

I, Ivania Montero Retana, Official Translator of the Ministry of Foreign Affairs and Worship of the Republic of Costa Rica, named by Agreement N°178-96 DJ of June 24, 1996, published in La Gaceta N° 4 of January 7, 1997, hereby certify that the document to be translated from Spanish into English reads as follows:

CHAPTER 1

GENERAL INFORMATION

1.1.1. INTRODUCTION

1.1.1. A multitask group of professionals from the Environment Management Center, the PSA Business Unit of Service Centers, the Legal and Health department and the Business Unit of Production presents the results of the Environment Impact Study (EslA for its acronym in Spanish) of the Garabito Electrical Generation Center, which will be built by Instituto Costarricense de Electricidad (ICE), in Ciruelas of Miramar, community of Puntarenas.

According to the effective environmental legislation, the proposed objectives for carrying out the study are:

- Identifying and assessing environmental impacts of different activities to be performed during construction and operation of new premises within the Garabito Electrical Generation Center.
- Having available an Environmental Impact Study (EslA) of the Project.
- Having available the Thermal Center Plan of Environmental Management.
- Obtaining environmental approval by the assessment entity of the Environmental Impact Study under applicable Law No. 7554 and its rules.

This study will determine new installation actions which may impact environmental, natural resources or sensitive environmental values and will also identify, predict and assess potential impacts as well as will propose mitigation or compensation actions applicable through the Environmental Management Plan.

The EslA totally fulfills national legislation requirements and existing rules pointing out the Environmental Organic Law (No. 7554), related guidelines which have been issued or endorsed by Secretaria Técnica Nacional Ambiental (SETENA, national environmental secretary) of Ministerio del Ambiente y Energía (MINAE), and the resolution No. 397-2001-SETENA, according to file 344-2001-SETENA as well as anything set forth by Ministerio de Salud (Health Ministry) regarding emissions.

1.2. Theoretical and Methodology Frame

This section covers legal surrounding conditions to be considered in the study, applied methodology and sets forth environmental needs of the Garabito Electrical Generation Project together with environmental issues which need solution.

1.2.1. Legal Frame

In 1995, the Environmental Organic Law –No. 7554 was promulgated and it sets forth in article 2 that;

- *Whoever contaminates or harms environment will be responsible for all harm and damages caused for such action or omission under laws and international treaties.*
- *The environmental harm represents a social, economic, cultural and ethnic crime.*

Chapter IV will set forth that human activities which alter or destroy environmental elements or generate waste, toxic or dangerous materials will require an Environmental Impact Assessment.

Additionally, it introduces the principle of objective responsibility which places direct responsibility for damages caused to environment and biological diversity not only to the interested party but to study authors and those individuals who approve it.

With promulgation of this Law, the National Secretary of Environment (SETENA) is created as a decentralized organism of Ministerio de Ambiente y Energía (MINAE) who will watch over rational usage of environment goods.

On January 16, 1997, the SETENA Procedure Rules were published with a main objective: setting forth requirements and procedures that will rule and approve the environmental studies or EsIAs. It also defines consultant corporation obligations, those of project developers, of SETENA, its internal organization and competence.

For the EsIA study preparation, SETENA issues methodology and content guidelines depending on project type. For electrical generation projects through usage of thermal plants, SETENA did not have available guidelines. To provide attention to the carrying out of this project, the Reference Term Form (FETER by its Spanish acronym) has been filled out. Form can be found in Annex 2.

Furthermore; there are no specific rules available for air quality that could be used in the country. In article 25 of official newspaper, La Gaceta No. 57 of March 21, 2002, the polluting atmospheric release Rules were published and on March 1, 2008 a Regulation over storage and marketing of hydrocarbons was published.

In General Health Law, Volume III, article 262,263, from article 293 up to 304, current air pollution provision summary is as follows;

- *Prohibition to all individual or company legally constituted to release, emanate or emit atmospheric pollutants which causes or contributes to air pollution.*
- *Installation of control systems for emission reductions to levels that will be included in rules for this purpose.*
- *Prohibition of any manufacturing plant functioning, industrial or commercial premise which does not have systems to avoid discharges into atmosphere of damaging pollutant for people's health.*
- *Nominates the Ministry of Health as the organization which authorized the installation, functioning, extension or modification of any industrial premise.*

For gases resulting from thermo electrical generation, Canada regulations will be considered because they have been endorsed by the Environmental Control Department of the Ministry of Health as follows:

**Gas emission rules for thermo electrical stations
(Based on Canadian rules, Note DECA-850-96 of Ministry of Health) for diesel
(motor) stations:**

Pollutant	Rule
NO ₂	More than or equal to 1MW: 55.5 g/MJ
CO	More than or equal to 1 MW: 1.8 g/MJ
Opacity	It can not exceed 10%, exemption of 4 minutes per hour or can exceed 10% but less than 60%
Hydrocarbons	More than or equal to 1MW: 2.2 g/MJ (using gas or double fuel) Others: 0.28 g/MJ

For combustion turbine (gas turbine):

a. Nitrogen Oxides:

The NO_x (grams) permitted mass is calculated per electric energy unit exit (Gigajoules) and an additional NO_x quantity emulated if it is shown that useful energy is recovered from exit thermal energy of the unit during normal operations.

The permitted emissions are:

$$(EXIT\ POTENCY\ X\ A) + (EXIT\ HEAT\ X\ B) = equivalent\ NO_2\ grams$$

Where, *EXIT POTENCY*: is the total electric energy or motive force produced, expressed in Gigajoules (3.6 GJ per MWh). *EXIT HEAT*: is total thermal energy useful recovered from combustion turbine(s). *A and B*: are emission rates permitted expressed in grams per Gigajoule, for potency components and heat recovery respectively, according to following table;

EXIT POTENCY FACTORS “A” (g/GJ):

Turbines that are not for peaks	Natural gas	Liquid Fuel
Less than 3 MW	500	1250
From 3 to 20 MW	240	460
More than 20 MW	140	380
Turbines for peaks	Natural Gas	Liquid Fuel
Less than 3 MW	Exempt	Exempt
More than 3 MW	280	530

EXIT HEAT FACTOR “B” (g/GJ):

For all units: Gas Natural 40
 Liquid 60
 Solid derivative products 120

b. Carbon monoxide emissions (CO):

For units included in provisions for NO_x of this Rule, CO emissions corrected to ISO conditions at 15% of oxygen and based on dry volume, shall not exceed 50 parts per million at nominal potency.

c. Sulfur dioxide emissions

Those shall not exceed:

- For liquid and gas fuels:
 For units that are not peaks, 800 g/GJ of exit and for peak units, 970 g/GJ of exit, based on low caloric value of fuel.
- For fuel derived from solids;
- 770 g/GJ of exit for fuel whose uncontrolled SO₂ emissions based on fuel sulfur content would be between 770 and 7700 g/GJ of exit or a minimum of sulfur capture of 90% for fuel whose uncontrolled SO₂ emissions based on fuel sulfur content would more than 7700 g/GJ of exit.

In June 1997, through Executive Decree No. 26042-S-MINAE, Rules on Rejection and Pouring of Waste Water were published setting forth

minimum permitted rules for pouring of pollutants. Among other issues, these rules include the physical-chemical features that domestic, commercial or industrial waste waters shall comply with when poured in natural or artificial water bodies.

On Friday, March 1, 2002, the official newspaper La Gaceta No. 43 published under decree number 30131-MINAE-S, the Rules for Regulation of Storage System and Trading for Hydrocarbons which set forth some specifications regarding general storage of hydrocarbons.

On March 21, 2002, the official newspaper La Gaceta No. 57 in its article 25, published the Regulation for Atmosphere pollutants Inmision and on March of current year, Rules for Regulation of Storage System and Trading for Hydrocarbons were published.

Other laws directly and indirectly related to environment and Electrical Generation projects are:

- Political Constitution, regarding landscape, as natural resource, it is protected under the Constitution, article 89: “one of the cultural purposes of the Republic is to protect natural beauty, preserving and developing the historic and artistically patrimony of the Nation and supporting all private initiatives for scientific and artistically progress” (Costa Rica, Political Constitution).
- Biological Diversity Agreement and appendixes I and II undersigned in Rio de Janeiro, Brazil, on June 13, 1992. Law No. 7416 of June 30, 1994, article 14 entry a);
- National Convenience Activities Declared under Executive Decree No. 25721 on October 17, 1996 (Rules to Forest Law No. 7575) in its article 2, sets forth National Convenience, that is, activities related to study and execution of projects or activities of public interest done by centralized government offices, autonomous institutions or private corporations that render services to the majority of population such as, water harnessing, transportation and supply; pipeline, road construction, generation, transmission, and distribution of electrical power, and mining activities.
- Public service. Law No. 7593 of August 9, 1996 of ARESEP, classifies power distribution, transmission and generation as public service.
- The Biodiversity Preservation and Priority Wild Area Protection in Central America is an Agreement undersigned in Managua on June 5, 1992. Law No. 7433 of September 14, 1994, article 30:
 - United Nations Framework Convention on Weather Change and its appendixes, undersigned in New York on May 9, 1992. Law No. 7414 on June 13, 1994, article 4 entry f);

- Regulation on procedures for archeology studies, published in La Gaceta No. 202 in article No. 78-A of Tuesday, October 19, 1999 under decree No. 28174-MP-C-MINAE-MEIC.
- International Important Humid Soils Convention especially as habitat for Water Fowl (Ramsar Convention), undersigned on February 2, 1971. Law No. 7224 on April 2, 1991, article 3 related to Strategic Planning.
- Convention for Protection and Development of Marine Environment and its Cooperation Protocol to fight against hydrocarbons releases in the Gran Caribe region undersigned in Cartagena de Indias, Colombia on March 24, 1983. Law No. 7227 on April 22, 1991. Article 12.
- Preservation and Wildlife Law and its modifications, Law No. 7317 published in La Gaceta No. 235 on December 7, 1992;
- Forest Law and its modifications, Law No. 7575 published in La Gaceta No.72 on April 16, 1996;
- Biodiversity Law, No. 7788 published in La Gaceta No. 101 on May 27, 1998
- General Law of Public Works Commission for Public Services and its modifications, Law. No . 7762 published in article 17— A, La Gaceta No. 98 on May 22, 1998;
- Administrative Contracting Law, No. 7494 published in article 20-A in La Gaceta No. 110 on June 8, 1995;
- Law of the Regulation Authority of Public Services, Law No. 7593 published in La Gaceta No. 169 on September 5, 1996;
- Law regarding Soil Usage, Management and Preservation, Law No. 7778 published in La Gaceta No. 97 on May 21, 1998;
- Hydrocarbons Law and its modifications, Law No. 7399 published in La Gaceta No. 95 on May 18, 1994;
- Mining Code, Law No. 6707 published in La Gaceta No. 230 on December 3, 1984;
- Emergency Law, Law No. 7914 published in article No. 78 La Gaceta No. 199 on October 13, 1999 and
- Law of Citizen Protection from Excessive Administrative Procedures No. 8220 published in article No. 22 in La Gaceta No. 49 on March 11, 2002;
- Law on National System for Quality, Law No. 8279, published in La Gaceta No. 96 on May 21, 2002;
- HISTORIC AND CULTURAL PATRIMONY: Political Constitution, Article 89, clauses 3 and 18. Law on control of exploitation and trade of archeological relics, No. 7 of 1938. International Treaty for Recommendation on Preservation of Archeological Goods which public or private works may endanger, No. 4711. Convention on World Cultural and Natural Patrimony, No. 5980 not ratified. General Law for Public Administration, No. 6727. Convention on Defense and

Preservation of Archeological Patrimony, both Historical and Artistic of American Nations, No. 6360 not ratified. Law on National Archeological Patrimony No. 6703. Law of Historic Architecture Patrimony, No. 7555. Rules for Archeological Study procedures, DE No. 28-174 MP-C-MINAE-MEIC. (Challenged). They become void due to its unconstitutional character of Executive Decree No. 28-174 MP-C-MINAE-MEIC in paragraph 2 of clause i) of article 2, the word “following” and text after word “old”; clause c) of article 5; paragraph 1 of article 6, phrase “according to procedures of Law number 7555”; clause d) of article 11; clause d) of article 12; as well as article 17, and due to this fact the requirements set forth in the Manual of Technical Instruments of Environmental Impact Assessment Process (SETENA No. 588-97) were in force again. *File No. 99-07926-0007-CO Judgment 2002-05245 Constitutional Court (Legal Newsletter, Tuesday, January 21, 2003 No. 14).*

1.2.2. Project needs and environmental difficulties

The production and energy supply sites are located in proper areas for environmental improvement; in addition, they are properly located for dispersion or optimal disposal of waste; strategic location regarding communication roads, supply, energy transportation and labor force availability.

For this particular case, environmental needs are studied regarding distance between premises and some close population centers as Ciruelas, Calle del Arreo and Cuatro Cruces. Distance becomes relevant due to noise and gas emission which will be produced.

Consideration has been given to the location of the Thermal Center and its relationship with wind flow, sun conditions, natural or artificial barrier existence, water supply, regulation plan term, and vicinity to sites of ecological, historical and cultural interest; in summary, effects on environmental conditions or processes.

This study will be focused on the posing of most relevant and feasible environmental impacts to propose, for each one of them, actions capable of avoiding, attenuating, controlling or compensating them.

Feasible environmental impacts are: gas and noise pollution generated by operation of the Generation Center. Since installation will be done in a place used for thermal generation, it has minimum repercussion during construction.

A relevant impact to be considered is the derivative product of polluting gases emitted during combustion. Main polluting agents produced by such plants are: particles, sulfur oxides, nitrogen oxide and carbon monoxide.

Impact extent of such emissions on environment depends upon:

- a) Atmospheric and physiographic conditions in the region, while permitting proper oxidation, dispersion and transportation.
- b) Quality of fuel used, especially regarding sulfur content.
- c) Time and conditions of machine operation.
- d) Nature of polluting gases regarding its behavior in the atmosphere and its action on human environment, ecosystems and structures.
- e) Control systems, follow up and corrective action plans.

A plant operating with diesel turbines produces an important quantity of noise within engine room and out of it. Normally, highest noise levels originate by gas currents which speedy move as valves do for the alleviation of steam pressure, turbines, and power generator motors or by operations which generate percussion as such as riveting, stamping or perforations.

This study will analyze current sound conditions of surrounding areas and will forecast total noise production when in operation and the environment capacity to absorb that noise load. It is also necessary to consider noise quality and intensity in the workplace, proposing attenuating systems for due protection of operators, visitants, neighbors and pedestrians whenever necessary.

1.2.3 Methodology

First action within process was to compile relevant available information regarding project own characteristics. The Garabito Electrical Generation Center was solely created for thermal generation and the area characteristics where it is located are optimal for industrial project development. For this reason, there was emphasis on proposing an environment management plan for this project to permit adequate plant operation within labor safety and with reduced environment impact.

Current study followed scheme shown in Figure 1.1. to keep a general format in the process of analysis and assessment of the Environmental Impact Study of the Garabito Electric Generation Center.

1.2.3.1. Impact Identification and Assessment

Once compiled and analyzed most information, some working meetings took place to define environment variables which could be affected and those actions which could alter in each working area, generating charts of identified environment impact.

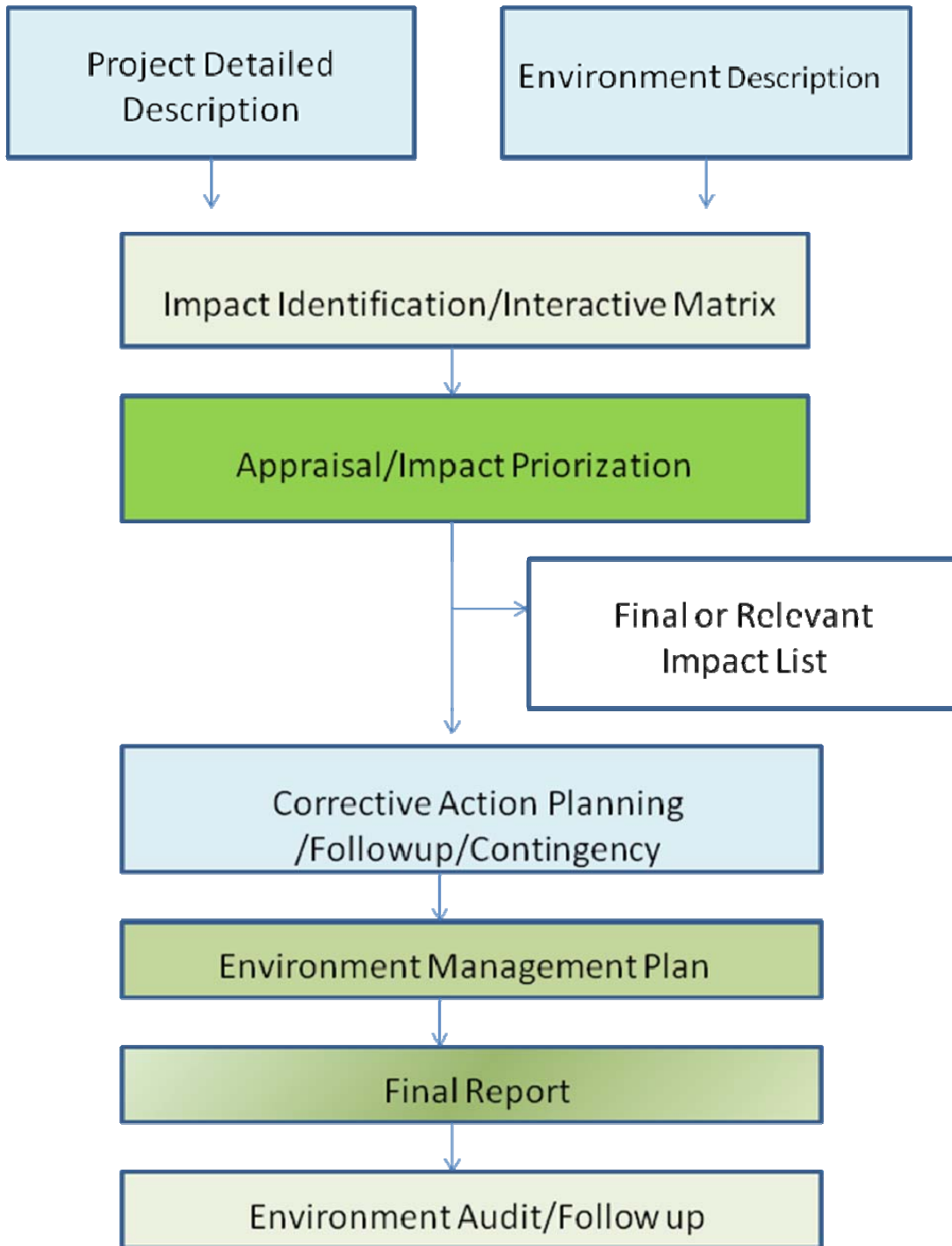
1.2.3.2. Appraisal of Relevant Impacts:

Based on a summary matrix of relevant impacts and on one detailed definition of impacts, a second phase took place appraising the environment impacts of the project. The impact appraisal started after previous identification of those effects

that a series of actions may generate on environment variables, using numeric values which permit set impact weights.

