INSTITUTO COSTARRICENSE DE ELECTRICIDAD
[COSTA RICAN INSTITUTE OF ELECTRICITY]
UEN Projects and Associated Services
Environmental Management Service Center

Environmental Technical Report on the Expansion of the Generation Capacity

Las Pailas Geothermal Plant

File 788-04 Setena

July 2012

CONTENTS

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1 INTRODUCTION

Since July 2011, the ICE has been operating the Las Pailas geothermal field located in the district of Curubandé of the canton of Liberia - Western Section of the Rincón de la Vieja Volcanic Massif, with the installation of a binary geothermal generation plant (drive fluid + vapor and water) and an installed power of 35 Mw. Based on the results obtained in the extraction of geothermal vapor in the first months of operation, it was decided to expand its generation capacity by an additional 55 Mw. Therefore, the necessary financing was sought to complete this second stage of development of the geothermal field.

The additional geothermal station will be located in the Southeastern Section of the geothermal field delimited in the Environmental Impact Study (EsIA), the area of operation of the geothermal resource will cover approximately 2.5 km^2. This land was considered in the thematic analysis of the areas of environmental influence of that Project during the performance of the EsIA (file 788-04-Setena, environmental feasibility according to Resolution No. 3688-2005-Setena, Annex No. 1).

When the President of the Republic, Ms. Laura Chinchilla visited Japan this past December, an agreement was signed with the Government of that country to initiate the paperwork for a loan to finance the facility. This geothermal field would operate with vapor resulting from a separation step, similar to those located in the geothermal field of Miravalles and known as Miravalles 1, 2 and 3, with a distribution of buildings or structures very similar to that presented by CM Miravalles 3 (Photograph No. 1.1 CM Miravalles 3. Photograph No. 1.2 CM Miravalles 1)

Photograph No. 1.1 of the distribution of the powerhouse and cooling tower constructions in Miravalles 3 - Photograph Rogelio Zeledón

Photograph No. 1.2 of the distribution of the powerhouse and cooling tower constructions in Miravalles 1 - Photograph Rogelio Zeledón

The feasibility study of this expansion is being carried out with the support of the Japanese consultancy West Japan Engineering Consultants, Inc. (West JEC), sponsored directly by —Japan International Cooperation Agency" (JICA) of the Government of Japan, under a Non-reimbursable Technical Cooperation granted to the ICE according to agreements subscribed by the Executive Branch and the Management of Electricity and Finances of the ICE with JICA.

The work schedule being handled by the ICE is to have this technical and environmental feasibility study at very advanced levels by December 2012, so that ICE is a candidate for an equity loan from the State to finance the construction of this expansion of the Las Pailas GP, with the clear understanding that for this only the Japanese fiscal period 2012 is available, which expires in March 2013.

On dates prior to the President's visit to Japan, several meetings were held with the Full Committee of Setena in order to establish the legal or regulatory mechanisms to handle the environmental feasibility of expanding the generation capacity of the geothermal field in operation. For this, the ICE was asked to file an environmental technical report according to note SG-ASA-059-2012 (Decree No. 34688 MINAE-S- MOPT-MAG-MEIC- art. 46 sec. 3), in which the procedure and content of this technical document are detailed. The following is noteworthy:

The environmental technical report must have:

a. The approach with due justification, through a note signed by the developer or the authorized person in the file, whose signatures must be authenticated by a notary public.

b. This request must contain a comparative table of the Management Plan with the originally approved works and the characteristics of the planned modifications as well as the possible environmental impacts that may be generated, with their respective environmental measures and indicators, which must be measurable.
c. Incorporate the new site design with a certification issued by a Certified Public Accountant (CPA) consigning the total investment to be made in the planned modification considering the value of the land.
d. A new Sworn Statement of Environmental Commitment, incorporating the new environmental commitments (Annex No. 2)
e. Legal Status of the developing company with no less than three months of issuance (Annex No. 2)
d. A technical report that ascribes to Decree No. 34688 MINAE-S- MOPT-MAG-MEIC, reforms to the General Regulation on Environmental Impact Assessment (EIA) Procedures Setena reform Article 46 (3) (Annex No. 3).

FORMAT OF THE ENVIRONMENTAL TECHNICAL DOCUMENT

Chapter No. 7, —Forecast Environmental Management Plan of the EsIA of the Pailas GP - 2004," is presented with the corresponding adjustments in the environmental measures that were altered in light of the construction of the new civil works required for the mounting of an additional station or turbine with 55 Mw of power. The additional modifications and comments are presented in text with letters (Arial 12), leaving the original text of the EMP in *single-spaced black cursive letters (Arial 10)*, as approved by Setena in 2004. For this expansion project, this instrument maintains its full validity and application.

2 LOCATION OF THE ADDITIONAL POWERHOUSE

Attached is the land registry plan in which the new powerhouse will be located in the Las Pailas geothermal field (Figure No. 2.1 - Annex No. 4), on lands owned by the ICE.

In Figure No. 2.2, the scheme of the future distribution of the additional section of the Las Pailas geothermal field is presented. The plan of this figure possesses a distribution at the scheme level of the possible platforms or drilling squares that will supply the additional geothermal station. At present it is difficult to locate its final position since this will depend on the answer given by the geothermal reservoir in operation there. This spatial polygon is located between CRTM05 coordinates 1189517.7N352353.4E/1190414.3N355355.0E. This land is in the process of acquisition and a budget of USD 2,000,000 (two million dollars) is available for its purchase.

Figure No. 2.1 Land Registry Plan (Annex No. 4)

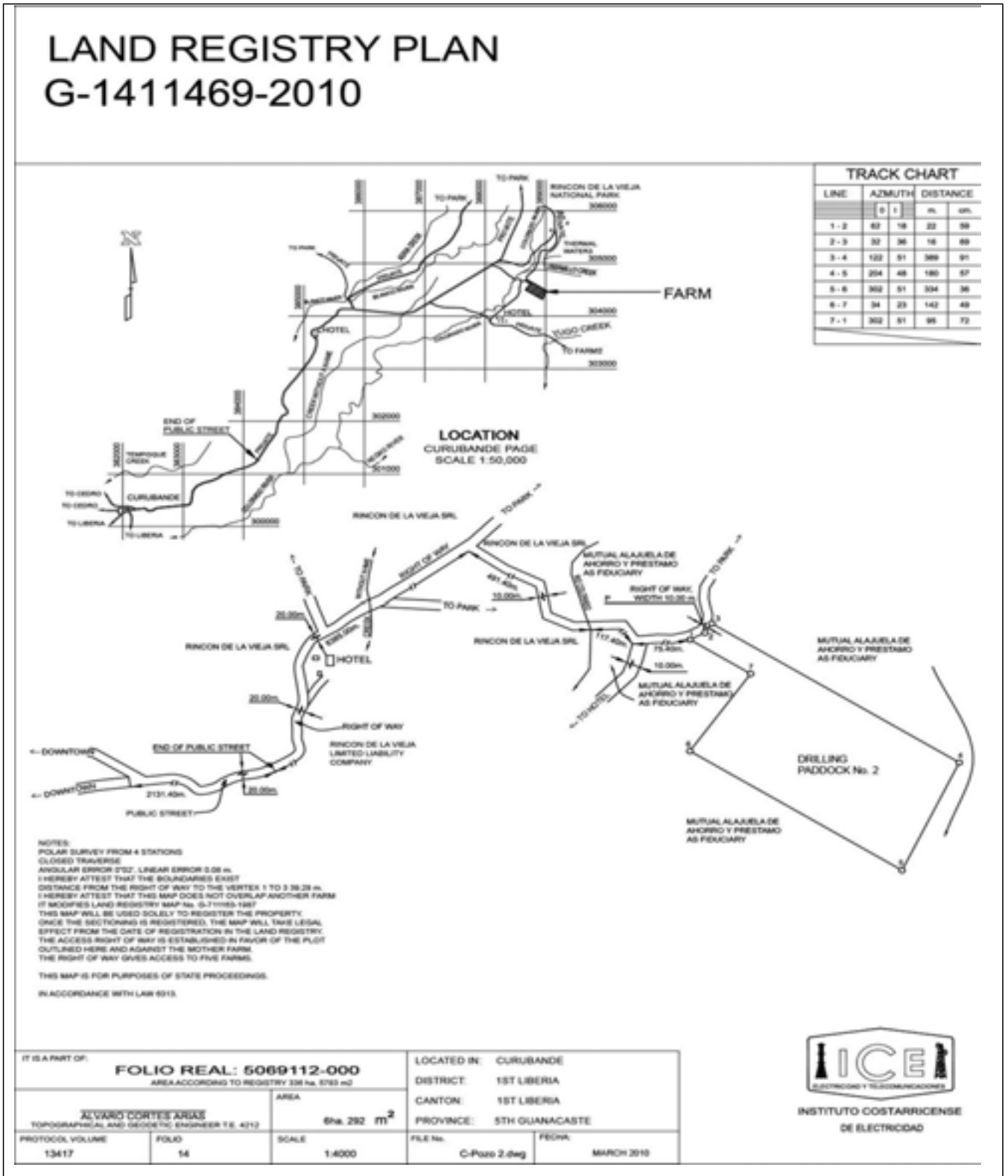
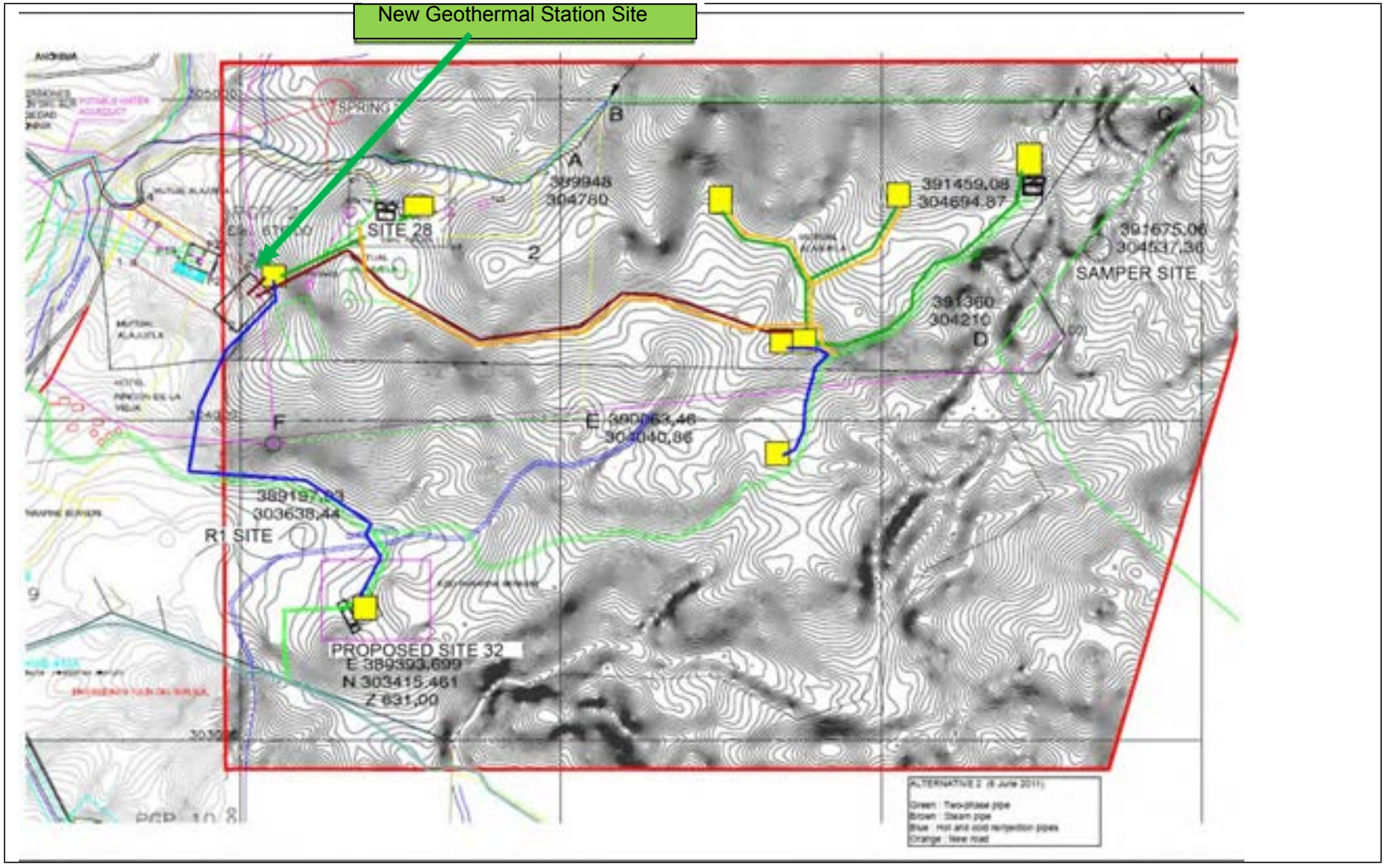


Figure No. 2.2 Schematic distribution of the conduction works of geothermal fluids to the new powerhouse - West JEC



3 CIVIL DESIGN OF THE ADDITIONAL FACILITIES

The additional geothermal stations will be a generation plant with simple flashing steam to condensation turbine (see Annex No. 5 for a more detailed description of the type of energetic cycle).

There will be several works in the station, of which the most important are: the building of the powerhouse, the cooling tower and the elevator substation, among others. The approximate dimensions of these buildings are shown in Figures No. 3.1 (3D drawing) and No. 3.2 (ground plan of their distribution). A brief description of each, along with their components, is presented below:

Powerhouse: comprising the main mechanical equipment, which are: the turbine, the speed regulator, the hydraulic oil system, the valves system, the protection system, the instrumentation and the condenser.

Main electrical equipment: generator, excitation system, and cooling system.

Auxiliary systems: System for discharging water from the plant, system for separating vapor, compressed air, extraction of gases from the condenser; chemical dosage system and H_2S detection system, among others. All of these systems are generally located inside of the powerhouse building and therefore have the adequate treatment for noises to ensure that the allowed limits are not exceeded in condensers, injectors and the rest of the electromechanical equipment.

Cooling tower: The cooling tower is the most important component of the cooling system, ensuring the operation of the condenser that receives the vapor when it is discharged from the turbine. This condenser is essential to optimize the thermal cycle and obtain the greatest extraction of energy available in the turbined vapor. The cooling tower receives hot water plus the condensed vapor that escapes from the turbine. It comprises six sprinkler cells in the upper part of the tower. Its operation is against air flow, which is made possible through the existence of a fan placed on top of each of the cells. The fans suck ambient air through the sides of the tower that are fully open. The air rises towards the discharge of the fans in the upper part of the tower and collides against air flow with the sprinkler water that cools on contact with the air. The cold water is collected in a common pool and is pumped back to the condenser to complete the cycle of the cooling system. The discharge pipes of the non-condensable gases are located in the upper part of the tower. These gases come in the geothermal vapor and accumulate in the condenser and are extracted by ejectors, compressors or vacuum pumps, or a combination of these. This discharge in the upper part of the tower favors the dispersion of such gases by using the forced draft of the tower‘s fans and reducing the environmental impact that they might have.

Elevating substation: this work allows preparing the electric energy produced in that station and transforming its voltage so that it can be transported more efficiently over a large distance through an interconnected system of transmission lines that are part of the national network. It comprises elevating transformers, instrument transformers that allow measuring and controlling the electrical variables of the substation; switches, sectioners and protections, as well as control elements. All of this equipment, as well as the interconnection cables between

the station and the transmission line, is supported on metal structures that are specially designed for this purpose. A building named Metal Clad is built within the Substation in which the substation's switches and control panels are confined.

Complementary buildings: In addition to the works mentioned, there is a series of smaller buildings that complement the geothermal-electrical station that, in this case, will be the same for the most part as those that are currently used in the geothermal station in operation, such as an administrative building, control room, a workshop building, materials and spare parts warehouses, a flammable materials warehouse, guard house, water treatment plant, fire control systems, among others.

In general, inside the geothermal plant there are multiple systems that permit the correct collection and treatment of all possible contaminating fluids that could be spilled in the event of breakdowns and maintenance of the equipment comprising it.

As for the other civil works or structures associated with a geothermal field, they are: a separator station, pipes for biphasic fluids, platforms, lagoons, accesses, among others. They are the same buildings that were described in the EsIA of the Las Pailas GP (Annex No. 3.1).

Figure No. 3.1 Constructive scheme of the new 55 Mw steam geothermal plant Geothermal Field Pailas - Juan de la Cruz Alvarado V.

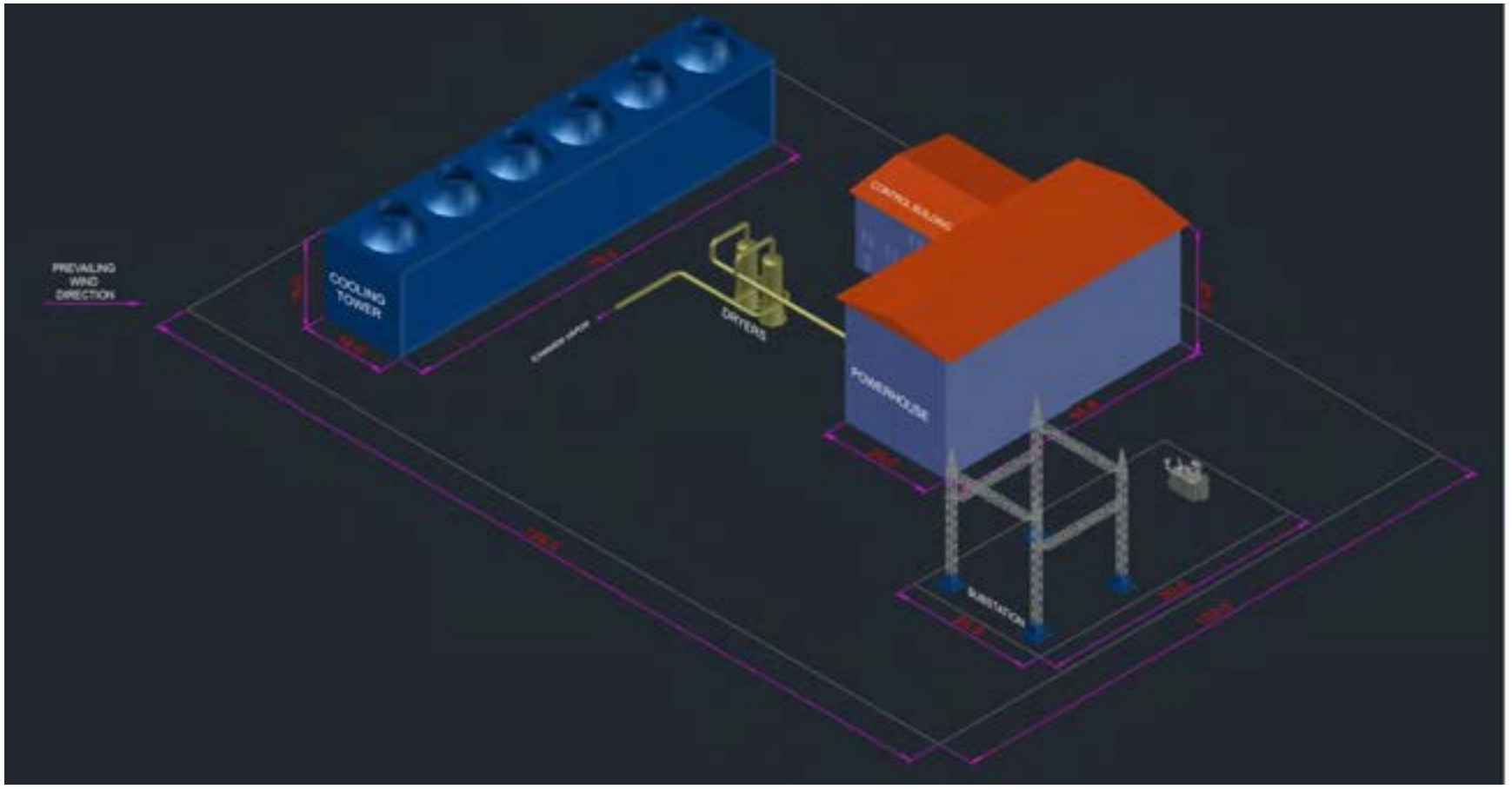
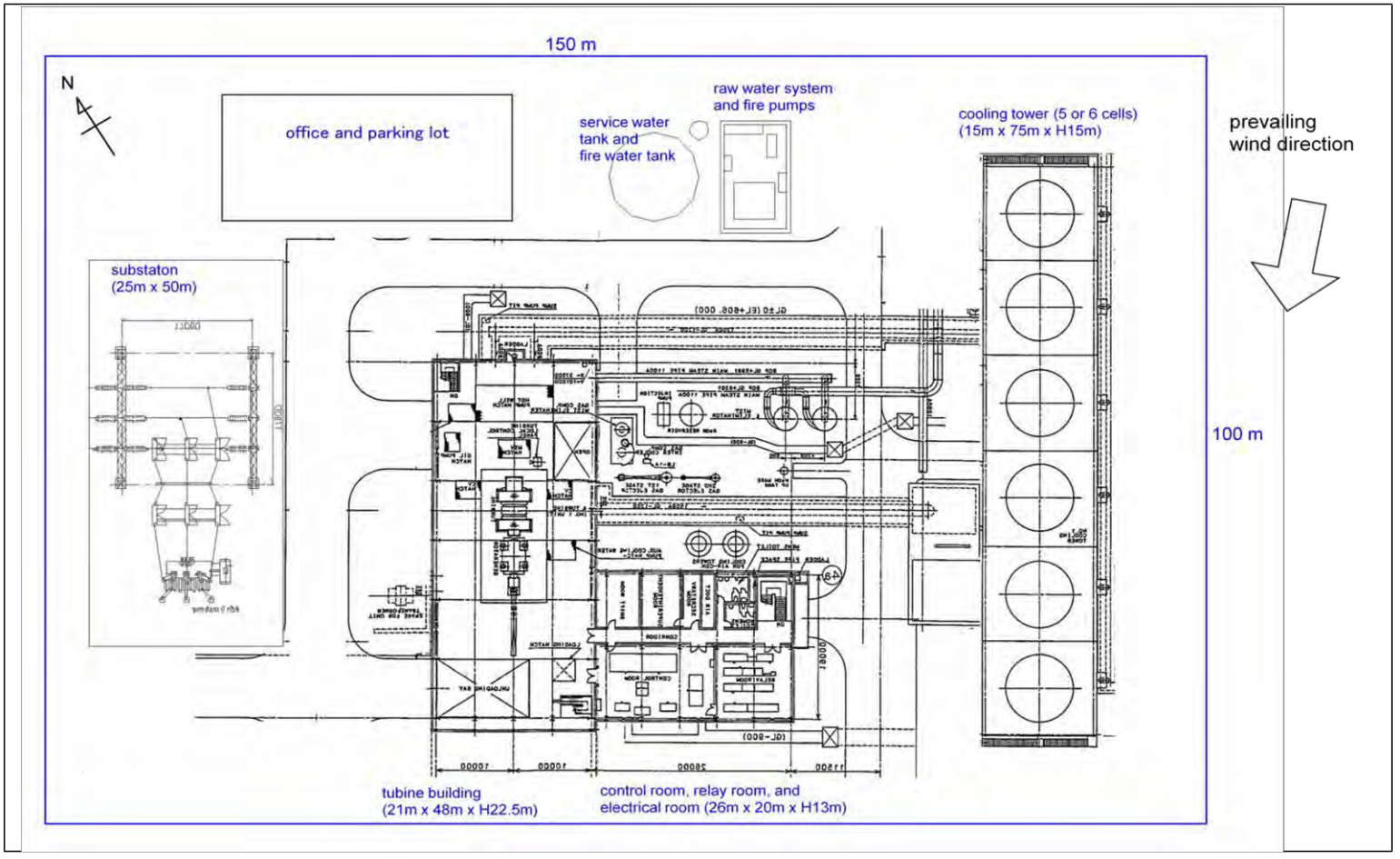


Figure No. 3.2. Distribution of the additional geothermal station



4 OVERALL INVESTMENT COST

According to the analysis carried out by the Department of Economic Engineering of the UEN Associated Projects and Services of the Costa Rican Electricity Institute, it is estimated that the total investment for the implementation of this expansion of the Las Pailas Geothermal Project totals **USD 316,837,799 (three hundred and sixteen million, eight hundred and thirty-seven thousand, seven hundred and ninety-nine U.S. dollars)**, which includes the direct cost of the works associated with the project, the acquisition of land, the cost of contingencies and interests and scaling during the estimated time of project construction.

The estimates made assume the following conditions:

- The generation of the project will be carried out with condensation technology (flashing), using a 5-cell cooling tower
- The construction period will last 4 years
- 19 wells will need to be drilled with directional technology, between producer and reinjection wells. For this aspect, the construction of 7 drilling platforms is required.
- The acquisition of 226 Ha of land is being considered
- The transmission of the project requires the construction of 1.5 km of transmission line and the construction and start-up of a half-diameter substation

The total estimated cost of the project is broken down as follows:

BUDGET FOR LAS PAILAS G.P. II (55 MW)	
ENTRY	**AMOUNT USD**
ADMINISTRATION	12,939,679
POWERHOUSE	19,974,314
INFRASTRUCTURE EXECUTION	5,783,506
SURFACE WORKS	32,354,452
CONSTRUCTION POLICY	2,354,739
TERRACE WELLS	5,592,231
DRILLING WELLS	65,896,957
ST-LT 9	5,187,84
M.H. EQUIPMENT	83,731,392
IMPORT M.H. EQUIPMENT	20,597,922
FIELD DESIGN	3,903,664
ENVIRONMENTAL MANAGEMENT	2,138,774
FIELD AND M.H. CONSULTANCY	2,500,000
LAND	2,000,000
DIRECT COST	64,955,480
INTEREST	14,796,980
COTINGENCIES	23,845,993
SCALING	13,239,346
FINANCIAL COST AND CONTINGENCY	51,882,319
OVERALL TOTAL	316,837,799

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Coordinator

Bernardo Murillo Arias Financial
Accounting Department Coordinator
Certified Public Accountant
CPA 5616

5 ADJUSTED FORECAST TABLE ENVIRONMETAL MANAGEMENT PLAN ESIA LAS PAILAS

Since it is the same action that was assessed in the EsIA of the Las Pailas GP regarding the extraction of the geothermal resource for the generation of electricity circumscribed in the area of environmental influence inventoried on that occasion, for this study no changes were identified regarding the number and/or diversity of the impacts that were identified.

The changes are given in the scopes and development indicators of the environmental measures formulated on such occasion by the execution team of the EsIA. For this reason they were adjusted in their scope and original cost.

The project expects to reduce greenhouse gas emissions by 80,878 t of CO_2 by year in the base scenario. The reduction in total expected emissions is 78,036 t of CO_2 per year (WEST JEC 2011) by replacing this energy with the energy supplied by a thermal plant.

The text of Chapter 7 of the EsIA (2004) is presented below with comments inserted in the sections adjusted in light of the expansion of the Las Pailas Geothermal Plant according to the format indicated on page No. 7.

"CHAPTER 7
ENVIRONMENTAL MANAGEMENT PLAN

Once the environmental control measures corresponding to each impact were defined, each measure was characterized as appropriate (preventive, mitigating or corrective) and had a location and manager assigned.

The result of this process is summarized in table No. 7.1, which contains the respective environmental management place, which can be found at the end of the document. The estimated costs of each of the proposed measures are also included in this table. Many of the activities of mitigation and prevention are closely related to the plant's construction and operation process, and therefore the control and follow-up to the environmental regent is necessary to fulfill its compliance.

7.1 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan is divided by the areas (environment elements) that were analyzed in the Environmental Impact Study, including the impact, mitigation measures, actions to be implemented, schedule, officers in charge and cost.

The main elements of the environment that are analyzed in the Environmental Management Plan (EMP) are as follows:

- **Geomorphology**

Change in microrelief due to the presence of the project works; therefore, the design of the project works must be readjusted to the current topography of the area.

In addition, changes in the behavior of runoff due to changes in the microrelief; therefore, there must be a way to handle water in excavations and material storage with sedimentary traps."

No significant changes were identified in the morphology of the relief; the relatively wavy or convex model of volcanic origin with moderate to smooth slopes is maintained. The site where the new powerhouse will be installed is a depression lined on its Northeast border by an escarpment of lava. This site is located on the geomorphology map that was attached to the EsIA.

- *"Soil/Oil and Fuel Spills*

Maintenance of the soil ecology, for which oil traps must be built and duly controlled to handle spills, as well as storage places and proper use of fuels. To such ends, the Rules on the Regulation of Hydrocarbon Storage and Trade System must be complied with Decree No. 30131-MINAE-S."

It applies to the additional civil works of 2012

- ***"Surface Water and run-off***

Install materials with permeable granular base on the running and pedestrian walking surfaces that permit it. Install ditches, drain boxes, sewers, sidewalks. Use material with permeable granular base around the different works, entrances, parking, etc. And maintain physicochemical and biological control of the water in the Negro and Colorado Rivers."

They are located in the watershed of an unnamed creek of the Colorado River, which is dry in the summer, on the left bank of an artificial canal for diverting water from the Colorado River to the Rincón de la Vieja Lodge hotel; a monitor of the quality (physical and chemical) must be set up: one monthly sampling for the construction phase and at least once every three months or quarterly during operation for the following parameters: temperature, pH conductivity, bicarbonates, chlorides and sulfates. This would be done in two sampling sites, one upstream from the powerhouse facilities and the other downstream around the perimeter of the hotel. (This measure must begin at this phase of the process of the environmental permit.)

