueled standby generator is able to supply the farm's electricity needs, in addition to the biogas genset.

e. Health emergencies
   - First aid kits are readily available on site for minor injuries. Farm personnel also have access to vehicles which can be used for transporting cases needing more advanced medical care.

Emergency services can be accessed along the national highway after about a 5 to 10-min drive from the Farm.

In the event that any of the listed emergencies occur, farm personnel are to report to the Farm Manager who is in charge of alerting the owner and emergency services near the property.

### 2.2.4 **Occupational Health and Safety**

CPA 47's risk management plan for general occupational health and safety issues associated with work in the Farm is presented in Appendix B. Health complaints and accidents will be recorded in a register and will serve as indicators of the plans effectiveness, together with results of workers' annual health check-ups.

## 2.3 **Monitoring, Reporting and Auditing**

The proponent will perform the monitoring plan in Table 3 and conduct regular inspection of its facilities not only for internal purposes but also to satisfy the requirements of the Environmental Management Bureau (EMB) for periodic self-monitoring reports (SMR). In addition, asessments will also be initiated during or immediately after incidents that may have compromised the integrity of the farm's facilities, especially the WWTF-MRF, and caused the release of pollutants in the environment. A registry of such incidents and other environmental emergencies and accidents will be maintained in the farm and its details reported in the SMR.

The SMR will contain the results of audits on the farm's environmental performance in terms of resource utilization, waste management, regulatory compliance, and fulfillment of environmental commitments among others. This document will be tendered to EMB quarterly. LBP-EPMD (Environmental Program and Management Department) will also be provided with copies of this document for reference and review purposes.

The owner and the Farm's Pollution Control Officer (PCO) will ensure that the farm is compliant with pertinent environmental regulations, including those listed in Table 3, and is performing its environmental commitments, including the implementation of this ESMP.

During the implementation of the CDM Program, LBP-EPMD will conduct monitoring activities in the farm at least twice a year to help the proponent execute, identify gaps in, and improve and update this management plan.

## 3 SOCIAL DUE DILIGENCE

### 3.1 Consultation and Participation

The stakeholders of the Project were identified and invited by the Proponent, together with LBP-EPMD, through letters and notices to the consultative meeting held on March 23, 2016 (9 AM to 2 PM) in Manolo Fortich. The meeting was attended by a total of 20 individuals from various institutions, including local officials and residents of communities near the project site.

All relevant information, especially those that pertain to the Project's environmental and social impacts, was communicated to the stakeholders during the consultations. Issues and queries raised were satisfactorily addressed by the Proponent and the other presenters.

### 3.2 Grievance Redress Mechanism

The Farm's manager is hereby designated as the main contact persons for grievances, feedbacks, and queries related to the project. She is to ensure that the details of complaints and the actions made to address the same will be recorded completely and truthfully in a register. Such information shall be part of the regular monitoring report for the project and will be made available to relevant stakeholders.

The Proponent will make every effort to settle any concern at the project level. Should its attempts be unsuccessful, issues will be raised to the following third party institutions for arbitration and possible resolution:

- Office of the Barangay Chairman
  Complaints shall be entertained in the *barangay* where the Farm is situated. The *barangay* office concerned will facilitate the negotiation process and LBP-EPMD will ensure that the complainant is properly represented.

- Municipal Office
  Should no agreement be reached at the *barangay* level, the matter will be elevated to a municipal government office. Depending on the nature of the complaint, grievances may be addressed to the Municipal Health Office, Agriculturist Office, Environment and Natural Resources Office, or other relevant municipal agency.

- LBP
  LBP through EPMD will take part on the resolution process only after the aggravated party has gone through the previous levels and finds the decisions rendered there unacceptable. EPMD will coordinate with the Proponent to ensure that issues regarding the latter's project are resolved to the best interest of the complainant.