In this method, the identification, prediction and appraisal of impacts involve future projection of environment scene with and without the proposed action.

Figure 1.1
Environment Impact Study Cycle



Using this method, five basic indicators were appraised: probability, intensity, magnitude, reversibility and duration.

For each indicator, the variables or appraisal criteria were selected. A value was assigned to each indicator between 0 and 10 (0,2,5,10) according to expert's criteria and selected variables to appraise it.

The five indicators used are:

Probability: It relates to measuring unit of certainty that the effect will be present. This is the first criterion that is appraised since if probability of occurring in a set place is null, then impact will be zero in value in that point and assessment will not continue.

Indicator appraisal is directly relates with the fact that the identified effect occurs as a consequence of analyzed action. Based on this, the indicator will have a high valued when occurrence probability is over 50%, it will have a medium value when probability is between 10 and 50% and a low value when was between 1 and 10%. Normally, probability is associated to expert criteria and based on experience from other projects.

Intensity: relates to the force or strength of the effect in the site under analysis.

Magnitude: relates to space influence of perturbation/disturbance.

Normal consideration related to space influence of effects sets forth that greater impacts were foreseen in project or action vicinity and that there is diminishing effect by distance from the site of disturbance. This is not always real since there are impacts that do not keep an obvious or direct action within geographic and temporary limits such as those generated by social and economic processes.

Magnitude is measured in different ways. Frequently, the criterion of the area where change is produced is used. For some impacts, the appraisal is qualitative since it involves determining if data is general in the region, locally or in some specific areas.

Taking into consideration these aspects, we supposed that impact had a low character (2) if action produces a very much located effect. If on the contrary, the effect does not admit a precise location within project area because is small but repeats itself many times covering a big area or it is an effect over a big area, we assumed that it had a general influence and was assigned a high value (10). The intermediate situation had a local impact and a medium value (5).

Duration: This is the time that goes by between action appearance and effect start on the environment factor studied. Duration was considered short whenever impacts appeared immediately or in less than 2 years, medium when it shows or remain in the environment between 2 and 5 years and long term when the effect takes 5 years to appear.

Generally, immediate impacts or those of short duration occur during project construction. Long term impacts are those that remain longer than the starting action or have future implications or secondary effects on the system.

Reversibility: it measures system capacity to go back to a balance situation similar or equivalent to initial situation either by natural means or through human intervention. It is also defined as “recoverability”.

The reversibility or recoverability is generally appraised according to expert criteria when face against a long term image with base conditions and total impact manifestation.

If effect is totally recoverable immediately or in the short term, less than a year, we assigned it a low value (2). If it is partially recoverable or could be mitigated has a medium value of 5. Last, if it is unrecoverable or irreversible (10) since it represents an alteration impossible to repair, both naturally or through human action, and it has a value of (10).

Chart 1.1 shows a summary of values used for each indicator.

Chart 1.1
Values used for each indicator

Probability	Intensity	Magnitude	Duration	Recoverability	Points assigned
High	Strong	General	Long	Irrecoverable	10
Medium	Medium	Local	Medium	Could Be Mitigated	5
Low	Light	In a Point	Short	Recoverable	2

The environmental impact rate obtained from the application of these criteria permitted the hierarchical organization of the effects among them.

Values obtained through usage of proposed scales in this chart are not absolute magnitude measuring units but represent values of relative magnitude to compare effects among themselves. The main goal was to determine which impacts need priority attention.

Ideally, those factors which maximize environmental damage must be treated first. Then, first step to apply any method of multiple factors must eliminate those effects that do not cause environmental damage (dominion analysis).

1.2.3.3 Impact by Hierarchical order

To perform the hierarchical organization of impacts, we used the weighed average method. Weights assigned to each indicator were established according to the study and characteristics of the area and taking into account all expert criteria.

Chart 1.2 shows weights assigned to current study.

CHART 1.2
Weights assigned to each indicator for hierarchical organization of Impacts

INDICATOR	CRITERION WEIGHT %
Probability	25
Intensity	20
Extension	25
Duration	20
Reversibility	10

Once total points for each indicator have been obtained, we proceeded to sum them up. Results granted total points for impact under evaluation in each place or project unit and this was defined as Environmental Impact Value (VIA, for its acronym in Spanish).

The level of importance or seriousness of impacts regarding points obtained, are shown in chart 1.3.

Once each impact has its individual value, impacts with VIA values equal or greater than 7.1 were considered most relevant project impacts and mitigation measurements were developed for them.

Chart 1.3
Environmental Impact Value (VIA) used to hierarchically organized the project environmental impacts

Seriousness or Importance	Points
Serious or Highest	9.1-10.0
Strong or High	6.1-9.0
Medium	4.1-6.0
Light or low	<4.0

1.2.3.4 Environmental Management Plan

A plan was prepared based on the assessment of impacts and feasible actions for its reversion, mitigation or compensation, especially of those considered relevant.

This plan includes environmental relevant impacts, actions for mitigation, responsible individuals, working areas, costs and minimum environmental functional specifications which describe programs and subprograms which pretend prevention, mitigation, or compensation of potential impacts which could be present on environmental components of the influence area of the project as product of construction, operation and maintenance of such Project. The environmental management programs shall need to adjust during the engineering detail phase of the project keeping functional specifications and efficiencies of different systems and shall be implemented during construction and operation phases so that this plan must be included in the general working program of the project.

1.2.3.5 Identification of lack of information

Study was performed through analysis of existing information or information that was generated through environment-project interaction o from field work where possible.

1.3 GENERAL INFORMATION

1.3.1 Physical or legal person

The Instituto Costarricense de Electricidad (ICE), has the legal standing identification number 4-000-042139-02, registered through Law Decree No. 449 on April 8, 1949. Any official notice could be sent to Fax No. 220-6292 o to ICE office in Sabana Norte, Headquarters, 13th floor. A certified copy of the Legal Standing of ICE by General Attorney is included in Appendix 1.

1.3.2 Professional team which prepared this EsIA.

Following ICE professionals participated as a multitask team in the preparation of this Environmental Impact Study:

Biologist Fernando Chavarría Picado, Coordinator
Professional college C.B.C.R. No. 526
SETENA register number No. 0171-96

Geologist Victoria Villalobos Rodríguez, MBA
SETENA Register number No. 051-99
Archeologist Ana Cristina Hernández Alpízar
SETENA Register number No. 030-99

Forest. Rolando Núñez González
Agronomist Professional College No. 3236
SETENA Register number No. 169-96

Technician Rafael Herrera N.
Labor Health
SETENA No. 103-99

Engineer Eduardo Longan Santonastasio
Engineer and Architect Professional College No. 5426
SETENA consultant in process

Geologist Adolfo Estrada del Llano
SETENA register No. 065-2001

Lic. Claudio Zeledón Rovira
SETENA Consultant No. 135-2001

In addition to them, officials from Environmental Management Centers, Underground Explorations and Design, and from PSA Business Unit, COSABA, and ICE Production Business Unit contributed to this work.

1.3.3 Reference Terms

Reference terms as of which this Study of Environment Impact (Appendix No.2) is based were given by Secretaría Técnica Nacional Ambiental (SETENA), as a response to the Preliminary Environmental Assessment Form (FEAP, by its acronym in Spanish) No. 344-2001 submitted by ICE on June 4, 2001. SETENA did inspection visits to verify information and obtaining a clear scene of project site.

2.2. DESCRIPTION OF THE PROJECT

The generation equipment projected to be installed in the Garabito Electrical Generation Center consists of two or three diesel - fueled turbogenerators with an approximate capacity between 25.000 and 60.000 KW and a steam turbine that will use the residual heat of the exhaust gases of the gas turbines, with a capacity

between 40.000 and 60.000 KW. The entire capacity of the system would be between 120.000 and 180.000 KW, depending on the conditions of the place.

The main works that will be constructed by the execution of the project are:

- Engine room for Diesel gas Turbines
- Two heat recuperators and duct and draw hole systems
- Engine room for Steam Turbines
- A control room that will house the control equipment
- A 230KV elevator substation
- A water treatment and demineralization system
- A humid-type cooling tower
- Buildings for: water treatment, workshops and storehouses
- A fire protection system
- Two 5.000 m³ tanks for diesel storage
- All the systems, components and complementary works for the reliable and safe operation of the units.

The attached map shows the place and scope of the new facilities, including all the works described above (Fig. 2.2)

2.2.5 Area of the project and area of influence

This section of the description of the project shows figure 2.6, with the areas of influence of the Generation Center, namely: Project area (AP, all initials in Spanish), Area of Direct Influence (AID), and area of indirect influence (AII) which extends throughout the County of Miramar.

The area of the project (AP) is limited to the works and activities inside the ICE property. Picture 2.3 describes the works and activities of the project with its respective space distribution inside the property.

Figure 26

AREAS OF INFLUENCE OF THE GARABITO ELECTRICITY GENERATION CENTER

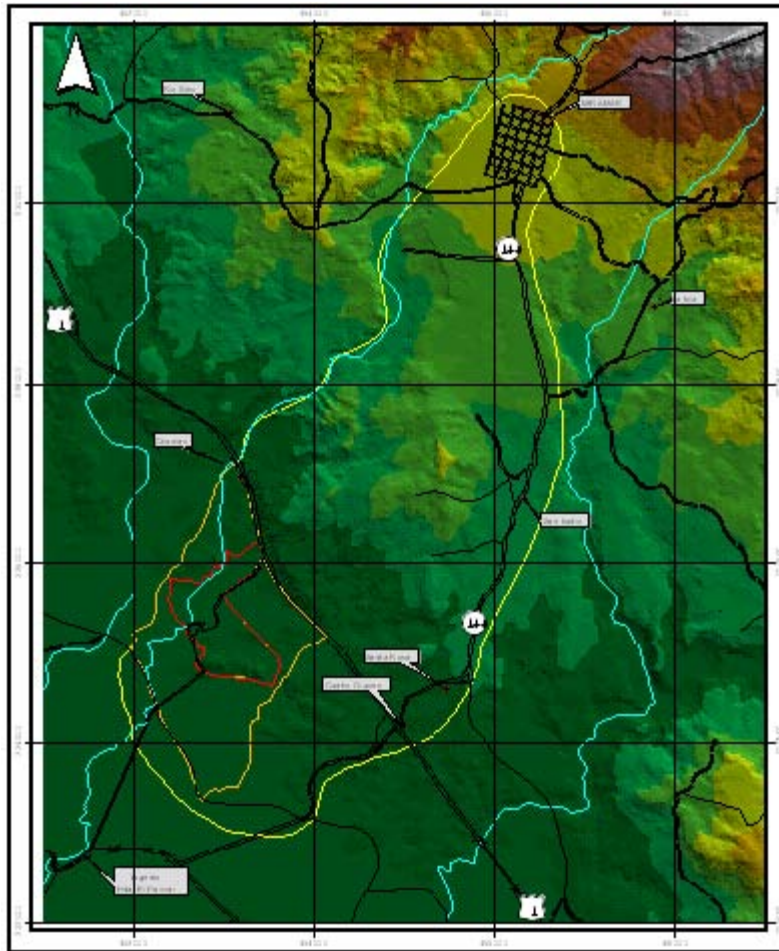


TABLE 2.3
Detail of the distribution of the works and
Activities inside the ICE property 2003

PROJECT AREAS	Has.
Area of the ICE works	14
Area of access routes	10
Area of turbine plant	7
Stacking Area	5
Area of sterile and organic deposits	5
Green protection area	47
	88

With regard to the Area of Direct Influence (AID) which is defined as the area on which direct impacts from the actions of the project can occur, it can be emphasized that this project, because it has a specific and temporary character, would cause some minor environmental impacts.

It is believed that the major effects will be the production of gas emission and noise during the construction and the operation of the Garabito Electrical Generation Center.

The residential houses closest to the AP are located approximately 500 m away, in a straight line. Although the distance is not very large, there is an important topographic barrier between the AP and the houses, which isolates them from the possible impacts generated, being more affected by the noise of the Inter-American highway.

The AP and the AID are located together with agro-industrial developments, and some secondary forest patches and grasslands.

The topographic conditions where the project is located, between the Ciruelas and Naranjo rivers (see figure 2.1), cause the Area of Direct Influence to be small. The topographic barrier effect causes that the main impacts produced be attenuated or have no influence.

3.1.2.2 Air Quality

In order to talk about changes in the quality of air it is necessary to define what should be understood as air pollution. It is defined as “ ... *the presence in the atmosphere of one or more pollutants in quantities and duration that are or tend to be harmful to the health or the well-being of human beings, the life of animals or of plants, or that hinders the enjoyment of life or of the property...* ” (Wark and Warner, 1990).

An interesting aspect of this definition is that it raises the term “pollutant” as “... dust, vapors, fog, liquids, smoke, other particles, vapor, gas, odorous substances, or any combination of the same, but that will not include non - combined water vapor.” (Wark and Warner, 1990). Air contamination is measured in relative terms based on a kind of “model air”, that is to say, the clean and dry air that can be found in deserted zones or in marine air far from the continental masses. Chart 3.2 shows the chemical composition of this “model air”.

Chart 3.2.
Chemical composition of atmospheric dry air

SUBSTANCE	VOLUME (PERCENTAGE)	CONCENTRATION ppm.
Nitrogen	78.084 ± 0.004	780 900
Oxygen	20.946 ± 0.002	209 400
Argon	0.934 ± 0.001	9 300
Carbon Dioxide	0.033 ± 0.001	315
Neon		18
Helium		5.2
Methane		1.2
Krypton		0.5
Hydrogen		0.5
Xenon		0.08
Nitrogen Dioxide		0.02
Ozone		0.01 - 0.04

Source: Handbook of Air Pollution, Publications PHS AP - 44 (PB 190-247), 1968 (40). , Quoted by Wark and Warnes (1990).

For the construction and operation of the Garabito Electrical Generation Center there is information relative to the emission of the current Barranca plant, produced by the monitoring made in the Thermal Park installed in the area, Barranca Plant (Annex 3).

An analysis of this information, made by PREEICA (2001), reveals that these measurements are plain and specific, and do not follow a systematical atmospheric monitoring program, and therefore the information must be cautiously analyzed.

Additionally, there are theoretical calculations generated by RECOPE based on the combustion of Diesel N°2, as well as on the information contributed by some equipment manufacturers.

There are other substances that are not listed in the table above, as is the case of H₂O, SO₂, formaldehyde, I₂, CO, CH₄ and some hydrocarbon vapors, but all of them have concentrations lower than 0.04 ppm. (Wark and Warnes, 1990).

Description of Pollutants produced by the combustion of Diesel N°2:

• Sulfur Oxides (SO_x)

As a result of combustion, a series of sulfur oxides are generated in different proportions (SO₂ in 98% and SO₃ in 1 - 2%). SO₂ is a colorless, not flammable gas, with a stinging and irritating smell in concentrations higher than 3 ppm. It is 2.2 times heavier than air. (Sanz Sa, 1991). In higher concentrations it produces a poignant and irritant smell. It is very soluble in water, and in the atmosphere it can react with more oxygen to form sulfur trioxide which, in the presence of moisture, produces sulfuric acid. Sulfur dioxide absorbs easily on particulate material and on other surfaces with which it makes contact. Its average life span in air has been estimated to be close to four days, but it changes considerably with temperature (Open University, 1975, quoted by the Tropical Scientific Center, 1989).

Sulfuric acid aerosols and other sulfates constitute between 5 and 20 per cent of the particles in suspension in urban air; therefore, they significantly contribute to the reduction of visibility, especially in concentrations higher than 0.1 ppm. The estimations show that a concentration of 10 ppm of SO₂, with 50% moisture, reduces visibility to close to 8 kilometers. When visibility is less than 8 kilometers, it is necessary to reduce the amount of landings at the nearby airports. (Wark and Warnes, 1990).

Sulfur compounds are responsible for damages to materials, particularly to metallic structures. Sulfur oxides accelerate corrosion when they combine with the factors of temperature and relative moisture, especially in relative moisture levels higher than 70%.

On the other hand, sulfurous and sulfuric acids are capable of attacking certain non-metallic construction materials, like limestone, marble, roof slates, and mortar, with which the acid forms sulfates that are very soluble in water, which are then washed by rain. (Wark and Warnes, 1990).

Another effect that sulfur oxides have is the increase in the drying time of paint. It has been shown that when paint dries off in the presence of SO₂ the final coating lasts less time. Nevertheless, sulfur oxides seem to have little or no effect on dry and hardened paints. (Wark and Warnes, 1990).