Photograph No. 5.1 Artificial water supply channel to the RVLodge Hotel - Northeast perimeter of the hotel. Photograph Gabriela Zeledón

- ***"Generation of Gas Emissions***

In general, comply with the provisions set forth in the Official Gazette No. 236 of December 6, 1999 on Decree No. 28280-MOPT-MINAE-S, related to the Regulations for the control and technical review of polluting gas emissions coming from motor vehicles. Furthermore, establish a protocol for frequent measurement of the concentration of gas emitted by chimneys. The minimum frequency will be one time per month during the first year of operation, and on a quarterly basis thereafter. Compliance with the provisions of Decree No. 30221-S regarding emissions in the perimeter of the facility."

Prediction of hydrogen sulfide (H2S) emissions

During the operation phase of the additional geothermal plant, the synergy with the emission of the gas H_2S on the site shall be considered; the main source of air pollutants will be the H_2S in the non-condensable gases (NCGS) released into the atmosphere from the geothermal reservoir through the power station. The main component of the NCGs is CO_2, which does not represent an impact on air quality. In addition to the H_2S, the NCGs also include a variety of gases that are released into the atmosphere in insignificant or negligible amounts. The H_2S and other NCGs are extracted by the vacuum system of the main condenser ad then is released through the batteries of the ventilator of the cooling tower for their dilution and dispersion.

This study was carried out to estimate the concentration of H_2S at the level of the ground during the operation of the expansion of the plant. The estimate was performed using a preliminary design of a 55 Mw geothermal plant.

H2S STANDARDS FOR AIR QUALITY.

The standard of the World Health Organization (WHO) for the concentration of H_2S in the air is presented in Table No. 1

Table No. 5.1 WHO Air Quality Guide

Contaminant	Average exposure time	Amount of the permissible concentration
Hydrogen sulfide (H_2S)	24 hours	150 (micro-grams/m_3)

Source WHO regional office for Europe, Copenhagen Denmark

METHODOLOGY

Description of the model

For the prediction and assessment of the concentration of H_2S in the air around the plant, the AERMOD dispersion model (American Meteorological Society/Regulatory model of the Environmental Protection Agency - EPA). This model is widely used throughout the world.

Meteorology

The most significant meteorological parameters that affect the dispersion of contaminants into the atmosphere are: wind speed and direction and atmospheric stability (estimated also using cloud cover and solar radiation).

These parameters must be measured over a time basis of atmospheric data. The meteorological data were obtained from the Las Pailas meteorological station (No. 74036) of the ICE located in the area of the project at coordinates 10° 46' N, 85° 21' E. There were three years of records (from 2008 through 2010) for wind speed and direction. The data records for 2010 were selected to create the model of the dispersion of non-condensable gases (NCG_s), since it was the most complete record from the three years of data. Figure-No. 5.1 shows the wind rose for 2010. Since the information on solar radiation or clouds was not available, the atmospheric stability (Pasquill stability) was created at D (neutral) and E (stable) in the dispersion model.

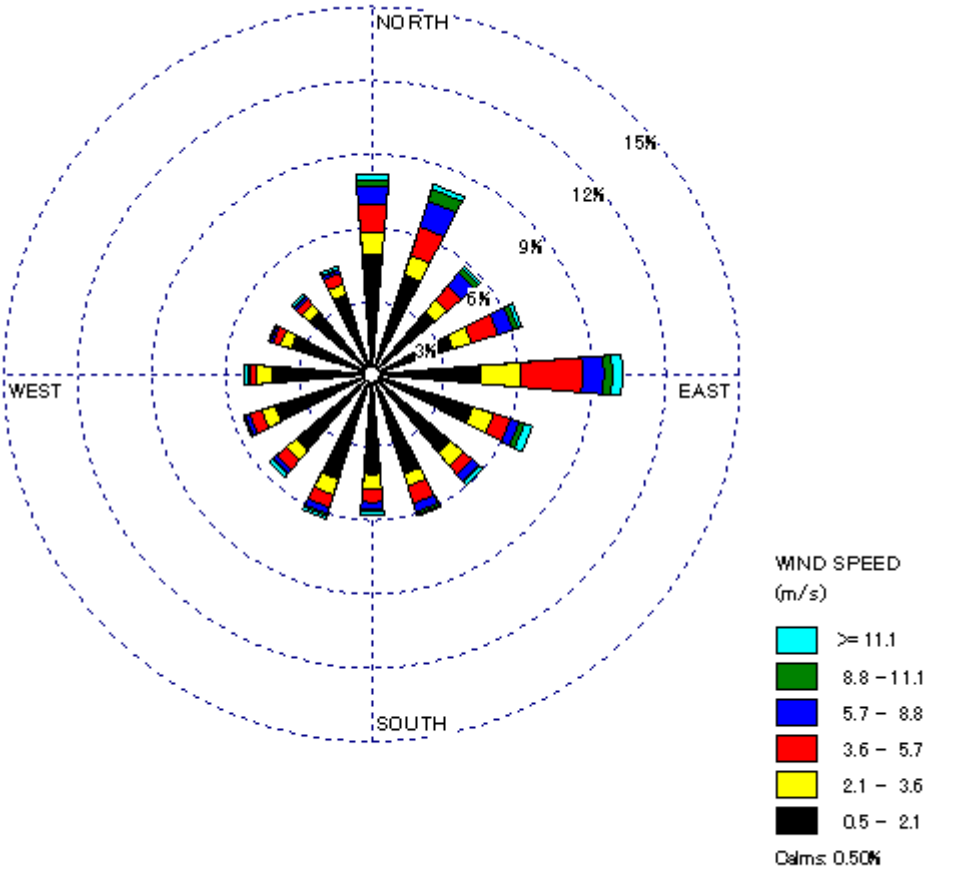


Figure No. 5.1 Wind Rose Las Pailas Meteorological Station No. 74036 (2010)

Description of the additional geothermal plant

In Figure No. 5.2 and Table No. 5.2, a drawing of the main facilities (powerhouse and cooling tower) is presented along with their dimensions in meters (m) and in Figure 5.3 their geographical location and distribution in the plant.

Table No. 5.2
Scale model of the facilities - structures of the new powerhouse

	Height (m)	Width (m)	Length (m)
Cooling Tower Building	14.08	78	19
Powerhouse	22.35	46	20

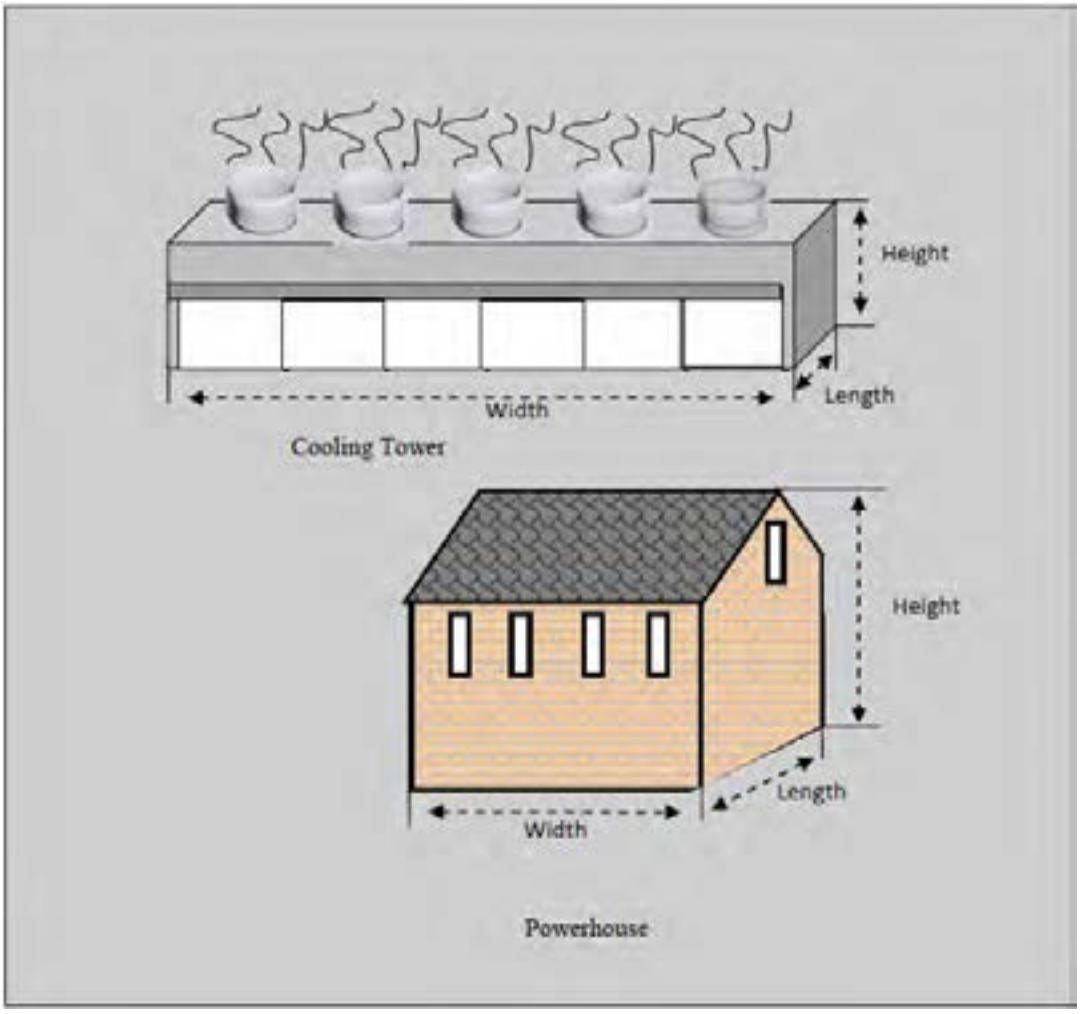
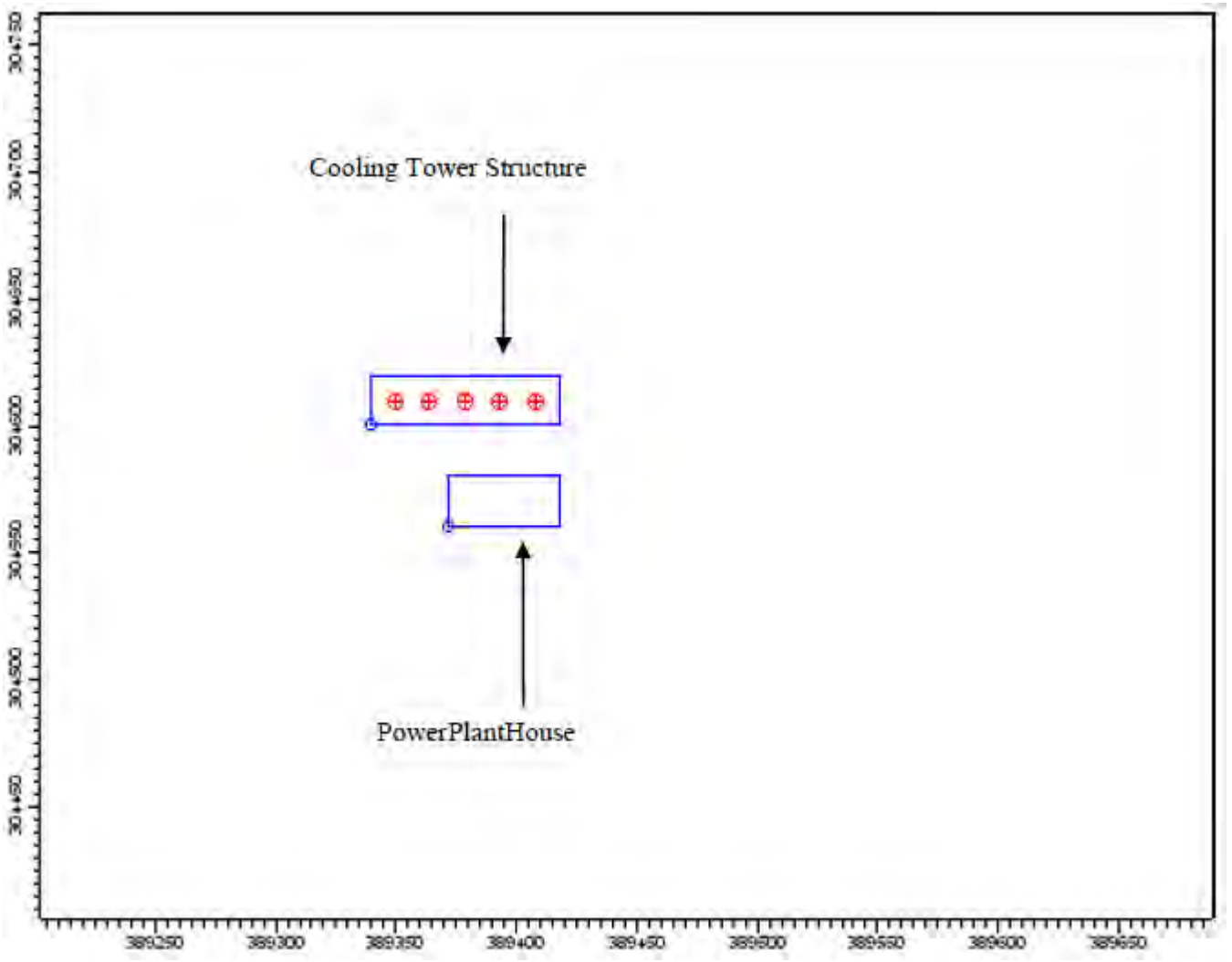


Figure 5.2 - Drawing of the Powerhouse and of the Cooling Tower West JEC

Figure No. 5.2 Geographical location and distribution in the plant of the buildings to be constructed, flat coordinates, Curubandé Page, IGN 1:50,000



Amounts of the H2S emission concentrations

The amount of H_2S emission was calculated assuming that the geothermal station will require a mass flow of vapor similar to that of the Miravalles II Unit (55 Mw) and using a concentration of H_2S in NCGs calculated as an average of what has been measured in the production wells of the Las Pailas geothermal field. (Table No. 5.3). -

Table No. 5.3 H2S content in the NCGs used in the model

	Units	Amount
GNC content in the vapor	% weight	0.11
H_2S content in the NCGs	% weight	3.2
Total fluid of the gases (including NCGs)	Kg/s	131.11

Table No. 5.4 shows the emission data entered into the gas dispersion model. Using the information from Miravalles II for design and dimensions, a system of six-cell cooling towers. Continuous operation throughout the year at full load; this scenario ensures the most unfavorable conditions of those that were considered for the dispersion model. In addition, according to the EsIA of the Las Pailas GP, the background concentration of H_2S in the project area is less than 0.001 ppm (1.5 micrograms/m3).

Table No. 5.4 Input data for the emission source point

Building	H_2S (g/s)	Height (m)	Temperature (ºC)	Exit speed (m/s)
Cooling tower	4.62	18.8	36	10

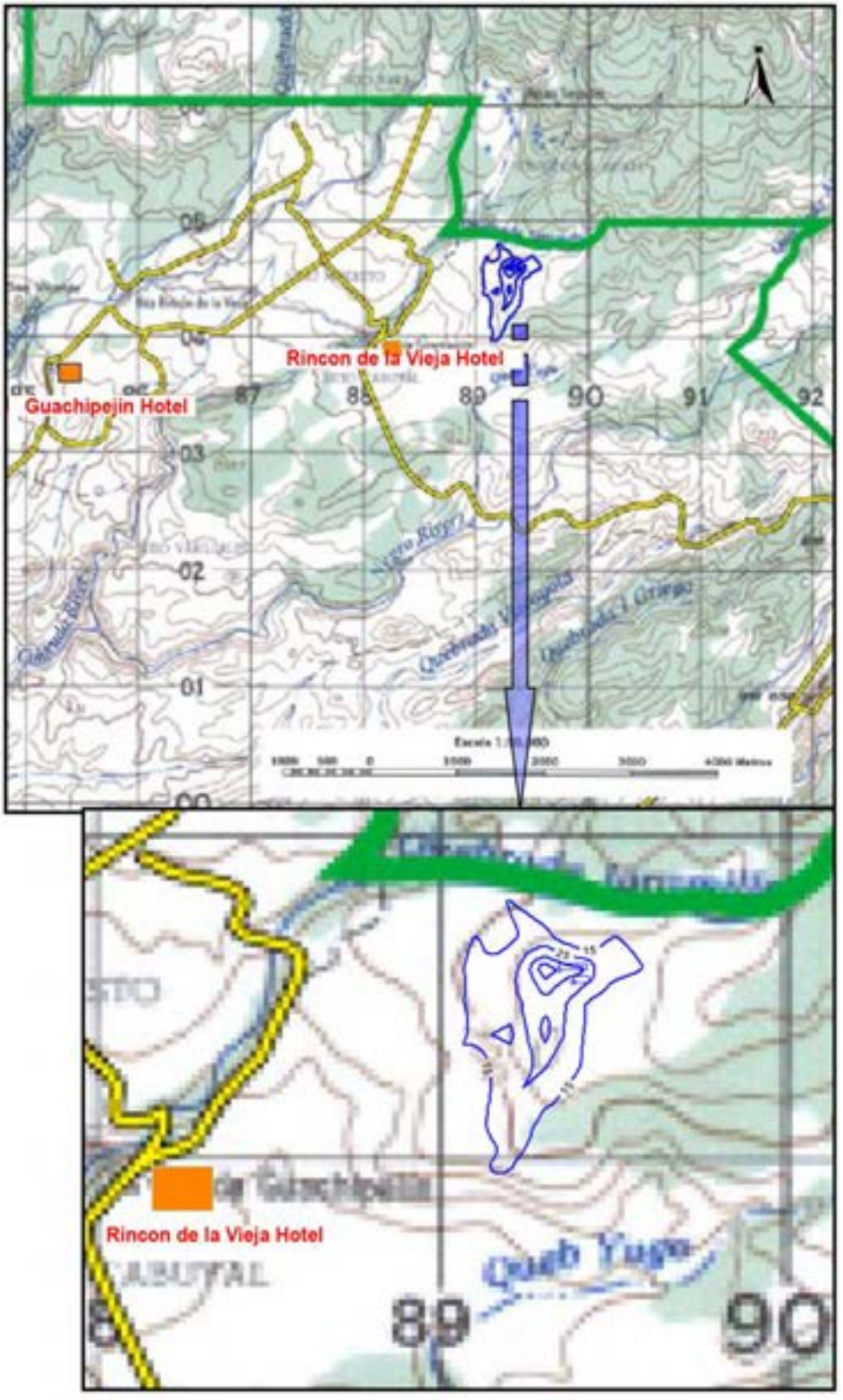
Results of the H2S dispersion model

Figure No. 5.4 presents the map of the environment of the additional geothermal station that applied the prediction model of the average concentration of H_2S over a maximum time of 24 hours of exposure at ground level (over the meteorological database for 2010). The area of greatest impact outside of the plant can be appreciated in the area around the cooling tower structure (25 micrograms/m_3).

The maximum average of the concentrations of H_2S over 24 hours in the plant is 52.87 micrograms/m_3 (0.035 ppm), which is significantly below the WHO's guidelines for 24 hours, which indicates an average value of 150 ug/m_3 (0.1 ppm).

The station currently in operation is located outside the radius of influence indicated herein at a distance whose summation influence (synergy) on the concentration of this gas is null, which is one of the elements considered for the location of the additional station.

Figure No. 5.4 Maximum expected average concentration of H2S in its environment (West JEC)



Additional environmental measure

During operation, a monitoring of the H_2S concentration must be performed within the perimeter of the plant. For this reason, a mobile unit for its detection and an equipped fixed station will be used. The fixed station will be installed on the grounds of the new powerhouse. The average of this gas in the air over 24 hours must not exceed 0.15 ppm. In a radius of one kilometer from the plant, the 24-hour exposure range established by the World Health Organization must be met. The reading of 150 $\mu g/m_3$ or 0.1 ppm of concentration of that gas in the air must not be exceeded.

- ***"Air Temperature***

Distribute equipments so that hot points are located in the most concentrated possible manner, and heat-insulate all equipment if so allowed by their design, in accordance with the chosen technology.

- ***Sonic Contamination***

The equipment to be acquired should guarantee that in the premises' boundaries, the noise does not exceed 45 dBA at any time of the day outside the nearest residence in the direct area of influence, given that the relevant mitigation measure is included in the design."

For purposes of the expansion, its follow-up must be reinforced in order to keep a continuous record of the noise levels during the construction and operation phase at its boundaries: West-Northwest, thus ensuring that the maximum threshold of sound pollution does not exceed on average the natural day and night levels by more than five units (decibels) outside of the nearest residence, in this case the Rincón de la Vieja Lodge hotel. This is located approximately 600 m from the additional powerhouse, where the average noise levels recorded in the month of July 2011 are close to 47 decibels dB(A); the average levels (in September of the same year) in the period of daytime operation of the Las Pailas stations were recorded at a continuous value of 61.7 dB(A) at 50 m from its perimeter fence. (Annex No. 6 Levels of natural noise, baseline in the area)

One of the measures focused on reducing the levels of noise in the area surrounding the RV Lodge hotel is to place the cooling tower in the East section of the station's yard, on the side opposite to where the hotel's facilities are located (Figures No. 3.1 and 3.2)

Table 5.5 Average noise level values Las Pailas Project Area dB(A) (ICE, 2004)

Measuring sites	Sound pressure levels (SPL) during the measurements units dB(A)		
	6:00 AM – 8:00 AM	12:00 PM – 2:00 PM	6:00 PM – 8:00 PM
RV National Park (park guard house)	52.4	47.3	49.0
RV Lodge hotel (outside)	50.4	55.0	53.5
RV Lodge hotel (indoors)	50.0	47.0	48.0
Road across from PGP platform No. 1	45.1	51.0	47.5
Forest adjacent to PGP 1	55.1	56.2	no data available
Guachipelín Hotel (outside)	48.3	56.0	54.0
Guachipelín Hotel (indoors)	44.6	44.0	44.0
Central park town of Curubandé	47.5	54.2	60.0

More recently, in the months of May and June 2012, the Management Unit of Occupational Health of the WS Geothermal Resources carried out a campaign to measure the sound levels at three sites within the perimeter of the hotel: the rear part (1 m) of Cabin #23, the hotel yard, and one meter in front of the hotel‘s reception desk. As a result of this campaign, an average total continuous sound pressure level was obtained at the measures of 45.78 dB(A) and the average values range from 32.1 - 51.1 dB(A). (Annex No. 6)

- ***“Landscape***

Change in the nature of the landscape due to construction of civil works during the construction phase and due to the permanence of civil works such as the Powerhouse Complex and other related detailed works, construction lines and dumpsites. Measures to be taken are to install ecological billboards, make the architectural design of the powerhouse complex in harmony with the environment, sow areas around the detailed works, establish and place plant screens and paint the works with colors that do not clash with the natural environment (Paragraph 6.1.6, Chapter 6).”

For the additional facilities

The removal of materials shall be reduced to only what is strictly necessary and any unnecessary cutting of vegetation shall be avoided. Just as with the current Powerhouse, the architectural design of the additional station shall be adapted within reason to the visual characteristics regarding the particularities of the dominant shapes and colors of the natural landscape of its environment. Plant screens shall be used in the surrounding areas through the use of a perimeter strip 50 m in width.

Considering that the average area of the proposed land is 2 Ha (200 x 100 m), a total area of 3 Ha would be available in the 50 m wide perimeter strip, within a landscape made up of a mosaic of plant coverage dominated by a wooded scrubland in which there will be an enrichment through the planting of trees native to the area, preferably not deciduous, but fast growing and with dense foliage.

For construction lines such as piping, perimeter plant screen must also be set up to disguise them and in the dumpsites to restore the sites through mixed planting of rural, fast-growing tree species.

- **Floral composition and design of plant screen for the powerhouse**

In order to create a plant screen with several layers, the design shall consider at least 10 tree species arranged in rows, which alternates between taller species such as guanacaste (*Enterolobium cyclocarpum*), Brazilian firetree (*Schizolobium parahyba*), chime tree (*Albizia guachapele*), cream albizia (*Albizia adinocephala*), algarrobo (*Cojoba arborea*), sandbox tree (*Hura crepitans*), yellow mombin (*Spondias mombin*), Spanish cedar (*Cedrela odorata*), mahogany (*Swietenia humilis*), Peruvian almond (*Terminalia oblonga*) and fig (*Ficus spp.*) with other species of medium size and/or slower growth rate such as Pepeto negro (*Inga punctata*), guabo (*Inga vera*), sotacaballo (*Zygia longifolia*), soapberry (*Sapindus saponaria*), trumpet bush (*Tecoma stans*), barre-horno (*Trichilia havanenis*), cabbage angelin (*Andira inermis*), cocobolo (*Dalbergia retusa*) and chaperno tico (*Lonchocarpus costaricensis*), among others.

The density of the planting or spacing between rows and trees will depend on the wealth of tree species present in the scrubland. The planting rows will be 1 m wide arranged perpendicularly to the slope of the hill and at a distance of 4 to 6 m from each other. In the rows the trees shall be planted with a spacing of 3 to 6 m. To attain a uniform distribution of the species in accordance with their characteristics of total height, size of crown, density of foliage, growth rate and light requirements, the following principles must be followed:

a. Alternating tall species with medium-sized species in the planting rows and, preventing the tall species from being together, especially if they have wide crowns of dense foliage such as the algarrobo and fig trees, to avoid an excessive shade from suppressing the smaller contiguous species.
b. Medium-size species that need more light for their development (heliophytes), such as the pepeto negro, guabo and trumpet bush, must be surrounded by some tall species with thin, light-permeable foliage such as guanacaste and chime tree, and where possible with small crown such as Brazilian firetree and Peruvian almond, in addition to other species with semi-dense foliage such as cream albizia, hogplum and cedar.
c. The medium-height partial sciophytes that require partial shade for their development, such as barre-horno and cabbage angelini and to a certain extent the sotacaballo, chaperno tico and soapberry, must have tall neighboring species with dense foliage, such as the algarrobo, fig, sandbox tree and mahogany so that they can be provided partial shade.
d. Avoid planting several specimens of species with crowns of dense foliage together, such as sotacaballo, pepeto negro, cabbage angelin, barre-horno, algarrobo, mahogany and fig, to prevent an excess of shade that prevents the development of the undergrowth.
e. It is recommended to increase the distancing for tall trees with broad crowns of thick foliage to avoid the suppression of smaller contiguous species.

f. Give priority to and plant in greater proportion species of rapid |.
g. Plant cedar and mahogany so that they are isolated in order to prevent the attack of the mahogany shoot borer (Hypsipyla grandella).
h. Perform release pruning and thinning to avoid suppression of smaller species and those of slower growth rate, encouraging healthy individuals with vigorous development of species attractive to wildlife.

Table 5.6 presents some morphological characteristics of the species such as crown size and foliage density as well as growth rate and light requirements that allow orienting the design or spatial arrangement of the mixture of species.

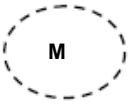
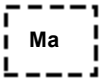
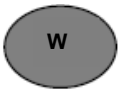
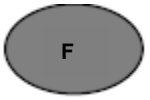
Table 5.6 . Characteristics of the Priority Reforestation Species of the GP Pailas II

Species					
Common Name	**Scientific Name**	**Crown Size**	**Foliage Density**	**Growth Speed**	**Light Requirement**
High Stratum					
Monkey soap	Enterolobium cyclocarpum	Wide	Thin	Fast	Heliofita
Brazilian firetree	Schizolobium parahyba	Medium	Thin	Fast	Heliofita
Albizia male	Albizia guachapele	Medium	Thin	Fast	Heliofita
Wild tamarind	Cojoba arborea	Wide	Dense	Fast	Heliofita
Sandbox tree	Hura crepitans	Medium	Dense	Fast	Heliofita
Cream albizia	Albizia adinocephala	Medium	Semidense	Fast	Heliofita
Yellow mombin	Spondias mombin	Medium	Semidense	Fast	Heliofita
Bitter cedar	Cedrela odorata	Medium	Semidense	Fast	Heliofita
Mahogany	Swietenia humilis	Medium	Dense	Fast	Heliofita
Fig	Ficus spp.	Wide	Dense	Medium	Partial esciofita
Peruvian almond	Terminalia oblonga	Small	Thin	Fast	Heliofita
Medium strata					
Pepeto Negro	Inga punctata	Medium	Dense	Fast	Heliofita
River koko	Inga vera	Medium	Dense	Fast	Heliofita
Longleaf zygia	Zygia longifolia	Medium	Dense	Medium	Partial esciofita
Vanilla	Tecoma stans	Small	Semidense	Fast	Heliofita
Costa Rican Lonchocarpus	Lonchocarpus costaricencis	Medium	Semidense	Medium	Heliofita
Wingleaf soapberry	Sapindus saponaria	Medium	Dense	Medium	Partial esciofita
Rosewood	Dalbergia retusa	Medium	Semidense	Medium	Heliofita
Havana trichilia	Trichilia havanensis	Medium	Dense	Slow	Esciofita
River Almond	Andira inermis	Medium	Dense	Slow	Esciofita

Figure No. 5.5 shows an example of a mixed planting for the plant screen of the powerhouse, based on stipulated mixture design criteria and using the symbology shown in table No. 5.7.