To further ensure the proponent's accountability, contact details of the Farm's management and LPB-EPMD shall be provided to stakeholders during consultations and through postings at public notice boards. For this project, the following serve as grievance administrators:

- Prudencio E. Calado III
  Head/Assistant Vice President, LBP-EPMD
  Telephone No.: (632) 405-7339
  Fax No.: (632) 528-8484

### 3.3 Information Disclosure

This ESMP and other relevant information regarding the Project will be published in LANDBANKS's website where it can be readily accessed by the public. Printed copies of

this document will be submitted to EMB Region 10 and will also be available inin LANDBANK's library (1598 M.H. Del Pilar cor Dr. J. Quintos St., Malate, Manila, Philippines) and in the World Bank InfoShop.

### 3.4 Equal Opportunity

CPA 47 is an equal opportunity employer, not regarding gender, age, disability, and ethnicity in evaluating and hiring potential employees.

### 3.5 Resettlement

The Project is located inside the premises of CPA 47, a private property. No individual was displaced for nor were there any indigenous peoples affected by the establishment of the Farm and the Project.

### 3.6 Others

Employees of CPA 47 receive standard basic salary at the minimum, 13th month pay, and other regular statutory benefits, in addition to free meals and lodging at the Farm.

## 4 ESMP REVIEW AND UPDATING

This ESMP shall be reviewed annually and will be updated subject to the results of the semiannual monitoring activities conducted by the Proponent and LBP-EPMD. Reviews may be done more frequently or earlier than schedule, especially after events resulting in significant adverse effect to the environment.

## 5 INSTITUTIONAL ARRANGEMENTS

### 5.1 The Proponent

The Proponent will be responsible in all the aspects of the Project, including the implementation of this ESMP. He will shoulder all costs associated with the construction and operation of the project, internal monitoring activities, and meeting various statutory requirements. Specifically, he shall cause the accomplishment of the following:

- exercise environmental and social due diligence in implementing the project
- incorporate sound practices in environmental, health, and safety management
- comply with relevant national and local laws and satisfy regulatory obligations
- perform diligent environmental and system monitoring
- prepare and submit on schedule accurate monitoring reports to EMB and LBP
- cooperate with the LBP and other regulatory agencies by providing assistance and correct and relevant information regarding the project and its environmental performance for reference, review, and monitoring purposes
- promote transparency by maintaining open lines of communication with project stakeholders and giving them access to relevant information
- initiate resolution of conflicts that may arise as a result of the project's operation

The proponent, in close coordination with LBP, shall implement the project based on LBP's ESSF and on the agreed activities and timelines stipulated in the memorandum of agreement (MOA) and subproject agreement (SPA) between the said entities.

### 5.2 LANDBANK

LBP shall serve as the financial and technical intermediary for the CDM Program of Activity (PoA) under which the project of CPA 47 is being implemented. It shall provide the proponent carbon and investment finance assistance for the installation of an anaerobic wastewater treatment facility equipped with a biodigester and methane-fueled power generator. Moreover, it shall act as the entity in charge of project validation and verification activities, and of collation of relevant information and monitoring data for the undertakings mentioned. Specifically, LANDBANK, through EPMD, shall:

- make available financing facilities to the proponent, subject to existing lending policies of LBP
- coordinate and facilitate communications and transactions between the proponent and World Bank or other carbon buyers, Designated Operational Entity, and when necessary, with other project partners
- administer the agreements (MOA, SPA) forged between LBP and the Proponent
- provide technical support and relevant trainings to farm owners and personnel in partnership with other institutions
- ensure compliance of the Project and its proponent with the rules governing PoAs and with its commitments in the MOA and SPA
- ensure compliance of the Project and its proponent with relevant standards and regulations and environmental commitments by conducting onsite monitoring and evaluation and desk reviews
- provide assistance to the proponent in complying with statutory requirements for the project
- ensure the project's sustainability by monitoring the long-term implementation of the safeguards specified in this ESMP and its environmental performance in general
- gather, collate, and review pertinent information and documents (including safeguard instruments, reports, and permits and clearances) concerning the project
- participate in conflict resolution initiated by the proponent
- prepare and submit monitoring reports to World Bank regularly
- satisfy its obligations under the Emissions Reduction Purchase Agreement between LBP and World Bank

LBP shall assist the proponent in its implementation of the project in accordance with LBP's Safeguards Framework and the agreed activities and timelines stipulated in the MOA and SPA.