Effects on health: The effect on human health of prolonged exposure to SO₂ is variable, from simple irritation of the airways up to death. Chart 3.3 shows the main effects on human health of SO₂, smoke and particles in suspension at different concentrations when individuals are exposed to prolonged contact.

Several animal species including man react to SO₂ with phenomena of the bronchial constriction type, even at concentrations as low as 1 ppm if exposure is short. Nevertheless, when exposure is long, the effects of SO₂ in combination with the relative moisture and the particles constitute a potentially serious danger to health (Wark and Warnes, 1990), as can be seen in Chart 3.3.

CHART 3.3.

Relationship between exposure and effects for sulfur dioxide, smoke and all particles in suspension: effects of long exposures

Concentration, annual measures based on average values of 24 h, ($\mu\text{g} / \text{m}^3$)		Total particles in suspension	Effects
SO ₂	Smoke		
200	200	---	Sheffield, England. Increased respiratory illnesses in children (Lunn et al., 1967, 1970)
---	---	180 ^b	Berlin, New Hampshire, USA. Increased respiratory symptoms, decreased respiratory functions in adults (Ferris et al., 1973)
150	---	---	England and Wales. Increased respiratory symptoms in Children (Colley y Reid, 1970).
125	170	---	Krakovia, Poland. Increased respiratory symptoms in adults (Sawicki, 1972)
140 ^d	140 ^d	---	Great Britain. Increased illnesses of the lower respiratory tract in Children (Douglas & Waller, 1966)
60-140 ^a		100-200 ^c	Tokyo. Increased respiratory symptoms in adults (Suzuki & Hitosugi, unpublished data, 1970)

Source: Sanz Sa, J.M. La Contaminación Atmosférica. Ministerio de Obras Públicas y Transportes. Madrid. 1991 (80).

a Automatic conduct metric method

b Device for large volume samples (average of two months, possible under calculation of annual average)

c Light dispersion method, results not directly comparable with the rest.

d Calculations based on observations made after the study has concluded; probable under calculation of exposure during the first years of the study.

The other measurements have been made with the method of the Organization for Cooperation and Economic Development or by the British method for daily smoke and sulfur dioxide (Ministry of Technology, UK, 1966; Organization for Cooperation and Economic Development, 1965)

Chart 3.4

Relationship between exposure and effects for sulfur dioxide, smoke and all particles in suspension: effects of exposures in the short term

Concentration, annual measures based on average values of 24 h, ($\mu\text{g} / \text{m}^3$)		Total particles in suspension	Effects
SO ₂	Smoke		
>1000	> 1000	---	London, 1952. Significant increase of mortality, up to approximately three times the normal rate, during five days of fog. The pollution figures are average for the entire zone: maximum (Central location) of SO ₂ 3700 $\mu\text{g} / \text{m}^3$, of smoke 4500 $\mu\text{g} / \text{m}^3$ (Ministry of Health, UK, 1954)
710	750	----	London, 1958-1959. Increased daily mortality in up to 1.25 times above the forecasted rate (Lawther, 1963; Martin & Bradley, 1960)
500	500	---	London, 1958-1960. Increased daily mortality (as above) and of hospitalizations, evidenced when the indicated contamination levels were exceeded (their magnitude increased constantly with contamination) (Martin, 1964)
500	---	---	New York, 1962-1966. Co-relation of mortality and pollution: excess of 2 per 100 in the indicated level (Bruechley, 1973)
500	250	---	London, 1954- 1968. Increased symptoms, registered through the daily log technique, among bronchiolitic patients, when indicated contamination levels were exceeded (measures of the entire zone) (Lawther, <i>et al.</i> , 1970)

300	140	---	Vlaandingen, The Netherlands, 1969 - 1972. Temporary decreased respiratory functions (Van der Lender, <i>et al.</i> , 1975)
200 ^a	---	150	Cumberland, West Virginia, USA. Increased frequency of asthma crises in a small group of patients, when the indicated levels of pollution were exceeded (Cohen <i>et al.</i> , 1972)

a Method of West - Gaeke.

b Method with large volume samples.

The other measurements have been made with the method of the Organization for Cooperation and Economic Development or by the British method for daily smoke and SO₂ (Ministry of Technology, UK, 1966; Organization for Cooperation and Economic Development, 1965)

Source: Sanz Sa, J.M. La Contaminación Atmosférica. Ministerio de Obras Públicas y Transportes. Madrid. 1991 (81).

• Nitrogen Oxides (NO_x)

In the process of combustion, up to eight different types of nitrogen oxides can be generated, although in general the most important ones are NO and NO₂. NO is a toxic, colorless, odorless gas and it is not flammable. NO₂ is a brown - reddish gas, it is not flammable, but it is toxic and it is characterized by a very asphyxiating smell (Sanz Sa, 1991).

Nitrogen oxides are generated through two mechanisms:

a) the fixation of nitrogen, by the reaction between the nitrogen molecules present in the air and in oxygen, a reaction that is possible given the high temperatures in combustion chambers (Between 1300 and 2500 °C)

b) the oxidation of nitrogen compounds contained in the fuel: the NO_x do not damage the materials, but in combination with water, NO₂ reacts forming nitric acid, a known corrosive agent of metallic surfaces. NO₂ absorbs visible light and at a concentration of 0.25 ppm it causes a significant reduction of visibility.

Effects on health: In the concentrations normally found in the atmosphere it is only potentially irritant and potentially related to chronic pulmonary fibrosis. Some increase has been observed in child bronchitis (2 - 3 years of age) when the concentration is lower than 0.01 ppm, and in combination with non - burnt hydrocarbons, nitrogen oxides react in the presence of solar light and form photochemical smog.

• Carbon monoxide (CO)

Carbon monoxide is a colorless, odorless and tasteless gas; its density is 0.965 the density of air and it is slightly soluble in water. It is flammable and it burns with a blue flame, although it does not maintain combustion. It is highly stable and it has an average lifespan in the atmosphere of between 2 and 4 months.

CO is produced as a result of one or several of the following processes (Sanz Sa, 1991):

- Incomplete carbon combustion.
- Reaction to high temperatures between the CO₂ and materials that contain carbon.
- Dissociation of CO₂ at high temperatures.
- Atmospheric oxidation of methane coming from the anaerobic fermentation of organic matter.
- Process of production and degradation of plants chlorophyll.

CO seems to not have harmful effects on the surface of materials or on the higher forms of plants in concentrations below 100 ppm in exposures of 1 to 3 weeks. (Wark and Warner, 1990)

Effects on health: CO is a gas that, when inhaled, blocks the oxygen receptors in the pulmonary alveoli, preventing the normal exchange of gases to take place. CO is lethal in concentrations higher than 750 ppm. However, exposures to CO for 8 or more hours at concentrations of 30 ppm alter some psychomotor tests (Wark and Warnes, 1990).

• **Particles in suspension (PS)**

Particles in suspension are those solid and liquid matters dispersed and dragged by air, with a diameter of more than 0.0002 µm, but less than 500 µm. (Wark and Warnes, 1990).

One of the better-known effects of particles in suspension is the reduction of visibility, produced by the absorption and dispersion of light. Particles can be chemically active or not; if they are not active, their combination with other substances can produce active substances, depending on the chemical composition and on the physical state.

Among the most common damage of particles in suspension we find the “soot” effect, that blackish and sticky film that adheres to clothes, curtains, walls, etc. With the settling of the particles, other direct damages can be generated like intrinsic corrosion, or by the activity of absorbed chemical corrosive substances or absorbed on metallic surfaces.

Effects on health: The effects of particulate material suspended in the air on human health are not well defined, although three action mechanisms are supposed:

1. The particle can be intrinsically toxic due to its inherent chemical and / or physical characteristics.
2. The particle can interfere with one or more of the mechanisms that usually clear the respiratory system.
3. The particle can act as the carrier of a toxic substance absorbed.

It has been observed that particles that contain fluorides seem to cause physiological damage to plants, and magnesium oxide produces poor growth of the plant. In animals, the effects of the particles will be manifest with the ingestion of contaminated grasses, whether the plant has absorbed the pollutant or the plant serves as mechanical support for the same. In this aspect, cow and sheep cattle have been observed to be poisoned by arsenic because the grass they ate was covered with particles of arsenic. (Wark and Warnes, 1990)

The effects observed on human health are summarized in Chart 3.5. Unfortunately, in Costa Rica there is no effective control of emission of particles to the atmosphere, and if there is, it is inoperative.

Chart 3.5
Effect of particles in suspension on human health

Concentration, $\mu\text{g}/\text{m}^3$	Measurement Time	Effects
60-180	Annual geometric average, with SO_2 and humidity	Acceleration in the corrosion of steel and zinc sheets
75	Annual average	Environment air quality standard
150	Relative humidity lower than 70 per cent	Visibility reduced to 5 miles
100-150	-----	Solar light reduced in one third
80-100	With sulfation levels of 30 mg / cm^2 / month	An increase may occur in the mortality rate of people over 50 years of age
100-130	With $\text{SO}_2 > 120 \mu\text{g}/\text{m}^3$	It is possible for children to experience an increase in the incidence of respiratory illnesses
200	Average of 24 h and $\text{SO}_2 >$	The morbidity of workers may

	250 µg/m ³	be caused by an increase in absenteeism
260	Maximum once every 24 h	Environment air quality standard
300	Maximum of 24 h and SO ₂ > 630 µg/m ³	In patients with chronic bronchitis, acute worsening of symptoms may appear
750	Average of 24 h and SO ₂ > 715 µg/m ³	There might be an excessive number of deaths and considerable increase of illnesses

Source: Wark and Warnes, *Contaminación del Aire*. Limusa. Mexico. 1990 (40).

Chart 3.23

HOMOTERA	
Aphididae	1
NEUROPTERA	
Corydalis sp. (Corydalidae)	1
COLEOPTERA	
Elmidae	8
TRICHOPTERA	
Trichop.(fam. No ident)	1
DIPTERA	
Chironoidae	2

*Note: Ciruelas River Analysis. 2002

3.2.2.2 ECOLOGY OF FAUNA

This section contains an analysis of the ecology of the aquatic and terrestrial fauna, which is extremely important for the project due to its conditions of study and the information it provides. The inventory of the same can be seen in detail in Chart 3.23, previously described.

Benthos

Macroinvertebrates, important components of the aquatic system (mainly Ciruelas River), are organisms that comprise the benthos of the rivers and brooks and those organisms that live in a very close relationship with the bottom, whether to adhere themselves to it, to excavate it, to move on its surface or to swim close to it, without going too far from it.

Fish

Like much of the aquatic fauna, fish present different behaviors, because of the modification of their habitats, due to reproduction or to feeding habits, therefore it is possible to find carnivorous, herbivorous and omnivorous fish, and as we will see in the description of the main group, poecilids feed on insects, an important base of their daily diet, and therefore their study as a group is very important in aquatic systems. Next is the description of the main groups of fish found in the sampling made in the Ciruelas river, inside the property of the ICE.

Poeciliidae Family: (Poecilia gillii): They are small viviparous fish, which vary between 8 and 150 mm long. It is one of the most domineering fresh water groups of the area of study. They inhabit the shallow waters of small and large flow rivers, and with large or small amounts of vegetation, and others have adapted to the crystalline and cold brooks of the mountains. The color and characteristics of the male genital organs are used for their classification (Bussing, 1987).

Reptiles

Mammals, reptiles and amphibians are more difficult to observe in the field. Of these, the presence of lizards and “*chisbalas*” was observed, in addition to the common toad. According to the Distribution zones of the Costa Rican Herpetofauna (Savage and Villa 1986), the area is located in the zone comprised in the Bajuras of the northwest Pacific, adjacent hills and Central Western Plateau (NW).

Costa Rica has 150 species of amphibians and 212 species of reptiles, while in the zone earlier mentioned there is very little sampling, but due to the reduced size of the area of influence of the project and to the small quantity of specimens of reptiles and amphibians, it is not possible to infer any impact by the project.

Birds

Due to the total elimination of the forest in the direct influence area of the project and surroundings of the indirect influence area and consequently in the project site, due to the use of agriculture, there has been a reduction or almost disappearance of the typical components of the region's fauna.

The project is located in a strongly disturbed area, then it is considered that the fauna associated with it is not so representative of the vegetative associations and life zone, due to the strong alteration of the primary forest coverage, which appears in the form of small residual patches on the river banks and to the east of the property (small forest in the property of the Rudin family).

Urban growth in the region exerts an anthropocentric effect towards the tree areas of the region, which has caused the most representative group of fauna to be the avifauna component in this sector, moving towards other more tree bordering regions where feeding and nesting places are located.

Chart 3.23 of the fauna reported above shows the species of birds that are located for the most part in the zone outside of the project, which shows the presence of species of birds accustomed to coexist in disturbed areas (*comemaíz*, *zanate*, *piapia*, quail) among others.

The avifauna observed is more related with open zones with warm temperatures, which allow them to alternate in several successive ecological stages, wooded grazing lands with their lower stratum dominated by grasses and semi-woody pastures and patches of intervened secondary forests.

The avifauna present in the area is comparative to that of the rest of the Central Valley, intervened both by agricultural and urban activity, presenting species that have adapted their feeding and behavior habits to the presence of humans.

The main component of the fauna is the avifauna, which is the one that can be most affected by the project.

The status is dominated by the permanent resident birds (38%), whereas the transitory migratory birds are 30%. The resident ones, which do not reproduce and which stay in the zone for several months, are 20%. The predominant habitats are dominated by the species of open or very disturbed habitats with 46% and the species of wooded habitats that appear in 36%.

Mammals

Due to the degree of alteration of the area, the presence of big mammals is not very likely (with the exception of the Congo Monkey, *Alouatta palliata*), but it is not so for the presence of the bald fox, the armadillo, the wild rats and the squirrel, which have learned to coexist with grassland vegetation and dispersed trees.

Chapter 4

4.2.1 Population

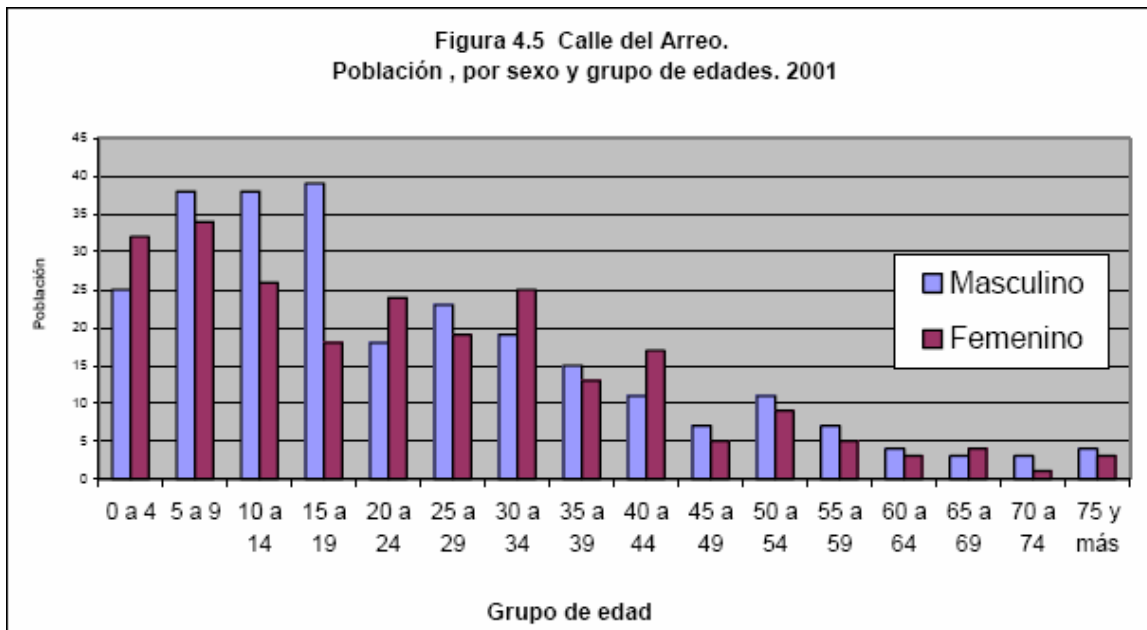
The two closest settlements to the Project area are La Calle del Arreo and Ciruelas; therefore, they are the object of this chapter and will be analyzed separately due to their particular characteristics.

La Calle del Arreo (Prod Street)

What it is known as La Calle del Arreo, are vestiges of what it was the main road in Costa Rica, between Costa Rica and Nicaragua, and between Costa Rica and Panama. This old route was probably named like it because cattle were transferred (prod) up to Nicaragua. It was no longer used once the Interamerican Highway was built in 1959 (Figure 4.4).



In the sixty's, this road started to get populated by families who arrived from different parts of the country but especially from Guanacaste who worked as laborers in new sugar cane plantations of Ingenio El Palmar (reference is later made to the Ingenio, the sugar mill). In the seventy's when social movements started in Puntarenas, new comers limited the land and constructed their houses. Afterwards, ICE and AyA Institutions should install electricity and potable water services.



Fuente: CCSS. Área de Salud Montes de Oro. 2001.

Currently, and according to CCSS(Social Security Office) data, total population of La Calle del Arreo is 503 inhabitants of whom, 53% are male and 43% are female (Chart 4.5), and 30 of these individuals are foreigners (80% of foreigners are Nicaraguans).

There are 123 families and the average inhabitants by household is 4%; most of these people work at the Ingenio El Palmar (sugar mill) and during low sugar season, between August and November, men go to work as coffee grain collectors.