Table No. 5.7 Symbology of mixed plantings tree species for PG Pailas II

High Stratum

Monkey soap	*Enterolobium cyclocarpum*	Wide crown sparse foliage	
Brazilian firetree	*Schizolobium parahyba*	Medium crown sparse foliage	
Male albizia	*Albizia guachapele*	Medium crown sparse foliage	
Wild tamarind	*Cojoba arborea*	Wide crown dense foliage	
Sandbox tree	*Hura crepitans*	Medium crown dense foliage	
Cream albizia	*Albizia adinocephala*	Medium crown sparse foliage	
Yellow mombin	*Spondias mombin*	Medium crown sparse foliage	
Bitter cedar	*Cedrela odorata*	Medium crown sparse foliage	
Mahogany	*Swietenia humilis*	Medium crown dense foliage	
Fig	*Ficus spp.*	Wide crown dense foliage	
Peruvian almond	*Terminalia oblonga*	Small crown sparse foliage	

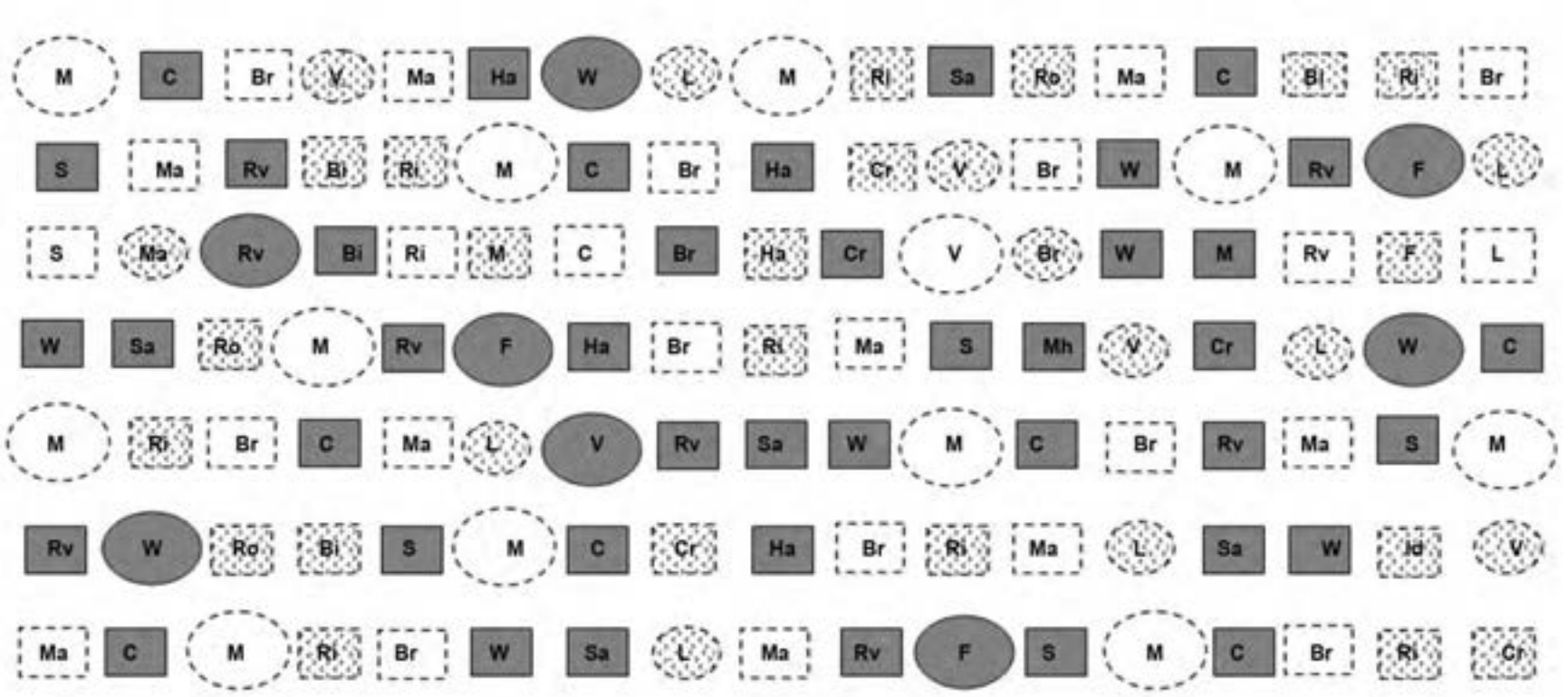
Medium strata

Pepeto Negro	*Inga punctata*	Medium crown dense foliage	
River koko	*Inga vera*	Medium crown sparse foliage	
Longleaf zygia	*Zygia longifolia*	Medium crown dense foliage	
Vanilla	*Tecoma stans*	Small crown semidense foliage	
Costa Rican Lonchocarpus	*Lonchocarpus costaricensis*	Small crown semidense foliage	

Wingleaf soapberry	*Sapindus saponaria*	Medium crown dense foliage	
Rosewood	*Dalbergia retusa*	Medium crown sparse foliage	
Havana trichilia	*Trichilia havanensis*	Medium crown dense foliage	
River Almond	*Andira inermis*	Medium crown dense foliage	

Created by Forest Engineer Rolando Núñez G.

Figure 5.5 Design example of mixed planting for plant screen for GP Pailas II powerhouse.



Elaborado por Ing. Forestal Rolando Núñez G.

An important aspect to consider is the location of the high power electrical cable corridor leaving the new plant, where medium high trees should be planted that do not affect the safety of the transmission.

- **Floral composition and design of the plant screens for the pipelines**

For the masking of the pipelines, perimeter plant screens should be used with a minimum width of 20 m. In areas of scrub through enrichment and in the case of pastures with mixed plantings of rapid growth and dense foliage arboreal species, preferably nondeciduous and medium stature such as: pepeto negro (*Inga punctata)*, river koko (*Inga vera*), longleaf zygia (*Zigia longifolia*), wingleaf soapberry (*Sapindus saponaria*), vanilla or yellow trumpetbush (*Tecoma stans*), bastard cedar (*Guazuma ulmifolia*), Havana trichilia (*Trichilia havanenis*), cabbagebark tree (*Andira inermis*), guava (*Psidium guajava*), nance (*Byrsonima crassifolia*) and Costa Rican lonchocarpus (*Lonchocarpus costaricensis*). In lesser proportion it is recommended to plant other species that are rustic, quick and attractive to wildlife, but about whose development in planting is not known, such as Jamaican nettletree (*Trema micrantha*), Johnny berry (*Miconia argentea*), sweet capulin (*Mutingia calbura*) and snailwood (*Conostegia xalapensis*). Also to increase the floral wealth and promote formation of biological corridors, some high stature species may be included such as monkey soap (*Enterolobium cyclocarpum*), Brazilian firetree (*Schizolobium parahyba*), male albizia (*Albizia guachapele*), cream albizia (*Albizia adinocephala*), wild tamarind (*Cojoba arborea*), melero (*Thounidium decandrum*), sandbox tree (*Hura crepitans*), yellow mombin (*Spondias mombin*), bitter cedar (*Cedrela odorata*), mahogany (*Swietenia humilis*), sura (*Terminalia oblonga*) and fig (*Ficus spp*.).

The establishment may be made by broadcast seeding with a mix of several species or by mixed planting alternating deciduous species with evergreens, sparse foliage species with dense foliage species, quick species with slower growth species and tall species with others of shorter stature.

- **Floral composition and design of the mixed plantings in tailings.**

In the tailings, restoration of the sites will be done through the establishment of a plant, bush, and tree cover, both by natural regeneration and inducement. The tilling of the soil will be ensured before this point, as well as the placement of an organic layer of soil of at least 30 cm, to provide an adequate substrate for the establishment of natural regeneration as well as for the trees to be planted.

In sites with near-by seed sources, such as primary or secondary forest, the natural regeneration should be protected from fast growth herbaceous, bush, and tree species that are attractive to the wildlife which may inhabit the site. Fast growth rustic species of trees should be planted in a complementary manner, such as guava (*Psidium guajava*), nance (*Byrsonima crassifolia*), pepeto negro (*Inga punctata*), river koko (*Inga vera*), vanilla or yellow trumpetbush (*Tecoma stans*), bastard cedar (*Guazuma ulmifolia*) y monkeysoap (*Enterolobium cyclocarpum*). Including small to medium stature rustic pioneer species, attractive for the wildlife, but about which their planting development is unknown, is recommended, such as male nance (*Clethra mexicana*), Jamaican nettletree (Trema

micrantha), sweet capulin (*Mutingia calbura*), Johnny berry (*Miconia argentea*), Xalapa snailwood (*Conostegia xalapensis*), Florida toadwood (*crownania glabra*) and Guatemalan crownania (*crownania guatemalensis*) among others, in addition to cream albizia (*Albizia adinocephala*) and melero (*Thounidium decandrum*). The species to plant and the density of planting will depend on the presence and abundance of natural regeneration species. The design should be one of mixed planting alternating species between lanes. To complement this, the broadcast seeding technique may be used in some areas but with a mix of several species.

- **Site preparation, maintenance, and silvicultural management of plant screens and forest plantings.**

During excavation and conditioning of the punctual and linear worksites such as the powerhouse, drilling platform, piping and tailings, the top layer of organic soil should be separated and stored, to then deposit a layer of at least 30 cm on the land where the plant screens and forest plantings are to be established. In the event that the land has been compacted after dismantling the temporary works such as concentration yards or other facilities, the land must be tilled before the layer of organic soil is placed on it. Erosion control works should also be carried out, such as retention nets, drainage canals, energy dissipators, and sedimentators.

For a period of at least seven years, it will be a priority to carry out a periodic assessment of the undergrowth, diseases and insect attacks, as well as fertilization and additives for the soil. For proper development of the trees, it is essential to carry out silvicultural management through formation and liberation pruning, as well as thinning based on the technical recommendations of qualified personnel.

It is necessary to clarify that, for undergrowth control, workers must be trained to identify the plants of the area, to mainly eliminate the grasses and vines that choke the planted trees and leave the regenerated bush and tree species that are naturally attractive for wildlife, such that they supplement the trees planted in the formation of the dense foliage plant screens that meet the objective of masking the works and constituting a habitat for wildlife.

- **Compliance and performance indicators.**

Compliance and performance of these measures should be verified, through the monitoring of the following variables or indicators:

a. Tilling of compacted land and deposit of organic soil layer of at least 30 cm.

b. Creation of erosion control works such as guard canals at the top of the slopes, retention nets, drainage canals, energy dissipators, and sedimentators.
c. Use of at least 10 tree species giving priority to fast growing species, for enrichment, wide plant screens and mixed plantings at the powerhouse and tailings. In the perimeter screens of the piping, a minimum of 5 tree species should be used.
d. Survival in the first year of 75% or more of the population.
e. Average annual growth in height greater than 1 m for the fast growth trees such as monkey soap, Brazilian firetree, male albizia, sandbox tree, cream albizia, wild tamarind, yellow mombin, ceder and mahogany and an average annual growth greater than 0.5 m in height for the species of smaller stature or slower growth such as pepeto negro, river koko, vanilla, longleaf zygia, Costa Rican lonchocarpus, fig, rosewood, Havana trichilia, vanilla or yellow trumpetbush, bastard cedar, nance and mountain almond.

Photograph 5. 2 Panoramic view of the construction site of the additional geothermal plant

As can be seen in the photograph, the site selected is located on gently sloping land covered by scrubland with trees in the southeastern section of the Las Pailas geothermal campus in operation. At the base of the hillside the strip of forest is visible that separates it from the Hotel Lodge Rincon de la Vieja facilities. Photography Rogelio Zeledón Ureña

- ***"Social:***

Information about the project will be disclosed by means of talks, meetings, posters and murals, which will contain data on issues such as occupational health, employment safety, technical aspects of the project, environmental guidelines established by the ICE and aspects related to the handling of archaeological heritage. A particularly important issue to be taken into account would be the social behavior of workers. They should be requested to have respectful and socially acceptable conduct,

particularly in leisure time or breaks. These talks must be given at the beginning of construction jobs.

The ICE's contribution to preserve the environment would be an issue to be adequately coordinated through the Project Manager in order to comply with the established environmental guidelines and generate as much as possible the participation of environmental programs with community organizations of the communities located near the Project."

Currently, the Curubandé community has a population of 2527 inhabitants, 1231 men and 1296 women (INEC - Census 2011) and an Association of Integral Development (ADI) presided over by a board of directors. Other social groups are work committees organized to attend to the needs of communal action such as the school board, church committees, EBAIS, sports whose members are formalized and supported by the ADI, currently some of these are in the process of reactivation, the Aqueduct Association (ASADA) that administers the communal aqueduct. There are three catholic religious groups or congregations and two evangelical.

The changes in the communal infrastructure starting from the date that the EsIA was carried out are visible in the road network, particularly the road connecting with the Inter-American highway that leads to the city of Liberia. Almost one-third of its length is paved, as is the main square of this community. The rest has a ballast portfolio with a rainwater evacuation system in excellent condition; this condition has allowed it to improve the transportation system in general but especially the bus service to the center of Liberia. New classrooms have been constructed in the school and one of them is equipped with computer equipment with Internet access. In public services, the public lighting was improved, as well as access to communications and the aqueduct infrastructure.

The economic activities of the community still revolve around agricultural activities and tourism generated by the presence of mountain hotels (tourism - adventure) in the area. One portion of this workforce is contracted by the ICE, which would vary in the coming years when the number of contracts is increased for construction of the second phase of the GP Pailas.

Photograph No. 5.3 Employee of the GP Pailas Public Relations Unit in an organized activity with the children from the Curubandé school in celebration of the recent Arbor Day. Photograph Gabriela Zeledón.

Photograph No. 5.4 Members of the new board of directors of the ADI of Curubandé-2012 Photograph Maritza Rojas Molina

- Agricultural Activity

The Las Pailas Geothermal Campus -- Powerhouse expansion area is a pasture that has been abandoned for several years, which has a —Stubbly" landscape with what is left of flat deteriorated pastures in a tree-filled panorama.

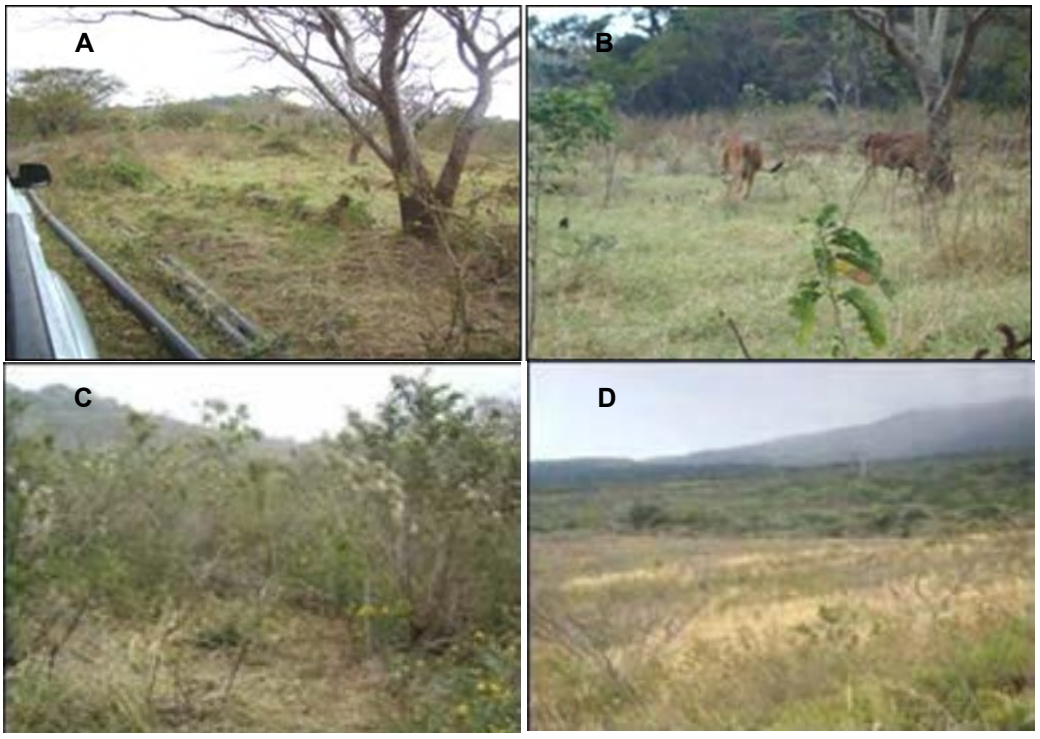
Identified between the herbaceous remains of the old pasture, are the African Bermuda grass (*Cynodon nlemfuensis*) and the naturalized Jaragua (*Hipharrenia rufa*) possibly, introduced in the area around the 1920's. Likewise, bahia grass (Paspalum notatum and P. conjugatum) can be weakly identified, among other natural grasses, such as sweet shadow grass.

All the previous pasture's graminea species that were in a state of abandonment (introduced or natural), tend to disappear from a pasture and move toward the natural recovery of the environment. In the case of this land, tending to move toward a state of pastureland prior to the current scrub or forest fallow, with semi-bush or tree succession, consequently.

Among the natural semi-bush vegetation from the present natural regeneration, the —bmweed" was observed among other species in the Piperaceae family. The vines at the site are evident and well dispersed throughout the area, among them —lana de cuello." All these species called weeds, or not desired in a pasture from the Agricultural point of view for the proper management thereof. They quickly colonize the abandoned pastures, clear and present evidence in this site of Pailas 2, visited.

Below are photographs of the area in question showing the presence of grazing animals.

Photograph 5.5: A, B, C, and D.



Panoramic views of the Las Pailas Geothermal Campus expansion area *(Powerhouse Site)* Illustrations: A. Access to the site, B. *"Brahaman Red"* Livestock pasture, C. and D. Ironweeds and panoramic view of the site. Photograph William Garcia A.

a. "Everyday Life or Social Dynamics

This aspect would be also clearly impacted as experience has shown in the construction of important works, in the event the Project is finally built. The presence of increasing groups of workers living in a camp or inserted in the community entails, though in a temporary manner, a series of alterations in everyday life caused by the aforementioned presence of workers cohabiting in the same space. About 1000 workers are expected to be present at some time in Las Pailas GP over 36 months.

The demand for goods and services (mainly during night hours) related to leisure and the use of free time increases; consumption of spirits would be the most demanded with possible consequences for migrants and local residents which need permanent prevention measures with residents and workers. An information and educational plan is recommended to reduce or mitigate possible impacts, provided that new workers are incorporated in the community before and after the construction of the project.

b. Basic Services

Evidently, the community of Curubandé has resolved the availability of these services and does not expect any impact, except for the availability of water resources. At present, the aqueduct feeds from a water intake in Quebrada Victoria, an influent stream of the Colorado River. The localization

of said intake is near the area where the Machine Hall of this GP would be built; for that reason, that intake would probably be affected. The intensity would be strong and the extension would be high. The persistence would be mild from a physical point of view, but the social impact would be significant.

On the other hand, given the chemical characteristics of water resources in the area, including water for consumption, the current water source has no sustainability guarantee over time. For that reason and to prevent possible negative impacts in a very sensitive issue, it would be advisable to move the intake serving Curubandé to the intake currently serving Liberia, or otherwise use some source from a spring of water existing in the northern hillside of Góngora hill. To such ends, the pipeline should be extended in the necessary section and should be coordinated with the A and A regional office in Liberia.

Attention should be given as well to the access road to Curubandé due to the increase in vehicular circulation, as well as the condition and capacity of the primary school once the project is commenced."

The communication plan to —stakeholders" (interest groups) will continue for the environmental area of influence that began with the construction phase of the GP Las Pailas as recorded in the regency reports (IRAs) of administrative file No. 788-04-Setena: Community of Curubandé Guachipelin and Lodge Rincon de la Vieja hotel owners.

For the provision of potable water, conversations were revisited with the Costa Rican Institute of Aqueducts and Sewers (A and A, regional office of Liberia) in order to evaluate the options for building an aqueduct (intake, tanks, and conductions) that would capture spring waters from the mid-upper section of the River Blanco basin with the goal of providing potable water to the additional geothermal plant facilities and replacing the current water uptake from the local aqueduct of the Curubandé community. Annex No. 7 presents a proposed diagram plan for this aqueduct as well as a still conservative estimate of its construction cost around close to US$350,000 (three hundred and fifty thousand dollars). In the event that this option cannot be undertaken, whether due to availability of the water resource of the appropriate quantity and quality or due to legal problems in obtaining this concession, the connection should be evaluated of the A and A water uptake in the high basin of the Negro River that furnishes the city of Liberia, a junction path between San Jorge and Pailas. For this a water —faucet" connection should be requested with this institution. The cost of the latter option would increase because of the distance from which the waters were attained, which is more than five kilometers, in addition to dealing with runoff waters, which will require installing a treatment plant to make them potable.

The preceding is because the Project Area (PA) does not have springs or bodies of water that meet the chemical quality conditions for human consumption.

***Photograph No. 5.6*Q. Limones Finca Mundo Nuevo [New World Farm] Agrio River microbasin - Photograph Rolando Núñez**

***Photograph No. 5.7*Nascent from the spring of the Ravine Lemon trees Finca Mundo Nuevo coordinates 385753 E 303615 N, Curubandé Page, Altitude 620 m.a.s.l. Photograph Rolando Núñez**

***Photograph No. 5.8*Nascent Ravine Choporron or (no name) left margin Finca Mundo Nuevo coordinates 386375 E 305600 N, Curubandé Page, IGN Altitude 640 m.a.s.l. Photograph Rolando Núñez**

***Photograph No. 5.9*Nascent spring right margin Ravine Choporron (no name) coordinates 386314 E 305684 N, altitude 645 m.a.s.l. Curubandé Page. Photography Rolando Núñez**

Photograph No. 5.10 **Ravine Choporrón (no name) Finca Mundo Nuevo microbasin Blanco River Photograph Rolando Núñez**

c. "Archaeological Heritage

In order to protect the National Archaeological Heritage, the environment manager shall ensure compliance with prevention, mitigation and compensation measures (survey, supervision of earth work in the machine hall, fencing of cemeteries in the land acquired by the ICE, moving the Zapote petroglyph, awareness talks with the community) proposed in this document. These measures will be executed during the construction stage of the project; in the event that the exploration, it must be carried out before any movement of land because this study may derive from an evaluation or archaeological recovery. If an evaluation or recovery is needed, a research proposal must be presented to the National Archaeological Commission, the entity in charge of granting permits to carry out archaeological research in our country."

When it is necessary to carry out any additional work for the project, archaeological research must be carried out ahead of any movement of earth. This is for the purpose of preventing the alteration of any pre-Columbian evidence that may be found in that place. This will allow proper management of the cultural resources in accordance with the legislation on National Archaeological Heritage Law No. 6703

- Flora

"Flora is one of the elements that must be considered in the EMP because it affects the entire project, such as pastures with isolated trees, scrublands, herbaceous vegetation and secondary woodland."

The plant cover at the powerhouse site consists of scrubland with trees comprised mainly of bushes along with thin disperse trees of species such as monkey soap (*Enterolobium cyclocarpum)*, albizia (*Samanea saman*), bastard cedar (*Guazuma ulmifolia*), laurel (*Cordia alliodora*) and guachipilin (*Dyphisa americana*).

The top arboreal layer of a height of 6 m is thin, with disperse individuals. In contrast the bush stratum of 3 m in height is dense, dominated by ironweed (*Vernonia patens*) along with grandcousin (*Triumfetta lappula*), wax mallow (*Malvaviscus arboreous*), *cordiaguana castensis*, trailing lantana (*Lantana montevidensis* and *L. camara*), whitebrush (*Lippia oxyphillaria*), light-blue snakeweed (*Stachytarpheta jamaicensis*), senna (*Senna pallida* and *S. nicaraguensis*), several solanceas such as nightshade (*Solanum tomentosum* and *Cestrumsp*.), honey mesquite (*Prosopis juliflora*), bull horn acacia (*Acacia collinsii*), shameplant (*Mimosa pudica* and *M. dormiens*), *Mikania pittieri*, *Wissadula hirsuta* and *Clivadium sp*., associated with regeneration of tree species, some very abundant such as bastard cedar, just as pumpwood (*Cecropia peltata*), laurel (*Cordia alliodora*), Guatemalan crownania (*crownania guatemalensis*), casearia (*Casearia arguta*), bitterbush (*Picramnia antidesma*), gumbo-limbo (*Bursera simarouba*), Florida toadwood (*crownania glabra*), bastard hogberry (*Margaritaria nobilis*), guava (*Psidium guajava*), achiotillo (*Vismia baccifera*), melero (*Thounidium decandrum*), nance (*Byrsonima crassifolia*), gumtree (*Sapium glandulosumy S. macrocarpum*), P. Wilson (*Zanthoxylum setulosum*), Apeiba tibourbou (*Apeiba tibourbou*), bastard cedar *(Luhea speciosa*) and pepeto negro (*Inga puctata*), in addition to the herbs of chan (*Hyptis suaveolens*), ciquapatle (*Montanoa tomentosa*), jackass bitters (*Neurolaena lobata*), bushy lippia (*Lippia alba*), nees (*Dicleptera unguiculat*a), Florida tasselflower (*Emilia fosbergii*), jaral (*Calea pittieri*) and snow squarestem (*Melanthera nivea*). In this stratum also abundant are the vines of churristate (*Merremiaumbelata*e *Ipomea spp*.), nance colorado (*Banisteriopsis cornifolia*), Peruvian Trueno black vine (*Banisteriopsis muricata*), Liana de cuello (*Amphilophium paniculatum*), abuta (*Cissampelos spareira*) and *Serjania* sp., among others. (See photographs No. 5.11 – No. 5.12).

In this expansion of the development of the Las Pailas Geothermal Campus, for the elimination of this vegetation at the site of the new powerhouse and the rest of the sites to be potentially affected still not delimited as are the additional platforms and the new conductions of vaporducts, prior to their removal they must be adjusted to the current legislation and to the guidance of MINAET on the subject of permits for cutting trees.

Photograph No. 5.11 View of the scrubland that covers the area of construction of new geothermal plant buildings - Photograph Rolando Núñez GP Pailas

Photograph 5.12 Sector with Jaragua grass on the scrubland with trees Photograph Rolando Núñez

- ***"Fauna***

Fauna is important in the environmental assessment of the project; therefore, it is included in the EMP since the different activities and works of the project directly and indirectly affect insects, amphibians, reptiles, birds and mammals."

As the Las Pailas geothermal campus is to the south of the Rincon de la Vieja National Park,

an inventory was made of the fauna that inhabits or moves through the lands where the additional civil works will be built. As has been noted, these are abandoned pastures in a process of early biological succession. The study area covers an area of life, in accordance with the Life Zones system of L. R. Holdridge: Humid tropical forest transition to pre-mountain.

Biotic Characterization

- Herpetofauna

Samples were taken during the study period to determine diversity, distribution and possible spawning sites of the different species that inhabit the study area, so as to estimate the impact that the construction and exploration of the geothermal campus could have on these populations.

Lines of search for amphibians and reptiles were established in the lands to be affected by the construction of civil works as well as in the gallery forest on the shores of the Colorado River and the polygonal paths of the area of direct environmental influence, which was evaluated in the AP of the EsIA Pailas I. Individuals were not recorded, except for full identification in situ.

- **Bird fauna**

Monthly samples were taken at different times of day, and distribution was determined. The species observed were noted. The principle method used was direct identification, and indirect methods such as identifying bird calls, tracks, nests. Individuals were not captured.

Photograph No. 5.13 Stripe-headed sparrow (*Aimophila ruficauda*) - seedbed - Photograph Carlos Arrieta

- **Mammalian Fauna**

Circuits along the block of area proposed for the Powerhouse were performed, using direct as well as indirect identification, observing tracks, burrows, paw prints and excrement. A fog net was placed to capture and immediately release bats after their identification.

The information obtained through indirect methods was accounted as a location data point.

With gregarious species, the groups of animals or prints are recorded as one observation. In the case of primates, when the group is heard, it is recorded as the minimum average of individuals that have been observed on the campus within the gallery forest of the Colorado River (AID), if the horde has not been seen directly.

Results

-Herpetofauna
-Amphibians

Because the study was conducted during the dry season, in the collections of amphibians there were few specimens both in terms of species and in number of individuals (Table No. 5.6). The common toad (***Chaunus marinus)*** is the most dispersed species, in addition to the most abundant, being observed both in day and night and in less humid sites as well as very humid ones, both in the grass, thicket, paths. The common toad **(*Chaunus marinus*)** is probably the most abundant because of its ability to resist dessication. It requires less humidity than other individuals. Adults of this species were observed at a great size compared to other adults in other areas. This may be due to the fact that in the adverse conditions of the dry season, individuals enter into territorial competition and the dominant ones find niches with better food and displace the less competitive ones.

Other species were observed in the area of indirect influence, specifically in the gallery forest of the Colorado River, seeing thus the dependence of the amphibians on bodies of water.

Table No. 5.6: List of Amphibians Found on Sample Sites of GP Pailas II.

Species	Common Name	Habitat	Area of influence
Chaunus marinus	Common toad	Brushland with	Direct
Ollotis coccifer	Toad	Brushland with	Direct
Ollotis luetkenii	Toad	Brushland with	Direct
Cochranella granulosa	Glass frog	Gallery forest	Direct
Smilisca baudinii	Tree frog	Gallery forest	Indirect
Craugastor fitzingeri	Leaf frog	Gallery forest	Indirect
Smilisca sordida	Tree frog	Brushland with	Direct

In the area of direct environmental influence, ***Ctenosaura similis*** and ***Ameiva festiva*** were observed, and in the area of indirect environmental influence (mainly in the gallery forest), ***Norops oxylopus*** and ***Basiliscus basiliscus*** were observed.

Photograph No. 5.14 Leaf frog (*Craugastor fitzinger*) - Photography Carlos Arrieta

Nests of *Ctenosaura similis* and the adults protecting them have been observed on paths, open areas and scrubland. Many of these nests were observed to have been scavenged by animals. For the month of May, young specimens have been observed. The ***Ameiva festiva*** is observed as an abundant species in the area of study, preferring the scrubland and the pathway.

The species found in the area of direct influence are the most common in a habitat with these characteristics. Unusual species were not observed, nor were those in danger of extinction (Table No. 5.7).