## 5.3 Department of Environment and Natural Resources

The Department of Environment and Natural Resources (DENR) is the primary government institution mandated to manage and protect the Philippines' environment and natural resources. It is also the Designated National Authority (DNA) of the CDM Program in the Philippines. As DNA, its main role is to review and endorse PoAs to the United Nations Framework Convention on Climate Change.

### 5.3.1 Environmental Management Bureau

Through the EMB, DENR sanctions and regulates the activities of the Project by means of various legal instruments. EMB also leads (whether or not as part of a Multi-partite Monitoring Team) the periodic monitoring of the Project's compliance and impacts, including the fulfillment of the commitments stated in this ESMP. Prior to construction, EMB was the agency tasked to review and evaluate the environmental soundness of the Project and authorize its establishment through the issuance of an Environmental Compliance Certificate.

## 5.4 Municipal Government

The municipal government of Manolo Fortich licenses the operation of CPA 47 through the issuance of a business permit. This permit is only given to businesses able to satisfy its prerequisites – building and occupancy permits, zoning clearance, sanitary permit, and fire clearance, among others..

Agencies and offices of the municipal government of Manolo Fortich will also, if necessary, lead / facilitate the resolution of complaints arising from the Farm and Project's operations.

## 5.5 World Bank

The World Bank is the main Carbon Buyer of the Project, but will also serve as an advisor to LPB in carrying out the latter's responsibilities as the coordinating and managing entity for CDM projects. The Bank will conduct regular monitoring, audits, and appraisals on the Project's safeguards performance against its established policies, as well as provide technical guidance to LBP and to the Proponent.

## 6 SUB-PROJECT ACCOUNTABILITY

In line with Section 3.02 on *Sub-Project Development and Operation by the Sub-Project Entity*, Item (q) of the Sub-Project Purchase Agreement (SPA) signed by the Farm Management, the Sub-Project Entity (Farm Management) agrees and undertakes to:

(q) implement and operate the Sub-Project in compliance with the World bank Operational Policies, including without limitation and as applicable, the Environmental Management Plan, Resettlement Plan, Indigenous Peoples Plan, and any other requirement resulting from the application of the World Bank Operational Policies.

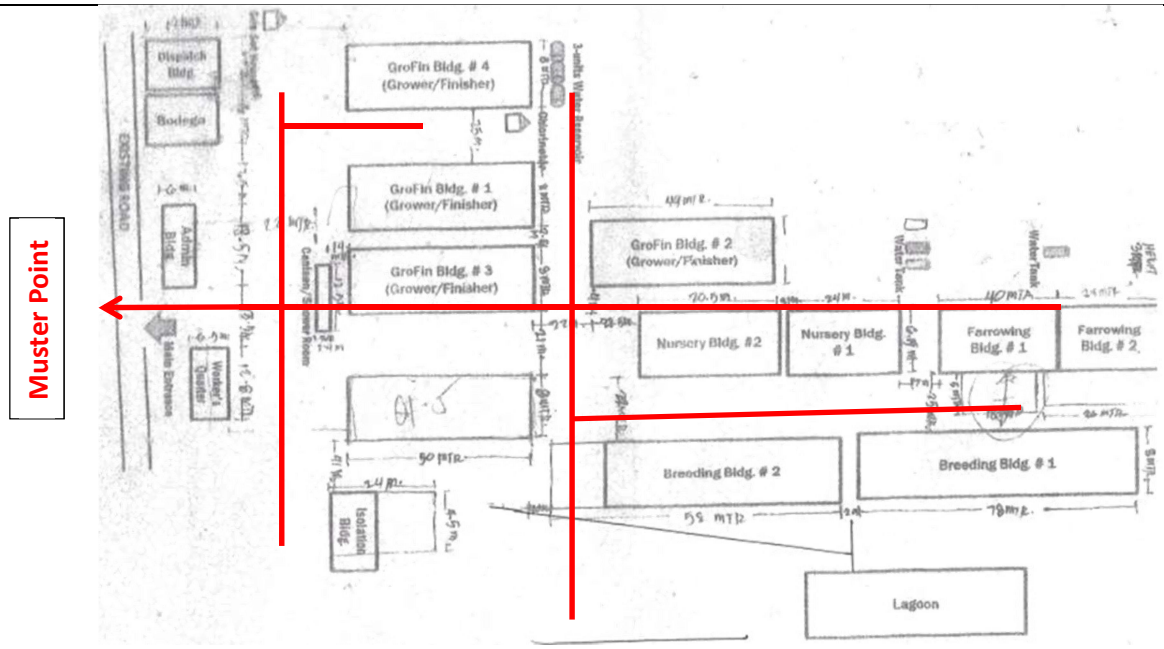
Having signed the SPA, the Farm Management is accountable to comply with the commitments stated in this document.