Ciruelas

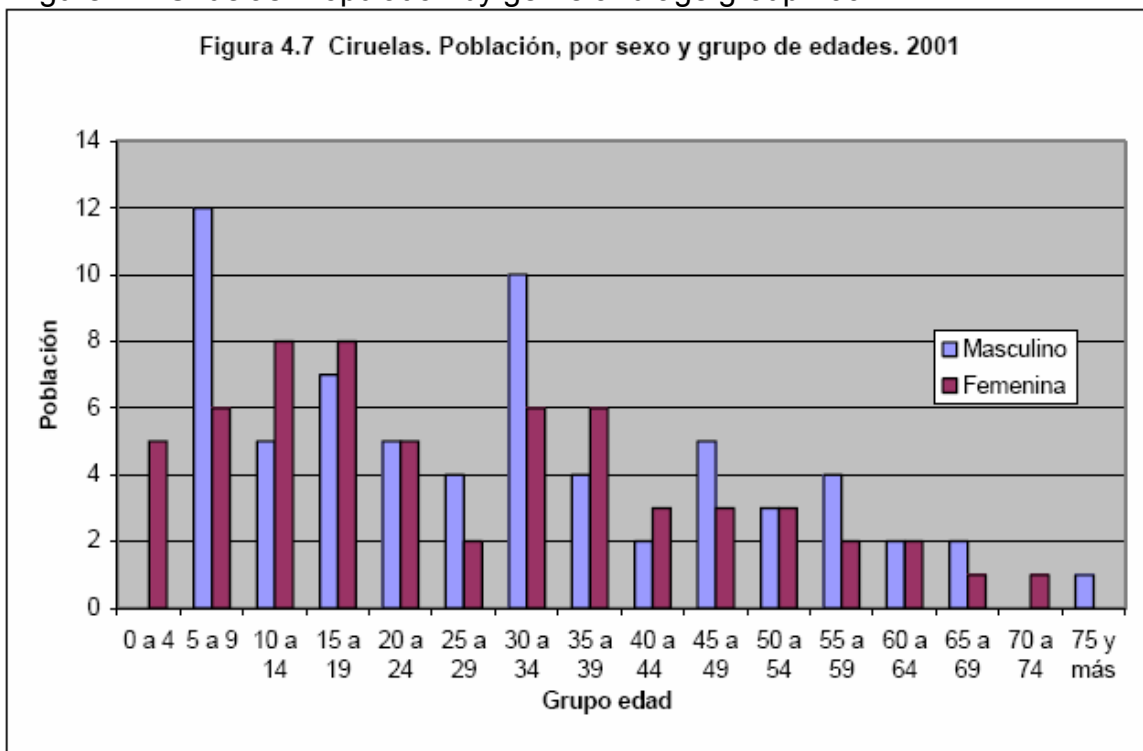
Ciruelas is not a typical rural community of our country but a place where there are big cattle and industry farms, one next to the other.

Los Miranda, los Rudín-Arias, los Elizondo and los Matamoros are families who live here since 1960 and some before this time. For example, of 30 houses there, five belong to families that are not the owners of the land, they are located next to the Río Seco river in poor conditions; in three of the rest live the owners of the farms and in the rest workers of the farms. (Figure 4.6)



Figure 4.6 Ciruelas School

Figure 4.7 Ciruelas. Population by genre and age group 2001



Fuente: CCSS. Área de Salud Montes de Oro. 2001

127 inhabitants make up the Ciruelas population of whom 52% are male and 48% are female. There are 30 families and the average inhabitants per house is 4.2%. According to CCSS there are two foreigners (Figure 4.7).

4.3 Socio Economic Characteristics

4.3.1 Land Possession

Big properties are the characteristic of the Project zone; as it is described by the Extensionista Agrícola del Ministerio de Agricultura y Ganadería (MAG), “extremely concentrated” [land]. El Ingenio El Palmar operates in 6000 has. while other farms use 1000, 300, 200 and 100 has. For example, owners of La Calle del Arreo have small lots where they have their houses and some trees which provide them shade; in Ciruelas, small owners are located close to Río Seco in small lots where they built five houses in poor conditions. Most of the Ciruelas population lives in the farm houses where they work.

4.3.2 Current use of the land

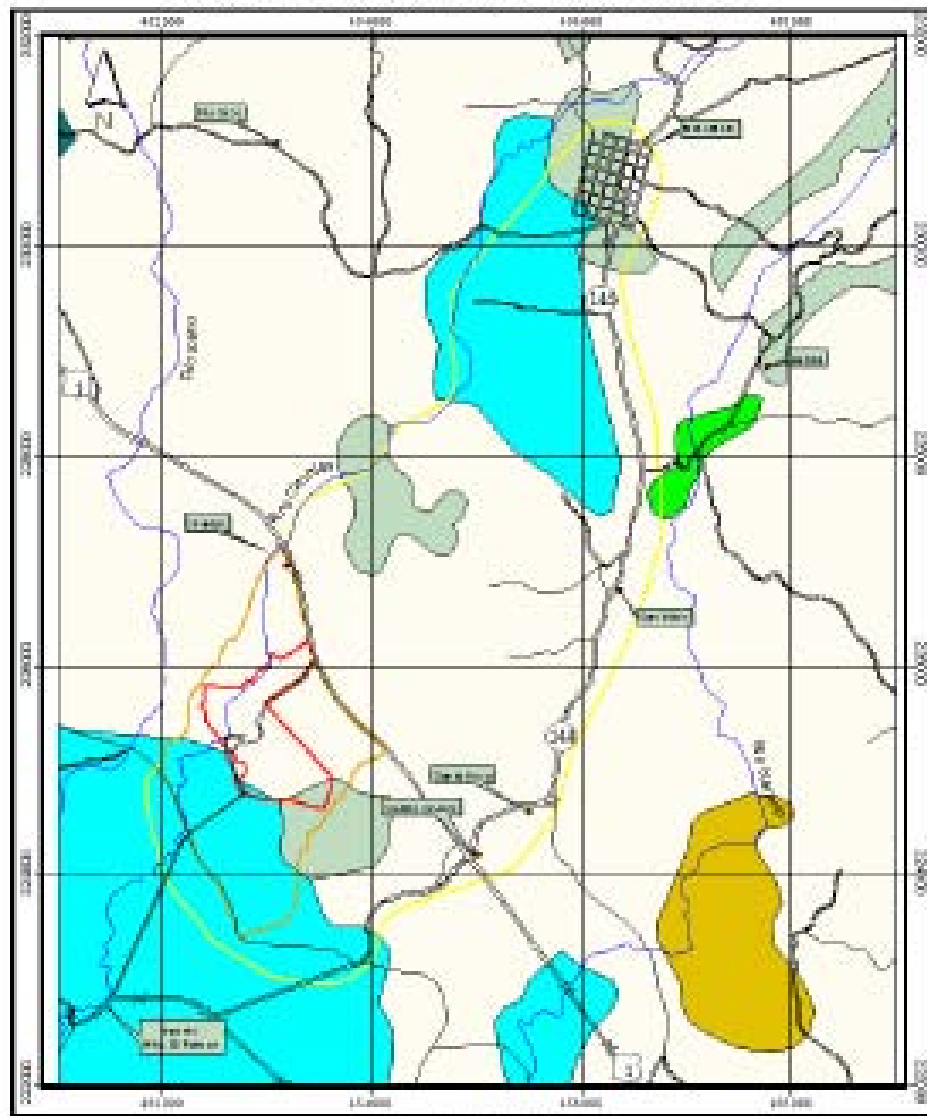
For soil usage analysis, the Terra Project aerial pictures of December 1997 and March 1998 at a scale 1:40:000 were used. In the zone closest to the Project, soil is used for agriculture. There are big extensions of grass and trees which evidence an extensive cattle activity.

Similarly, there are big areas to grow sugar cane (*Saccharum spp*) whose production is processed in the mill located in the same plantation land. Other crop of the zone at smaller scale than sugar cane is Mango (*Mangifera spp*) which is sold to ASOFRUT Company for exportation.

Soils are also used for forest; two small industrial zones make up the sugar and rice mills; the urban part which is located in certain parts of the Interamerican highway and some others in what it was the old Calle del Arreo.


USO ACTUAL DE LA TIERRA CENTRO DE GENERACIÓN ELÉCTRICA GARABITO

Figura 4.11



ESCALA 1:50 000

4 Kilómetros

<ul style="list-style-type: none"> Línea de agua Faja de protección Línea de acceso a la zona de CGL Línea de acceso a las vías de CGL 	<ul style="list-style-type: none"> Área con cultivos Área con cultivos de alta productividad Área de pastoreo Área de pastoreo de alta productividad Área de pastoreo de baja productividad Pastos Área urbana 	<p>COMITÉ DE OVEJÍN AMBIENTAL</p> <p>Solitario : Geog. Victoria y Bello snc</p> <p>S.J.G. - La Faja, Antioquia</p> <p>Diciembre, 2000</p>	 <p>INSTITUTO COLombiano de Estudios y Promoción del Medio Ambiente</p>
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4.3.2.1 Agricultural and Industrial Activities:

As it has been mentioned, agricultural, industrial and cattle activities are practiced in the surroundings of the AP. The industrial one includes industrialization of rice, sugar and production of animal food. Cattle activities are focused on breeding of pigs and sheep with two purposes, mostly for meat and the rest for milk.

Industry is the main activity in the zone; reference is made to it separately.

El Ingenio El Palmar, started operations in the zone since 1959 in farms that were used for cattle. Lots were purchased by Mr. Mario Miranda Arrinda, Cuban, who arrived in the country in 1960. Currently, sugar mill processes sugar cane produced in the 6500 has of surroundings lots within limits of districts of San Isidro de Montes de Oro and Pitahaya de Puntarenas. From sugar production, which represents 10% of national production, 60% is used in local market and 40% is exported. During “zafra” times, sugar production is equal to 850 to 1 million sugar quintals (Miranda, Com. Per.) (Figure 4.12)



Figure 4.12 “Young” sugar cane plantations of Ingenio El Palmar. On the right, La Calle del Arreo and trees that run along the Ciruelas River in the back.

“Zafra” is the practice of burning sugar plantations completely to cut those afterwards and pick up the harvest. Between December and April of each year the zafra takes place. Zafra in detail is as follows: a worker verifies the lot, usually 4 has. that will be burned, reviews anything that is located around it, if there are crops, foliage is wetted, wind direction is taken into account and fires it. Fires take approximately 10 minutes to reach its fullest strength at 300 °Celsius degrees of temperature; at a distance of 10 meters, temperature reaches 150° Celsius. During “zafra” times, 30 has are burnt per day (Mejía. Com.per) Sugar cane harvest is usually done by men and more frequently by machinery.

Arrocera Miramar (rice mill) started operations in 1951. Three activities done here are rice industrialization, animal food production and bovine and porcine production whose production is sold “in pie”(live) in national market. Rice is partly imported and other is brought from Guanacaste, Parrita, Los Chiles and Quepos. At rice mill premises rice is separated from chaff, packed and sent to market. This production represents 15% of national production. For animal food production it uses yellow corn (imported), soya, vitamins, and wheat and rice derivative products. (Figure 4.13)



Figure 4.13 Rice mill Miramar

4.6 Local Perception about Project

As part of preparation of the environmental impact study, during November and December 2002, there were some meetings held in the communities affected by the Project. General population, local organizations and private companies in the area of the study were invited to participate. (Annex 5).

On November 18, and during an extraordinary session, a project presentation was given to members of the Municipality of Montes de Oro since this is the administrative department who rules over the territories of the influence area. Members of the council were pleased and supported it.

On November 25, in the School of Santa Rosa, a meeting took place with the Development Association of Santa Rosa to tell them about the Project and clarify their doubts. This Association was involved since La Calle del Arreo and Ciruelas community are part of its jurisdiction. Members of the Association were pleased with the electrical generation center construction and operation plans.

On November 26, Project was presented to La Calle del Arreo community and on December 3, to the Ciruelas community in their schools. Those are the closest towns to the site where the Generation Center will be built. General population, private companies, local organizations such as Sports, Health and in favor of Children's Help, in favor of Church's activities, in favor of youth; Solidarity Association of El Ingenio sugar mill, Sugar mill El Ingenio and Rice mill Miramar were summoned. Doubts were satisfactorily clarified and population showed that they were interested on the project, especially for the labor offer that it could represent, although they are positive it will be a temporary one.

In general, native population considers project an opportunity for the industrial development of Ciruelas and as a relevant work source in the zone taking into account that other economic activities will be developed around the Center's operation.

CULTURAL CHARACTERIZATION

4.7 Archeological Patrimony

4.7.1 Archeological and Ethno historical Background

The study zone is located in the Central Pacific area and is part of the Central Archeological Region. According to Corrales (1992), based on evidence recovered in Central Pacific and Central Valley zone, he sets forth that both make up the Central Pacific Archeological Sub region.

In the year 1989, the National Museum started the Central Pacific Archeological Project. This project wanted to assess the characteristics of the area in terms of intermediate location between Gran Nicoya Archeological Region and the Central Intermountain (Corrales, 1992, 1994).

Such research consisted of a systematic prospect (low basin of Tárcoles River, Salinas plain- Tivives swamp, half part of Jesús María River, the Jacó coastal valley explorations and high parts of Parrita valley) where surface collection and excavations were done. A total of 66 archeological sites were reported.

Afore mentioned sites show evidence of the ceramic presence related to Pavas phase (300 a.C.-300 d.C), Curridabat (300-900 d.C.) and Cartago (900-1500 d.C.) of the Central Vallery temporary sequence. Ceramic vestiges related to Tempisque (500 a.C-300 d.C.), Bagaces (300-800 d.C.) and Sapoá (800-1350 d.C) in Gran Nicoya were also reported. This fact confirms the close relationship of

both regions. Another archeological site, where employees of National Museum did research on in 1997, was the Orocú deposit located in the town of Chomes.

A test was made here over a funeral mound detecting ceramics related to Bagaces and Sapoá periods as well as to Curridabat phase (Guerrero, J.V, personal conversation, 2002).

The closest archeological sites to the land where thermal plant will be built are Aranjuez deposit (P-200 Ar), located in the town of Aranjuez and Palermo site located 2 km northwest from Aranjuez. Due to a complaint, this site was visited because natural phenomena was destroying it since the river left the site uncovered and neighbors took advantage to “plunder” the site. Ceramic material observed belong to Bagaces period (Hernández, A.C. and M.Castro, 1998).

The Aranjuez deposit was probably a funeral site according to people in the zone. Many river pebbles and ceramic pieces were extracted related to period Bagaces.

First written data about Indian population in the study are tracked down to the XVI century. According to Ibarra (1998), the main Indian group in the region was Nicoya and among other main groups in the coastal zone in the Nicoya Gulf are Corobicí, Abangares, Orotina and Chomes. This last group controlled the territory where the thermal plant is planned to be built.

Existing information on the Chomes Indian group is scarce but due to its geographical location is probably that existed in close relationship (socio economic activities) with Central Valley groups.

According to collected data from archeological works and first written data done in the Central-Pacific Archeological Sub region, works done in the study area are scarce and particular; the zone needs further research to get to know better the human settlement patterns of old inhabitants and their interrelations with their closest groups (Central Valley and Gran Nicoya).

5.1 PHYSISCAL ENVIRONMENT

5.1.1 Impact on surface and underground waters

In chart 5.2, there is a summary of the possible impacts and its valuation on surface and underground waters within the area of direct influence of The Garabito Electrical Generation Center. As there can be seen it will not represent a significant impact.

**Chart 5.2
Valuation of the Impacts on Superficial and Underground Waters**

Impact	Probability	Intensity	Extension	Duration	Reversibility	V.I.A

Underground waters						
Fuel Leak Pollution	5	2	5	2	5	3.80
Surface Waters						
Domestic/Residual Waters	2	2	2	10	2	3.60

Underground Water Pollution due to Fuel Leaks:

Probability

Given median permeability of the surface lithology and the fact that most of the works will be based directly on the ground, at a period of contingency although it is not probable that it occurs, it could happen stored or transported fuel spills on the way to the plant polluting the freatic level.

Intensity

The potential sites to be altered are limited. Intensity would be affected by the magnitude of the spill, and any pollution made to the freatic level will quickly disappear due to the proximity of neighboring rivers. Intensity of pollution is low.

Extension

Considering that eventual pollution is associated to the sites where fuel is moved or stored, extension to be altered is considered medium.

Duration

Given the analyzed contingency, it will be rapidly flushed considering its closeness to the Ciruelas River canon, but probability of occurrence would take place in the long term considering it an improbable risk, determining an indicator of occurrence of 2.

Reversibility

In the occurrence of a spill, and the impossibility to recover the rocky environment affected, it has a value of 5.

Superficial Waters: Domestic / Residual Waters

Probability

The probability of generating domestic or residual waters, as a result of plant operation is low.

Intensity

The institutional controls in handling residual waters will appear as the result of a contingency or the irresponsibility of the personnel, for which the intensity is considered low.

Extension

The limited scope of an accident with residual waters and the area to be affected determine a value of 2.

Duration

The possibility of a human error, mainly at the beginning of plant operation, makes it last for a short period of time.

Reversibility

Recovering a deteriorated area due to residual waters is considered equal to 2.

5.1.2. Impact on the Resource: Air

The main impacts on air are identified along the different stages of the project; such relevant impacts are included in the Environmental Management Plan:

Construction Phase:

Quality of Air vs. Cleanness of the site
Quality of Air vs. Excavations
Quality of Air vs. Constructions
Quality of Air vs. Movements of the ground
Quality of Life vs. Noise Generation
Quality of Life vs. Dust Generation
Roads and highways vs. Movement of the ground
Movement of the ground vs. Fauna
Movement of the ground vs. Flora

Operation Phase:

Gas emissions vs. Quality of air
Gas emissions vs. Fauna
Gas emissions vs. Flora
Gas emissions vs. Affecting quality of the rain (acid rain)
Gas emissions vs. altering local micro weather
Gas emissions vs. increase of particle concentration
Power Generation vs. Liquid residue pouring
Power Generation vs. Solid residue generation
Power Generation vs. Noise Generation
Power Generation vs. Vibration generation
Power Generation vs. Solid Waste Production

Maintenance and Contingency:

Quality of air vs. hydrocarbon spill
Quality of air vs. fire
Superficial water vs. fuel spill

Superficial water vs. oil spill
Superficial water v. centrifugation mud and purge of tanks
Maintenance vs. solid toxic waste generation
Maintenance vs. solid metal waste generation
Maintenance vs. purge waste production
Maintenance vs. cleaning cooling systems

The impacts present environmental interactions between the proposed actions by the project and environment, and at the same time environmental actions are presented over the project.