Table No. 5.7: List of Reptiles Found on Sample Sites of GP Pailas II.

Species	Common Name	Habitat	Area of influence
Ameiva festiva	Central	Brushland with	Direct
Norops oxylopus	Lizard	Gallery forest	Indirect
Gonato desalbogularis	Gecko	Gallery forest	Indirect
Basiliscus basiliscus	Common	Gallery forest	Indirect
Norops humilis	Lizard	Brushland with	Direct
Leptodeira annulata	Frog-eating snake	Gallery forest	Indirect
Ctenosaura similis	Black spiny-	Brushland with	Direct

Photograph No. 5.15 Black spiny-tailed iguana (*Ctenosaura similis*) - Photography Carlos Arrieta

Bird fauna

The directly influenced area of study is characterized by a sector of natural succession with young native forest species of size no greater than approximately eight meters and scrubland areas. In this ecosystem, the bird fauna communities take advantage of the resource for food, nesting, and foraging.

In the scrubland habitat with trees, colonies of hummingbirds ***Amazilia saucerrotei*** and ***Amazilia tzacatl*** were observed, using this habitat in the dry season because there is vegetation with flowers. These individuals were observed to be territorial and concentrated in certain sectors

taking advantage of the abundant flowers. In the same sector, thicket tinamou (*Crypturellus cinnamomeus*) were observed and constantly heard, which is a land species that uses the vegetation as a refuge, for nesting and food.

Various species of seeding birds were observed (***Geothlypis poliocephala, Aimophilar uficauda***); various species of psittaciformes (***Aratinga canicularis, Amazona albifrons***), columbiformes (***Zenaida asiática, Columbina inca, Columbina tapalcoti***), taking advantage of seeds and fruits from pioneer native species; insectovore insects were observed such as ***Crotophaga sulcirostris, Morococcyx erythropygius, Pitangus sulphuratus, Campylorhynchus rufinucha, Tyrannus tyrannus, Tachycineta albilinea, Megarhinch uspitangua, Myiozete tessimilis***; birds of prey were also observed such as (***Accipiter striatus, Milvago chimachima***), which allows us to note that the area is good for capture and feeding on small rodents, birds, and insects.

In the gallery forest, birds were observed that primordially require this habitat, that would not be affected directly by the construction and operation.

Amazona albifrons, Ramphastus sulphuratus, Calocitta formosa, Cyanocorax morio, are species that were observed in the different habitats, in numerous groups. Therefore they could be defined as successful species, very much due to being highly social (Table No. 5.8).

Table No. 5.8: List of Birds Found in Sample Sites.

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Species	Common Name	Habitat	Area of influence
Crypturellus cinnamomeus	Thicket tinamou	Brushland with trees	Direct
Zenaida asiática	Dove	Brushland with trees	Direct
Eumomota superciliosa	Turquoise-browed motmot	Gallery forest	Indirect
Crotophaga sulcirostris	Groove-billed ani	Brushland with trees	Direct
Morococcyx erythropygius	Road runner	Brushland with trees	Direct
Geothlypis poliocephala	Grey-crowned yellow throat	Brushland with trees	Direct
Leptotila verreauxi	Dove	Gallery forest	Indirect
Cyanocorax morio	Brown jay	Gallery forest	Indirect
Pitangus sulphuratus	Great kiskadee	Brushland with trees	Direct
Coragyps atratus	Vulture	Brushland with trees	Direct
Cathartes aura	Vulture	Brushland with trees	Direct
Accipiter striatus	Sharp-shinned hawk	Gallery forest	Indirect
Aimophila ruficauda	Seedbed	Brushland with trees	Direct
Columbina inca	Inca dove	Brushland with trees	Direct
Aratinga canicularis	Parrot	Brushland with trees	Direct
Campylorhynchus rufinucha	Rufous-naped wren	Brushland with trees	Direct
Calocitta formosa	White-throated magpie-jay	Brushland with trees	Direct
Chiroxiphia linearis	Long-tailed manakin	Gallery forest	Indirect
Basileuterus rufifrons	Rufous-caped warbler	Gallery forest	Indirect
Myiarchus nutingi	Nutting‘s fly-catcher	Gallery forest	Indirect
Amazilia saucerrotei	Hummingbird	Brushland with trees	Direct
Patagioena flavirostris	Dove	Gallery forest	Indirect
Caprimulgus vosciferus	Whip-poor-will	Gallery forest	Indirect
Thryothorus maculipectus		Gallery forest	Indirect
Columbina tapalcoti	Inca dove	Brushland with trees	Direct
Ramphastus sulphuratus	Toucan	Gallery forest	Indirect
Tyrannus tyrannus	Nutting‘s fly-catcher	Brushland with trees	Direct
Tachycineta albilinea	Mangrove swallow	Brushland with trees	Direct
Megarhynchus pitangua	Great kiskadee	Brushland with trees	Direct
Milvago chimachima	Yellow-headed caracara	Brushland with trees	Direct
Amazona albifrons	White-fronted amazon	Brushland with trees	Indirect
Brotogeris jugularis	Orange-chinned parakeet	Gallery forest	Indirect
Myiozetetes similis	Nutting‘s fly-catcher	Gallery forest	Indirect
Amazilia tzacatl	Hummingbird	Brushland with trees	Direct

- **Mammalian Fauna**

This is the order with the greatest problems for observation since most of the specimens are nocturnal.

In addition to the observation of specimens, dens, and trails, mist nets were placed in the area of direct influence and in the gallery forest. Sherman traps were not used for the capture and identification of rats.

In the forest gallery of the Colorado River (AID), two packs of mantled howler monkeys (***Alouatta palliata***) with nine or more specimens per pack were observed, raccoon (***Procyon lotor***) tracks were observed. A vampire bat (***Desmodus rotundus***), which indicates that it feeds off of the livestock located in nearby farms, and a fruit bat (***Artibeus jamaicensis***) were captured. In the area of direct influence, a variegated squirrel (***Sciurus variegatoides***), eastern cottontail (***Sylvilagus floridanus***) and coyote (***Canis latrans***) feces as well as white-tailed deer (***Odocoileus virginianus***) tracks were observed (Table No. 5.9). It is at this point where seeds and fruits of native trees that are used for food, such as monkey soap (***Enterolobium cyclocarpum***), bay cedar (***Guazuma ulmifolia***), Apeiba tibourbou (***Apeiba tibourbou***), were observed in the dry season.

The gallery forest and the area near the National Park indicate that the area is a biological corridor between a point of transition or influence with the neighboring patches and forests.

Photograph No. 5.16 Fruit bat (*Artibeus jamaicensis*) - Photograph Carlos Arrieta

Table No. 5.9: List of Mammals Found on Sample Sites of GP Pailas II.

Species	Common name	Habitat	Area of influence
Alouatta palliata	Mantled howler	Gallery forest	Indirect
Sciurus variegatoides	Variegated	Brushland with	Direct
Sylvilagus floridanus	Eastern cottontail	Brushland with	Direct
Canis latrans	Coyote	Brushland with	Indirect
Odocoileus virginianus	White-tailed deer	Brushland with	Indirect
Procyon lotor	Raccoon	Gallery forest	Indirect
Desmodus rotundus	Vampire bat	Gallery forest	Indirect
Artibeus jamaicensis	Fruit bat	Gallery forest	Indirect
Mephitis macroura	Hooded skunk	Brushland with	Indirect

Conclusion

Of the fauna species observed in the project area (PA) (covered by brushland with trees) and the area of direct influence (AID), no uncommon or endangered species were observed, but rather species typical of brushland or areas affected by athropogenic effects that have been influenced for years have been influenced by the ranches of the area.

Due to the closeness to the National Park and the vigilance that is performed in the sector, it can be seen that the fauna of different orders is abundant rather than scarce.

Recommendations

- One of the points of importance is the location of the Powerhouse of the Pailas II Geothermal Field, since it is a secondary forest or brushland adjoining the Rincón de la Vieja National Park and with a gallery forest of the Colorado River. As its position is so sensitive both from the social and environmental point of view, it is recommended to have a friendly handling with the environment, which implies installing night lights (lamps) with bell shades and in some sectors using lighting with heat sensors, use only yellow light.

- Handling waste water, recyclable materials campaign, handling of reusable materials, refuse.

- Use plant screens as camouflage for exposed pipes, infrastructure.

- Handling of green areas with native species.

- Place protective fences and speed bumps at different points used by the wildlife as passages or reserve areas, especially frogs, reptiles and mammals.

- One permanent Biologist is needed on site to train and manage personnel for the capture and relocation of wild animals in the construction stage and generation stage of the Pailas II Powerhouse. This Biologist will represent the geothermal field in situations of logistics and coordination with National Park representatives from MINAET, representatives from the Guanacaste Conservation Area, representatives from Hotels and environmentalist members of the communities neighboring the Pailas II Geothermal Field.

- Develop training for all personnel hired for the Pails II Geothermal Field on the treatment of wildlife.

ASSOCIATED TRANSMISSION WORKS

- **Substation**

Constant consideration must be given to the soil and landscape so as to avoid alterating the environment; furthermore, adequate cleaning, collection and treatment of solid waste and control of liquid and gas substances spillage will also be monitored."

For this case in 2012, a new electrical substation does not need to be built as the one built for the first geothermal power plant will be used.

- ***"Transmission Line:"***

For the energy output from the additional geothermal station, a stretch of transmission line is needed to connect to the 230 kV Pailas substation approximately 2 km in length. Its layout would be located on ICE lands.

For this reason what is stated below in the EMO must still be followed.

"The Environmental Management Plan of Las Pailas Geothermal Project contains recommendations or corrective measures that will help reduce, eliminate or compensate the effects of the construction of the transmission line, as well as responsible actions and costs of the activity. It should be noted that some of the corrective measures have already been contemplated in the design of the project and in its normal implementation plan:

- ***Geomorphology***

The application of ordinary construction measures applied to these types of works (such as the design of the access entrance, sewage, debris handling, final on-site clean-up, etc.) lower the impact on geomorphology to highly acceptable levels in the transmission line works.

- ***Soil***

To install the transmission towers, access roads must be improved and/or created, which require cuts in the land. To mitigate the impact, roads must be designed considering safety angles of slopes and inclinations on the existing land. Likewise, surface runoff water should be channeled to decrease the process of water erosion; in the event erosion occurs, crossing canalization should be placed to cut runoff water.

The excavation material must be placed in dump sites previously selected.

- ***Vegetation***

Given that during the construction of the transmission line some trees must be pruned throughout the layout of the line, tree genetic material should be planted in the project region. Other similar projects have considered planting five trees per each tree removed.

Trees must not be cut at the vegetation ground level within the easement if it is determined that it is herbaceous vegetation; if so, vegetation can be permitted to grow naturally.

During the transmission line works, the pruning of trees must be restricted to the amount strictly necessary, taking out the branches of trees that, due to their location or size, do not represent a serious threat to the transmission line integrity. As in current times, the prohibition to extract vegetable material from the corridor by personnel associated with the construction and maintenance of this work will continue in force.

In evaluating the need to cut trees or branches from a tree threatening to fall down, the following measures will be taken into account:

a. The direction of predominant winds;
b. The orientation of the relief (slope);
c. The location of tree branches (form of the crown);
d. The maximum known height for the species.

Within the line, herbaceous and bush vegetation shall be respected as much as possible if they do not exceed the allowed height limits, based on the design conditions of the transmission line to comply with safety rules in force.

- ***Fauna***

Although it has been determined that the fauna will not be affected by the project, it is important to point out that it is not allowed to capture birds present in the project site by workers building the transmission line; the same is applicable to the hunting of mammal species present in the region, such as squirrels, rabbits, wolves and armadillos.

Electrocution of birds standing on the transmission lines occurs by contact with two conductors or, more frequently, by simultaneous contact with a conductor and the post or tower. Good results are achieved with certain measures such as isolation of brackets, insulators or conductors, and the protection of structures. Whenever possible, a section of the conductor is isolated or elements are modified in the structure, increasing their dimensions.

The most obvious measure to mitigate birds and airplane collision risks is to place signs on the cables to increase their visibility. In this sense, it has been proven that the measures applied by electric power companies, such as installing spirals (30 cm diameter) and neoprene strips (35 cm long) are recommended to reduce birds' mortality.

- ***Landscape***

It is advisable to reforest the boundary of the easement in three strata, using local species, selecting low-

growing vegetation to reduce the risk of flashovers. As a general measure, the burning of construction residues, bags and waste, that endangers the present habitats should be prohibited. All construction residues must be removed; any waste material should be transported to a nearby dump site for final disposal.

- ***Socioeconomics***

a) Furnish detailed information to residents of the area of influence on the following aspects: Commencement of the construction works; Size of the works; National and regional advantages of the new transmission system; Problems that will arise during the construction period.
b) Maintain updated information in connection with electromagnetic fields and health studies. This measure responds to the fact that it is a controversial issue that may come up at any time.
c) Maintain an alert attitude in the event of any communication of concern from the community so as to address it and maintain a prevailing harmonious mood at the time the study is to be carried out. This task may be entrusted to the environmental manager.
d) Address the community's concerns detected or notified to the ICE in a fast and timely manner.
e) Place danger signs in the towers since they will transport high-voltage energy.
In terms of the construction, operation and maintenance of these transmission lines, three phases must be considered: Assembly, operation and maintenance:

- ***Assembly of the Transmission Line:***

The following should be taken into account in this phase of the project:

a. Earth works.
b. Reconditioning and construction of road infrastructure.
c. Alteration of the landscape due to the construction of the transmission line works.
d. Local change of the use of land.
e. Changes in the drainage micro-network.
f. Low vegetation throughout the corridor.
g. Changes in fauna habitats.
h. Changes in the quality of life of the population.

- ***Operation of the Transmission Line:***

a. Increase in noise pollution.
b. Changes in the micro drainage.
c. Increase in the risk for landslides.
d. Changes in the structure and composition of the vegetation under the TL.
e. Increase in the risk of collision for birds.
a. Increase in local electromagnetic fields.

- ***Maintenance of the Transmission Line:***

During this phase, the most important measures for the local and immediate environment are as follows:

a. Control of the vegetation in the corridor of the easement
b. Maintenance and control of access roads."

In the passage of the Colorado River, adjustments must be made to the design of the line for the use of taller structures that minimize the cutting of tree vegetation in the river canyon. (See photograph No. 5.15).

The main foreseen effect is a potential break in the continuity of the biological corridor of the riverside forest of the bed of the Colorado River. To mitigate this impact, an adjustment must be made to the structural design at this point to raise the conductors and attain higher minimum clearance distances. This will mitigate the initial impact of the opening of the easement and allow the coexistence of the passage of wildlife by that wooded area during the operation stage. During the maintenance stage of the line, this measure must be respected, except in the case of a contingency or force majeure that shall give rise to larger-scale interventions in this forest.

At present (July 2012), no impact has been identified to the natural bird fauna at that site as a result of collisions on the existing lines as there are no mortality detection reports of specimens assigned by the personnel there, but it is not ruled out for the future. The electromechanical design of the line must plan for the installation of bird dispersers.

Picture No. 5.17 Panoramic view of the layout of the new stretch of the transmission line to connect to the Pailas substation. Photograph Rogelio Zeledón

"7.2. ORGANIZATION OF ENVIRONMENTAL MANAGEMENT

Environmental management is the mechanism for the implementation of the different recovery, restitution, mitigation, prevention and compensation programs mentioned in the Environmental Management Plan, and to carry out the adjustments in the detailed design phase, based on the observations of the environmental inspection done by the executing unit of the ICE and SETENA.

This section contains minimum functional environmental specifications, which shall be monitored during the construction and operation of the Las Pailas Geothermal Project, as well as some specifications that extend to the operation and maintenance of the geothermal power plant (Production).

These specifications describe the activities seeking to prevent, mitigate, or compensate the potential impacts that may occur on environmental components of the project's area of influence due to the construction, operation and maintenance thereof. The environmental management programs shall be adjusted during the detailed engineering phase of the project, maintaining the functional specifications and efficiencies of the different systems, and they shall be implemented during the construction and operation phases.

According to the Environmental Management Plan (EMP) an Environment Manager should be appointed and kept to execute and monitor the functionality and progress of each work, plan and program of the Environmental Management Plan and other measures contemplated by the National Environmental Technical Secretariat (SETENA, in Spanish) or those arising during the construction and operation of the project. Periodical reports must be submitted about the environmental engineering progress, problems and solutions adopted in coordination with the environmental inspection department of the ICE, in accordance with the Costa Rican legal framework.

Goals of the Environmental Management of the Project:

Execute the environmental management plan of the project materialized in the measures, works design, construction procedures and supplementary programs.

During the execution of the works of the project, ensure compliance with the environmental rules included in the environmental impact study and the specifications thereof, as well as environmental laws and regulations issued by competent Environmental Authorities.

Act as a fundamental tool of awareness management, not only of internal personnel but also of the ICE, as well as to identify environmental problems not initially considered in the Environmental Management Plan, and propose and implement solutions for them.

Minimal functions of the Environmental Manager

- *Execute the works and carry out the environmental management measures specified in the project's environmental impact report*.

As indicated at the start of Section 5 of this study, the follow-up of full compliance (according to performance indicators) must be assumed regarding the implementation of the new scopes or actions identified in the EMP adjusted for this phase of expansion of the generation capacity of the Pailas geothermal field.

- *"Prepare periodic reports for the inspections that the environmental authority will carry out on the progress of the project and of the environmental management.*
- *Report to the community about the project, in coordination with the Project Director, the number of jobs that will be created in the front and the requirements for contracting labor and goods and services.*
- *Design and coordinate the delivery and dissemination of informational material that is necessary for reporting the activities related to the project.*
- *Coordinate the management of the Project - Community relations using permanent dialogue with the population located in the area (decision-making bodies, influential figures and the general population), a process which much ensure that the various activities are carried out and that the community has participation.*
- *Implement the mechanisms and means that favor clear, efficient, direct and timely information.*
- *Disseminate the benefits that will be generated as a result of the performance of the Project in the short, medium and long term.*
- *Coordinate the project's environmental management, which will be directly responsible before the environmental inspection of the ICE or SETENA.*
- *Perform the general follow-up of the procedures established in each of the project phases.*
- *Carry out the management to obtain the additional permits and licenses not included in the environmental approval from SETENA.*
- *Supply information to the higher-level decision-makers and the ICE's implementation unit.*
- *Act as a liaison between the ICE's Project Director and the workers about aspects related to its environmental management.*
- *Organize and preside over the meetings required by the upper strata and those required to prepare reports and follow-up on the different activities.*
- *Identify the additional resources, such as specialists and consultants, control equipment, etc., required for the fulfillment of the Environmental Management Plan.*
- *Keep the project director and the ICE informed permanently about the problems the he or she believes merit corrective actions or handling contingency measures.*
- *Ensure the integrity in the handling of the management and the support of all activities.*
- *Identify the environmental effects not considered in the Environmental Impact Study of the geothermal plant, during the construction or operation phase for which reason the following activities will be performed:*

Reports

The Director of Environmental Management will submit reports of his or her management that he or she will send to the environmental authority (SETENA). The minimum information that is proposed in such reports is the following:

7.3 MONITORING AND FOLLOW-UP PLAN

The Monitoring and Follow-up Plan is part of the general inspection of the project and comprises a set of activities for the control and follow-up of the execution of the Environmental Management Plan for the development of the construction, installation and operation of the Las Pailas Geothermal Project.

Objectives

The main objectives of the environmental monitoring and follow-up or inspection are as follows:
- Monitor the compliance with the environmental management plan of the project materialized in the management measures, works design, construction procedures and supplementary programs.

- Carry out a systematic follow-up of the programs included in the environmental management plan. Evaluate and record the relevant recommendations for improvement thereof.

- Control compliance with the regulations established for the prevention and preservation of the environment and the natural resources issued by competent environmental authorities.

- Participate with the Project Manager in the management of relationships with external entities and authorities in charge of the supervision of the environmental project, elaborate reports on the progress of the project and the environmental management.

- Establish mechanisms for immediate response to deviations in the behavior of altered ecosystems due to project activities, not only in the construction phase but also in the operation phase.

- Identify environmental and social problems not initially considered in the environmental impact study, arising out of the construction of the project, and take all necessary steps so as to find appropriate solutions.

- Demand and certify the necessary evidence to verify the efficiency and effectiveness of all the systems and environmental control measures needed for the construction and operation activities.

- Design and implement test and reception protocols for each environmental management subprogram.

- Prepare periodical reports for the general inspection and project management departments, reporting on a quarterly basis about the compliance, problems, adjustments and progress of the Environmental Management Plan.

- Under no circumstance shall the Environment Manager be responsible for monitoring and follow-up, carrying out management tasks and activities that contradict or make the works of the project redundant."

5.1 Costs of the adjusted environmental measures (indicated in the ESIA 2004 as preliminary)

For the adjustment of implementation costs of the environmental measures indicated herein to 2012 amounts, the consumer price index CPI of the Central Bank 2007 to 2012 of 48.5% for general construction was applied.

The Coordination of this environmental readjustment of the original design with the purpose of ordering the presentation of the adjusted environmental measures in a simpler and/or more practical way applied the use of codes according to "Section 7-3 Monitoring and Follow-up Plan" which stated "Preliminary Environmental Measures - Environmental Management Plan

"The costs of each specific activity are located in table No. 7.1 of the Environmental Management Plan; however, some other costs are named that are made to the benefit of the environment in the area of influence of the Las Pailas GP, such as:

a) *The costs of the water sample collection campaign and laboratory determinations or analysis (physical-chemical) and microbiological analysis in the surface water in the area of the environmental influence of the Project. The cost of the former is $725 per month. The cost of the latter, or microbiological analyses, is $375 per six months of construction."*

Code: 1 MP-AGU-P2

Biannual physical-chemical monitoring program (in months of March and October) in the supply channel water of the Rincón de la Vieja Lodge hotel (concession of water from the Colorado River). This would mean collecting water samples and determinations of at least six (6) parameters: (temperature, conductivity, pH, bicarbonates, chlorides, sulfates). This analysis would be done in the Chemical Laboratory of the ICE in Miravalles. The cost will be $2,000/year (two thousand US dollars/year) and the follow-up would be done during the construction phase, as well as during the first five years of the operation phase of the plant, in the event that a constant scenario is maintained in regard to behavior of the water quality (3 years of construction + 5 years of operation = **USD 11,000.00**).

b) *"Costs of an appraisals campaign at 4 sites located in the beds of the Blanco and Colorado rivers are $100. This does not include data processing costs.*

c) *Platform stabilization costs are included in the cost of its construction; for Las Pailas it is approximately $52,000 per platform."*

Code: 2 MP-PLA-P2

At least 5 additional deep drilling platforms or squares are being planned for multiple wells

which means that **(USD 390,000)** would have to be added to the current amounts (2012).

d) *"Cost of perimeter fencing of drilling platforms with barbed wire and reinforced with mesh cyclone in the first 30 cm of fencing. Approximate cost per platform = $4,200, considering the fencing for a hectare, including materials (poles, wire, mesh), labor, equipment, payroll taxes, etc.*

Code: 3 MP-PLA-P2

Perimeter mesh cyclone fencing of the drilling platforms or squares. For the additional platforms ***USD 50,000*** would have to be added to the current amount (2012). In areas with forest coverage, the minimum required space for deep drilling tasks must be respected and not make more than three wells per platform.

e) *"Cost of the structures attached to the walls of the tanks to facilitate exiting. Approximate cost per platform = $520, considering materials, labor, equipment, etc.*

Training project personnel, in topics referring to environmental education and proper waste management. Approximate cost (annual) = $2,100."

Code: 4 MP-PLA-P2

For the 5 additional platforms **USD 5,000** would have to be added to current amounts (2012) for the case of the structures attached to the sludge tanks **(the subject of education is included in the EMP)**.

f) *"Waterproofing of drilling tanks and/or pits, at USD 6 per m2; 3400 m2 are waterproofed at each drilling platform, which means that for each platform a cost of $20,400 is being managed."*

Code: 5 MP-PLA-P2

For the 5 additional platforms **$153,000 (one hundred and fifty-three thousand US dollars)** would have to be added to current amounts (2012) for the waterproofing of the bottom and walls of sludge tanks or pits.

g) *Acquisition and assembly of equipment, infrastructure, etc. to monitor air quality $84,000. The maximum period of useful life of the equipment is three years.*

Code: 6MP-AIR-P2

Acquisition and assembly of a fixed station for continuous monitoring of air quality with measurement sensors for the concentration of the gases: H_2S (0.03 ppm), CO_2, noise levels equipped with a meteorological station to be located within the perimeter of the new plant**. Cost: $100,000**

h) *"Operation of the system (Monitoring of CO2, H2S, humidity, temperature, winds) $4,200*

i) *Promote a training campaign or process on the subject of the environment of the multiple-use community, evacuation of consultations and approach to the residents, whose approximate cost for 5 months is $21,000.*

j) *Approximate cost of the noise measurement campaigns for a period of 5 days during construction. $1,000/day."*

Code: 7MP-RUI-P2: COST INCLUDED IN THE EMP

k) *"Training project workers in the proper handling of solid waste and their ecological awareness would imply the hiring of at least one biologist with sufficient knowledge in that field.*

l) *Archaeological Heritage: Once the places where the works will be built are defined: (substation, vapor ducts, waste pipes, aqueducts, new roads, dumpsters, civil works, substation and the drilling of new wells), an archaeological prospection must be performed in the Las Pailas GP. This investigation must be carried out prior to any earth work or clearing of vegetation. Its duration may be 2 months and it will require contracting an expert in archaeology. For this task the estimated cost is $3,400, including field, laboratory and office work."*

Code: 8 MP-ARQ-P2

An expert in archaeology on the payroll of the project included in the construction and handling budget of the geothermal field.

m) *"For the supervision of earth works in the place where the powerhouse will be installed it is necessary to contract an archaeologist during the clearing of vegetation and earth works (construction stage). The estimated time is fifteen days ($670)."*

Code: 9 MP-ARQ-P2

An expert in archaeology on the payroll of the project included in the construction and handling budget of the geothermal field.

n) *"For funerary archaeological sites present on the land that the ICE intends to acquire, a barbed wire fence will be placed on its perimeter with concrete poles and a total value upwards of $4,720 (including materials, labor, payroll taxes, use of equipment and administrative costs).*

o) *The budget for the rescue of the Zapote petroglyph was estimated at $9,000 and includes the contracting of heavy equipment (crane, trolley and operators) for transfer to a location that meets the proper conditions for preservation and display (the powerhouse is suggested). An open shed with cement iron, wooden posts and imitation tile roofing must be built to install it, or designed according to the place where it will be placed. An explanatory sheet will also be included. Another planned aspect is the contracting of services of a restorer for cleaning and preservation of the rock.*

p) *In order to sensitize the population of Curubandé to the archaeological heritage, 3 lectures or workshops will be given addressed to children, teens and adults. These workshops include an instructor and teaching materials whose cost is $1,000."*

Code: 10 MP-ARQ-P2

An expert in archaeology on the payroll of the project included in the construction and handling budget of the geothermal field.

TOTAL ADDITIONAL COST FOR THE EXECUTION OF THE —PRELIMINARY" ENVIRONMENTAL MEASURES ADJUSTED TO THE ADDITIONAL GEOTHERMAL STATION IS $709,000 (SEVEN HUNDRED AND NINE THOUSAND DOLLARS). COSTS CARRIED FROM 2007 TO 2012 APPLYING THE CPI OF THE CENTRAL BANK OF COSTA RICA.

7.5. "ENVIRONMENTAL FEASIBILITY OF THE PROJECT

The geothermal resources have been known and used in various forms for thousands of years. In spite of this, their use for large-scale generation of electricity continues to be reduced. Since geothermal energy uses natural energy fluids it is considered as a renewable form of energy and, therefore, clean energy. Today the continuous development of plants for the production of geothermal energy around the globe has shown that the environmental impacts produced, even when they are severe such as those generated by conventional energy plants (coal, oil, nuclear), require relatively simple control and mitigation measures as far as their implementation to reach the tolerance values allowed by the environmental regulations in force both at the local and international levels.

Quite the opposite has happened with the environmental benefits from geothermal operations. These have been growing in the areas surrounding the sites of geothermal operation, in particular in relation to the recovery of vegetative mass, as a demonstration of what is described herein it is simply enough to visit the Miravalles Geothermal Field to appreciate the thick forest cover that has been regenerating the areas surrounding the land being used. This land that was formerly mostly pasture or scrubland is forested today with a moderate biodiversity, a fact that has also produced a recovery in the wildlife existing in the region. Neighbors have even reported the presence of animals that had disappeared decades ago.

Regarding the area of Las Pailas, at this stage of the technical-environmental investigations no element or natural process can be seen or detected that nullifies the environmental viability of a geothermal development with the dimensions stated here, although this particular area has certain natural oddities such as the boundary with a national park and the presence of two mountain hotels, associated with an evolving natural and anthropogenic landscape. These elements, instead of being affected would benefit, as they are parallel activities and not exclusive, and in other regions of the world they have been incorporated into geothermal developments, as in the case of Italy, the United States, Japan, Indonesia, and Mexico, among others.

In spite of this the definitive panorama on its environmental feasibility will be given once the exhaustive environmental impact study of this project has been evaluated.

7.6 MINIMUM ENVIRONMENTAL SPECIFICATIONS

The specifications have been organized into three large groups of programs that cover the physical, biotic and social aspects for the construction and operation stage. The programs are complemented by the Environmental Management Plan and are applied in the construction and operation stage of the project.

7.6.1. Construction stage"

All of the measures or specifications indicated in the EMP of the original approved environmental design apply to the expansion. (Annex No. 8)

"This stage covers all of the preliminary activities, preparation of the land, civil works, electromechanical assembly, tests and start-up. Some of the works submitted must be designed in detail and approved by the project inspection. Their execution shall be adjusted to the final work schedule."