**REFERENCES**

1 en.climate-data.org
2 vm.observatory.ph
3 noah.up.edu.ph (ESRI Base Map)

APPENDIX A.

Site Evacuation Plan




**CPA 47 POINT PERSONS:**

Farm Manager: +63.915.256.9965

**LOCAL EMERGENCY CONTACT DETAILS:**

Manolo Fortich Police Station: **(088) 230 2244**
Manolo Fortich Fire Station: **0975 331 7371**
Bukidnon Provincial Hospital: **(088) 230 2111**

APPENDIX B.

# Health and Safety Risks Management Plan of CPA 47

| Hazard | Possible Harm | Source / Cause | Prevention / Minimization* | Person/s Responsible |
|---|---|---|---|---|
| **physical** | | | | |
| noise | discomfort, hearing damage | pig squeals | - wear appropriate PPE (ear protection) | Farm Personnel |
| | | running machineries and vehicles | - install noise-control devices when applicable<br>- regular equipment inspection and maintenance<br>- equipment housed in enclosed structure, if applicable<br>- schedule shifting duties<br>- install signage and warnings<br>- wear appropriate PPE (ear protection) | Team Leader<br>Farm Personnel |
| vibration | discomfort, ergonomic and nerve injuries, fatigue | running machineries | - ensure all loose equipment are securely placed<br>- perform regular equipment inspection and maintenance<br>- install signage and warnings | Team Leader<br>Farm Personnel |
| electricity | shock, electrocution, burns | faulty machineries and power lines | - get services of a licensed electrician<br>- consult equipment manual<br>- perform regular equipment inspection and maintenance | Maintenance<br>Farm Personnel |
| | | improper use (or servicing) of electrical equipment | - restrict access to equipment<br>- install signage and warnings<br>- train staff (consult equipment manual)<br>- wear appropriate PPE | |
| heat | burns | running machineries (hot surfaces, vapors, liquids) | - use insulation where possible<br>- install machine guards<br>- install signage and warnings<br>- wear appropriate PPE (such as long sleeved shirts) | Maintenance<br>Farm Personnel |
| | discomfort, heat exhaustion, heat stroke | working in enclosed spaces with limited ventilation | - adequate hydration and rest breaks | Team Leader |
| dust | irritation, respiratory distress / diseases | feeds, ambient dust | - calm work pacing to avoid exciting the pigs<br>- thorough cleaning of indoor spaces<br>- PPEs (mask) | Farm Personnel |
| poor lighting | eye strain, can't see hazards | unlit / inadequately lit areas | - install light sources<br>- carry portable light sources<br>- work during daytime whenever possible | Team Leader<br>Farm Personnel |
| **chemical** | | | | |
| harmful gases, dust, vapors (inhalation) | discomfort (odor), asphyxiation, poisoning, respiratory distress / diseases | degrading organic wastes | - observe measures for odor control<br>- install signage and warning labels<br>- train staff (on handling hazardous substances and wastes and working in confined spaces; review MSDS / product information sheets)<br>- wear appropriate PPE (mask)<br>- ensure first aid kits are readily available | Manager<br>Team Leader<br>Farm Personnel |
| | | hazardous substances (cleaning and pest control chemicals, veterinary medicines, fuels, hazardous wastes, etc.) | | |
| | | fuel burning (machineries, vehicles) | - perform regular equipment inspection and maintenance | Maintenance |
| | | fugitive gases | - perform regular inspection and maintenance of biogas system | Maintenance |
| hazardous substances (contact, ingestion) | irritation, burns, poisoning, skin problems | hazardous substances (cleaning and pest control chemicals, veterinary medicines, fuels, hazardous wastes, etc.) | - use proper labeling, containers, and storage<br>- restrict access to chemical and hazardous waste storage<br>- train staff (handling hazardous substances and wastes; review MSDS / product information sheets)<br>- only competent staff should administer veterinary medicines<br>- ensure first aid kits are readily available<br>- PPEs (gloves, eye glasses) | Manager<br>Team Leader |
| **biological** | | | | |
| pathogens / infectious agents, toxins and other products | various infectious diseases, parasites, irritation | pathological materials / tissues | - observe proper disposal of animal and veterinary wastes<br>- implement quarantine measures<br>- good housekeeping practices (disinfection)<br>- practice hygienic practices (especially hand hygiene)<br>- perform workers' regular health examination<br>- train staff (on animal handling, proper waste handling and disposal)<br>- wear appropriate PPE (gloves, mask, goggles) | Manager<br>Veterinarians<br>Team Leader |
| | | sick animals | | |
| | | animal excretions and fluids | | |
| | | manure (wastewaters) | | |
| | | sludge | | |
| | | veterinary wastes (especially sharps) | | |
| | | potential disease carriers (objects, people, dust) | | |
| | | insects, pests, vermin | - proper disposal of odorous wastes<br>- good housekeeping practices<br>- implement pest control measures | Farm Personnel |
| **ergonomic** | | | | |
| ergonomic stress | ergonomic injuries | repetitive actions, forceful exertions, sustained awkward posture | - use aid of appropriate equipment for lifting/moving heavy objects<br>- use of proper lifting techniques<br>- implement buddy system at work<br>- ensure job rotation / adequate rest (in between tasks) | Team Leader<br>Farm Personnel |
| | | improper use of equipment | - train staff (consult manuals) | Team Leader<br>Farm Personnel |
| | | use of faulty equipment | - repair or replace equipment | Team Leader |
| **other accidents and contingencies** | | | | |
| slips, trips, falls | injuries, wounds, contusions | spills (slips) | - maintenance of walkways<br>- daily safety briefings and regular trainings<br>- barricading of work areas<br>- wearing of appropriate PPE | Maintenance<br>Farm Personnel |
| | | various objects, debris (trips) | | |
| | | heights, slips (falls) | | |
| entanglement | injuries, wounds, strangulation | machineries | - install machine guards<br>- tie back long hair<br>- wear long sleeve shirts<br>- avoid wearing loose-fitting clothes and personal | Farm Personnel |