Project Actions on Environmental

Construction Phase:

Quality of Air vs. Cleanness of the site
Quality of Air vs. Excavations
Quality of Air vs. Constructions
Quality of Air vs. Movements of the ground
Quality of Life vs. Noise Generation
Quality of life vs. Dust Generation
Quality of life vs. Preliminary Temporary Works
Roads and highways vs. movements of the ground
Movements of the ground vs. Fauna
Movements of the ground vs. Flora

Operation Phase:

Gas emissions vs. Air Quality
Gas emissions vs. Fauna
Gas emissions vs. Flora
Gas emissions vs. Rain quality (acid rain)
Gas emissions vs. altering the local micro weather
Gas emissions vs. Particle concentration increase
Energy Generation vs. Liquid residue spill
Energy Generation vs. Solid residue generation
Energy Generation vs. Noise Generation
Energy Generation vs. Vibration generation
Energy Generation vs. Solid waste Production
Energy Generation vs. Effects on life quality for Barrio Santa Lucia and Libertad 81 inhabitants
Noise Generation vs. Fauna
Install light vs. Alter night fauna behavior

Maintenance and Contingency:

Quality of air vs. hydrocarbon spill
Quality of air vs. fire
Contingencies vs. air temperature
Aquiferous water beds vs. fuel spill

Aquiferous water beds vs. oil spill
Aquiferous water beds vs. centrifugation mud and purge of tanks
Maintenance vs. solid toxic waste generation
Maintenance vs. solid metal waste generation
Maintenance vs. purge waste production
Maintenance vs. cleaning cooling systems

Environment Actions on the Project

Construction Phase

Metallic structures corrosion due to sea breeze action
Floods in the excavation sites due to precipitation

Operation Phase

Metallic structures corrosion
Weather condition changes in the area

Maintenance and contingencies

Deliberate fire
Hurricane
Water system breaking

Impact Identification and Description According to Interaction:

Gas Emissions vs. air temperature

When Plant starts operation hot gases will be generated product of combustion. These gases will produce the following impacts:

- a. Alter air temperature around the plant
- b. Generate turbulence accelerating convection process of the air masses.

a. Air Temperature Increment

Probability

During operating stage of the plant, in single mode, gas temperature will be approximately 539°C, in the Combined Cycle, temperature will be 175°C. This sets up a contrast with the 28°C room temperature reported in the area. The probability that the air temperature increases in the immediate area around the plant is high, for which 10 is assigned.

Intensity

The effects of the air temperature increase will be intense in the area closest to mouth of the chimneys, but localized and reduced to a small range around them. At floor level (2 m), intensity is considered low for which a value of 2 is assigned and a high value if the intensity is measured at the mouth of the chimneys; just over the vertical exit of the chimney, at 25 m over floor level, intensity is high so a high value of 10 is assigned.

Extension

The effects of hot air are enclosed within project area at 50 m range of the plant and will take place by means of radiation, for which it is considered a very located in a specific point effect and a value of 2 is assigned. If the extension of the hot feather is considered, the effect would be local and would have a value of 5. Nevertheless, the distance hot air needs to travel to cool down to room temperature given the particular topographic conditions is unknown.

Duration

The effect will be permanent from the moment the machine is turned on and will cease only for maintenance and emergencies. A value of 10 is assigned.

Reversibility

The process is irreversible unless the plant is shut down or equipment to recover heat is installed (like a boiler in a combined cycle) in which case it will be mitigated, for which it is assigned a value of 10 in an open cycle.

Nevertheless; when the combined cycle starts the gas temperature of chimneys will go down to 70%, for which a value of 5 is assigned.

b. Air Turbulence increase:**Probability**

When a column of hot air is released in the atmosphere, the difference of temperature will force cold air masses to move down by movement of the hot air masses. Inevitably, at the area of the project, there will be an increase of air turbulence favored by the presence of the chimney and Engine Room and Control Center buildings. A low value of 2 is assigned.

Intensity

Information available on turbulence intensity is unknown but it is assumed that is low when facing dominating atmospheric systems in the Project Zone. A 2 value is assigned.

Extension

Very located in a specific point and will hardly go beyond the area of the Project with perceptible effects, a low value of 2 is assigned.

Duration

It is high because it will extend while the plant operates. A value of 10 is assigned.

Reversibility

Even if there is a possibility to reduce air turbulence by designing underground buildings, making structural design using aerodynamic criteria, adding natural barriers against wind, all these measures are expensive and will only mitigate the effect. A high value of 10 is assigned.

Contingencies vs. Air Temperature

It is expected that the cases considered here will never occur

- a. Plant Fire
- b. Fuel tank Fire
- c. Induced fires in surrounding areas

a. Plant Fire:

Probability

It is considered low due to the fire control measures included in the plant design. A low value of 2 is assigned.

Intensity

In case of fire in the plant, the intensity would be medium due to the fire control measures included in the design for these situations. A value of 5 is assigned.

Extension

It is located in a specific point effect. A value of 2 is assigned.

Duration

It is short. A fire would not last more than 12 hours if fuel storage is close. Value=2

Reversibility

In case of a fire in the plant the effects will be irreversible. Value=10

b. Fuel Tank Fire:

Probability

Due to the fuel storage and movements it is considered fire proof under normal circumstances; such an emergency is considered not very probable. Value=2

Intensity

If fire occurs in the fuel tanks due to the high volume stored (5 million liters in each tank, 3 tanks total) the intensity would be considered high, for which a value of 10 is assigned.

Extension

The effect will be located in a specific point without exceeding the area of the project. Value=2

Duration

Short, no longer than 24 hours. Value=2

Reversibility: Irreversible. Value=10

c. Induced fires in the surrounding areas

Probability

Medium=5, as this is a periodical process that happens every year and is provoked by the landowners for the “zafra” or for people who visit these empty lots.

Intensity

The effect of this activity upon the project will be limited to the annoying smoke and its intensity would be low. Value=2

Extension

Due to the fire nature, an induced fire is located in a specific point. Value =2

Duration: Short, Value=2

Reversibility: The effect upon the environment is reversible. Value=2

Air quality vs. Cleanness of the site

Possible impacts here are:

- a. Dust generation
- b. Respiratory affection increase
- c. Scenery deterioration
- d. Increase of air opacity
- e. Smell generation

a. Dust Generation:

Probability

If the process happens in the dry season, a great amount of dust will be produced when cleaning the site for the project. High value=10

Intensity

Removing the green cover of the ground (grass) will be low. There is no big impact expected. Value=2

Extension

Located in a specific point, only on the project area Value=2

Duration

Short, no more than 3 weeks. Value=2

Reversibility

The process can be mitigated, covers can be placed on top of the ground avoiding wind blows the soil. Value=5

b. Increase of Respiratory and oftalmologic affections

Probability

Low=2, Being an unpopulated area, the sample cannot be measured or controlled.

Intensity

It will have a low effect due to the fact that the area is pretty much unpopulated.
Value=2

Extension

Effect will be located in a specific point, limited to the area of the project. Value=2

Duration

Short duration while works are done. Value=2

Reversibility

Totally reversible process Value =2

Scenery Deterioration

Probability

Site cleaning will provoke a change in the scenery. Probability of its occurrence is medium. Value=5

Intensity

When vegetal cover is removed, alteration will be partly intense and it was assigned a value = 5

Extension

Effect over Project area solely Located in a specific point Value=2

Duration

Short duration, less than a year Value=2

Reversibility

Effects can be mitigated once works have finished. Value=5

d) Increase of air opacity

Probability

When site is cleaned there will be a fine dust layer that will make air opaque in the Project area, but it will depend on the season when works are done. Value=5

Intensity

Phenomenon will be temporary and not intense. Value=2

Extension

Located in a specific point in the Project area. Value =2

Duration

Short duration, less than a year. Value=2

Reversibility: Recoverable through replacement of vegetal coverage. Value=2

e)Smell generation:

Probability

Smell generation will happen for removal and organic matter death in presence of humidity and rains. Nevertheless, it is no probable that it happens during dry season. Value=2

Intensity

Either on dry or rainy season, an intense impact is not foreseen. Value=2

Extension

Located in a specific point in the Project area. Value=2

Duration

Short, limited to site cleaning term, no longer than 2 weeks. =2

Reversibility

Totally recoverable=2

Air Quality vs. Highways and roads

There is no new road construction planned with Plant construction but widening and improvement of existing access roads is included. In addition, side road construction is foreseen for equipment transportation up to plant location.

The following impacts on quality air are foreseen:

- a) Dust generation
- b) Respiratory affection increase
- c) Scenery deterioration
- d) Increase of air opacity
- e) Smell generation

a)Dust Generation

Probability

It is not probably that there will be more dust than the existing one in the zone roads. Value=5

Intensity

Small or no effect extra over current system conditions. Value=2

Extension

Located in a specific point in regards to route only and it will depend upon the route selected to transport equipment: truck or train. For both selections value=2

Duration

Short, limited to road improvement and equipment insertion. Value=2

Reversibility

Effects can be mitigated and easy to solve. Value=5

b) Respiratory affections increase**Probability**

Low. The zone is already altered, and then any road improvement will only benefit it. Value=2

Intensity

Light. Effects will be positive. Value=2

Extension

In the event of respiratory affection increase, effects will be limited to road side places. Located in a specific point. Value=2

Duration

Short, less than a year=2

Reversibility

Recoverable. Any improvement in the access roads implies a zone improvement. Value=2

c) Scenery deterioration:**Probability**

Low. It will be a positive impact. Value=2

Intensity

High intensity in scenery deterioration is not expected. relevant improvement is rather expected a Value=2

Extension

Located in a specific point. Limited to access roads. Value=2

Duration

Short, while Project operates. Value=2

Reversibility

Recoverable, although it is not expected that it will return to what it was. Value=2

d)Air opacity Increase:**Probability**

Low. Whenever roads improve, air clarity increases. Value=2

Intensity

Low. Intensity is not expected for an increase in the air opacity. Value=2

Extension

Located in a specific point. Value=2

Duration

Short. While roads are maintained in good conditions, opacity will not occur.
Value=2

Reversibility

Recoverable, although that is desirable no to return to current conditions. Value=2

e)Smell Generation:**Probability**

Low, limited to materials used for road improvement. Value=2

Intensity

Light, almost null. Value=2

Extension

Located in a specific point, it will extend to road improvement at the most. Value=2

Duration

Short, while machinery works on road improvement. Value=2

Reversibility

Recoverable. Effect to less than a day. Value=2

Rain vs. Gas emissions

Possible impacts would be:

a. Acid rain:

Probability

High. Since gas is out of chimney contact clouds in the sky and produces condensation, SO₂ molecules turned oxidized into sulfurous acid and from there by

oxidation into sulfuric acid. Nitrogen oxides will be released almost in form of NO₂ which, through same way will derived into nitric acid. With CO, it can get oxidized into CO₂ or into the acid form as carbonic acid. Value=10

Intensity

Low. Plant contributions compared to global emissions will not significantly alter current conditions. Value=2

Extension

Unknown. It is assumed that is local, but it depends on weather variables. Value=5

Duration

Long. It is present while plant operation, although a phenomenon could occur in absence of plant operation (due to pollutants emitted by other sources). Value=10

Reversibility

It can be mitigated with filter installation. Value=5

b) Increase in metallic surface corrosion exposed to rain action

Probability

Medium in close areas in the plant. Value=5 and low in further areas.

Intensity

Low in leeward. Value=2 medium at windward. Value=5

Extension

General, the effect cannot be contained in a limited space. Value=10

Duration

Long while plant operates.=10

Reversibility

It can be mitigated through application of pain and filters. Value=5

c) Partial or total effect on vegetal coverage and crops

Probability

Low. It will be present in conditions of low circulation of air. Value=2

Intensity

Low. Plants can show a temporary wilting, especially when rainy season starts. Value=2

Extension

Located in a specific point in the plant area. Value=2

Duration

Long. The phenomenon is susceptible to occur while the power plant is in operation. Value = 10

Reversibility

Reversible, permanent damage is not expected. Value= 2

d) Reinforced concrete abrasion

Probability

Low. In extreme rain acidity conditions, it could present superficial abrasion. Value = 2

Intensity

Low. Significant changes are not expected. Value = 2

Extension

Specific. Limited to the project area. Value = 2

Duration

Long. Effects will be seen in the long term. Value=10

Reversibility

Irreversible. One the surface is damage; the plaster has to be replaced. Value= 10

e) Respiratory and ophthalmic affection incidence increase

Probability

Medium: If there is acid rain. Value = 5

Intensity

Medium. It depends on the sensibility of each organism. Value= 5

Extension

General. Since it depends on the sensibility of each organism, the impact could be perceived out of the specific area. Value= 10

Duration

Long. Immediate phenomenon manifestation while the power plant is in operation. Value =10

Reversibility

It can be mitigated using adequate filters, a good maintenance program and good fuel quality. Value= 5

f) alteration of the chemical soil composition

Probability

Low. The amount of acid rain is insufficient to cause changes on the chemical composition of the soil. Since those soils present a volcanic origin, there is relevant sulfur insufficiency, so it is expected that the soil absorbs this mineral. Value = 2

Intensity

Low. The effect will not be perceived further than the first centimeters of humus, if the vegetal cover has not retained them before. Value = 2

Extension

General. The system can not be kept closed. Value =10

Duration

Long. Effects, if any, will be perceived in the long term. Value = 10

Reversibility

It can be mitigated, if using adequate filters. Value= 5

➤ Humidity vs. Gas Emissions

It is expected a small increase in the relative humidity levels in the area surrounding the plant, but global effects are null.

a) Relative Humidity increase

Probability

High. With combustion and the cooling tower, there will be a relative humidity increase. Value = 10

Intensity

Low. The phenomenon will be less intense in the plant area. Value = 2

Extension

Located in a specific point, it is no farther than the project area. Value = 2.

Duration

It is long while the plant operates, while manifestation will be immediate. Value =10.

Reversibility

It is irreversible. Value=10.

➤ **Weather vs. gas emissions**

The probability that such a specific effect affects weather; even at a local level is practically zero. The summary below shows the main impacts on the air resource (chart 5.3)

Chart 5.3
Impact values on air

Impact	Probability	Intensity	Extension	Duration	Reversibility	V.I.A
Emissions vs. Temperature						
Air temperature increase	10	5	2	10	2	6.20
Air turbulence Increase	10	2	2	10	10	6.00
Contingencies vs. Temperature						
Fire of the plant	2	5	2	2	10	3.7
Fire of fuel tank	2	10	2	2	10	5.2
Quality vs. cleanness of the site						
Dust generation	10	2	2	2	5	4.3
Air opacity increase	5	2	2	2	2	2.6
Quality vs. roads and highways						
Dust generation	5	2	2	2	2	2.90
Air opacity increase	2	2	2	2	2	2.00
Quality vs. Preliminary works						
Dust generation	5	2	2	2	5	2.9
Air opacity increase	5	2	2	2	2	2.6

Quality vs. Excavations						
Dust generation	10	5	2	2	5	4.8
Air opacity increase	5	2	2	2	2	2.6
Quality vs. Emissions						
Gas emission	5	5	10	5	5	6.25
Change of air by emissions	10	5	2	10	2	6.2
Air opacity increase	5	2	5	10	5	5.1
Quality vs. Noise and vibrations						
Noise / vibrations	10	5	5	10	5	6.75
Rain vs. Emissions						
Acid rain	5	2	5	10	5	4.85
Corrosion increase on Metallic surfaces	5	5	2	5	5	4.5
Humidity vs. emissions						
Relative humidity increase	5	2	2	10	10	4.85
Weather vs. emissions						
Local and regional weather change	0					0

5.1.2.1. Diesel combustion pollutants

A brief description of the most important pollutants produced by diesel # 2 combustion is below.

Sulfur Oxide

As a result of combustion, it generates a series of sulfur oxides in different proportions (SO₂ -98% and SO₃ -1-2%). The SO₂ is not flammable and is

uncolored; it has a strong and irritating smell in concentrations over 3 ppm. It is 2.2 heavier than air (Sanz Sa, 1991). In high concentrations it produces a fetid and irritating smell. It is soluble in water and in the atmosphere it can react with oxygen to become trioxide of sulfur, which in the presence of humidity produces sulfur acid. Sulfur dioxide is easily absorbed over material particles and other surfaces that contact it.

It is estimated that its shelf life is 4 days in the air, but it varies considerably with temperature (Open University, 1975, cited by CCT, 1989).

The sulfur compounds are responsible for damaging metallic structures, the sulfur oxides accelerate corrosion when in contact with relative humidity and temperature, especially when the level of relative humidity is over 70%. On the other hand, sulfurous and sulfuric acids are able to attack some non-metallic construction materials such as, limestone, marble, roof slate and mortar with which the acids make sulfates very soluble with water, that are later washed out with the rain (Wark and Warnes, 1990).

The effect of being exposed to SO₂ on human health is varied, from simple irritation of the respiratory system to death. In chart 5.4 are shown the main effects of SO₂, smoke and particles in suspension to different concentrations on human health when individuals are exposed for long periods.

Some animal species, including humans, react to SO₂ with bronchiole constrictive affections. When exposed to long periods the effects of SO₂ combined with relative humidity and particles constitute a serious potential danger to health (Wark and Warnes, 1990), as shown in chart 5.5.