For this expansion project, the duration of the construction phase is estimated at 3 years.

- ***"Treatment of construction waste water.***

The waste water from the washing of vehicles used to transport concrete (mixers) and equipment and tools required to prepare concrete mixtures must be deposited in pits dug out in the ground that meet the functions of sedimentation and filtering of water with waste content. The following measurements are recommended: depth 1 m; width 1.5 m and length 4 m. These dimensions ensure a storage capacity for waste of 5 m_3, leaving a free edge of 0.15 m. The pit will treat the water from washing from the production of approximately 800 m_3 of concrete. Once the pit has been filled it must be covered with the materials that was removed when it was dug.

This system acts as a sedimentator and filter for the treatment of waste water of this type. The efficiency in these pits is 80% depending on the filtration capacity of the soil. The number of pits to be installed will depend on the amount of concrete needed for the construction of the plant considering the treatment capacity mentioned previously. The applicable Standards are: Organic Environmental Law (Law 7554) Art. 65 and 66)

- ***Control and treatment of oily waste water***

For the control of contamination from greases and oils, a concrete slab 20 meters wide and 10 meters long shall be built to be used for washing, oil changes and maintenance of vehicles and machinery used in construction. This slab will have a concrete perimeter channel that will lead the waste water to a grease trap, which can also act as a sedimentator. Once the water passes through this system, it can be led to the perimeter channels on land that collect the run-off water and later to the sedimentation tank.

The greases and oils collected in the grease trap shall be disposed of by being mixed with liquid fuels such as fuel oil. The transversal section of the channels must have a trapezoidal shape, with lateral inclines and a 1V:1H slope depending on the conditions of the land. The minimum longitudinal slope of the channels must not be less than 0.5% or greater than 2%. For the placement of channels on lands with slopes greater than 2%, it is recommended to use concrete or bonded stone steps that enable adjusting the slope to the maximum allowed. The minimum width of the base of the channels will be 0.4 m.

The grease trap will be designed for a retention time of 15 to 20 minutes and according to the estimated flow that this area will manage or if it can be uncovered according to the weather records of annual maximum precipitation. The applicable Standards are: Organic Environmental Law (Law 7554) Art. 65 and 66, among others.

- ***Handling and disposal of industrial solid waste***

The type of solid waste that is produced during the construction of a geothermal plant are: paint waste dissolvents, industrial greases and oils, chemical products, the packaging containing them, plastic and wooden packaging, ferrous and nonferrous metal scraps, welding stub ends and others. Much of this waste is toxic or hazardous while other waste can be used or recycled. The project shall have a system for classification and recording of this waste (characteristics, amount storage and final disposal) and a place for storage and temporary disposal within the construction prior to its final disposal.

Hazardous or toxic waste shall be contained in hermetic packages that are resistant to water and atmospheric agents and handed over to the health authority of the municipality of Liberia for its final disposal. Hazardous or toxic waste shall have an area covered from sun and water and with enough ventilation so as to prevent the concentration of gases and odors as well as extinguishers to extinguish potential fires. Access to the area shall be restricted only to personnel responsible for its collection, recording and disposal. The applicable Standards are: Organic Environmental Law (Law 7554) Art. 68, Law of Use, Handling and Conservation of Soil Art. 33

- ***Environment: training***

Train workers on the project's Environmental Management Plan. Prevent actions that threaten the integrity of the environment, encourage the responsible management of the environment from each workstation, and assign environmental responsibilities to each project worker on issues of workplace security and occupational health.

The training workshops shall be given by a professional or group of professional on subjects regarding: a) Justification and national need for the project, b) Technical and operational characteristics of the project, c) The ICE's environmental policies and d) Environmental effects of the project in construction and operation, e) Environmental handling of the project, dumping, emissions, solid waste, fauna and flora, social management, etc., f) Project progress, g) Environmental problems and solutions h) Environmental planning and corrective actions, i) Industrial safety and occupational health. Applicable standards: Organic Environmental Law (Law 7554) Art. 12 and 13.

7.6.2 Operation Stage

The environmental handling systems and works for the operation stage shall be designed and built for the project.

During the testing and start-up phase the efficiency of each environmental handling system will be inspected and modification will be given as to whether it meets the given specifications.

The operator designated for the plant will be present as an observer of the testing phase and the reception of the plant and will receive training on the correct operation of the environmental management systems.

- ***Control and treatment of domestic waste water"***

For this expansion the water treatment tank that was built in the first construction phase of Pailas I will be used. (Photograph No. 5.18)

"For the operation stage a domestic waste water treatment system shall be built in stages as follows:

Grease trap: removes by flotation the saponified or emulsified greases. The grease trap is a concrete chamber in which the greases are deposited in the upper part by flotation. Its function is to prevent greases and soaps from bathrooms and kitchens from reducing the efficiency of the following treatment stages. Its design depends on the number of people served consumption and return of water per person retention time.

The effluent passes to the septic well: where a digestion - decantation process of the medium suspended in two chambers is carried out. The retention period shall be between one and two days. The solids settle in the bottom of the tank and carry out anaerobic digestion of the organic material, assisted by the layer of foam that forms on the liquid's surface.

Digestor: fixed medium percolator (anaerobic - ascending filter). Since the effluent of the septic well does not yet have the proper physical-chemical and organoleptic quality to be discharged into a surface fountain, it must be treated. The anaerobic filter produces the digestion or final decomposition of carbonaceous organic matter dissolved in the effluent. It must be placed after the septic well and is a concrete or brick tank fed from the bottom through a mixing chamber.

The effluent passes through a porous medium or thick filter (cornerstone 2" in diameter) and moves up through the gaps left in the material, forming a biologically active film which degrades the organic material anaerobically.

For its sizing, a unit volume for the filter of 0.05 m^3 *can be applied per resident served. The applicable Standards are: Environment Law (Law 77554); the domestic waste water treatment system (grease trap, septic tank and anaerobic filter) shall meet at least the regulations on dumping and reuse of waste water (no. 26042-S-MINAE).*

Photograph No. 5.18 Waste water treatment tank Pailas Geothermal Field Photograph Gabriela Zeledón

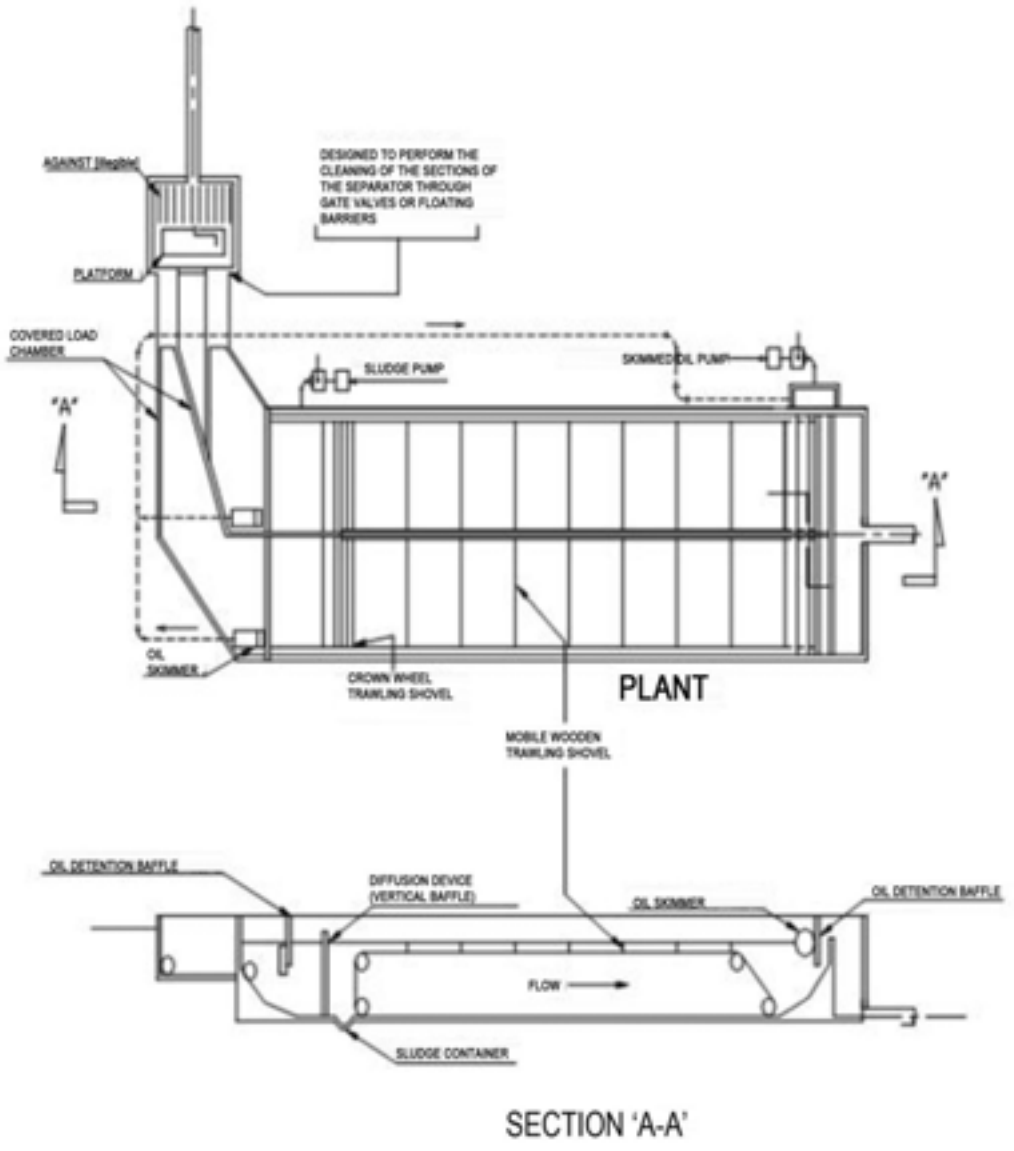
- *"Control and treatment of industrial waste water*

The oily waters and acidic or alkaline waters of the digestion system will be treated through the following subsystems: API/PPI separator of greases and oils: this structure shall be built to collect the industrial waste water with concentrations of greases, oils and liquid fuel contents, storm rain water and ground water siphons of the following areas: fuel treatment system, spill containment dikes of fuel tanks and rain water collection in the same area. Equipment maintenance areas (workshops), turbine area substation yard, other areas likely to generate water with a content of oils and fuels. (Figure No. 7.1).

The API is a rectangular unit in which free oil and sedimentable solids are removed, due to the difference in gravities, from oily waters. These units do not break emulsions or remove soluble substances. The equips consists of a pool, through which oily water flows slowly so that the oil rises to the surface where it forms a film that is retained by a baffle and removed by a skimmer. The equipment is also provided with a system for removing solids that settle in the separator. Before the API separator, a tank must be placed where different pipes that transport effluents of oily waters from different areas converge.

For the design of the API separator the following must be taken into consideration: specific gravity of the water, absolute viscosity of the water, specific gravity of the oil and size of the particles. Neutralization system: the water digestion process for the cooling systems generates acidic or alkaline residual waste water, which shall be treated in a neutralization tank.

This tank shall be cylindrical, built of reinforced concrete coated with epoxy resins or resins resistant to the action of acid or alkaline substances and also shall be buried. This tank is equipped with agitators for better homogenization of the mixture, automatic dosifiers of acid or alkaline substances for the neutralization of the effluent to pH values between 6 and 9 pH units. The neutralization equipment shall include metering pumps for acids and alkali, a turbine-type electroagitator, structural metal bracket to support the agitator, pipes, fittings, valves and other pieces necessary for the required flow and power. The applicable Standards are: Organic Environmental Law (Law 7554), Guides from the World Bank 1996



TYPICAL DIAGRAM OF AN API SEPARATOR

Figure No. 7.1
Scheme of an API separator

- ***Handling and disposal of domestic solid waste***

  The types of domestic solid waste that are usually produced during the operation of a geothermal plant are: food waste, packaging waste, polypropylene paper and bags, among others.

  For the proper disposal of this waste, the following activities must be performed: Immediately store the waste at the source of production in appropriate containers; it is necessary that these containers be resistant to attack by animals (rodents and canines). For practical purposes, 5 gallon disposable bins or similar elements with a maximum capacity of 25 kg may be used.

  A plastic bag is placed in the lower part that retains the waste and is periodically removed. The layout and density of bins per area will vary according to whether they are office, maintenance, dining or break areas.

  Collection shall then be carried out, in which the person responsible for this activity will take the collected waste, in bags, to a containment pit built specifically for this purpose. Collection must be done as soon as the storage containers reach their capacity, or at most every three days, whichever occurs sooner. The storage area shall be removed from areas of work, break or feeding and clearly indicated.

  Lastly, the waste shall be delivered to the municipality of Liberia for its final disposal in a maximum time of one week.

  For the dimensioning of the pit, the number of people who will be present during the operation of the plant shall be taken into consideration, assuming a per capita production of 0.5 kg/res-day (TCHOBANOGLOUS, 1994), and a density of 400 kg/m3 corresponding to uncompacted waste. The applicable Standards are: Organic Environmental Law (Law 7554) Art. 69

- ***Handling and disposal of industrial solid waste***

  The type of industrial solid waste that is usually produced during the operation of a geothermal plant are: paint waste dissolvents, industrial greases and oils chemical products the packaging containing them plastic and wood packaging, scrap of ferrous and nonferrous metals, welding stub ends and sediments and sludges from water treatment systems.

  During operation, there shall be a system for classification and recording of this waste (characteristics, amount storage and final disposal) and a place for storage and temporary disposal within the construction prior to its final disposal. Hazardous or toxic waste shall be contained in hermetic packages that are resistant to water and atmospheric agents and handed over to the municipality of Liberia for its final disposal.

  Hazardous or toxic waste cannot be stored outdoors and shall have an area covered from sun and water and with enough ventilation so as to prevent the concentration of gases and odors as well as extinguishers to extinguish potential fires. Access to the toxic waste storage area shall be restricted only to personnel responsible for its collection, recording and disposal.

  The stabilization tank shall be unoccupied when the volume of sediment takes up two thirds of the useful volume. The solids from the tank will be piled in a ground pit to be dried and then disposed of in the city's landfill. The sludge and sediment removed from the API separator or any other system will be handled and disposed of in the same way.

The greases and oil removed from the API separator can be mixed with the fuel used for the operation of the plant. The greases and oils collected in the grease traps of the waste water treatment system will be dried with the sludge and disposed of in the city's landfill. The applicable Standards are: Organic Environmental Law (Law 7554) Art. 68, Law of Use, Handling and Conservation of Soil Art. 33

- ***Environmental education***

Inform the plant's workers about the environmental policies for handling the environment. Train the plant's workers on the project's Environmental Management Plan. Prevent actions that threaten the integrity of the environment, encourage the responsible management of the environment from each workstation. Assign environmental responsibilities to each worker of the plant. Train the plant's workers on issues of workplace security and occupational health.

The Environmental Manager will maintain, for the entire life of the project, a training program for the workers. The goal of this program will be to encourage responsible and efficient handling of all environmental variables as well as to disseminate the project's Environmental Management Plan.

The training workshops shall be given by a professional and group of professionals who are specialized in environmental handling and industrial safety. The following subjects shall be covered:

a) Technical and operational characteristics of the project, b) The environmental policies of the project, legal responsibilities, c) Environmental effects of the project, d) Environmental handling of the project, dumping, emissions, solid waste, fauna and flora, social management, etc., e) Environmental problems presented and solutions given h) Environmental planning, solution of future problems and corrective actions, i) Industrial safety and occupational health. The applicable Standards are: Organic Environmental Law (Law 7554) Art. 12 and 13."

5.2 COMPARATIVE CHART BETWEEN THE APPROVED MANAGEMENT PLAN AND THE FEATURES OF THE AMENDMENTS TO EXPAND LAS PAILAS GEOTHERMAL PROJECT (ANNEX No. 8 SHOWS THE ORIGINAL APPROVED AMENDMENTS TO ENVIRONMENTAL MANAGEMENT PLAN (EMP))

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Geomorphology	Surface Runoff due to superficial microrelief variation.	- Surface Drainage - Avoid accumulation of mounds and surface drainages		1 GEM-P2	This means that due to earth movement works in preparation for construction, it is probable that the new formations might change surface runoff. This must be avoided.	Apply Resolution No. 1948-2008-SETENA. 7.5 Slag heaps, pp.18-19 / 11, Storm water management, pp. 22- 23	Cost considered in the construction budget +**19000** (inspection costs)
	Change in Project micro relief	-Control of excavations when Works are finished -Stabilize by placing grass on slopes or other adequate materials		2 GEM-P2	Regreening of slopes and berms with plants and trees native to the area, immediately after slope contouring.	Roads, platforms, buildings: Apply Resolution No. 1948-2008-SETENA 7.4, Slope Management, pp.17-18	
	Alteration in the behavior of runoff due to change in n microrelief	- Water management - Collection of materials using sediment traps		3 GEM-P2	Apply ground water management practices such as drainages, sewers, gutters, culverts, stabilization of slopes and energy dissipators	Construction sites: Apply Resolution No. 1948-2008-SETENA, Section 11 Rainwater Management	
Landscape	Change in naturalness of landscape by	1.Environmentally harmonious powerhouse design.		4 PAI-P2	1. Design building with glass walls with reflective mirror film.		

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
	presence of powerhouse and related buildings	2. Place "green" screen along NE flank of and around powerhouse. 4. Turf areas around works			2. Place tall grass screen 600m long along NE flank of powerhouse (bordering with road to Volcán Rincón de la Vieja), property of ICE. Section 6.1.6.3. 3. Plant trees and bushes on all 4 flanks of powerhouse.		
	Change in naturalness of landscape due to slag heaps	1. Environmentally harmonious geomorphic design 2. Revegetation of slag heaps		5 PAI-P2	1. The final design of slag heaps shall harmonize with the geomorphic environment . 2. Planting vegetation on slag heap sites. Section 6.1.6.4.a.	Apply as per indications contained in the environmental construction -guide Resolution No.1948-2008-SETENA. 7.5, Slag Heaps, pp.18-19 / 23, Landscape Management, pp.30-31 6 hectares of additional land are available for slag heaps on the ICE grounds (includes transportation and distribution of organic soil layer (20 cm thick) and regreening	
	-Change in naturalness of due to addition of linear works	1. Paint pipelines in green to harmonize with environment 2.Revegetate area alongside pipelines		6 PAI-P2	1. Paint steam pipelines and other exposed piping and mufflers in green to harmonize with environment; color shall consider the dry and rainy seasons: 2. Regreening of areas in between exposed steam pipelines and other exposed piping and along the road to Volcán Rincón de la Vieja, owned by ICE. Section 6.1.6.4.b.	Use olive green pipe coverings similar to RAL 7008 (RAL Generic Paint Chart) and reinforce with green screens around the perimeter of pipeline rights-of-way.	

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Soil	-Change in soil surface due to excavation works and presence of slag heaps -Erosion due to elimination of soil cover. -Increase in runoff and soil erosion	-Enrichment with trees and ornamentals (Reforestation) -Place organic cover in Areas without buildings and that were affected by the project -Design structures prone to infiltration works -Carry out earth-retaining works		7 SUE-P2	-Plant trees bushes, fruit trees according to design of selected sites -Plant trees and ornamental plants around works and in organic soil areas .-Follow up and Maintenance of restoration works according to topography -Cut the terrain to make way for roads These cuts can be made manually or with machinery	Road Design -Calculation of road-cut safety angle -Channel runoff water to prevent erosion, -Weekly visit to verify the following: Identification of works: Design measure:_____ % completion: 0%__ 25%___ 50%__ 75%___ 100% ____ Justification:_____ Inspection date:_____	**33000**
	-Gas emissions: acid rain	-Monitoring and control of emissions. - Soil monitoring and analysis		8 SUE-P2	-Plant native plants and trees in order to protect the soil in sites likely to be affected by emissions - Monitor and control soils in the areas of influence of the project	Conduct a complete chemical analysis of soil and foliar tissue in pastures within 1000 m of the perimeter of the plant's grounds (two sampling campaigns) one year before the start of plant operation and 5 years after the operation phase. (Minimum 10 sampling sites per sampling	

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
	Oil and fuel spills	-Placing oil traps . -Leak management and control		9 SUE P2	Design storehouse	Weekly visit to verify the following: -Identify traps -Condition of traps -Control types -Measure taken -Date of inspection Fuel storage and adequate use of fuel -Design specific areas for fuel change in machines and equipment	
	Disturbance and alteration of soil profile due to excavations	-Restore soil cover with organic material, slag heaps leftovers		10 SUE-P2	-Plant trees brushes, grasses in selected sites and following the design agreed on after finishing the Project.	Apply indications contained in the Environmental Construction Guideline - Resolution No. 1948-2008-SETENA, section 7.4 - Slope Management pp.17-18	
Quality of Life	-Noise, vibrations and emissions produced by the plant	Monitor noise, vibrations and emissions in accordance with the controls and specifications in the environmental guidelines established -establish a maintenance and inspection plan		11 RUI-P2	Use appropriate technology to reduce and control noise, vibrations and emissions -Execute the maintenance plan and environmental inspection –Comply with mitigation actions included in the Works Design	Employ noise reduction devices in electro-mechanical equipment and in the design of the building where they will be housed to insure compliance with legally accepted levels	**770000**

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
		Periodical inspection of machinery and equipment of the Center -Comply with mitigation actions as per works design -Verify compliance with the works acceptance protocol			-Comply with provisions in the Works Reception Protocol .	Buildings closest to the Plant - Decree No. 28718-S, art.20 - shall follow the design established in Section No.2 of this environmental technical study	
Services	Increase in service demand. – Deficiency in common services.	-Improve current services such as water, telephone and power, road slots and sidewalk construction		12ACU-P2	Coordinate with staff in charge of providing basic services -Evaluate common needs	Build an aqueduct for potable water supply for the new generation plant; its reservoir will be injected into the local aqueduct of Curubandé to replace the current water intake at Quebrada Victoria stream. Maintenance of aqueduct onwards of storage tank will be responsibility of the ASADA of Curubande (Annex 7)	**350000**

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Social and Cultural Dynamics	-Alteration of daily life in the community due to the presence of many strangers	-Workers shall follow the behavior standards (especially during their leisure time),with the local people		13 SOC-P2	Maintain adequate coordination to prevent conflicts with the community, by means of a constant communication and the enforcement of internal working regulations -Talks to get to know the standards and regulations and possibilities for recreation and leisure		**5000**
Health and Occupational Health	-Increase in occupational accident rates -Construction related noise	-See to the compliance with occupational security standards – Train the staff participating in the construction as far as occupational health is concerned before the starting of works.		14 SOC-P2	Employer shall apply the Law on Occupational Risks and its regulations, as well as the General Regulation for Occupational Hygiene and Safety –Use the appropriate occupational health and safety	Enforce Resolution No. 1948-2008- SETENA Section 12 Occupational safety and hygiene, p.23	**12000**
Employment	-Increased labor demand in the area	-Give priority to contracting workers from the area		15 SOC-P2	Inform on real labor requirements and their temporary nature		

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Archeological Heritage	Alteration of potential archeological sites due to the removal of soil during construction	Carry out an archeological survey in the project area before removing any soil or cutting the vegetation .		16 ARQ-P2	Hire a professional archeologist who shall carry out field work, lab work and desk work	Valid for the 2012 expansion of the geothermal field construction and operation phase of the geothermal field	Cost of professional archeologist considered in the geothermal field construction and management payroll budget
		-Sopervision of earth movement works at powerhouse construction site		17 ARQ-P2	Hire an archeologist during the vegetation cleaning and land movement phases		
Vegetation	Clearing of vegetation is necessary for road construction, although in the case of Las Pailas, road opening will be minimal, thus reducing the environmental impact	Regreening alongside roads and on slopes and berms with grass and shrubs -Reforestation with trees and tree maintenance in first 2 years.-	Forrest Ranger Log	18 FLO-P2	-Protection of land for efficient natural and induced regeneration.	Apply indications contained in the environmental construction guideline Resolution No. 1948-2008-SETENA.6. Vegetal Cover Management and Protection Areas pp.11- 13, particularly the provisions of section 6. 10. “Along with the construction permit it is necessary to have the (MINAE, SINAC) permit for tree cutting and trimming as indicated in Arboreal Plan, pursuant to the Forestry Law”	**10000**

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Waste Management	-Generation of organic waste	Implement Waste Management Plan according to Chapter 2 of this study		19 RES-P2	Implement Waste Management Plan during the project construction phase	Strengthen Waste Management Plan - Resolution No. 1948-2008-SETENA 17.- Waste management, p.26	**111000**
Birdlife	-Bird collision	-Bird distractors -Bird control and monitoring		20 FAU-P2	Place distracting signs	-Place fences and speed bumps at various points that wildlife, especially frogs, reptiles and mammals, use as passage areas. -A permanent, on-site biologist shall be required to train and manage staff in capturing and relocating wildlife species during construction and generation stages. - The biologist will represent the geothermal field in logistics and coordination matters before representative of MINAET National Parks, members of Guanacaste Conservation Area and representatives of hotels and environmental activists working in the communities in the vicinity of the geothermal field of Las Pailas II.	5000 Cost considered in the Plant's operational payroll budget (biologist fees)

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Surface waters and runoff	-Reduction in the water infiltration rate to permeate covered surfaces	-Install permeable granular materials on bearing and transit surfaces and allow pedestrian traffic. –Installation of gutters, drain boxes, sewers, sidewalks		21 AGU-P2	- Use cobblestones, grass, block, or other permeable granular based material around the different works, driveways, and parking lots. - Coordinate with the Director PG A -	Apply Resolution No. 1948-2008 - SETENA Section 11 stormwater management, using granular materials such as gravel of varied granulometry.	**20000**
Air	-Gas emissions	-Measure emissions periodically at least once a month during the first year of operation and quarterly from the second year of operation as required during plant operation. -Monitor the state of health of plant employees through medical records. Perform health checkups annually including, among others, audiograms, blood and respiratory system tests, stress level tests, etc.		22 AIR-P2	Select adapt and implement the most appropriate monitoring methods according to plant conditions using available data and appropriate technologies. -Selection of analysis method will be undertaken jointly with the manufacturer, subject to the generation technology deemed most appropriate -Periodical monitoring in predefined sites –Quarterly Monitoring for H2S -Compliance with the country's environmental regulations	-Conduct continuous monitoring of H2S concentration levels using a fixed onsite station equipped with sensors. Adjust to permitted gas concentration as per ranges indicated by the World Health Organization (≤ 0.1 ppm on average in 24 hours)	Considered in the environmental measures

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
	-Atmospheric quality vs. equipment tests	-Comply with the law in force regarding gas emissions and immissions. During equipment tests, primarily in the powerhouse and during pipeline blowdowns, considerable amounts of noise are normally produced as a result of testing.		23AIR-P2	Country, emissions as per Decree N° 30221-S in the perimeter of the plant Control and monitoring during tests	Inform the neighboring population about the tests and avoid night hours. Continuous monitoring of	
	-Atmospheric Quality vs. Plant Operation	Operation of a geothermal plant entails continuous emissions of gases into the atmosphere. Therefore, controls will be necessary to ensure established limits are not exceeded in order to avoid effects on people.		24 AIR P2	Periodic control and monitoring	H2S gas concentration in the atmosphere and noise levels within the perimeter of the plant shall be performed at least once a month internally and externally to the main buildings. Adjust to permitted gas concentration ranges as indicated by the World Health Organization (≤ 0.1 ppm on average in 24 hours)	

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Noise pollution	-Noise and vibration as a result of plant operation	-The equipment to be purchased shall ensure that noise levels at the edge the property will not exceed 45 dBA* at any time of the day outside the nearest home .Otherwise, design barriers and acoustic screens will be required, if not included in the design already. -*According to national standards		25 RUI-P2	-Carry out a noise study at the site before and after commencement of works (isophones).This study will be repeated every five years during the operation period to verify changes in the environment. -Periodically monitor noise at plant and direct area of influence once a year. The first year this will be done quarterly during plant operation.	Continuously monitor noise levels using a fixed station on the plant's grounds Adjust to permissible ranges as per Decree 28718-S Noise Contamination Control	Cost considered in the Plant´s operational budget
TRANSMISSION							
Soils	-Excavation cuts in terrain For new roads.	-Adequate design for road cuts		26 SUE-P2	Calculation of safety angle in the cut design. Channel runoff water to prevent erosion.	Apply resolution No. 1948-2008- SETENA, Section. 7.4 Slope Management, pp.17-18 2	Cost considered in the Construction budget

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Vegetation	-Elimination of vegetation for road opening	-Revegetation of roads and slopes.		27 FLO-P2	Protection of land for an efficient natural and induced regeneration .	Respect low grass, tree and bush vegetation as far as possible, not exceeding permitted height levels, based on the design conditions to comply with safety standards in force	**13000**
	-Elimination of trees, cutting	- Reforestation and maintenance - Tree cutting and reforestation plan		28 FLO P2	Forest reforestation to obtain cutting permits -Cutting management plan -Prepare a reforestation plan to plant in the ICE land plot or other land -Cut the minimum necessary in trimming, never clear cutting		
Water quality	-Contamination due to sediments	-Road design –Water management at roads and tower site -Cut design		29 AGU-P2	-Least steep road route design selection –Use of sewage in rivers, flooded areas and surface water management -Calculation of safety angle in road-cut design. -Channel runoff water to prevent erosion. -Ditches and runoff breakers in slopes -No dumping of removed soil in rivers and streams		Cost considered in construction budget
Flora and Fauna	Extraction of plants and birds	-Wildlife hunting ban and restriction.		30 FAU-P2	Environmental education to workers regarding ban on hunting	Placement of signs banning wildlife hunting	**2000**

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Birdlife	Bird collision	-Bird Distracters and bird control and monitoring		3I FAU-P2	Placement of signs	Placement of bird dispersers	**3000**
Soils, fauna, flora and water	Temporary habitat alteration	-Route design -Programming of right-of-way clearing activities -Training of field staff		32 FAU-P2	-Stacking of packing material. -Final route design shall be made by an interdisciplinary group in order-to maintain corridor continuity. -Consider design variables to adapt transmission line characteristics to passage through corridor -Plan right-of-way clearing works to avoid interfering with migration and reproductive seasons -Instruct staff to not extract species		Permanent Cost considered in the Plant's operational budget (biologist fees)
Social	-Concern of community regarding construction of transmission line	-Contact with community. –Road signs –Placement of road signs		33 SOC-P2	Establish communication channels to clarify any doubts or concerns. – Distribute information brochures		Permanent cost considered in the Plant´s operational budget +5000 (Construction)

Measures in the approved Environmental Management Plan				Measures defined for the expansion			
Component	**Impact**	**Environmental Measures**	**Indicators**	**Impact Code**	**2004 Measures as per Environmental Impact Study**	**Additional Environmental Measure /indicator**	**Cost (US$)**
Safety	-Risk due to l/line construction	-Use of safety equipment and staff training		34 SOC-P2	-Training of staff in the use of appropriate equipment	Resolution No. 1948- 2008-SETENA Section 12 Occupational Safety and Hygiene, p.23	Cost considered in the Plant´s operational budget
Landscaping	-Alteration of landscape quality	-Reforestation with appropriate species		35 PAI-P2	Planting of vines and ornamental species	Vegetable greening around and at the foot of the tower to hide the lower part Keeping the safety distance required From conductors.	**6000**
Atmosphere	-Fire hazard	Control flammable materials		36 AIR-P2	Avoid accumulation, surface mounds and drainages. -Collect wastes (mainly glass) and dispose in the plant –No burning wastes –No dumping flammable liquids -Prevent fire hazards	Set up a forest fire control system to monitor the perimeter of the new facilities	Permanent cost considered in the Plant´s operational budget
				TOTAL ADDITIONAL COST LAS PAILAS ENVIRONMENTAL MANAGEMENT PLAN: US$1426000.00			

6 ANNEXES

6.1 Annex 1. Resolution No. 3688-2005 SETENA — Environmental Feasibility of the Pailas Geothermal Project

ANNEX 1

Ministry of Environment and Energy

National Environmental Technical Secretariat

SETENA

Resolution No. 3688-2005-SETENA

GIVEN IN THE MINISTRY OF ENVIRONMENT AND ENERGY, NATIONAL ENVIRONMENTAL TECHNICAL SECRETARIAT, AT 14 HOURS AND 10 MINUTES ON 12 DECEMBER 2005.