| | | | | |
|---|---|---|---|---|
| | | | accessories<br>- regular equipment inspection and maintenance | |
| blows, punctures | injuries, wounds, contusions | pig handling | - use animal restraints<br>- ensure enough space to maneuver<br>- train staff (animal handling techniques)<br>- wear appropriate PPE (boots, gloves, etc.) | Team Leader<br>Farm Personnel |
| sharps | sharps injuries, wounds | veterinary activities, waste handling | - ensure only trained personnel conduct veterinary activities<br>- wear appropriate PPE (gloves, goggles) | Team Leader<br>Farm Personnel |
| fires | burns | faulty electrical systems, explosions, fugitive gases, accidental ignition | - comply with requirements and regulations of fire authorities<br>- provide adequate and proper (multipurpose) fire protection equipment<br>- designate smoking areas away from digester, gas tanks, and electrical equipment and storage of combustible materials (compost, sludge, chemicals)<br>- regular clearing of vegetation near farm structures<br>- install signage and warnings<br>- train staff (on contingency plan and proper equipment use)<br>- perform regular inspection and maintenance of electrical systems and equipment | Maintenance |
| blast | blast injuries | excessive pressure in biodigester, fugitive gases, contained gases in confined spaces, fires | - keep sources of heat, including machineries, at a safe distance from biogas facility<br>- prohibit smoking and use of cellphones around biogas system and gas storage facilities<br>- perform regular inspection and maintenance of MRF<br>- install signage and warnings | Maintenance |

* Shaded rows / items applicable for Anaerobic Digestion System