➤ Nitrogen Oxides

In the combustion process there can be generated up to 8 different types of nitrogen oxides, but the most important ones are NO and NO₂. NO is a toxic gas, has colorless, odorless and it is not inflammable. NO₂ is a reddish gas, it is not inflammable, but it has an asphyxiating smell (Zans Sa, 1991).

The nitrogen oxides generate by means of two mechanisms:

- a. Nitrogen fixation, by the reaction between the nitrogen molecules present in air and oxygen, given the high temperatures in the combustion chambers (1300 to 2500°C).
- b. The oxidation of nitrogen compounds contained in fuel.

Chart 5.4

Relation between Exposition and Effects for Sulfur Dioxide, Smoke and total particles in suspension, Effects to long exposures:

Concentration		Annual Medium concentration based on medium values of 24 h (mg/m ³)	Effects
SO ₂	Smoke		
200	200	-	Sheffield, England, Increase of children respiratory affection Lunn et al., 1967, 1970)
-	-	180b	Berlin, New Hampshire, EUA, respiratory symptoms increase, adults respiratory function decrease (Ferris et al., 1973)
150	-	-	England and Wales, Increase of children respiratory affection (Colley and Reid, 1970)
125	170	-	Krakovia and Poland, Increase of adults respiratory affection (Sawicki, 1972)
140 ^d	140 ^d	-	Great Britain, Sheffield, England, Increase of children respiratory affection (Douglas and Waller, 1966)
60-140a	-	100-200 ^c	Tokyo, Increase of adults respiratory affection (Suzuki and Hitisugi, 1970)

- a conduct metric automatic method
Device for big volume samples (2 month average, possible from the annual average)
- b
- c Light dispersion method, results not comparable directly to the rest
Calculation based on observations done after study was concluded, probable underestimation of the exposure during the first years of the study
Sanz Sa, J.M. the atmospheric pollution, Ministry of Transportation, Madrid, 1991, (80)
- d

Note: the rest of the measurements have been taken through the method of the Economic Development and Cooperation organization or using the British method for sulfur dioxide or smoke (Ministry of technology, UK, 1966, Economic Development And Cooperation Organization, 1965)

Chart 5.5

Relation between exposition and effects to the sulfur dioxide, smoke and the particles in suspension total: Short term exposition effects

Annual average Concentration based on Average Values of 24 hours (mg/m ³)		Particles in Suspension Total	Effects
SO ₂	Smoke		
>1000	>1000		London 1952, an import increase in the mortality index. It was triple than normal during five days of fog. Pollution figures are average for the entire region: maximum (central site) of SO ₂ 3700 mg/m ³ , of smoke 4500 mg/m ³ (Ministry of Health, UK, 1954)
710	750		London 1958-1959 Increase of the daily forecasted mortality index up to 1.25 (Lawther, 1963; Martin and Bradley 1960)
500	500		London 1958-1960 Increase of the daily mortality index (as above) and of hospital registration when the pollution indexes exceeded (its magnitude constantly increased with pollution) (Martin 1964)
500			New York 1962-1966 Correlation between mortality and pollution excess of the 2 for 100 in the indicated level (Bruechley, 1973)
500	250		London, 1954-1968 Increase in the symptoms recorded by means of logs with broncheolitic patients when indicated pollution levels exceeded (entire zone measurements) (Lawther, et al., 1970)
300	140		Vlaandingen, Netherlands, 1969-1972 temporal descent of the ventilatory function (Van der Lender, et al., 1975)
200 ^a		150	Cumberland, West Virginia, USA Asthmatic crisis frequency increase in a small group of patients when indicated pollution levels exceeded (Cohen et. Al., 1972)

a West-Gaeke Method

b Big volume sample method

Source: Sanz Sa. J.M. La Contaminación Atmosférica. Ministry of Public Works and Transportation. Madrid. 1991 (81).

Note: The rest of the measurements were made using the Cooperation and Economic Development Organization y by British method for smoke and the daily SO₂ (Ministry of Technology, UK, 1966; Cooperation and Economic Development Organization, 1965).

The NO_x do not damage materials, but in combination with water, the NO_2 s react forming nitric acid, a very well known corrosive agent of metallic surfaces. The NO_2 absorbs visible light and in a concentration over 0.25 ppm causes an important visibility reduction.

In concentration normally encountered in the atmosphere, it is just potentially irritant and potentially related to chronic pulmonary fibrosis. It has been observed a small increase in child bronchitis (2-3 years old) when concentration is lower than 0.01 ppm and in combination with unburned hydrocarbons, the dioxide of nitrogen reacts in the presence of solar light and form photochemical smog.

➤ **Carbon Monoxide (CO)**

Carbon monoxide is a colorless, odorless and tasteless gas; its density is 0.965 the density of air and it is slightly soluble in water. It is flammable and it burns with a blue flame, although it does not maintain combustion. It is highly stable and it has an average lifespan in the atmosphere of between 2 and 4 months.

CO is produced as a result of one or several of the following processes (Sanz Sa, 1991):

- Incomplete carbon combustion.
- Reaction to high temperatures between the CO_2 and materials that contain carbon.
- Dissociation of CO_2 at high temperatures.
- Atmospheric oxidation of methane coming from the anaerobic fermentation of organic matter.
- Process of production and degradation of plants chlorophyll.

CO seems to not have harmful effects on the surface of materials or on the higher forms of plants in concentrations below 100 ppm in exposures of 1 to 3 weeks. (Wark and Warner, 1990)

Effects on health: CO is a gas that, when inhaled, blocks the oxygen receptors in the pulmonary alveoli, preventing the normal exchange of gases to take place. CO is lethal in concentrations higher than 750 ppm. However, exposures to CO for 8 or more hours at concentrations of 30 ppm alter some psychomotor tests (Wark and Warnes, 1990).

➤ **Particles in suspension**

Particles in suspension are those solid and liquid matters dispersed and dragged by air, with a diameter of more than 0.0002 μm , but less than 500 μm . (Wark and Warnes, 1990).

One of the better-known effects of particles in suspension is the reduction of visibility, produced by the absorption and dispersion of light. Particles can be

chemically active or not; if they are not active, their combination with other substances can produce active substances, depending on the chemical composition and on the physical state.

Among the most common damage of particles in suspension we find the “soot” effect, that blackish and sticky film that adheres to clothes, curtains, walls, etc. With the settling of the particles, other direct damages can be generated like intrinsic corrosion, or by the activity of absorbed chemical corrosive substances or absorbed on metallic surfaces.

It has been observed that particles that contain fluorides seem to cause physiological damage to plants, and magnesium oxide produces poor growth of the plant. In animals, the effects of the particles will be manifest with the ingestion of contaminated grasses, whether the plant has absorbed the pollutant or the plant serves as mechanical support for the same. In this aspect, cow and sheep cattle have been observed to be poisoned by arsenic because the grass they ate was covered with particles of arsenic. (Wark and Warnes, 1990)

The side effects over the human health of the particle in suspension are not well defined, however, three mechanism of action are supposed:

- Particles can be intrinsically toxic due to its inherent chemical and physic characteristics. Particles can interfere with one or more mechanisms that usually clears the respiratory system
- Particles can act as a conductor of an absorbed toxic substance
- The side effects in humans are summarized in chart 5.6.

Unfortunately, in Costa Rica there is not control of particle emissions into atmosphere.

Prediction Models

There have been developed diverse methods to predict the leeward emission levels from a transmitter source. Among them, there are the Bigaussian models, which achieve a representation of the physic behavior of the pollutants in the atmosphere.

These models are based on the fact that a column of gases or brush discharge that emanates from a chimney possesses an inner composition of the same gases which are normally distributed in a vertical and horizontal direction of the transversal area of the column.

In this way, the concentration of the leeward emission source can be established as a function of the distance to the source of the Gaussian dispersion parameters for each distance and wind speed at the emission altitude (CCT, 1989).

The brush discharge behavior is directly related to the vertical gradient of the temperature in the atmosphere of the region, which in general terms determines the so-called atmospheric stability. The dried adiabatic gradient or neutral stability has a temperature gradient of $-1\text{ }^{\circ}\text{C}/100\text{m}$, in other words, the temperature

diminishes one degree Celsius per each 100m of altitude. In this condition, a volume of pollutant does not gain or loss floatability after its emission.

The unstable atmospheric conditions with gradients higher than $-1\text{ }^{\circ}\text{C}/100\text{m}$ add floatability to the emission and stable conditions or inversions with gradients lower than the dried adiabatic inhibit the vertical movement. The mixture layer is a region of the atmosphere limited by a layer of hot air that inhibits any movements in ascending direction of a cooler air mass. The altitude of this mixture ledger can affect notably the dispersion process (CCT, 1989)

The configuration of the gas column is affected by the atmosphere stability. Because of this, there has been able to identify different configurations such as, conic form for sub adiatric vertical gradient up to fumigations, when the brush discharges load below the thermo inversion altitude.

The current behavior of the gas column varies as the meteorological conditions of the region vary showing different configurations along the day. This behavior is difficult to predict based on mathematics models which are generally applied just to short term periods of time (between 10 and 60 minutes) (CCT, 1989).

Chart 5.6
Effects on Human Health of the Particles in Suspension

Concentration, $\mu\text{g}/\text{m}^3$	Measurement Time	Effects
60-180	Annual geometric average, with SO_2 and humidity	Acceleration in the corrosion of steel and zinc sheets
75	Annual average	Environment air quality standard
150	Relative humidity lower than 70 per cent	Visibility reduced to 5 miles
100-150	-----	Solar light reduced in one third
80-100	With sulfating levels of $30\text{ mg} / \text{cm}^2 / \text{month}$	An increase may occur in the mortality rate of people over 50 years of age
100-130	With $\text{SO}_2 > 120\ \mu\text{g}/\text{m}^3$	It is possible for children to experience an increase in the incidence of respiratory illnesses
200	Average of 24 h and $\text{SO}_2 > 250\ \mu\text{g}/\text{m}^3$	The morbidity of workers may be caused by an increase in absenteeism

260	Maximum once every 24 h	Environment air quality standard
300	Maximum of 24 h and SO ₂ > 630 µg/m ³	In patients with chronic bronchitis, acute worsening of symptoms may appear
750	Average of 24 h and SO ₂ > 715 µg/m ³	There might be an excessive number of deaths and considerable increase of illnesses

Source: Wark and Warnes, *Contaminación del Aire. Limusa. Mexico. 1990 (40)*.

5.1.3 IMPACT ON LAND RESOURCES

➤ Local topography/landscaping

The main impact this project will cause on the topography/landscaping will take place during construction, when preparing the ground, since the ground leveling works will reconfigure the land surface. Removed materials will be placed in a space designated for the debris in the same property creating a located and temporary topographic change. The construction of the warehouse and administrative building will have a minimum impact on this variable. Chart 5.7 summarizes the impacts on this area.

Chart 5.7
Impact valuation on the land resources

Impact	Probability	Intensity	Extension	Duration	Reversibility	V.I.A
Local Topography						
Preliminary Works	10	2	2	2	2	4.0
Excavations	10	2	2	2	2	4.0
Waste treatment	10	5	2	2	5	4.9
Soil						
Roads	10	2	2	2	2	4.0
Removal at site of works	10	2	2	2	2	4.0

Preliminary Works:

It must be considered that agricultural and cattle raising works had previously altered the studied area minimizing the impact of the plant. Then, the fact of the current flat-undulated configuration of the ground in a way eased the works to be done minimizing the volume of removed materials, while permitting the area inhabitants to better assimilate the new topography.

Probability

Topographical variations are imminent. The probability is high. Value is 10.

Intensity

Taking into account the preliminary area alteration, the intervention grade is considered low.

Extension

The effect is restricted to the project area. The extension is located in a specific point.

Duration

The start of the preliminary works will be immediately manifested on the local topography.

Reversibility

Once the land is leveled, its original topography/landscaping will be lost due to construction works. However, noise barriers will be properly designed with the material moved or this material will be deposited in the space designed for debris, so the impact can be mitigated.

Excavations

Works will have a lower impact since it will be developed on a previous altered area by leveling works and such presence will be temporary (while construction starts). This situation produces a dilution and a consequent attenuation of the impact.

Probability

The impact on the topographic/landscape is imminent. The probability is high.

Intensity

It is considered low due to previous observations.

Duration

It will be visible immediately after the beginning of earth movements. It will not take long.

Reversibility

Buildings and other works will replace the excavated areas, and the debris product of earth movements will be used to build barriers. It is recoverable.

Waste treatment

The removed accumulated materials product of land leveling, earth moving foundation works as well as well as the debris generated by the project construction will modify the topography of the area. In the case of the construction debris, the impact will be temporary since it has to be removed from the area and

treated properly. However, this is not the case of the soil-removed products; since if necessary, will be used as noise barriers. The effect is considered beneficial.

Probability

There is a high probability of occurrence.

Intensity

The intensity is low since change will be produced in a specific area.

Extension

The extension does not exceed the designated area.

Duration

Short term impact

Reversibility

Effect can be mitigated.

➤ **Soils**

In order to assure adequate foundations for the construction works, soil edaphic profile will have to be removed or the surface soil will have to be treated so the impact infringes to the area would be partial. This is an inevitable and necessary process due to this kind of development works.

Access roads

Due to the site conditions chosen for construction, the access roads are going to be lineal works of minimal extension in the project area. However, this process implies the surface soil removal and its substitution for impermeable materials adequate for vehicle circulation. In the best scenario, supposing the omission of the impermeable layer while construction, there will be soil compactness and the activation of layer erosion process and/or generated by hydric or aeolian agents.

Probability

Road access will impact the soil. Value is 10

Intensity

The compactness impact as well as the lost of the superficial layer will determine a strong intensity. Value is 2

Extension

The impact just will show during access road construction. The impact is specific. Value is 2

Duration

Effects on soil are immediate. Value=2

Reversibility

Temporary access roads can be recovered by means of superficial breaking up of ground. Regarding permanent access roads, an adequate channel network of the run-off waters will minimize erosion risk. The impact can be mitigated. Value is 2

Soil destruction due to the works

Probability

Soil destruction is necessary to provide adequate foundation to works. The probability is high. Value is 10.

Intensity

Taking into account the alteration of the preliminary area, the intervention degree is considered of low intensity. Value is 2.

Duration

The start of preliminary works will be manifested immediately on the ground. Value is 2.

Reversibility

Once the ground is leveled, the original landscaping will be lost as a result of the construction of works; however, the waste material will be used as adequate designed barriers. The impact can be mitigated. Value is 2

Local Geomorphology

Temporary Preliminary Works

As a result of the preparation, leveling of the ground, excavations and material stock, the geomorphology or superficial structure of the ground will be modified in every site where the civil and electromechanically works will be placed. There will also be impact in surface dumpsite. During construction, the geomorphology will be modified due to the excavation process and the recovery of the original model will not be possible. In the dumpsite, the micro topography and the surface micro drainage will change due to the material stock on those sites. Part of the excavation product, will be later used as noise mitigation walls around some primary sources: engine room, cooling towers, tanks and sub station. The geomorphology impacts will be generated where material is extracted (excavations) as well as where it is deposited.

It must be considered that Plant area has been previously altered by the land and cattle activities developed in the farm such as the sugar cane and mango plantations, as well as the terracing and leveling. These activities help to mitigate the impact in the site. Thus current configuration of the farm will facilitate works to minimize the removed material volumes and on the other hand it will allow the local audience to better assimilate the new topography.

The season of the year in which the work construction initiates will determine the activation of specific erosive processes due to earth movements. If it is carry out

during rainy season, there will be an activation of concentrated erosive processes alteration of the surface dumpsite. If it is carry out during dry season, there will be an activation of the aeolian erosion, in other words, the dust volume will be increased by earth movement works during project construction and by the increase of the vehicle circulation on the blast and ground roads.

The geomorphology modification presents a direct and secondary connection in surface run-off waters since it will change direction and speed of flow mainly during construction rainy season. If run-off waters' speed is accelerated, it will also increase the dragging capacity and the amount of material carried into the fluvial flows and low parts. This condition alters the hydrologic system associated with the increase of sediment load. Another alteration is the diminishing of infiltration water rate due to construction and generation of waterproof surfaces such as sidewalks, parking areas; civil works surroundings, access roads and others.

Impact Valuation: geomorphology

According to chart 5.8 of impact valuation, the change of the geomorphology, in other words, the surface form of the ground has a negative moderate connotation. The incidence probability of the change is indispensable; the alteration degree of the site is low. The site where the ground will be modified is specific, just the area where works take place. Even though the impact will be permanent, the land modification will be moderately reversible since with the application of mitigation measures the original estate will not be recovered, but it will get an adequate equilibrium.

Chart 5.8 summarizes project construction impacts on the geomorphology.

Chart 5.8

Impacts valuation of the geomorphology during the construction stage

Elements to be affected by the works Geomorphology	Probability	Intensity	Extension	Duration	Reversibility	V.I.A
Micro topography change due to excavations	5	2	2	2	5	-3.0
Micro topography change due to material stock in dumpsites	5	2	2	2	5	-3.0
Change of speed and direction and flow of surface run-off waters	5	2	5	2	10	-4.3

Below a brief description of each value indicators for geomorphology

Micro topography change due to excavations

Location

Project area

Probability

This impact incidence on geomorphology is moderate

Intensity

Due to the intervention degree, alteration and current usage of land in the area, the intensity is low

Extension

It will just show on the specific project site

Duration

The excavation process will be concluded parallel to the project construction stage.

Reversibility

If the mitigation measures proposed are applied, the excavation impacts will be partially recoverable.

Micro topography change due to material stock in dumpsites

Location

Project area

Probability

This impact occurrence is moderate.

Intensity

It is considered low, due to dump location

Extension

It will just impact project site. It will be specific.

Duration

It is considered temporary.

Reversibility

Due to the location and design of the dumpsites as well as the mitigation measures to be implemented, it is considered that the impact is partially recoverable. Thus, part of the material product of excavations will be used as noise barriers creating a beneficial impact.