ADMINISTRATIVE RECORD No. 788-2004-SETENA

LAS PAILAS GEOTHERMAL PROJECT

The Secretariat's Committee of the Whole heard on report DAP-946-2005 regarding the analysis of the information and documentation requested via Official Communication SG-2800-2005 from the Las Pailas Geothermal Project, presented by Mr. Carlos Obregon Quesada on behalf of the corporation *Instituto Costarricense de Electricidad* (Costa Rican Institute of Electricity, or ICE by its Spanish acronym), file number 788-2004-SETENA.

FINDINGS

ONE. The Preliminary Environmental Assessment Form (FEAP) of the Las Pailas Geothermal Project was received at this Secretariat on 13 September 2004, submitted by Mr. Carlos Obregon Quesada, on Behalf of the ICE. The administrative file number assigned is 788-2004-SETENA.

TWO. By resolution 2487-2004-SETENA, dated 13 December 2004, a request was made for submission of an Environmental Impact Study (EIS). This document was received in this Department on 4 August 2005, presented by Mr. Carlos Obregon Quesada on behalf of the ICE.

THREE. Based on Official Communication DAP-803-2005, prepared by Sonia Espinoza, engineer from the Project Management Department, which refers to the technical analysis of the EIS submitted by the developer, it was determined that it complies with the terms of reference and technical requirements issued by this Secretariat.

FOUR. Via Official Communication SG-2800-2055 dated 7 November 2005, the developer was Notified (after analysis of the EIS document) That the Project Management Department in its report DAP-803-2005 determined that it is in order to continue forward with the environmental assessment process of the referred project, for which it becomes necessary to request that the developer meet the following requirements:

Make an environmental security deposit in the amount of $ 1,373,733.86 (one million three hundred seventy-three thousand seven hundred thirty-three dollars and eighty six cents or its *colón* equivalent).

a) Appoint an Environmental Officer
b) Submit a minute book of 100 pages to serve as Logbook.

The above documents must be submitted by the developer one month before the start of activities.

c) Submit an Affidavit of Environmental Commitment via Official Communication within fifteen days after notification.

FIVE. The documentation requested via Official Communication SG-2800-2005 – Affidavit of Environmental Commitment – was received by this Secretariat on 29 November 2005. Other documents (Appointment of Environmental Officer, receipt of environmental security deposit and Logbook) will be submitted one month before starting works, as established.

WHEREAS,

ONE. Mr. Carlos Obregon Quesada is authorized to request an environmental assessment on behalf of the ICE.

TWO. Article 19 of the Organic Law of the Environment states that “resolutions of the Environmental Technical Secretariat should be substantiated and reasoned, and shall be binding for both individuals and public bodies and agencies.”

THREE. Article 6 of the Amendment to Article 45 of the General Regulation on EIA Procedures of Executive Decree No. 31849-MINAE-S-MOPT-MAG-MEIC states the following on the Fundamental Environmental Commitment Clause: "This Environmental Feasibility License is granted on the understanding that the developer of the project, work or activity will comply fully with the technical, legal and environmental standards and regulations in force in the country and other such standards and regulations to be executed before other Costa Rican State Authorities. Breach of this clause by the developer shall not only subject the developer to sanctions for noncompliance with such regulation, but –the clause being part of the foundation on which the License is sustained–, shall cause the Environmental Feasibility License to be automatically rescinded with all technical, administrative and legal consequences this will have on the activity, work or project and their developer, in particular regarding the scope of Article 99 of the Organic Law of the Environment.

FOUR. Article 17 of the Organic Law of the Environment states that "human activities that disturb or destroy elements of the environment or generate waste or toxic or hazardous materials will require that an environmental impact assessment be conducted by a National Environmental Technical Secretariat as created by this law. Prior approval by this body will be an essential requirement to initiate activities, works or projects. The laws and regulations shall indicate which activities, works or projects shall require an environmental impact assessment." "Within this administrative procedure, it was determined that the appropriate environmental assessment tool to be requested from the developer was an Environmental Impact Study, which was duly analyzed; this led the Project Management Department to determine in its report DAP-803-2005 that it complies with the terms of reference and technical requirements issued by this Secretariat.

FIVE. Pursuing to the control and monitoring powers set out in Article 20 of the Organic Law of the Environment (which states that "the National Environmental Technical Secretariat shall establish tools and means to monitor compliance with the resolutions of the environmental impact assessment ... (and) in cases of violation of its content, the Secretariat may order the suspension of works ... (and) the person concerned, the author of the study and those who approve it shall be directly and jointly liable for damages"), the documents listed in FINDING NUMBER FOUR were requested via Official Communication SG-2800-2005, which were analyzed and determined to be compliant; therefore in this case it is appropriate to approve the environmental impact assessment tool and the additional documents submitted and grant the Environmental Feasibility License.

SIX. The Committee of the Whole at its meeting number 030-2004, in Article 43 issued by Resolution 1269-2004-SETENA, dated 16 August 2004 agreed "to allow the developer (public or private) to present the environmental security amount, the appointment of the environmental officer and the environmental logbook one month before starting the works, activities or projects.

THEREFORE,

The Committee of the Whole, at its regular meeting No. 068-2005 of this Secretariat dated 5 December 2005 **resolved** in Article 70 that:

ONE. The Environmental Impact Assessment (EIA) submitted for evaluation by the developer is approved.

TWO. The Affidavit of Environmental Commitment requested via Official Communication SG-2800-2005 submitted by the developer on 29 November 2005, is approved.

THREE. Mr. Carlos Obregon Quesada, legal representative of the corporation Costa Rican Institute of Electricity (ICE) and the Las Pailas Geothermal Project, as per administrative record-SETENA 788-2004, is Instructed to deposit the environmental security in the amount of $ 1,373,733.86 (one million three hundred seventy-three thousand seven hundred thirty-three dollars and eighty six cents or its *colón* equivalent) in the Securities Custody Account No. CV-7297-SETENA-MINAE in the National Bank of Costa Rica - San Jose. The project name and the file number must be specified, and the corresponding deposit slip shall be furnished to this Secretariat. The deposit shall be good for a minimum of one year in accordance with Article 21 of the Organic Law of the Environment. Moreover, the appointment of the Environmental Officer must be made with current registration in the Register of Consultants of SETENA by sending a note signed by the owner with the acceptance of the Designated Professional. The letter of appointment signed by the developer, the letter of acceptance signed by the consultant, and the 100-page logbook (the latter shall be kept in the project facilities during the lifetime of the environmental officership), shall be submitted one month before the start of activities, and all other specified documents shall be submitted to the Secretariat within the same period. Failure to submit the documents listed in the allotted time shall cause enforcement of the provisions of the existing legislation.

FOUR. Based on the environmental characteristics of the Project Area and its interaction with the activities to be undertaken by the project, the frequency of the Environmental Officer's reports to SETENA will set at every three months during the construction phase and at every six months during the operational phase, until this office deems appropriate. The Environmental Officer's reports must be submitted within a maximum of 10 days after the end of the reporting period. The reporting period

of the first Environmental Officer's report shall begin with the start of project activities. For the purposes of the preparation of these reports, determining the number of visits to the project site shall be the responsibility of the Environmental Officer depending on the characteristics of the project and pursuant to the format established by this Secretariat. Based on these reports and the monitoring program, SETENA can adjust the amount of the environmental security and issue mandatory compliance measures to keep the project, work or activity within a controlled range of environmental impact. The officer and the owner shall provide support to the inspections carried out by SETENA.

FIVE. Non-compliance with the requirements of this Secretariat and with the obligations set out in the Environmental Impact Assessment and the Affidavit of Environmental Commitment shall be punishable in accordance with the provisions of Article 99 of the Organic Law of the Environment and other legislation in force.

SIX. The interested party is notified that pursuant to Articles 17, 18 and 19 of the Organic Law of the Environment, the interested party is deemed compliant with the environmental assessment procedure of the following characteristics:

Project Name: Las Pailas Geothermal Project.

Owner: Instituto Costarricense de Electricidad (ICE)

File Number: 788-2004-SETENA

Location: Province: Guanacaste

Canton: Liberia

District: Curubandé

Cartographic Sheet: Curubandé. Scale: 1:50.000

Coordinates: 303-306 North / 384-390 East

Project Description: The Las Pailas Geothermal Project is located in the foothills of the southwestern flank of the volcanic massif of Rincon de la Vieja, between 500 and 700 meters above sea level. The project will be developed by ICE. The area is drained by the micro-watersheds of the rivers Río Blanco and Río Colorado, which flow into Río Tempisque. Administratively, the project is located in the District of Curubandé de Liberia. In 1996, ICE perforated 9 temperature-gradient wells shallower than 500 meters. Since 2002, a stage of increased environmental analysis of the scope of project was initiated, which included biological (flora and fauna), social and geological variables. Moreover, the collection of physical and chemical data (atmosphere, hydrology and soils) was strengthened in the area. The project area is approximately 10 sq. km. Within this area, provisional facilities, access ways, drilling terraces, deep wells, steam pipelines, separating stations, a power plant, a substation and transportation works will be built. The Las Pailas project is expected to have an initial field capacity of 55 MW. In this process, it is estimated that it will be necessary do drill 12 wells, of which 8 will be used for production and 4 for reinjection. However, final details of the project will not be ready until the feasibility studies are completed. Currently, five test wells have been drilled (P1, P3, P4 and P5 for reinjection and P2 requires greater depth). The parcels necessary to develop this field are located in the properties of Hacienda Guachipelín and Vistas del Placer. These properties will be negotiated by the ICE.

Therefore, the Environmental Feasibility License is granted to the project, giving way to the Environmental Management Stage on the understanding that the Fundamental Environmental Commitment Clause stated in the third Whereas above must be complied with.

SEVEN. The term of this environmental feasibility license shall be for a two-year period for the start of activities. If the works are not started on time, the provisions of the existing legislation shall apply.

EIGHT. The regular procedures to appeal the decision before SETENA and the Ministry for Environment and Energy may be invoked within three days from the day following the notification of this resolution,

in accordance with sections 342 et seq. of the Civil Service Law and Article 87 of the Organic Law of the Environment.

NINE. The file number, resolution number and full name of the project must be clearly stated in all documentation submitted to SETENA.

Let it be so notified.

Patricia Campos Mesén

Secretary General

SETENA

6.2 Annex 2. Sworn Declaration of Environmental Commitment and Legal Status Certificate of ICE

6.3 Annex 3. Decree No. 34688 MINAE S-MOPOT –MAG-MEIC Reforms to the General Regulation SETEMA –Reply note SETENASG-ASA-092012. Specifications of the present environmental technical study.

LA GACETA DIGITAL Diario Oficial

La Gaceta Nº 157 — Thursday August 14, 2008

Nº 34688-MINAE-S-MOPT-MAG-MEIC

THE PRESIDENT OF THE REPUBLIC AND THE MINISTER OF ENVIRONMENT AND ENERGY, THE MINISTER OF HEALTH, MINISTER OF PUBLIC WORKS AND TRANSPORT, THE MINISTER OF AGRICULTURE AND LIVESTOCK AND THE MINISTER OF ECONOMY, INDUSTRY AND TRADE

In exercise of the powers bestowed on us in Article 140, paragraphs 3) and 18) 146 of the Constitution of the Republic of Costa Rica, Articles 25 paragraph 1), 27 paragraph 1) and 28 subsection 2) section b) of Law No. 6227, Law of Public Administration May 2, 1978, Environment Law No. 7554 of October 4, 1995, the General Health Law No. 5395 of October 30, 1973, as amended, Law of Use, Management and Conservation of Soils No. 7779 of April 30, 1998; Plant Protection Act No. 7664 of April 8, 1997, Organic Law of the Ministry of Economy, Industry and Trade No. 6054 of June 14, 1977 and Law Protection of citizens from excessive Administrative Proceedings and Requirements No. 8220 of March 4, 2002.

Whereas,

1º— It is the policy of the Government of the Republic to achieve sustainable development in every area of national production activities, both in the public and private sector, preserving and protecting the environment, the country's natural resources and promoting economic and social progress, by harmonized, coordinated, systematized and consistent actions.

2º— The Comptroller General of the Republic in its Study No. 04 - PFA, "Audit on Environmental Impact Assessment 2000", concludes that: "... this entity is not being efficient or effective in managing processes for preliminary environmental assessment, monitoring and tracking, since it is diverting its resources in the assessment of many projects with low environmental impact... ”

3º— As part of the solution to improve operations on the part of the National Environmental Technical Secretariat SETENA, it is necessary for the resources to be better allocated and for procedures to become agile, modern and reliable, enabling better control systems and monitoring of cases under study, which can be achieved through a less rigid organizational structure, which must meet the current requirements of assessment.

4º— SETENA must be allowed the possibility of complementing their technical capacity, and making the best use of the resources available to the government in order to improve coordination, and combine efforts in order to promote a swifter level of response to management, with the support of officials in other government ministries, and, as required, the professional services of accredited bodies, when the complexity of the studies that are being evaluated warrants it.

Therefore, We Decree the Following

Reform of the General Regulations on the Procedures of Environmental Impact Assessment (EIA)

Article 1º— Article 9, the title of Section II-B, Article 12, Article 13, the title of Section III-C and paragraph 4 and 5 of Article 17 of Executive Decree No. 31849-MINAE-S-MOPTMAG-MEIC of May 24, 2004, General Regulations on procedures for Environmental Impact Assessment (EIA) are hereby amended so as henceforth to read as follows:

~~-~~Article 9—Documents for Environmental Assessment

Environmental Assessment Document –D1. Environmental Assessment Document–D1, must be used for activities, works or projects categorized as high or moderate IAP (A, B1 and B2), as established in these regulations.

(...)

Environmental Assessment Document –D2: Environmental Assessment Document D2 must be presented by the developer of the activities, works or projects categorized as low IAP (C), as defined in these Regulations, including:

(...)".

~~-~~Section II-B

Environmental Assessment Procedure for Category C".

~~-~~Article 12.— Requirements. The developer of an activity, work or projects in category C, in order to comply with the process of environmental impact assessment and obtain environmental viability in accordance with the following article shall submit:

(...)"

~~-~~Article 13.— **Processing the activity, work or project category C.** The procedure to be followed by activities, works or projects in category C, is as follows:

1. Present 2 originals and 2 copies of the requirements set out in Article 12 above, at SETENA offices or at the offices of the Area of Health, Ministry of Health or environmental authority duly empowered by the SETENA where the activity, work or project is located.

2. The designated manager or officer of the SETENA or Area Office of the Ministry of Health or the environmental authority duly empowered by SETENA, will immediately return to the developer, the copy duly stamped with the assigned number of the application and the CBPA.

3. The manager of the SETENA or Area Health office of the Ministry of Health or the environmental authority duly empowered by the SETENA will prepare a list of all activities, works or projects received on a daily basis.

4. Having drafted the list, if the documents are presented at the offices of an entity other than the SETENA, the manager or designated official in the Area of Health of the Ministry of Health or the environmental authority duly empowered by SETENA, within a period not exceeding 5 working days, shall send the SETENA a copy of the D2 with annexes by the most expeditious means available. The developer will have the power to fax the SETENA the D2 stamped as received, accordingly.

5. After receiving the D2, SETENA will review the documentation at the respective department.

Provided there are no errors or omissions in this document (D2), at that point environmental viability is granted. It should be clear to the developer that such environmental viability will be obtained, as long as the SETENA within a period of up to 10 days, beginning the moment it receives the documentation , does not formally communicate that they must make corrections or clarifications, or present what is specified in Article 9 paragraph a), when the category of activity, work or project is not for C. In the event there is no communication, the developer shall verify, after the deadline expires, that the activity, work or project is in the official record of SETENA approved Environmental Viable projects in order to use its registration number for processing permits from other authorities."

–Section III-C

Environmental Assessment Procedure for Categories B2, B1 y A" –Article

17.— SETENA Processing

(...)

4. The respective department of SETENA must complete the technical procedure for the file within three weeks, after which it must issue the corresponding technical report.

5. SETENA, in a period not to exceed three weeks, shall issue the administrative resolution confirming the qualification obtained by the developer or the representative, or its rejection.

(...)"

Article 2º—Amend Article 3 paragraph 42, Article 41, Article 67 of Executive Decree No. 31849-MINAE-S-MOPT-MAG-MEIC of May 24, 2004, General Regulations on procedures for Environmental Impact Assessment (EIA), hereinafter to read as follows:

–Article 3º—Definitions and abbreviations.

(...)

42. Environmental Guide: environmental document officialized by MINAE comprising environmental measures and guidelines that are generic in nature, organized according to the components of the development cycle of a temporal or spatial activity, work or project in accordance with the productive sector or subsector to which it belongs, which includes all phases of design and implementation. This document, in addition to indicating environmental measures to be applied, provides guidance on the steps for Environmental Assessment to be followed in order to ensure a real introduction of the environmental dimension in the planning, design and execution of the activity, work or project, and, as required, its expansion and improvements.

If the developer of the activity, work or project voluntarily avails itself of the contents of the environmental guide in whole or in part as applicable, the State considering it part of its commitment to environmental responsibility, will streamline its processing of the Environmental Assessment..."

—Article 41.—Communication on initiating EIA revision before Civil Society.

The developer or project manager, on behalf of the SETENA, shall publish the environmental impact study or studies, which it is presenting before SETENA, in a national newspaper, in accordance with the form provided by the SETENA, and will note that such studies or Environmental Impact Statement are available to the public. This communication will indicate schedules, sites of consultation the deadlines for feedback and how they should be presented, all in accordance with the procedure established by the SETENA.

To the extent possible, and as an additional mechanism SETENA will use other available and approved media to disclose to the general public the necessary information on the EIS under review."

-Article 67.- Integration of the environmental variable in Regulation Plans and other land use plans.

Regulatory plans established by the Urban Planning Law, and the Law of the Maritime Zone, or any other instrument of planning and land use planning, as a way to plan the development of human activities that potentially impact the environment must meet the requirement of integrating the environmental impact variable, which is subject to a process of environmental viability assessment by SETENA prior to approval by the relevant authorities.

The introduction of the environmental variable in the master plans or other land-use planning instrument shall be subject to technical procedure for the introduction of environmental variables in regulatory plans established in the Manual Process Technical Instruments for Environmental Impact Assessment (EIA Manual-Part III). This procedure may be applied both to those territorial planning instruments that will be developed or are in development, and those others that are already approved, but have not yet integrated the environmental variable.

To insert the environmental variable in architectural master plans, they must comply with the provisions of the Manual of Technical Instruments Process for Environmental Impact Assessment (EIA Manual - Part III) noted, in order to become Environmental Development Plans."

Article 3°— Add a subsection 57a to Article 3, a Section VIII "Environmental Assessment Procedure for activities, works or projects located in geographic areas with a regulatory plan or other instrument of land use planning with integrated environmental variable and approved by SETENA" a paragraph 3 of Article 46, paragraph 6 of Article 99 and paragraph 7 of Article 101 of Executive Decree N ° 31849-MINAE-S-MOPT-MAG-MEIC of May 24, 2004, General Regulation Evaluation Procedures Environmental Impact Assessment (EIA), to hereafter read as follows:

-Article 3.- Definitions and abbreviations.

(...)

57a. Environmental Development Plan: Environmental Development Plan: Architectural Master Plan that has incorporated the Environmental Impact Variable, according to the technical procedure established in Decree No. 32967-MINAE, which is subject to review by the SETENA for obtaining environmental viability. It is the proposed land use ordinance on private property that incorporates said variable...".

-Section VIII

Environmental Assessment Procedure for activities, works or projects located in geographic areas with a regulatory plan or other land-use planning instrument with an integrated environmental variable, and approved by SETENA.

The activities, works or projects corresponding to potential environmental impact categories C and B2 listed in Annex 2 of these regulations, must comply with an environmental registration procedure with SETENA, by presenting Form D2 established in Section I-A of Chapter II of these regulations. With the presentation of these documents and the appropriate SETENA receipt stamp, the project is automatically environmentally viable.

-Article 46.— Validity of Environmental Viability (license).

(...)

3. Activities, works or projects that are in operation and which are EIA approved, and whose original design needs to be adjusted as a result of their development, may maintain the environmental viability

that was granted already (license), provided they comply with the following terms:

a. Present an environmental technical report on Environmental Retrofitting the original design, prepared by an accountable environmental consultant according to the format defined by SETENA.

b. The design adjustment should not involve substantial changes to the original design, meaning that such changes do not involve a modification of the category of Potential Environmental Impact (PEI), approved by the SETENA in the original project, such as changing the activity, work or project, changing the site of location of the project area, and proposed that the production process is similar to that was originally proposed.

c. A comparison is to be done of the environmental impacts assessed and measures and any necessary extension , when required, so that the project, work or activity maintains the environmental equilibrium status that was granted during the environmental impact assessment. In addition, an adjustment must be made to the forecast Management Plan when technically justified, with environmental measures that are the result of such analysis.

The verification of the change in these conditions will be endorsed by the General Secretariat on the basis of an administrative decision within a maximum of ten working days, in order to maintain the validity of the environmental license."

-Article 99.—**Suspension of the registration**.

(...)

6. Certifying and providing false information regarding the activity, work or project in the Environmental Assessment process from its inception to the end."

-Article 101.—**Causes of administrative sanctions for those responsible for environmental aspects**. (...)

7. Certify the false situations of the activity, work or project that are the subject of the

Environmental License." Article 4º—**Effectiveness**. It is effective from the time it is published.

Given at the Office of the President of the Republic.—San Jose, on the twenty-fifth of February, two thousand eight.

OSCAR ARIAS SANCHEZ.— The Minister of Environment and Energy, Roberto Dobles Mora. -Health Minister Maria Luisa Avila Agüero.-The Minister of Public Works and Transportation, Karla González Carvajal.-The Minister of Economy, Industry and Trade, Marco A. Vargas Díaz.-The Minister of Agriculture, Javier Flores Galarza.-1 time. - (Application No. 12713-MINAE).-C-131 065. - (D34688-73603).

MINAET	MINISTRY OF ENVIRONMENT, ENERGY AND TELECOMMUNICATIONS	
Ministry of Environment, Energy and Telecommunications	TECHNICAL SECRETARIAT ON ENVIRONMENT Tel: (506) 2234-3420 / Fax (506) 2253-7159 P.O. Box 5298-1000 San Jose	**SETENA** www.setena.go.cr

ANNEX 3B

SG-ASA-059-2012
20 January 2012

Mr.
JORGE E. BALVERDE BARRANTES
LEGAL REPRESENTATIVE
COSTA RICA ELECTRICITY INSTITUTE
FAX: 2220-7664

REF.:

- LAS PAILAS GEOTHERMAL PROJECT
- ADMINISTRATIVE FILE: 788-2004-SETENA

Dear Sir:

On 23 November 2011, the matter concerning an amendment to the project in question was presented to SETENA. Once the proposal was analyzed, it was ascertained that the project modification at hand corresponds to the following:

"The installed generation capacity in the plant is proposed to be increased by 55 MW for a total power of 90 MW. This would involve the drilling of additional wells and the construction of an additional powerhouse. Two options are being evaluated for the location of the latter, both within the Project Area (PA) polygon referred to in the EIS that was the basis for granting the plant's Environmental Feasibility License. It should be stressed that any actions shall comply with the provisions of Executive Decree No. 34688-MINAE. The modification would aim at an expansion of the Project Area (PA) in the North-East section of the geothermal field, to the coordinates 39200 E – 305000 N of the Lambert grid (Curubandé IGN sheet, 1:50000 scale) and the boundaries of the Rincon de la Vieja Volcano National Park. This area was covered within the indirect influence area (IIA) of the project's EIS, according to its various thematic maps. To this end, the ICE would perform the appropriate environmental study to identify changes in environmental impacts and adjust as appropriate the Environmental Management Plan Forecast (P-PGA) endorsed by the Environmental Feasibility License granted."

Therefore, the represented party requests the official endorsement to the procedure indicated by this agency. Thus, in view of this request, the Secretary determines that:
The proposal is reasonable, as long there is compliance with the provisions of Executive Decree No. 34688-S-MINAE-MOPT-MAG-MEIC, specifically the provisions of Article 46, paragraph 3:

"Article 46. –Term of the Environmental Feasibility License.
3. Any activities, works or projects in operation under an approved EIA and for which an adjustment to the original design must be made as a result of their development may retain their already-granted environmental feasibility license as long as they comply with the following terms:

a. Presentation of a environmental technical report for the Adjustment of the Original Environmental Design, prepared by a responsible environmental consultant according to the format determined by SETENA.
The adjustment of the design should not involve substantial changes to the original design; that is, such changes shall not involve a change of the potential environmental impact (PEI) category approved by SETENA for the original project, including the change of activity, works or project, change of location of the project site; moreover, the proposed production process should be similar to that which was originally proposed.
c. Presentation of a comparative analysis of the environmental impacts assessed and countermeasures, as well as any required expansions, so that the project, works or activity may maintain the environmental equilibrium status granted during the environmental impact assessment. In addition, an adjustment to the Management Plan Forecast must be made when technically justified, including any environmental measures resulting from this analysis.

…"

In addition to the above, the following must be submitted:

a. The proposal with due justification in a note signed by the developer or the authorized person on file, whose signature must be authenticated by a notary public.
b. Such request must contain a comparative table of the Management Plan with the originally approved works, the characteristics of the proposed modifications, and an analysis of potential environmental impacts with their corresponding countermeasures, as well as the pertinent environmental indicators, which shall be measurable.
c. Certification of the new site design by a Certified Public Accountant (CPA) consigning the total investment in the proposed modifications, considering the value of the land.
d. A new Sworn Declaration of Environmental Commitments containing the new environmental commitments.
e. Legal personality of the developer issued not less than three months ago.

Sincerely,

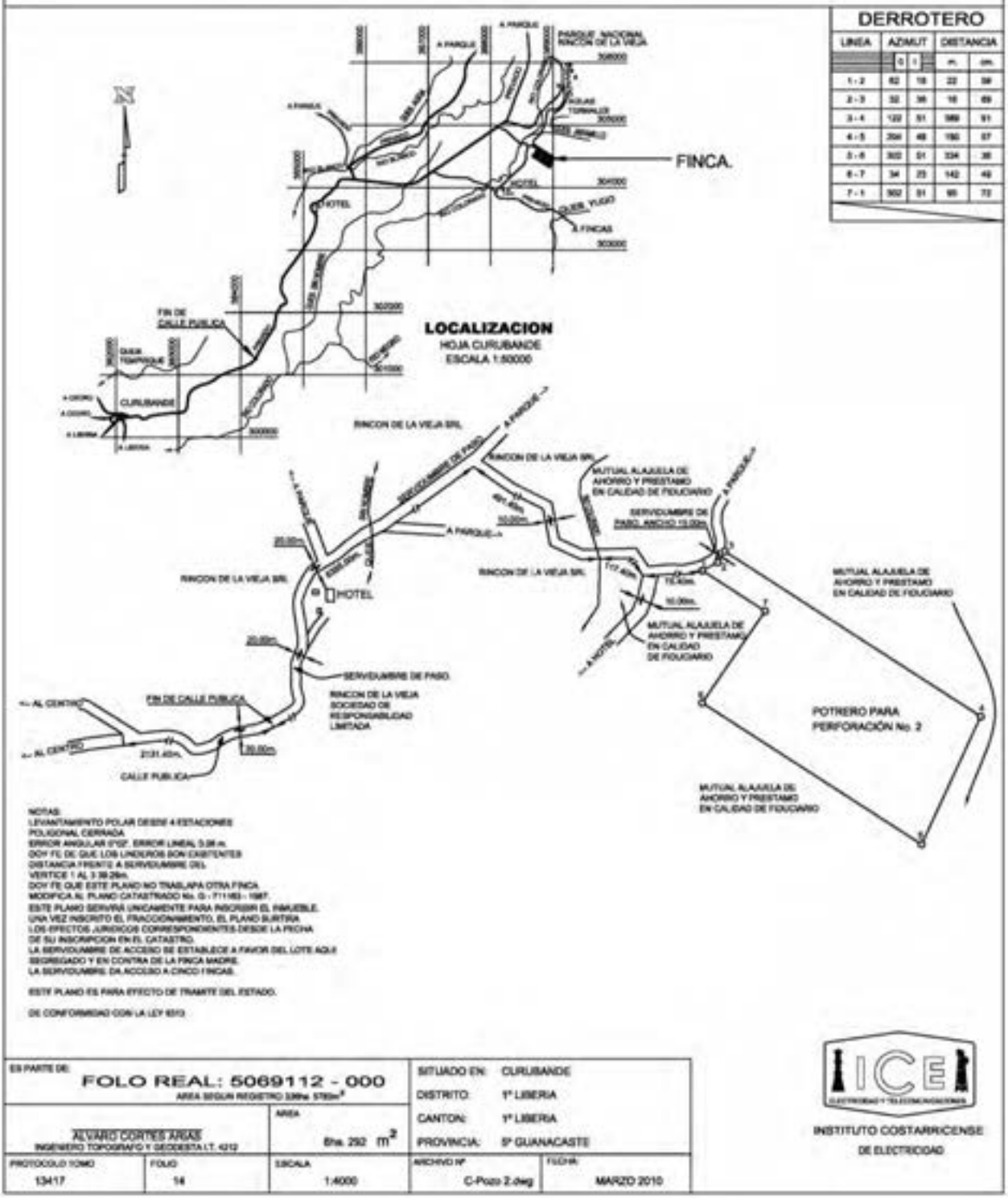
URIEL JUÁREZ BALTODANO
SECRETARY GENERAL
TECHNICAL SECRETARIAT ON ENVIRONMENT

MARIO CÉSPEDES PEREIRA
HEAD of A.I.
ENVIRONMENTAL AUDIT AND MONITORING DEPARTMENT

[STAMPED WITH THE SEAL OF THE NATIONAL TECHNICAL SECRETARIAT ON ENVIRONMENT]

6.4 Annex 4. Survey Office map of the location of the additional geothermal plant of Las Pailas

CATASTRADO
G-1411469-2010



6.5 Annex 5. Description of the condensation cycle for Simple Flash Geothermal Generation Plants.

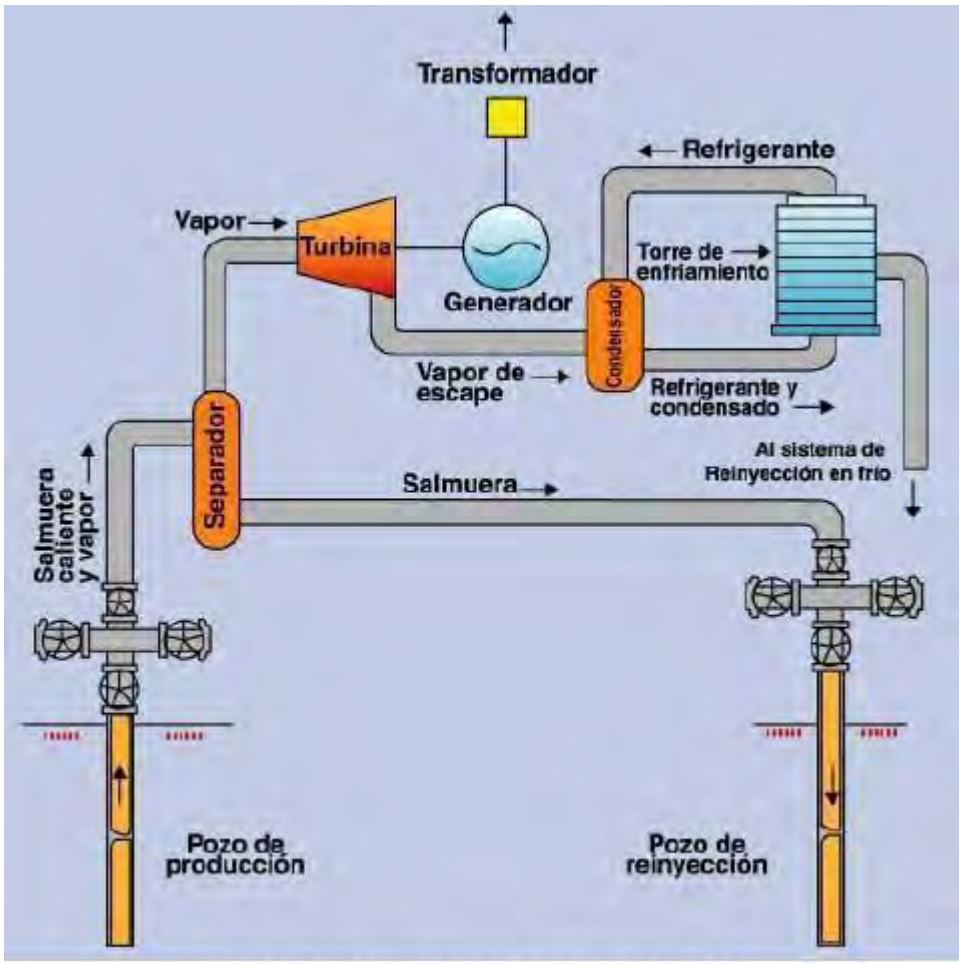
DESCRIPTION OF THE CONDENSATION CYCLE FOR SIMPLE FLASH GEOTHERMAL GENERATION PLANTS

Victor Cabezas, Engineer, CS Design

General description of the process-

The fluid from the production wells passes through a separation stage where it passes through a liquid stage (brine) which is then sent along to be re-injected under heat to a geothermal bed and a gaseous phase which is sent to the turbine and then discharged to the condenser

The geothermal fluid is pumped to the cooling tower and utilized again in the condenser as a cooling agent. The residue from the cooling tower is sent to the cold re-injection system.



CICLO DE CONDENSACIÓN

Extraction of the fluid in the production wells

The energy contained in the geothermal bed is extracted by means of the perforation of deep well with depths varying from 1500 to 3000m

On the surface of each production well a system of valves is located known as the “well valves head”. By means of carbon steel surface tubes of diameters between 0.3 and 1.05 meters -specially supported and protected with thermal insulation in order to avoid heat loss- the geothermal fluid is carried to a separation station.

Separation Stations or Separation Satellites

The separation stations, or “satellites,” separate the vapor from the geothermal fluid or brine coming from the production well. The brine is re-injected at a temperature from 160 to 170C, while the vapor is carried to the collector at the powerhouse with a pressure of 6 bars and a temperature of 160C.

Vapor collector and vapor silencer in the powerhouse

The vapor products from the separation stations or “satellites” converge on the vapor collector; and this is where the vapor pressure is stabilized before entering the turbine. The photographs show the vapor collector and the silencer, which serve the function of dissipating the energy in the case of an emergency shutdown of the plant.

Turbo Generator

The separated vapor is carried to the powerhouse area, which is where the turbo-generator for the generation of electricity is located. The generator turbine arrangement transforms the energy of the vapor into mechanical energy; and the latter into electrical energy; by means of the principle of the expansion of water vapor and the acceleration of the vapor particles. The turbo-group turns at

3600rpm in order to obtain, from the two pole generator, an output of 60Hz with an exit voltage 13.8Kv and a power of 55 Mega Watts.

Cooling Tower

The condensation of the vapor and the cooling of the gases upon the discharge of the turbine are brought about by the water of the cooling system. The heat of condensation is freed to the atmosphere by way of the cooling tower. The photograph shows the cooling tower of Miravalles Plant 1.

6.6 Appendix No. 6. Noise Levels. Noise-level measurements rounds carried out in the environmental influence zone of the Las Pailas Geothermal Plant.

11 June 2012

GSO-0006-2012

Geol. Rogelio Zeledón Ureña

Strategic Projects and Associated Services Business Unit Environmental

Management Services Center

Dear Sir:

With the purpose establishing the levels of sonic pressure which might be arising in the installations of the Hotel Rincón de la Vieja Lodge; according to the request for performing sonic measurement rounds in the said installations, the Management of Occupational Health (GSO) of the Geothermal Resources Service Center has made the following observations.

The sonic pressure level (SPL) measurements were made with Quest-brand Sound Level Meter model Sound Pro SE/DL. The parameters established were: the type of SLM filter applied (Wide Band Measurements of ambient sound); the weighted frequency used was the –A" frequency; the type of noise was defined as continuous in accordance with the characteristics shown and therefore its response time was predetermined in the –slow" mode. The details for each one of the measurements were as follows:

Table 1. Levels of sonic pressure reported in the facilities of the Hotel Lodge

Sonic Measurements				
Date	Location	Measurement 1 (dB(A))	Measurement 2 (dB (A))	Mean (dB (A))
26/04/2012	1	29,8	30,0	34,3
	2	31,5	32,0	
	3	38,0	37,0	
27/04/2012	1	30,0	32,6	34,0
	2	30,0	29,7	
	3	36,6	37,6	
02/05/2012	1	30,3	29,9	32,1
	2	30,2	31,2	
	3	35,0	33,4	
05/05/2012	1	36,5	35,9	40,0
	2	38,8	37,2	
	3	42,6	43,2	
11/05/2012	1	40,0	40,8	44,9
	2	48,0	36,0	
	3	48,1	45,0	
17/05/2012	1	45,0	46,8	49,4
	2	50,5	37,6	
	3	52,7	51,3	
28/05/2012	1	51,2	49,9	51,1
	2	50,6	50,1	
	3	52,8	51,5	
02/06/2012	1	48,0	38,0	45,7
	2	45,3	40,2	
	3	40,0	50,0	
07/06/2012	1	45,0	38,0	45,9
	2	41,0	36,0	
	3	50,0	49,0	

Source: GSO.

Location:

1= Rear of de Cabin #23.

2= Garden located in the East sector, specifically where the sign –39-42" (cabin numbers) is.

3= Near the Reception area.

Measurement 1= morning hours, 8:00-10:00 a.m.

Measurement 2= afternoon hours, 2:00- 4:00 p.m.

The values indicated in the preceding table are affected by ambient variables specific to the geographical location and the type of activities carried out in the hotel (animal sounds, maintenance of parks, among others). This can be implied by the maximum value obtained which corresponds to 52,8dB (A) (see table 1), given associated maintenance works and the presence of hotel guests in the recreation areas on the day of measurement. This is not the case with the minimum value reported which corresponds to 29,8dB (A). It is important to stress that these values were reported in similar hours of measurement, which occurred during morning. Nevertheless the measurement points were different and distant from each other. (See details in the following sketch of the points identified as 1 and 3.

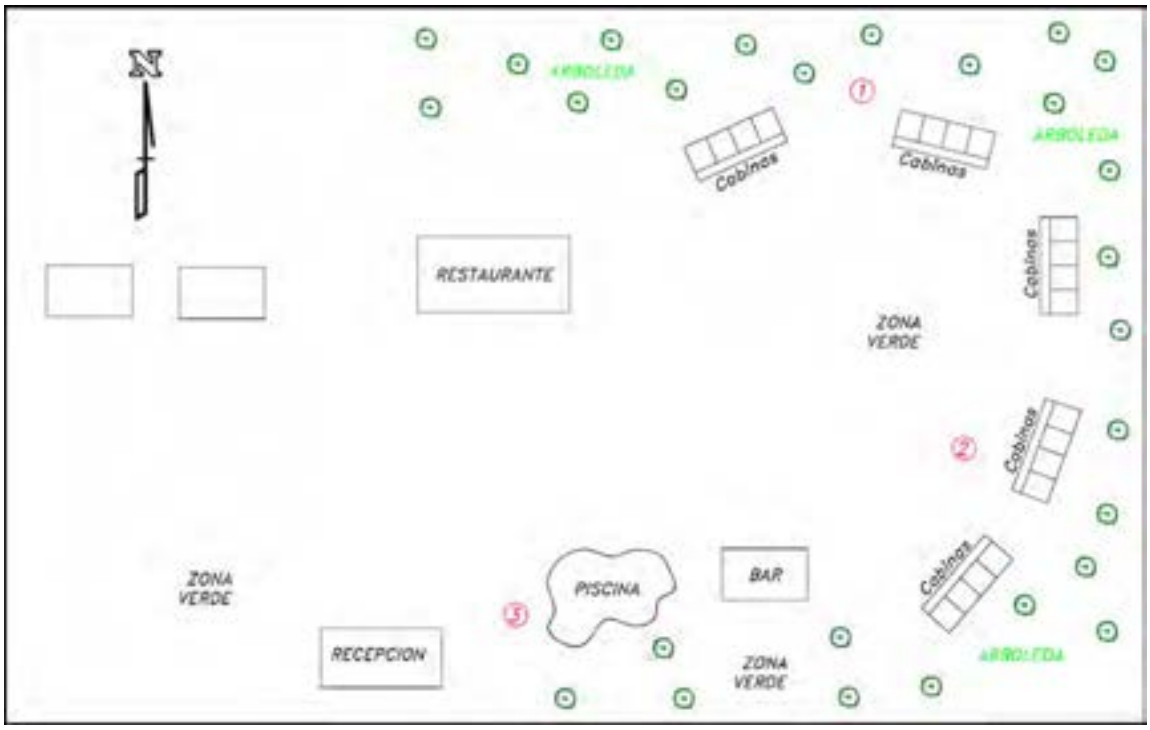


Figure. Diagram of the physical distribution of Hotel Rincón de la Vieja Lodge.

Source: GSO.

The level of total continuous sonic pressure of the measurements corresponds to 47.78dB (A) and the average values oscillate within the range of 35.1-51.1dB (A); so that it is necessary to take into account the current national norms, given that the compliance with those depends on the day and the type of area to be evaluated.

Yours sincerely,

Occupational Health Management

Carolina Ballestero Dávila Engineer in Charge

UEN, PROJECTS AND ASSOCIATED SERVICES
GEOTHERMAL RESOURCES SERVICE CENTER
PO Box 10032-1000-San Jose - Costa Rica

JULY 2011

Dr.
Alfredo Mainieri Protti
CSRG Director

SUBJECT: LAS PAILAS NOISE MEASUREMENT REPORT.

Introduction

The term noise is defined as any unwanted, and therefore annoying, sound that can produce physiological or mental disorders or both. Determining what is noise and what is not is a relative concept due to the fact that something that can be noise for some people, may be a mere or even pleasant sound for other people. A clear example of this condition is music. For this reason, the law clearly defines which sound levels are allowed for different zone types.

Article 20 of the **Regulations to control noise pollution** sets allowable noise limits during the day and night, as well as guidelines to determine zone types, depending on the activities carried out therein. For example, because there is no regulatory plan for Las Pailas that clearly defines which areas are industrial, commercial, urban or of transition (in accordance with Article 4 of the Regulations), the existence of tourist activities, including hotels, lodges and houses, causes the zones where such facilities are located to be considered as ***urban-residential*** areas. Therefore, the maximum allowed limits are set to 65 dbA during the day and 45 dBA at night in areas where the hotel, the ranger's house and the tourist shop/cafe (near the parking lot) are located.

It is equally important to note that, according to the provisions of Article 5, “No person or entity shall cause or permit the production or emission of any noise in violation of existing laws and these Regulations.”

There are some exceptions in Article 23 that apply only to the hours between 6:00 a.m. and 8:00 p.m. for cases such as sounds produced during installation and repair of essential public services, also including power plants, substations and water pumping equipment during temporary emergencies.

Results of measurements performed

Below is a summary of noise measurements results for Las Pailas. These data were obtained with the flow of the wells first directed to the mufflers on the platforms and then to the satellites' mufflers. Importantly, the measurements correspond to daylight conditions.

Figure 1 shows the critical zones that fall under the category of populated areas (urban residential) in red circles.

Figure 1: *Critical zones, maximum permitted levels of 45 dB(A) - 65 dB(A).*

The ranger's house and the shop/cafe near the parking lot are the most critical, due to the proximity of wells 03 and 08 and the absence of sufficient natural barriers to help reduce noise levels. In the case of the hotel, a dense forest cover does exist that acts as a buffer. The hotel is located at a greater distance from the works and the sound generated by the river helps mask the noise coming from the wells or the satellites.

Table 1 shows the measured sound levels at various points of interest.

Table 1: Measured noise levels - dB(A) (19/07/2011)

		Noise level dB(A)			
Measurement Site		**A**	**B**	**C**	**D**
Satellite	Edges	76	68	71	83
	At 100 m	43	44	59	58
PGP03 - PGP17 Platform	Edges	70	64	65	69
	At 100 m	53	54	61	58
PGP01 - PGP12 Platform	Edges	71	71	64	69
	At 100 m	60	62	54	58
PGP08 Platform	Edges	63	67	67	69
	At 100 m	56	53	56	52
Park Shop		57			
Hotel		47			

(1) These readings were taken at the chainlink fence of the satellite. See Annex.

(2) These readings were taken at 100 m from the edges de la platform. See Annex.

As can be seen, at a radius of 100 m around the wells and the satellite, measured noise values are within the limits permitted for daytime activities. Still, if this 100 m radius of were to be considered an industrial zone (75 dB(A) maximum day and night), in all cases the noise levels would be within the allowable ranges. It could be argued that this particular observation stems from the fact that populated areas are well defined and concentrated in the zone of the hotel and the ranger's house.

On the other hand, the measured noise levels in critical areas exceed allowable levels for the night time (45 dB(A)). The average level at the Hotel is 47 dB(A). However, with the conditions existing at the time of measurement, the noise from wells and satellite was almost imperceptible, masked by the sound of the river and the wind, and therefore it can be considered that a significant impact is not being generated in these facilities.

In the tourist shop/café and ranger's house areas the recorded level was 57 dB(A). Although not high, especially considering the proximity of the PGP03 and PGM08 platforms, these levels do exceed the maximum allowable limit for the nighttime, and therefore care must be taken when programming future operations in these two platforms. It is important to keep the well open for measurements at night time and in order to record data during the most critical condition.

Ambient noise levels in the area

Please note that environmental conditions affect the results of noise measurements, especially in this area where the winds are very strong during the summer season.

Table 2 and **Figure 1** show the measured noise values from 2001 to March 2011. As shown, there are times at which noise levels of 30 and 25 dB(A) are generated. The mean values in all cases are above the limit of 45 dB(A), even at the PGP05 and Hotel Guachipelin areas, which are the farthest away. In the case of the maximum values, levels of up to 84 dB(A) were recorded. Data analysis shows that 76% of the measurements are on the limit of 45 dB(A), and 10% are above the limit of 65 dB(A). These noise levels can be generated by wind, rivers and animals in the area.

Table 2: Noise levels measured from 2001 to March 2011 (dB(A))

	PGP02	Park	PGP03	PGP05	Hotel G
	dB(A)				
Average	47	44	48	46	45
Minimum	36	34	31	30	27
Maximum	79	62	84	78	71

Chart 1: Nose level frequency distribution (2001-2011)

The data allow to conclude that during the windy season the effect of noise generated by the wells and satellite are not be noticeable in most cases, **and therefore the test at the wells must be programmed during those periods**. The issue of exceeding allowed levels is thus avoided, since the standard indicates that in cases in which background levels are at their maximum limits, the latter may be increased by 5 dB (A).

Additionally, because noise nuisance is a matter of perception, if the noise is masked by the wind, it would not be considered a nuisance. However, it is clear that during tests, measurements must be made so as to verify compliance with the standards.

Figure 2 shows additional data confirming the existence of background noise that exceeds the limits specified in the legislation. These correspond to a study conducted during 2008-2009. As can be seen, the results are similar to those listed above, with the difference that points within forested areas were included, including sites located within the park and in the area of Borinquen.

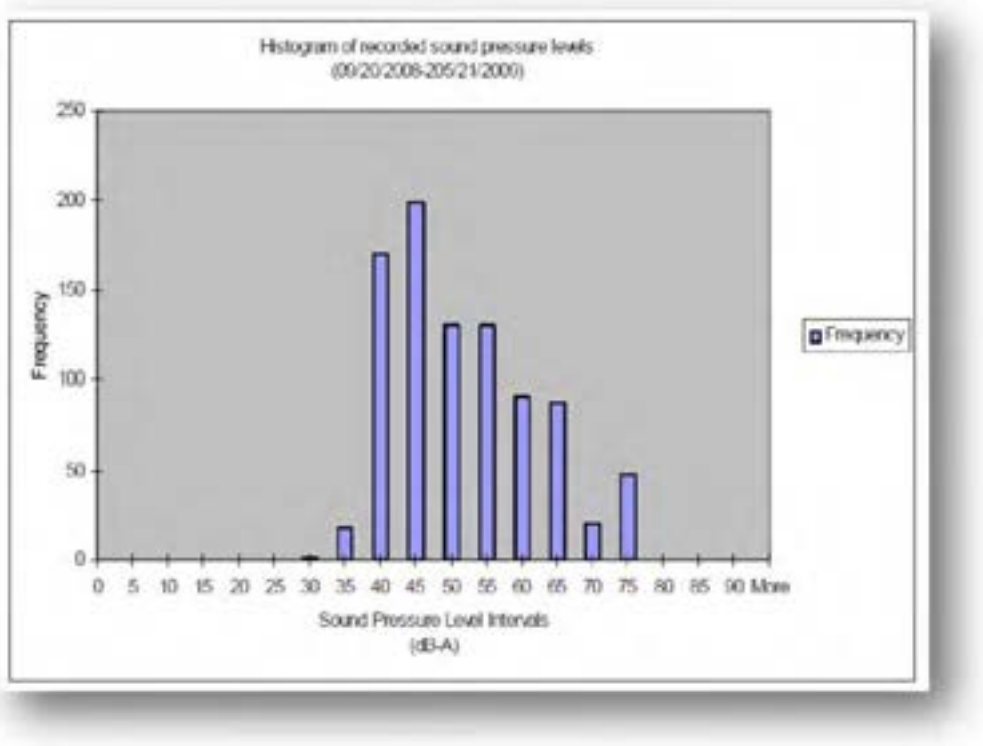


Chart 1: Nose level frequency distribution (2008-2009)

Source: Proceedings World Geothermal Congress 2010, Bali, Indonesia, April 2010, "Sound Pressure Level Measurements at and around the Las Pailas Geothermal Project and in Rincón de la Vieja National Park, Guanacaste, Costa Rica", Edward C. Hakanson

Conclusions

- With the prevailing environmental conditions at the time of measurement, the noise levels did not exceed the allowed levels for the daytime. However, noise levels are above allowed levels for night hours.

- Tests requiring to divert flow to the mufflers on the platforms during night hours should be scheduled for times of strong winds, when the average noise levels exceed the 45 db(A) limit. It must be remembered that in cases in which background levels are equal to or exceed the allowed limit, this allows raising the limit up by 5 dB(A), i.e. the allowed limit at night would be 50 dB(A). However, measurements must be made for each individual case in order to determine whether there is compliance with regulations.

Sincerely,

Mr. Guido Hartman Sequeira, Engineer
Environmental Management and Monitoring Unit,
Geothermal Resources Service Center

ANNEXES

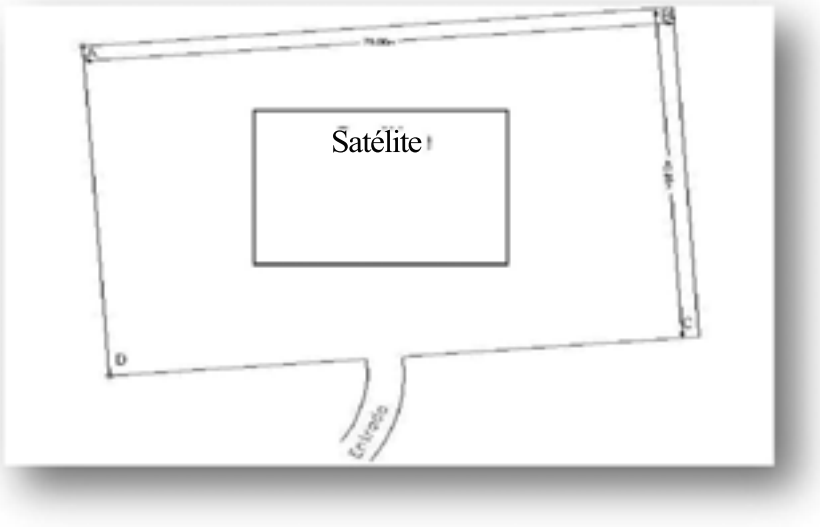


Figure 2: *Satellite noise measurement points.*

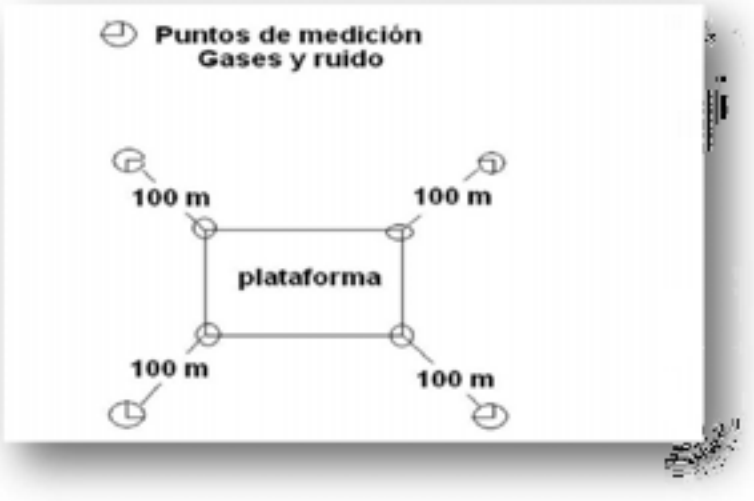


Figure 3: *Noise measurement points at 100 m from edge of satellite.*

Table No. 1

Emitting Source	Receiving Zones							
	Residential Zone		Commercial Zone		Industrial Zone		Comfort Zone	
	D	N	D	N	D	N	D	N
Residential Zone	65	45	65	55	70	60	50	45

Table No. 3

Emitting Source	Receiving Zones							
	Residential Zone		Commercial Zone		Industrial Zone		Comfort Zone	
	D	N	D	N	D	N	D **	N
Industrial Zone	65	45	70	65	75	75	50	45

6.7. Annex 7. Proposal for the construction of an aqueduct from the springs of the rivers Choporrón and Limones –Upper Basin of the Río Blanco.

Aproximate estimate – Curubande Project - ICE					
Detail	Volume	Length	Flow	Diameter	Total Cost
	(m3)	(m)	(l/s)	(pulg)	(¢)
Catchments					2,000,000
Section A-D		1600	2.50	4	40,000,000
Pailas GP Tank	40				6,000,000
Section D-F		2100	1.50	2	16,000,000
Section C-F		2100	3.00	3	32,000,000
T.Q.G. (2 units)					2,000,000
Section F-E		4000	4.50	3	61,000,000
T.D. Curubande	75				12,000,000
Total					171,000,000

(see other file –Annex 7B" for diagram)

6.8. Annex 8. ORIGINAL TABLE (APPROVED) of the Environmental Management Plan (PGA) ADJUSTED AS PER THE PROPOSED EXPANSION- COMMENTS ON THE EXPANSION ARE INDICATED IN BLUE.