Change of speed and direction and flow of superficial run-off waters

Location

Area of Direct Influence

Probability

The direction, flow and speed of run-off waters will be changed during excavation and construction of the works during rainy season (access materials, stock and dump materials as vegetal cover). The probability of this change is moderate.

Intensity

Due to the alteration of the land, it is considered low.

Extension

Located in the specific Direct Influence site of project

Duration

During construction, but change will be permanent.

Reversibility

As the micro topography and soil usage change, the impact on the run-off waters is irreversible.

5.1.4 Environment Impacts on the project

A threat is all natural phenomenon that when manifested its violence and extension could cause damage to population, infrastructures, vital lines, production activities and general environment. As it is stated in the definition, natural phenomena are the inevitable manifestation of internal and surface activities of the planet. Among them, it can be mentioned volcanism, seismic activity and slope instability (slides, erosion).

It is clear that accepting these phenomena as inevitable, it can not be left out that any irrational activity increases vulnerability and acts as a catalyzed and magnifying element converting them into catastrophes.

Below, you can find an analysis of the main threats that have an influence on the studied region, taking into account that now this is the only study that can be performed since there is missing a data base much denser to execute a quantitative interpretation of the risk "sensu strictu".

Flood risk

The site is located near the Ciruelas River, and it was considered necessary to evaluate the flood risk to the future plant. To evaluate such risk, the site was visited and aerial pictures at a scale of 1:40000 of 1998 were observed. Conclusion is that the river does not represent any threat for the future plant.

On the Ciruelas River 100m down the stream under the bridge of the Interamerican High way, the river is divided in two branches. The right branch is named Espavel creek in the cartographic Chapernal sheet (scale 1:50000). In the aerial photography, it was observed a significant activity of this branch. It also shows an important deposition of heavy material in a slightly defined flow. The current tendency of this branch is to get together to the Seco River; nevertheless, it is observed that artificially this branch water is diverted aside towards the left branch. This deflection is obtained by a stone accumulation of the same river. This branch does not prove any threat to the future plant.

The left branch is the one that crosses the ICE property. It has a width of active flow that goes from 3 to the 7 meters increasing down stream and to the height of the margins with respect to riverbed varies from 0, 5 to 1, 5 m. The riverbed has heavy sediments mainly gravel (so large maximum of 30 to 40 cm.) and presents a vertical step pattern with short sequences of white water and small pounds. It was observed sand and fine gravel deposited recently. The day of the visit the flow of the river was low and the water mirror was submerged in some sections. Local erosion in the margins was observed but it is not observed any tendency of lateral migration.

The flow of the left branch has slight capacity and shows deposition of sediments in some points that can bring about overflows. It is not expected that the previous situation brings about a significant problem as this branch carries out low water

volumes and the flood plain is very extensive. When the water level surpasses the deviation work mentioned before, the majority of the avenue flow volume is downloaded by the right branch.

The site proposed for the plant is on a hill about 10 m of the Ciruelas River and there is no possibility that it is affected by the river. It has been proposed to deviate aside the left branch of the river, but we considered this action to be very expensive, from the economic point of view, and it does bring any advantage to the project.

The highly argillaceous soil and the small gorges on the site denote an area prone to swamps, but to the generalized slope towards the main flow assure a proper drainage of the waters towards it and do not constitute a danger to the project.

The same drainage patterns are proper of grounds not subject to floods where an external geodynamics characterized by a great load in suspension and its deposition on its margins. However, this case is the opposite, the drainages carry out little load in suspension and overflows are rare. In summary, there is no flood danger.

Seismic activity risk

This study has determined the main seismic sources that can affect the thermo power plant if it is not properly designed. The highest intensity is expected to be VIII (MM).

Due to the seismic potentiality of the thermo plant site, it is necessary to carry out an adequate earthquake-proof design of the civil works. The following are possible damages:

- Transformers fall and slides
- Cabinets, frames and control panels fall and slides
- Fault on the metallic base of the equipment support
- Connectors rupture between equipment due to excessive displacement
- Transformer, post and platform fall
- Pipe faults
- Transmitting line rupture
- Deformation or ruptures of fuel storage tanks
- Risk of fire and explosion if there is fuel spills

Slides

The current analysis of this risk is low, due to the topography of the area, if the environmental variables and the topography are not abruptly modified

Chart 5.9

Impacts Valuation of environment on the project

Impacts	Probability	Intensity	Extension	Reversibility	Duration	V.I.A
Flood risk						
Swamping increase on compacted solids	2	2	2	2	2	2.0
Slides						
Slope instability	2	2	2	2	2	2.0

Flood risk

Swamping increase on compressed soils

Probability

The possibility of swamping is low considering the natural structure of the soil site and then its compressing for the surface works.

Intensity

The compressing need for land which will be subject to surface works (sidewalks, office buildings, visual barriers, etc.) determine that the alteration intensity be low.

Extension

The limited area to be compressed determines that alteration will be specific to an area.

Duration

Since swamping manifestation will take place after compressing, it is expected that its manifestation on next rainy season will be short, so impact will be low.

Reversibility

Since the swamping can be control with adequate drainage of the ground, it is determined that alteration will be recoverable.

Seismic Risk:

Earthquake-proof design

Probability

Considering the low possibility of an induced earthquake, but the high possibility of a wake in the area, the design must consider the incidence of this event in a short term. Due to this reason, its value is 5.

Intensity

According to previous events that affected the construction site, the possibility of an earthquake is of medium intensity. This fact is considered as of medium intensity

Extension

Since the future plant has a specific location, the seismic design will only apply to its works.

Duration

There is a need for an operation term insurance for the plant. This fact is valued with 2

Reversibility

The earthquake-proof design is a project need and a legal requirement. Its application has a mitigation effect of the event.

**Slide risk
Slope intensity****Probability**

The Ciruelas River margin stability points to a low probability of slide occurrence due to slope instability.

Intensity

Knowing the slide magnitude occurred on this river slopes, the impact is considered low.

Extension

The slides on the flow in the Ciruelas and Naranjo rivers have been so specific that allow assuring that any slide incidence near the plant will be of similar or lower magnitude.

Duration

The apparent slope stability near to site to be modified foresees a low probability of slides.

Reversibility

The direct and indirect methods available for the stability evaluation allow mitigation and minimization of an eventual manifestation.

5.3 IMPACT OVER THE SOCIO-ECONOMIC ENVIRONMENT

5.3.1. Identification and Valuation of Impacts on Socioeconomic and Cultural Environment

5.3.1.1 Socioeconomic Environment

The impacts are assessed according to the Indicator Method. This is done for the construction phase (Chart 5.15), the operation phase (Chart 5.16) and the maintenance phase (Chart 5.17) of the project.

The charts show the environmental elements that are susceptible to be altered on each phase, and also the indicators used to obtain the value for each impact. These elements are grouped as follows: use of the land, social and economic, and services and infrastructure.

For the use of the land, the following elements are taken into consideration: residential, agriculture/industrial, agriculture/cattle raising, soil usage change and community use. For the social and economic aspect the socio cultural dynamics, population, quality of life, health and community safety, economic structure, employment, wages structure, and value of the properties are evaluated. In services and infrastructure services, roads and community infrastructure are included.

For the impacts graded higher than 4 a description of the characteristics is made. The relevant impacts are the ones higher than 6 and are reconsidered in the Environmental Management Plan (PGA) to propose the necessary mitigating measures to minimize the impacts. Some are positive and some are negative.

5.3.1.1.1 Valuation of the Impacts in the Construction Phase (Chart 5.15)

Use of the Land

In the construction phase all the elements that constitute the variable Use of the land have low impact; a brief description is given below:

The use of the land as residential in the construction phase is considered negative and low, the variable residential against industrial (in this case the plant) are not compatible; nevertheless, the plant would be built at a prudent distance (800m approx.) from closest houses. Besides, Ciruelas growing trend is to the agro industrial activity.

Chart 5.15
Valuation of Socio Economic Impacts
Construction Phase

Environmental Elements to be altered	Indicators					Via
	Probability	Intensity	Extension	Duration	Reversibility	
Use of the land						
Residential	2	5	2	5	2	-2.20
Agro Industrial	2	2	2	5	2	2.60
Farming	2	2	2	5	2	2.60

Change in the Use of soil	2	2	2	5	5	2.90
Community use	2	2	2	2	2	2.00
Social & Economic						
Socio Cultural Dynamics	10	5	5	2	2	-5.30
Population (structure and density)	5	5	2	2	2	3.30
Quality of life	10	5	2	2	2	-4.50
Health and community safety	10	5	10	2	2	-6.60
Health and labor security	5	5	2	2	2	-3.30
Economic structure	2	2	2	2	2	2.00
Employment	10	10	10	2	2	7.50
Wages structure	5	5	5	2	5	4.40
Value of properties	10	5	5	5	10	6.70
Services and infrastructure						
Services	10	5	5	5	2	5.90
Roads	5	2	2	5	2	3.30
Community infrastructure	5	2	2	5	5	3.60

The agriculture/industrial, farming and change the use of land will have low impact on this phase, because they do not contradict the trend towards agro industrial development of the area.

The impact on the community use of land is also low because there is no interference between the project and this one.

Social and Economic

In the construction phase the most important factor to be considered in the social and cultural dynamics of the community is the staying of a big group of foreign workers cohabiting with the native habitants of the community; this situation changes the routine of the place. It does not matter if the workers live in a camp or in rented houses. There is a created demand especially at night, food and entertainment promoting the abuse of alcoholic beverages among workers of the project. In this case the impact on socio cultural dynamics is valued medium and negative; it appears that this impact can be minimized if foreign workers live in the camp at Ciruelas due to the particular characteristics of the place.

The population and economic structure indicators have a low impact result. Health and labor security have also low impact but it is considered negative. Even though security measures are taken, there is always a risk level in processes like this one.

Population density and structure are not affected because construction does not last long. The impact on the economic structure is low because it does not interfere with the economic activity of the area. It is expected that land ownership does not imply a change on the economic structure.

The quality of life of the inhabitants that live by AP, health and social security will be partially impacted by the dust, noise, vehicle circulation or machinery, heavy duty equipment and construction materials and other problems caused by construction and it is considered a negative impact.

Among the impacts valued higher than 4, there are negative and positive. The negative ones are socio cultural dynamics, quality of life, health and security. The positive ones are employment, wage structure, and property value. Find below a detailed description.

Characteristics of the Impacts valued higher than 4

Negative Impacts:

Socio Cultural Dynamics: Value of the impact -5.3 (medium)

Probability

The probability that daily life at a small city be affected by a group of workers in a determined period of time is high. It is expected that the impact can have a different magnitude if workers live in the camp Ciruelas or in nearby cities like Miramar and / or Puntarenas. If they live in the camp (Ciruelas), the effect to this population would be lower than in any other community because it has different characteristics from a typical community of the area, as explained in chapter 4, Socio Demographic characteristics. The amount of workers could be up to 200 during highest period of construction.

Intensity

The intensity would be medium because there will be a number of workers staying for 22 months.

Extension

It will be medium because workers will move around the surrounding areas of the project.

Reversibility

Life would go back to normal once construction is finished.

Quality of Life: Value of the impact: -4.5 (medium)

Quality of life means having access to public services, education, housing, and enjoy other conditions like breathing pure air, absence of noise, pollution; with all these a feeling of conformity and welfare will be generate. In this case, when

“quality of life” is value it makes reference to the absence of pollution in general rather than access to public services.

Probability

The probability that the quality of life of the inhabitants of the surrounding areas deteriorates is high considering the dust and noise produced by construction which will remain during this process

Intensity

It would be medium, only during the 22 months of construction there will be noise and dust.

Extension

The area affected will be AP, a local effect.

Duration

Duration relates to the construction duration of the Project.

Reversibility

Once the construction is finished life will go back to normal.

Health and Community Security, Value of the impact -6.6 (medium)

Probability

The probability that health and security are threatened is high because during construction, circulation to AP, transporting construction materials, equipment, machinery, and workers will increase. Noise and danger in the Inter American highway will increase.

Intensity

The intensity of the transit to Ciruelas is considered medium.

Extension

The most affected area would be Ciruelas; nevertheless, the problem generated by the increase of circulation will be suffered by both communities along the road, especially at the Garabito Generation Center-Ciruelas and from the Costanera Highway, Puerto Caldera-Ciruelas.

Duration

Constructions will last 22 months, for a short period of time the movement of heavy equipment, machinery and materials will be frequent. Then it will diminish as construction continues.

Reversibility

The possibility to mitigate the impact on health and security in relation to noise and other situations is high because once project is finished, the problem will disappear.

Positive Impacts

Employment, value of the impact 7.5 (high)

Probability

The probability is high. The project will generate around 200 job opportunities for workers of the area.

Intensity

The impact is high for a new source of employment present in an area where unemployment and temporary jobs are frequent.

Extension

It will generate jobs to people from Miramar, Santa Rosa, San Isidro.

Duration

Work duration and its impact would be short.

Reversibility

The construction will last 22 months so the recovery capacity will be high.

Wages Structure, Value of the impact: 4.4 (medium)

Probability

This structure would also be impacted, because the scale to be applied would be higher than other work sources like private companies that operate in the area of influence of the project.

Intensity

It would have a medium intensity impact, considering the scale applied by ICE or the company hired for construction works. It frequently results to be more favorable to workers than the one used by private companies.

Extension

The impact will extend to All (Miramar, Santa Rosa, San Isidro).

Duration

It will be the same of construction term.

Reversibility

The place will go back to normal once the construction is finished.

Property Value: Value of the Impact: 6.7 (medium)

Probability

Property value will also be affected, with the acquisition of land by The ICE and the construction of the Power Generation Center. There will be an increase in the value of the land and current infrastructure.

Intensity

This impact will be medium because the agriculture/industrial features of the area; this will increase the value of the land and infrastructure.

Extension

It will extend to AID.

Duration

This impact is considered medium because it will continue after the project is finished.

Reversibility

It will not be recovered.

Services and Infrastructure

In the construction phase, all of the elements that constitute the services and infrastructure will show low impacts. It is expected that the services and infrastructure will be lightly affected. Because the high concentration of land ownership in the area; it is possible that demand of private services will not happen. In relation to the roads there will not be any new one except for the roads within the property.

5.3.1.1.2 Impact valuation in the Operation phase

Use of the land

Among the different land uses and its relation to the operational phase of the plant, the value of the impact is low, except for residential use that is considered medium and negative. In this case and within the AID its current use is limited to La Calle del Arreo, which does have a possibility to grow;

Environmental Elements to be altered	Indicators					Via
	Probability	Intensity	Extension	Duration	Reversibility	
Use of the land						
Residential	5	5	2	5	5	-4.2
Agro Industrial	5	5	2	5	2	3.9
Farming	5	2	2	5	2	3.3
Change in the Use of soil	5	2	2	5	5	3.6
Community use	2	2	2	2	2	2
Social & Economic						

Socio Cultural Dynamics	2	2	2	2	2	2
Population structure and density	2	2	2	2	2	2
Quality of life	10	5	5	10	5	-7.2
Health and Community security	2	5	2	5	5	-3.5
Health and labor security	5	5	2	5	2	3.9
Economic structure	2	2	2	2	2	2
Employment	5	5	5	5	5	5
Wages structure	5	5	5	5	5	5
Value of the properties	10	5	5	10	5	7.2
Services and infrastructure						
Services	5	5	10	5	2	6.2
Roads	2	2	2	2	2	2
Community infrastructure	2	2	2	2	2	2

since it is surrounded by El Ingenio El Palmar. There are big farms in Ciruelas and unless the land is segregated and urban developments, expansion is not expected although there is an urban development taking place a kilometer from Cuatro Cruces and one kilometer from AP. The infrastructure would be surrounded by ICE property and trees will be planted to work as a natural barrier against noise. It is considered a negative impact for the area and its surroundings and a limitation for future urban development.

Social and Economic

In the operational phase the indicators that constitute the social and economic variables such as socio cultural dynamics, population, health, security and economic structure have been valued low. Find below the major impacts with a higher value than 4 that can be negative and positive.

Characteristics of negative impacts with higher value than 4:

Residential: Value of the impact: -4.2

Probability

The probability that it negatively affects residential use is medium because it is not nice to live by a Power plant and will also affect environment making the place less attractive for urban development.

Intensity

It is considered medium even though there are no plans for urban development projects.

Extension

It will have a local impact in the AID area.

Duration

The duration is in accordance with the life of the plant.

Reversibility

It is considered medium; even though it is not attractive to live by the Power plant, some urban centers may develop in the surrounding areas.

Quality of Life: value of the impact: -7.6 (medium)**Probability**

The probability that the quality of life for inhabitants of AP surrounding areas deteriorates is high considering the noise, vibration, and gas emission that will be present while plant operates.

Intensity

It is considered medium because Plant will not work continuously.

Extension

It would a regional impact.

Duration

It will last until the plant operates

Reversibility

It is not reversible.

Characteristics of positive impacts with a value higher than 4:**Employment: value of the impact: 5 (medium)****Probability**

The job offer in the operational phase is less than- 30 jobs- than during construction, but jobs will last longer.

Intensity

It is considered medium because it provides a new source of employment in an area where occasional work and unemployment are frequent.

Extension

It will generate work to All people (Miramar, San Isidro, Santa Rosa)

Duration

Job term will be short period as well as the impact.

Reversibility

Construction will approximately last 22 months though the recoverability is high.

Wage Structure: Impact Valuation 5 (medium)**Probability**

The wage structure will also be affected, because the wage structure applied probably will be higher than the one applied by the other job sources (private companies that operate on the project site). This will favor workers since salaries will be higher than the once offer in the area.

Intensity

Considering this is a new project in the zone, and the ICE or the company contracted for project construction will have a wage structure normally favorable to the workers that the one applied by the private sector, the intensity will be medium.

Extension

The impact will reach All (Miramar, San Isidro, and Santa Rosa)

Duration

The duration is equal to project construction.