ORIGINAL TABLE (APPROVED) SHOWING THE ENVIRONMENTAL MANAGEMENT PLAN (EMG) ADJUSTED AS PER THE PROPOSED EXPANSION- COMMENTARIES ON THE EXPANSION ARE INDICATED IN BLUE

***The total cost reflected in this table does not include the cost of the preliminary environmental measures nor that of the measures whose costs are included in the budget for the construction of the Geothermic Plant (Biol. Fernando Chavarría, June 2012; in Appendix 8 a copy of Resolution No1. 1948-2008 SETENA Environmental Guide for the Construction is annexed)**

Environmental Measure Code	Environmental component	Impacts	Mitigation, prevention, compensation	Measures	Timeline	Owned by	Cost ($) *Costs carried over from 2007 al 2012 applying Consumer Price Index of Banco Central de Costa Rica
	BIOPHYSICAL						
	Geomorphology	*- Surface runoff by variations in microrelief.*	*- Surface drainage, water management*	*Avoid the accumulation of mounds and surface*	*Construction*	*Director of Las Pailas GP*	*2500*
1 GEM-P2				Limited to the construction areas. Resolution No.1948-2008-setena 7.5 Slagheaps pp. 18.19 /management of storm waters should be applied 22-23			4000
	Geomorphology	*Change in microreliefs due to project works*	*Control excavations once the works have finished*	*Replant with native plants or trees on the slopes and verges immediately after contouring the slope.*	*Concomitant to the construction phase of the Las Pailas GP*	*Environmental Officer of PG Las Pailas*	*5000*
2 GEM-P2			*- Stabilize slopes and plant grass manicillo (Arachis pintoi) or use suitable materials such as concrete block pavement*	Access ways, platforms, and buildings. Apply Resolution 1948-2008-SETENA 7.5 – ~~-~~Slope Management"			8000

	Geomorphology	*Change in the behavior of the runoff due to changes in the microrelief*	*Water management during excavation and stockpiling of material in sediment traps*	*Use the best methods for management of surface water, such as drainage, drains, culverts, manholes, slope stabilization and energy dissipators*	*During the construction of the project*	*Environmental Officer of Las Pailas GP*	*4700*
3 GEM-P2				Construction sites as per Resolution 1948-2008 SETENA, section 1.1 Stormwater management			7000
	Landscape/tourism	-Detour with fencing along the route to the Rincón la Vieja Volcano National Park due to heavy traffic and construction.	*Construction and installation of fencing around: 1.Works under construction 2. Geothermal works of tourist interest*	*1. Construct and install fencing with information regarding ecological aspects of the works under construction. Section 6.1.6.1. Publicize the importance and tourist interest of the geothermic project and its components by means of billboards - Section 6.1.6.1*	1. From the beginning of the construction stage. 2. Immediately on completion of construction and throughout its operation	*Project Director*	*4000 Install at least two billboards with ecological information (See proposal in Annex 5).*

	Landscaping	Change in the naturalness of the landscape due to presence of Powerhouse and adjacent works.	1. Architectural design of powerhouse in harmony with its environment 2.Plant a vegetation screen on the northeast side of the powerhouse. 3. Plant vegetation screen around the powerhouse. 4 Turf the areas around the works	1. Design the construction with walls of reinforced mirrored glass in order to reflect the surrounding environment. 2. Plant a 600m screen of elephant grass on the northeast side of the powerhouse. (On the boundary with the Rincón de la Vieja Volcano, property of ICE section 6.1.6.3) *3. Plant trees and bushes on the four sides of the powerhouse. Section 6.1.6.2 fig.* 1..Turf open spaces around the works - Section 6.1.6.3.c.	*1. Design phase, C.S. Design and the Manager of the construction. 2. Previous to construction, if it is the dry season, wait until the rainy season in order for the screen to adequately establish itself 3.Immediately on finishing the Construction.*	*Project Director*	*1. Considered in CS Design budget 3000*
4 PAI-P2				Use perimeter screens of perennial vegetation on the boundaries of the new Plant on a strip with a width of at least 50m. Planting and tree distribution should be consistent with the design shown in the section _Landscape' (p.29). Plant perimeter screens around adjacent works.			(4500+15500) =20000

	Landscaping	Change in naturalness of the landscape due to presence of slagheaps	*1. Design to harmonize with the surrounding geomorphology. 2.Revegetate the slagheaps*	*1. The final design of the slagheaps should harmonize with the existing geomorphology, before they have been formed. 2. Vegetation should be planted in the areas used for slagheaps. (Section 6.1.6.4)*	*1.* 1.Design phase 2.Immediately after contouring the slagheaps.	*Project Director*	*200/hectare (estimated 1000)*
5 PAI-P2				*The provisions of the environmental guide for construction Res. No. 1948-2008-SETENA should be applied.* 7.5 Slagheaps pp. 18-19, 23 Landscape Management pp. 30,31 Additional 6 hectares for slagheaps available within the property of ICE (Includes the transport and distribution of the topsoil (with a thickness of 20cm) and its replanting.			5000/hectare (estimated 30000)

	Landscaping	*Change in the naturalness of the landscape due to the presence of linear works.*	*1. 1.Paint piping in green tones in harmony with the surroundings.* *2.Replant the areas parallel to the tubing*	***1.*** *. Paint steam pipelines and other piping in green tones in harmony with the surroundings. The color should take into account the dry and rainy seasons. Sec. 6.1.6.4.b. 2.Replant the boundary within the exposed tubing (steam ducts and other tubing) and the track to Rincón de la Vieja volcano, property of ICE, Sec, 6.1.6.4b 6.1.6.4.b.*	*Immediately on completion of the works.*	*Project Director*	*Considered in CS Design budget 8000*
6 PAI-P2				Similarly, the insulation for the tubing should be of an olive green similar to RAL 7008 (Generic Color Card RAL) and plant the perimeters of the rights-of-way of the tubing.			12000
	Soil	*Changes in the soil surface due to diggings and the presence of works and slagheaps.* *- Erosion due to elimination of vegetal cover.* *-increase in runoff and soil erosion*	*-Reforestation.* *- Place topsoil in areas free of works which have been affected by the project.* *-Design filtration friendly structures.* *-Carry out earth-retaining works.*	*Plant both ornamental fruit trees and bushes in selected sites in accordance with the proposed design.* *-Plant ornamentals and trees in the surroundings of the works and in spaces with topsoil* *-follow up and maintenance of the soil restoration work.*	*Immediately on completion of the construction stage-*	*Environmental Officer of PG Las Pailas*	*5000.*
7 SUE-P2				*Put aside, store and protect the top soil from work areas in order to re-use it areas to be reforested such as slagheaps and associated works.*			8000

	Soil	*Gaseous emissions:* acid rain	*- Emissions and soil control and monitoring* *- Soil monitoring and analysis*	*- Plant trees and bushes native to the area in the areas at risk in order to protect the soil.* *- Soil monitoring and control within the area of direct influence of the project.*	*At the end of the construction phase*	*Environmental Officer of PG Las Pailas*	*5000*
8 SUE-P2				It will be necessary to carry out a complete chemical analysis of the soil and leaf tissue in a radius of 1000m from the perimeter of the Plant. (2 sampling campaigns 1 year before the start of the operation of the plant and 5 years after the plant is in operation. (Minimum 10 sample sites/sampling campaign)			2012 Cost 5,000 per sampling campaign = 10,000
	Soil	Contamination by inert chemicals materials (amorphous silicate)	*Control and periodic monitoring of the soil within the substation area.*	*Design a storage warehouse*	*ST operation phase*	*UEN Electricity Transport*	*20.000*
	Spillage of oil and combustible materials	*-On soil plantlife* -on the ecology of the soil and the subsoil	*-Set up oil traps - Leak management and control*	*- Proper storage and use of fuels* - Design a designated area for the movement of fuel for machinery and equipment.	*During construction and operation.*	Project Director	*10.000*
9 SUE-P2							2012 Cost - 15000
	Soil	Excavation of cuts for new roads	*- Proper design of road cuts*	*- Calculation of safety angles in road-cut design. Channeling of runoff to prevent erosion.*	*Associated with construction*	Project Director.	*3000*
	Soil	Disturbance and alteration of the ground profile by excavations	*- Restore ground cover with organic material left over from the slagheaps.*	*1. Plant trees, bushes and grasses according to selected sites and the proposed design.* 2.Plant vegetation after completion of the project	- Immediately after finalizing the construction phase	*Environmental Officer of PG Las Pailas.*	3000

10 SUE-P2				The provisions of the environmental guide for construction Res. No. 1948-2008-SETENA should be applied. 7.4. Slope management pp. 17-18			Cost considered in Measure 5 PAI-P2
	SOCIAL						
	Residential use	*-Migration of people to sites near the project*	*-Place appropriately the maximum number of workers within the work camp.* *- Design the work place keeping to the norms of security and*	*- Construct the Works at a permissible distance and in accordance with the established norms and the boundaries of the project.*	*During the construction and operational phases of the Project.*	*Project Director*	*1000.*
	Quality of life	*- Noise, vibrations and emissions produced by operation of the Center.*	*- Monitor noise, vibrations and emissions as per environmental standards' controls and specifications established for this purpose* *- Establish a regular Maintenance and Inspection Plan for machinery and equipment of the Center.* *- Comply with the Mitigation Measures described in the Works Design Document.* - Verify compliance with the provisions of the Final Works	*- Use appropriate technology to reduce and control nose, vibrations and emissions.* *- Implement environmental maintenance and inspection plan* *- Comply with the Mitigation Measures described in the Works Design Document.* *- Comply with the provisions of the Final Works Acceptance Protocol.*	*- Construction and operation*	*Project Director and Environmental Officer*	*520000.*

11 RUI-P2			Acceptance Protocol.	Use of noise reduction devices on electromechanical equipment and in the design of the building that will house them, ensuring compliance with the permissible noise levels as per the law on the outside of the buildings closest to the plant. – Decree Nol. Decree No. 28718-S. To this end, design specifications set out in Section 2 of this environmental technical study shall be adhered to.			770000
	Services	*- Increased demand for services* *- Deficit of community services*	*- Improvement of the current required water, telephone and electricity services, stretches of road and sidewalk construction*	*- Coordinate with the entities in charge of providing the required basic services* *- Assess community needs*	*- During the construction phase of the Project.*	*ICE, Project Director and Environmental Officer*	*110000.*
12ACU-P2				Construct an aqueduct for supplying potable water to the new power plant; the overflow will be injected into the local aqueduct of Curubandé in order to replace the existing water intake at Quebrada Victoria. Maintenance of the aqueduct section starting at the ICE storage tank will be the responsibility of the Curubandé District ASADA			163000+1370000= 350000

	Community safety and health	*-Increased traffic to the Project site* *-Increased risk for pedestrians within the Project area.*	*-Build and design road safety components at the entrance of the Project site before the start of construction* *-Establish a Safety and Security System for entry and exit of people and heavy machinery from the Project site.*	*-Restrict access to outsiders to the construction site* *-Put the Safety and Security System into operation.*	*During the construction of the project*	*Project Director And Environmental Officer*	*1000.*
13 SOC-P2	*Socio-cultural dynamics*	*-Alteration of the daily life of the community by the presence of large number of outside people*	*-Workers should maintain respectful standards of conduct with the native population (especially in the workers' leisure time)*	*-Maintain proper coordination to prevent conflicts with the community through constant communication and implementation of internal workplace regulations* *-Talks to inform about rules and regulations and opportunities for leisure and recreation*	*-During Project construction.*	*Project Director.*	*1000..* 1500 +3500=5000
		-Environmental problems of surroundings	*-The center offers information and -ICE educates the community* *-Provide information and train workers on occupational health, safety, environmental guidelines, and appropriate social behavior* *-Ensure compliance with the legislation and environmental guidelines set forth by the Institution*	*- Educate staff through lectures on occupational health, safety and environmental guidelines established by the ICE.* *-Encourage all workers to observe socially acceptable behavior and respect with the populations living in the area of influence of the Project* *-Provide basic information on electric power and other aspects.*	*-Construction and Operation*	*Environmental Officer and Project Director*	*55000.*

		-Ignorance and lack of training of project workers and the general public	*Improve training of project workers.* *-Improve the knowledge of the general public concerning the project.* *-Educate the public and*	*-Generate educational and training materials Two-way communication.* *-Education and training of workers and the general public.*	*During construction*	*Project Director. Environmental Officer.*	*100000.*
	Health and safety at work	*-Increased levels of accidents at work* *-Noise associated with construction*	*-Ensure application of appropriate workplace safety standards* *-Train construction staff in industrial safety, before the start of construction.*	*-Employer shall apply the Occupational Hazards Act and its regulations, and the General Rules of Safety and Health at Work* *-Use appropriate safety equipment at work*	*-Construction*	*Project Director and Environmental Officer*	*8000.*
14 SOC-P2				Apply Resolution 1948-2008-SETENA section 12 Occupational safety and health pág.23			12000
	Employment	*-Increased labor supply in the area*	*-Give priority to hiring local workers*	*-Publicize the real needs of labor required, and the temporary nature of the work.*	*-During the Project's construction phases*	*Project Director*	*1000.*
15 SOC-P2							
	Property value	*-Increase in the value of property*	*Periodically update ownership costs*	*Anticipate future expansions and their costs*	*Construction / operation*	*ICE, Appraisals*	*1000.*
	Archaeological Heritage	*Alteration of potential archaeological sites due to earthworks during the construction phase*	*Prior to any earthworks or vegetation clearing, an archaeological survey shall be performed where project works are to be*	*This will require hiring an archeology professional. This includes field work, laboratory and office work.*	*It can have a duration of 2 months (construction phase)*	*Project Director and Environmental Officer*	*3400*

16 ARQ-P2			*built.*	Valid for the expansion of the geothermal field (2012 construction and operation phase of the geothermal field).	A full-time archeology professional		2012 costs – Permanent cost considered in the geothermal construction and operation budget
			-Supervision of earthworks in the area where the powerhouse is to be installed.	*Engaging an archaeologist during vegetation clearing and earthworks*	*Construction Phase: Estimated time is fifteen days*	*Project Director and Environmental Officer*	*670*
17 ARQ-P2							Already considered
			-Place a barbed wire fence with concrete posts in archaeological sites of a funerary nature present in the property that ICE intends to purchase.	*Assign a crew and purchase materials (posts, barbed wire, staples)*	*Once the land is purchased by ICE*	*- Project Director and Environmental Officer*	*4,720*
			Transfer the Zapote petroglyph to a site (powerhouse) which satisfies the conditions for its protection and conservation	*Construction of open shed with concrete slab, wooden posts and imitation roof-tile sheets. This site shall include an explanatory plaque. Hiring a restorer for cleaning and conservation activities.*	*During construction of the powerhouse*	*- Project Director and Environmental Officer*	*9,000*
			Sensitize the population of Curubandé to the area's archaeological resources.	*Three lectures or workshops aimed at children, teenagers and adults will be provided.*	*During the construction phase*	*Project Director. Environmental Officer*	*1000.*
	FLORA						

	Vegetation	*- Removal of vegetation when laying out new roads* *-Removal of trees*	*- Revegetation along roads, on slopes and berms with herbaceous and shrub species.* *-Reforestation and maintenance for the first 2 years.*	*- Protection of the soils for efficient natural and induced regeneration*	*Start of the rainy season*	*Project Director. Owned by*	*2.000.*
18 FLO-P2				The provisions of the environmental guide for construction Res. No. 1948-2008-SETENA should be applied. Management of plant cover and protected areas, p.11-13, particularly that which is indicated under item 6.10: "In conjunction with the building permit, a permit from the appropriate authority (MINAE SINAC) must be obtained for cutting and pruning trees indicated on the arboreal plan, in accordance with the provisions of the Forest Act"			500/ha =10000
	Forest cover	*-Impact on plant cover* *-Impact on living fences*	*-Maintain herbaceous vegetation in the Project site* *-Reforestation of areas available to the Project*	*Reforesting land belonging to ICE or other land owners, as appropriate.*	*Start of the rainy season*	*Project Director. Owned by*	*11500.*
	Forest cover (slag heaps)	*Presence of slag heaps in areas covered by vegetation.*	*-Adequately designing slag heap site, with berms, slopes, drainage and material to be deposited.*	*-Coordinate project works that require earth removal and grading.* *-Develop plan for placing removed material*	*Construction*	*Project Director and Environmental Officer*	*50000*
			-Design of compaction and grading works.				

	Forest cover (Waste)	*-Generation of organic and inorganic waste*	*Develop Waste Management Plan, according to the section on Waste of Chapter 2 of this study.*	*-Implement waste management plan during construction of the project*	*Construction*	*Project Director and Environmental Officer*	*75000*
19 RES-P2				Reinforce the waste management plan's Resolution No.1948-2008-SETENA 17 - Management of solid			111000
	Forest cover (Fire)	*Impact of wildfires on the project works*	*-Develop a plan for prevention and control of fires*	*-Implement plan for fire prevention and control.* *- Control and monitoring of sensitive areas*	*Construction*	*Project Director and Environmental Officer*	*67000*
	FAUNA						
	Flora and Fauna	*-Extraction of plants and birds*	*-Ban and restriction of wildlife hunting and extraction.*	*Environmental education to workers.*	*At the start of works*	*Project Director. Owned by*	*1000.*
	Birdlife	*- Bird collision*	*- Bird control and monitoring*	-Location of distracting devices. Place fences and speed bumps at different points that wildlife use as passageways or crossing areas, especially frogs, reptiles and mammals. A permanent on-site biologist is required	*Associated with construction*	*Project Director. Owned by*	*3000.*

20 FAU-P2				who can train and manage staff for the capture and relocation of wildlife during the construction stage and power generation stage of the Pailas II Powerhouse. This Biologist will represent the geothermal field in logistics planning and coordination activities with representatives of National Parks (MINAET), representatives of the Guanacaste Conservation Area, representatives of hotels and environmentalists from the communities surrounding the Pailas II Geothermal			5000 Permanent cost considered in the operating budget payroll of the Plant (professional biologist fees)
	Soils, wildlife and water	*-Pollution from solid waste generated from housekeeping or constructive processes*	*-Solid waste management and disposal in authorized landfills*	*-Heaping packing materials and housekeeping residues after sorting*	*At the start of works and during construction and operation stage*	*Project Director. Owned by*	*15000.*
							Cost already considered
	Soil, fauna, flora and water (Facilities)	*Impact by the presence of temporary project facilities*	*Design a plan to restore the sites occupied by temporary facilities, preserving and improving the environment*	*Conduct a coordinated decommissioning program for the project in order to avoid the appearance of*	*At the end of the construction stage*	*Project Director. Owned by*	*6000*

	Aquatic and terrestrial fauna	*-Oil and fuel spills on aquatic ecosystems.* *-On aquatic ecosystems* *-On ground fauna* *-On water pollution*	*-Set up oil traps* *- Leak management and control* *-Setting up areas for changing oil - Build vehicle maintenance sites* *-Regenerate appropriate habitats through reforestation.* *-Stabilize impacted areas* *-Proper maintenance and control of the environment (physico-chemical monitoring)*	*-Implement an equipment monitoring and maintenance plan.* *- Control of machinery washing areas and oil storage and disposal equipment - Environmental education programs* *- Properly dispose of oil waste and generate culture of protecting and improving the environment.* *- Regular monitoring of machinery and equipment and environmental monitoring:*	*Construction and operation*	*Project Director. Owned by*	*30000.*	
	WATER							
	Surface water and runoff	*- Reduction of the water infiltration rate by waterproofing covered surfaces*	*- Install granular-base permeable materials on road and pedestrian traffic surfaces, as far as practicable.* *- Installation of gutters, drain boxes, culverts and sidewalks*	*- Use paving blocks, grass, cinder blocks, or other granular-base permeable materials around the various works, driveways, parking lots.* *- Coordinate with the Director of the Pailas GP*	*During construction*	*Environmental Officer of Las Pailas GP,*	*8000.*	
21 AGU-P2				Apply resolution 1948-2008-SETENA section 11 stormwater management; granular materials such as gravel in suitable mesh sizes should be used			12000+8000=20000	
		Presence of drilling rigs in the project area	*-Build chainlink mesh fencing for safeguarding the works and the environment.* *- Waterproofing sludge basins.* *- Water channels and traps.*	*Appropriate design of concomitant works such as compaction, grading, drainage, water channeling, impermeabilization of basins.*	*During construction*	*Environmental Officer of Las Pailas GP*	*76600*	

			Adequate compaction, grading and drainage of land around the platforms				Cost already considered Preliminary measures
	SUBSTATION						
	Vegetation	*-Removal of shrubs typical of chaparral vegetation*	*Planting living feces along access road and garden management*	*- Planting low-statured plants in gardens and maintenance of living fences*	*After completion of ST phase and during the operation phase*	*Environmental Officer*	*1000.*
	Fauna	*- Collision of birds and extraction of wildlife*	*- Bird protection measures*	*- Installing screens and warning signs banning hunting.*	*Construction and ST*	*Project Director. Environmental Officer*	*2500.*
	Soil and water	*- Risk dielectric oil spill from a transformer*	*- Design to consider and mitigate this risk*	*- Appropriate design and supervision*	*Standard design already exists, and construction*	*Project Director. Environmental Officer*	*1500.*
	Soil	*- Fuel and lubricant spills*	*- Cleaning with absorbent material (sawdust, sand, etc.)*	*- Absorption and extraction of spill from ST area.*	*ST construction and operation phase*	*Project Director. Environmental Officer*	*1500.*
	ATMOSPHERE						

	Air	*-Gas emissions:*	*- Carry out periodic measurements of gas emissions at least once a month during the first year of operation and quarterly from the second year when required to operate the plant.* *- Monitoring the state of health of plant employees through medical records. Perform checkups annually including, among others, audiograms, blood and respiratory system tests, stress level tests, etc.* *- Comply with regulations regarding emission and immission of gases*	- Select, adapt and implement the most appropriate methods of monitoring plant conditions using available data and appropriate technologies. -The selection of methods of analysis will be done in partnership between the manufacturer and the operator, and shall be subject to the generation technology that is considered the most appropriate. -Periodic monitoring of predefined sites *- Quarterly Monitoring of H2S* *-Compliance with national environmental regulations relating to emissions, and Decree No. 30221-S regarding immissions at the plant perimeter*	Plant operation period	*Las Pailas GP UEN Production Environmental Officer*	*84000.*
22 AIR P2				Conduct continuous monitoring of H2S concentration via a fixed in-house station equipped with sensors. Adjust to the permissible ranges of gas concentration indicated by the World Health Organization (≤ 0.1 ppm on average in 24 hours)			Already considered Preliminary environmental measures

		- Air quality vs. equipment testing	During equipment tests, primarily in the powerhouse and during pipeline blowdowns, considerable amounts of noise are normally produced as a result of testing.	*Control and monitoring during testing*	*Construction / operation*	*Project Director and Environmental Officer*	*10000.*
23AIR P2				Inform people living in surroundings prior to conducting tests, avoiding night hours.			Cost already considered Preliminary environmental measures
		- Air Quality vs. Handling of Fluids	Handling of fluids is essential to the field's operation and this requires a series of activities involving the generation of noise in different sites on the field.	*- Controls in handling of fluids*	*Construction / operation*	Project Director and Environmental Officer	*4200.*
							2012 costs already considered
		- Air quality vs. Plant Operation	The operation of geothermal plants entails a series of activities involving the continuous emission of gases into the atmosphere. Therefore, it is necessary to maintain controls to ensure no limits are exceeded to avoid effects on	*Periodic control and monitoring*	*Operation*	Project Director and Environmental Officer	*4000.*

24 AIR P2			people.	Continuous monitoring of H2S concentration in the atmosphere and noise levels within the perimeter of the plant should be performed at least once a month on the inside and the outside of the main buildings. Adjust to the permissible gas concentration ranges as indicated by the World Health Organization (≤ 0.1 ppm on average in 24 hours).			Cost 2012 Permanent cost considered in the Plant's Operating Budget
	Air temperature	- Increase in air temperature due to heat radiation	- Distribute equipment so as to concentrate hot spots as much as possible. - Insulate equipment, where design permits, according to the chosen technology	- Maintain communication with plant personnel so they may take appropriate preventive measures. - Provide personnel with thermal insulation clothing when working in hot places.	*Plant operation period*	*Las Pailas GP UEN Production Occupational Health Unit*	*4000.*
	Noise pollution	*- Production of noise and vibration due the operation of the plant*	*-The equipment to be purchased shall ensure noise levels do not exceed 45 dBA at any time of day outside of the nearest dwelling beyond the boundary edges of the plant If this criterion is not met, barriers and acoustic screens should be designed, if not already covered in the design.* *- * According to the national standard*	*- Conduct a noise study on the site to assess conditions before and after construction of works (isophones). This study shall be repeated every five years during the operation period to check for changes in the environment.* *- Conduct regular noise monitoring of noise at the plant and in the area of direct influence, once a year. During the first year this will be done quarterly.* *- During plant operation*	*Plant operation period*	*Project Director and Environmental Officer*	*5000.*

25 RUI-P2				Conduct continuous monitoring of noise levels by means of fixed station within the plant grounds. Adjust to the permissible ranges as per Decree 28718-S - Noise Pollution Control			2012 Cost - Permanent cost considered in the Plant's Operating Budget
	TRANSMISSION LINE						
	Geomorphology	*- Surface runoff by variations in microrelief.*	*- Surface drainage, water management*	*- Avoid surface accumulation, mounds and drains.*	*Associated with its construction*	*Project Director. Power line and transmission officer*	*2000.*
	Soils	*Excavation of cuts for new roads*	*- Proper design of road cuts*	*- Calculation of safety angles in road-cut design. Channeling of runoff to prevent erosion.*	*Associated with construction*	*Project Director and Environmental Officer*	*2000.*
26 SUE-P2				Apply resolution 1948-2008-SETENA. 7.4 Slope Management pp.17-18 2			Cost considered in the construction budget
	Soils	*- Instability due to road and tower site construction*	*- Stability of roads - Bolting down towers*	*In unstable sites and surface water management*	*Associated with construction*	*Project Director*	*6000*
						Environmental Officer	Cost considered in the construction budget
27 FLO-P2	*Vegetation*	*- Removal of vegetation when laying out new roads*	*- Herbaceous regreening of slopes and along roads.*	*- Protection of the soils for efficient natural and induced regeneration*	*Start of the rainy season*	*Project Director and Environmental Officer*	*2500.*
							5000

		- Removal of trees along powerline right-of-way	*- Reforestation and tree maintenance* *- Felling and reforestation plan*	*- Forest Inventory to obtain felling permits* *- Felling management plant* *- Develop a reforestation plan for planting trees on ICE-owned and other property-owner's grounds* *- Fell the least possible number of*	*Construction: Start of the rainy season*	*Project Director and Environmental Officer*	*5.000.*
28 FLO P2				Within the right-of-way, maximum respect for herbaceous, shrub and low-statured tree vegetation shall be observed, depending on powerline design to meet current safety standards			8000
29 AGU-P2	*Water Quality*	*- Sediment Contamination*	*- Design of roads* *- Water management in road and tower sites* *- Road-cut design*	*- Selection of least steep route for road design* *- Using culverts across rivers, and flooded areas - Surface water management* *- Calculation of safety angles in road-cut design. Channeling of runoff to prevent erosion.* *- Use runoff breakers in slopes* *- Do not dump removed soil on rivers and streams*	*- Design measures - Construction*	*Project Director and Environmental Officer*	*5000* Cost considered in the construction budget
	Water	*- Risk dielectric oil spill from a transformer*	*- Design to consider and mitigate this risk*	*- Appropriate design and supervision*	*Associated with construction*	*Project Director and Environmental Officer*	*Associated with the design.*
	Flora and Fauna	*-Extraction of plants and birds*	*-Ban and restriction of wildlife hunting and extraction.*	*- Environmental education of workers.*	*At the start of works*	*Project Director and Environmental Officer*	*1000.*

30 FAU-P2				Installation of signs alluding to the ban on hunting and extraction of wildlife			2000
	Birdlife	*- Bird collision*	*- Bird control and monitoring*	*- Placement of signs.*	*Associated with construction*	*Project Director and Environmental Officer*	*1500.*
3I FAU-P2				Installation of bird dispersers every 10 meters			3000
	Soils, wildlife and water	*Temporary disturbance of habitats*	*- Route design* *- Programming right of way construction activities* *- Training of field staff*	*- Heaping of packaging materials* *- Final route design by interdisciplinary group in order not to disturb corridor continuity* *- Consider design variables to adapt the characteristics of the powerline for passing through corridors* *- Planning of right-of-way construction works in order to not interfere with the migration and breeding seasons* *- Instruct personnel not to collect species*	*Start of works and during the construction phase*	*Project Director and Environmental Officer*	*4800.*
32 FAU-P2				Conduct continuous monitoring of the incursion of wildlife into ICE-owned property in this new section of the geothermal field. To this end, the advice of a professional biologist will be sought during the construction and operation phases. This individual shall keep a log of such monitoring (sightings and rescues)			Permanent cost considered in the plant operating budget (professional biologist fees)
	Social	*- Concerns of the community about the*	*- Contact with the*	*- Establish communication channels*	*Construction*	*Project Director*	*1800*

33SOC-P2		*construction of the transmission line*	*community.* *- Road signage* *- Placement of road signs*	*to clarify doubts and concerns.* *- Distribution of leaflets*		*Environmental Officer*	2012 Cost - Permanent cost considered in the Plant's Operating Budget
	Safety	*- Risks due to powerline construction*	*- Use of safety equipment and worker's education*	*- Training the personnel involved and use of appropriate equipment*	*During construction*	*Project Director and Environmental Officer*	*1300.*
34 SOC-P2				Resolution 1948-2008-SETENA section 12 Occupational safety and health pág.23			2012 Cost - Permanent cost considered in the Plant's Operating Budget
	Landscaping	*- Visual intrusion*	*- Route selection*	*- Adopt guidelines for selecting alternative routes*	*- Final route design.*	*Project Director and Environmental Officer*	*800.*
	Landscaping	*- Landscape quality alteration*	*- Reforestation using appropriate species*	*- Planting vines and ornamental plants*	*During construction and upon completion*	*Project Director and Environmental Officer*	*4000.*
35PAI-P2				*Regreening of perimeter at the foot of towers to mask lower sections, keeping a safe distance from the power lines.*			6000
	Atmosphere	*- Fire hazard*	*- Control of flammable materials*	*- Avoid surface accumulation, mounds and drains.* *- Collection and disposal of waste (particularly glass) within the facilities*	*- Erection of towers - Clearing right-of-way - Maintenance work*	*Project Director and Environmental Officer*	*1900.*

36 AIR P2				Set up a forest fire monitoring and control system control within the perimeter of the new facility			Permanent cost considered in the plant operating budget
	Noise	*- Increased audible noise*	*- It is reduced with a greater distance to rights-of-way*	*- Minimum width of 15 meters used on both sides of transmission line along right-of-way*	*During the phase of purchase of rights-of-way*	*Project Director and Environmental Officer*	*5000.*
	Partial additional amount for continuity of Environmental Management Plan (EMP) – Las Pailas Geothermal Field Expansion						US $1,426,000
ADDITIONAL TOTAL AMOUNT FOR ENVIRONMENTAL MANAGEMENT (PRELIMINARY MEASURES + EMP) = US$ 2,135,000							