Reversibility

Once construction finishes, the initial state will be recovered.

Property value: Impact value: 7.2 (medium)**Probability**

Property value will be affected. Because the agriculture/industrial nature of the zone, the ICE acquisition of land and the plant construction, it is estimated that land and infrastructures in the zone will increase their value.

Extension

The impact will be extended up to the AID

Duration

Duration is expected to last more than 10 years.

Reversibility

Theoretically, original situation will not return in at least 10 years.

Services and infrastructure

The impact valuation related to the roads indicators and the community infrastructure are determined as low during operations and inside the AP since there will not be overused of the community infrastructure as no roads will be constructed, but inside the site project.

Positive Impact characterizing with values over 4:

Services: Impact value 6.2 (medium)

Probability

There will be a medium demand for services such as potable water, electricity, telephone, feeding, and accommodations.

Intensity

It will generate a service demand over All

Duration

Service demand will have a medium extend

Reversibility

It is considered a mid recover, since demand will have to adjust to the new requirement.

5.3.1.1.3 Impact valuation during the Maintenance stage

Use of the land

During the maintenance stage, the elements that make up land use will not be affected.

Social and Economic

During maintenance stage, the elements affected will be life quality, community safety, health, and labor safety. The effect is positive as all safety measures required will be kept updated and Plant will be in good condition and functioning.

Life quality: Impact value: 4.6 (medium)

Probability

The probability of impact on the life quality during the maintenance stage is high. The impact is positive since keeping generation centers in good conditions will allow controlling noise problems and gas emissions.

Intensity

Intensity impact is considered to be medium, as the maintenance process will be carried out periodically during project operation.

Extension

Extension is located in AP.

Duration

It is equal to project operation.

Reversibility

The maintenance process will permit to recover the negative impact allowing the implementation of the corresponding corrective measures.

Health and community safety: Impact value: 4.6 (medium)

Probability

There is high probability of impact health and communal safety during the maintenance stage. The impact is positive since keeping the generation center in good conditions will contribute to control problems.

Intensity

Intensity impact is considered to be medium, as maintenance process will be carried out periodically during project operation.

Extension

Extension is located in AP.

Duration

It is equal to project operation.

Reversibility

In the maintenance process, recoverability is seen as a situation to take advantage of to solve current or future problems.

Chart 5.17 Impact Valuations in the Socio Economical Environment
Maintenance Stage

Environmental Elements to be altered	Indicators					Via
	Probability	Intensity	Extension	Duration	Reversibility	
Use of the land						
Residential	0	0	0	0	0	0.00
Agriculture/Industrial	0	0	0	0	0	0.00
Farming	0	0	0	0	0	0.00
Change in the Use of soil	0	0	0	0	0	0.00
Community use	0	0	0	0	0	0.00
Social & Economic	0	0	0	0	0	0.00
Socio Cultural Dynamics	0	0	0	0	0	0.00
Population structure and density	0	0	0	0	0	0.00
Quality of life	10	5	2	2	2	+4.6
Health and security	10	5	2	2	2	+4.6

Health and labor security	10	5	2	2	2	+4.6
Economic structure	0	0	0	0	0	0.00
Employment	0	0	0	0	0	0.00
Wages structure	0	0	0	0	0	0.00
Property Value	0	0	0	0	0	0.00
Services and infrastructure	0	0	0	0	0	0.00
Services	0	0	0	0	0	0.00
Roads	2	2	2	2	2	2.00
Community infrastructure	0	0	0	0	0	0.00

Health and Occupational Safety: Impact value: 4.6

Probability

There is high probability of impact in health and community safety during the maintenance stage. The impact is positive since keeping the generation center in good conditions will contribute to control problems. In addition, this situation will contribute to control and mitigate any problem that may appear.

Intensity

Intensity impact is considered to be medium, as the maintenance process will be carried out periodically during project operation.

Extension

Extension is located in AP

Duration

It is equal to project operation.

Reversibility

In the maintenance process, recoverability is seen as situation to take advantage of to solve current or future problems.

Services and infrastructure

The impact value related to services and infrastructure will not be affected during the maintenance stage.

5.3.1.2 Labor Health:

As previous consultation the heads of different ICE plants, the main labor health problems reported by workers is the audition loss due to excessive noise, skin problems due to high temperatures and stress problems due to the issues mentioned and labor shifts. Regarding accidents, those with high incidence in thermal plants are fuel spills and fires.

Audition loss

Gradual audition loss by the operators is present by the exposition to intense noise. Measures applied so far have proven inefficient. The best measure so far is an auditory insulation booth.

Overheating:

Working in the engine room area, chimneys and turbines means that workers are exposed to temperatures between 60 and 65 degrees and eventually they have to move to different places within facilities at room temperature. Such situation has caused important body cooling due to brusque temperature changes.

5.3.1.3 Industrial safety contingencies

Contingencies are considered import elements in the environmental impact assessment, even though they shall not occur if construction and operation are executed correctly, normal practice indicates that these situations do occur: fires caused by fracture of the fuel pipe line in contact with boilers at high temperatures, mistakes in the manipulation of valves causing the consequent spill and fire risk, as well as pasture ground burns around the facilities. Because of it, it is important to take safety measures (spill pit, emergency exits, burn control and inspections) as previous training for the personnel to act in case of an emergency. These activities have to be coordinated with the ICE Emergency Operations Center (COPE).

5.3.1.4 Linking effects to labor health

Linking effects are accumulative or synergic impacts, in other words, those that are prolonged in time. The inductor agent action progressively increases severity since the environment lacks a proper elimination mechanism of temporary effectiveness. This kind of connection is similar to the increase of the action causing the impact or the impact produced by the combination of different agents or actions that suppose a superior environmental incidence that the effect added rather than impacts taken isolated. For instance, construction of the thermal power plant will generate dust, emissions and noise, then when the plant is in operation, the noise, the engine vibrations will add to the noise produced by cars and trucks when approaching the highway. Linking effects shall be identified in detail by further research.

5.3.2 Landscape

The complete civil work action implies landscape transformation in regards to its naturalness and quality, the site of the works of the “Garabito Electrical Generation Center” is not the exception. The permanent infrastructure on the land used will be the element that will visually interfere and modify landscape regarding its naturalness, color and texture.

The power plant visual point is the Interamerican High way at “Las Delicias” farm entrance. This point is located in a higher point than works and it is located at 0.8 km of distance. Although the site topography is flat, the visual point, the distance to the works and the lack of camouflage, makes it easier to see the works.

However, this impact will be minimized applying the suggested mitigation measures. (Figure 4.23 and 4.24 in Chapter 4)

The new area containing the works is located in a specific point and can be observed directly in a short period of time by people using the Interamerican high way as well as from the other side. Since this is a high speed road, visibility to the new power plant will be limited.

On the other hand, regarding landscape description at the influence site, there will be not identification of important landscaping units from a visual and aesthetic point of view that could be affected by the works. Moreover, the region is highly intervened by atrophic actions such as plantations, works, vitals lines, aspects that allow the new structure to integrate in the special context. So the impact to naturalness of the landscape because the presence of the new power plant and its related works is low.

Impacts Valuation: Landscaping

Based on the information in charts 5.18 and 5.19, the impact to the landscape is low. The impact is caused by the presence of the works: engine room, substation, tanks, administrative areas and others that are converted in visual obstacles that compete with the naturalness of the site, its shape and texture.

The impact incidence probability and intensity are low, since the impact will be minimized by the application of the recommended mitigation measures, and the impact extension will be manifested in a specific area.

The impact duration and the reversibility of the landscape will be low since the recommended mitigation measures will also be applied. Even though the landscape will not be turning to its original state, it will get an acceptable equilibrium.

The project presence in the site will also bring positive impact to the environment, especially to the landscape, as the construction of the project starts, there will start the location and plantation of vegetable barriers as mitigation measure. This has not only a positive value but also high and permanent benefit to the environment.

Charts 5.18 and 5.19 summarizes the construction process and the project operation stage on the landscape

Chart 5.18
Impact valuation on the landscape during the construction process

Site to be affected by the works	Probability	Intensity	Extension	Duration	Reversibility	VIA
Landscape						
Change in the naturalness because excavations	5	2	2	2	2	-3.8
Change in naturalness because the presence of solid waste	5	2	2	2	2	-3.8

Below, a brief description of each valuation indicator used for the landscaping

Change in the naturalness because excavations

Location

Project area

Probability

The incidence probability of a change is moderated.

Intensity

Because the site relief configuration and the human intervention, the action intensity is considered low.

Extension

The area to be occupied is specific.

Duration

The results due excavation and construction will be visible immediately but for a short term.

Reversibility

Impact due to excavation and material moving in the site can be diminished by applying the recommended mitigation measures. Impact will be partially reversible.

Change in landscape naturalness because the presence of solid waste (inert and organic)

Location

Project area

Probability

The presence of solid waste in the site is indispensable, but if handled properly, the impact can diminish.

Intensity

The presence of solid materials (construction waste materials product of the preliminary works, concrete structure, domestic waste, cables, tires, etc.) should be handled properly to lower the intensity.

Extension

Extension is specific.

Duration

Just on construction stage.

Reversibility

Properly managed, landscape recovery will be partially reversible and impact has a low value.

Chart 5.19
Impacts Valuation during the operation stage

Site to be affected by the works	Probability	Intensity	Extension	Duration	Reversibility	VIA
Landscape						
Change in the naturalness because presence of works	5	2	2	2	5	-3.0

Below, a brief description of each valued indicator used for landscape

Change in the naturalness because presence of works

Location

Project area

Probability

The impact incidence is moderate.

Intensity

Intensity degree is low.

Extension

The area in use is specific.

Duration

Although duration will be permanent, by implementing the recommended measures and by the current land occupation, works will be part of the surrounding areas.

Reversibility

The repercussion on the landscape will be moderately recoverable applying the recommended mitigation measures

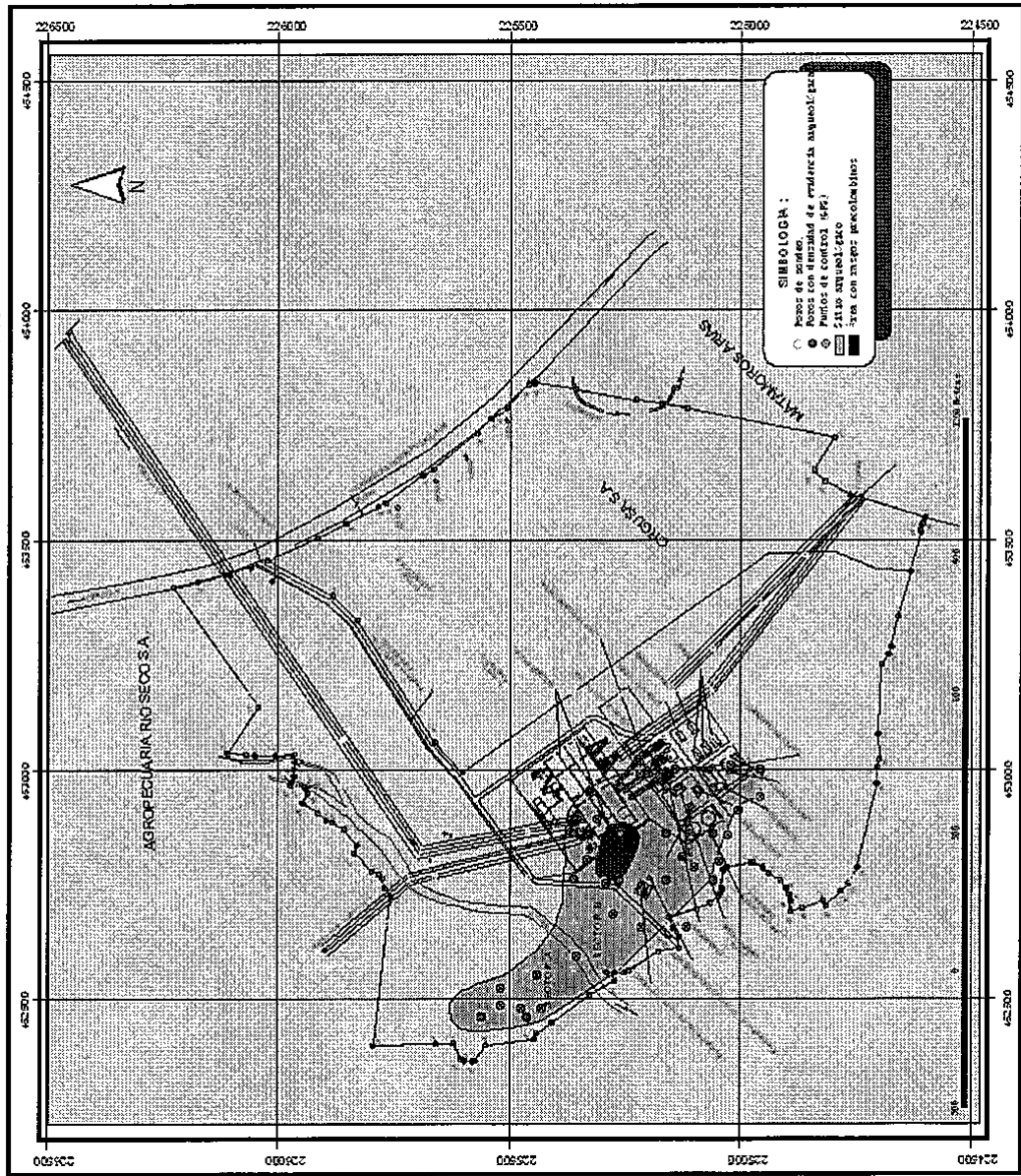
5.3.3 Archeological patrimony**El Palmar archeological site alteration vs. Project works**

The discovery of the archeological site “El Palmar” was accomplished by means of an archeological recognition and evaluation of the site where the Instituto Costarricense de Electricidad plans to build the power generation center. This archeological site is located in the northeast area of the property.

(El Palmar (Fig.5.1))

Figura 5.1

SITIO ARQUEOLÓGICO EL PALMAR
CENTRO DE GENERACIÓN ELÉCTRICA GARABITO



In order to guarantee the archeological deposit, we divided it in three parts or areas of the site: Part/Sector A. Located on the right hand side of Ciruelas riverbank, house constructions and three plantations that later on were cleared up by heavy machinery altered the site. This clearance has facilitated the observation of important cultural evidence (pieces of ceramics and pre-Colombian licit) (Fig. 5.2)



Fig. 5.2 Slope located at the right side hand of the Ciruelas riverbank. Pieces of pre-Colombian ceramics on the surface can be observed

Part B. It is located from the left hand side of the Ciruelas riverbank to the southeast border of the property (teak trees line). The vestiges of “Las Delicias” sugar cane mill are here. The sampling executed on the areas shows the severe impact infringed by this activity to the archeological resource.

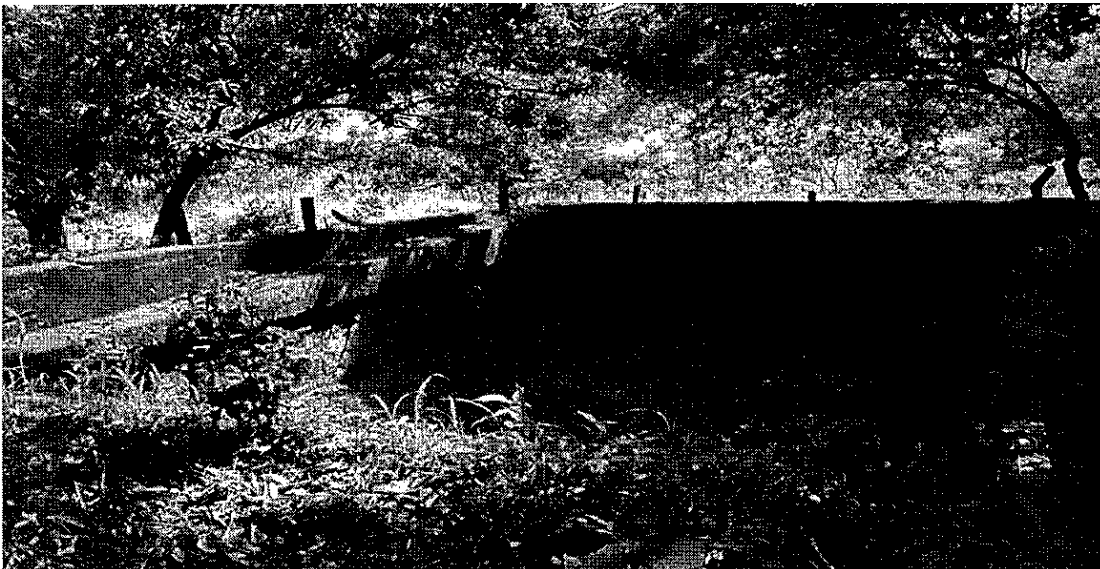


Fig. 5.3 Vestiges of the old sugar cane mill.

Sector C: located from the northeast border of the ORGUSA; S.A. property to the slope of higher elevation. This place was used as a pasturing area for cattle.

The archeological sampling done on sector C shows that the most important part of the indigenous activities took place in the highest zones with greater activity evidence in the undulated parts (convexes), pointing out the inverted stratigraphy. Reasons for this are erosion and the strong showers that moved down the slope the archeological evidence. (Fig. 5.4)



Fig. 5.4 Area showing a great presence of archeological evidence product of the run-off waters coming form near slopes

In this same area (northeast of the slope) it has been detected the presence of archeological vestiges, possibly of household use.



Fig. 5.5 Cultural evidence, possibly of household use

Based on the preliminary results of the archeological evaluation, it has been determined that some of the project related works will be located in the archeological site “El Palmar”. Based in these results, it a preliminary impact valuation, will be executed and prevention, mitigation and compensation measures will be proposed to protect the archeological cultural heritage.

Probability

“El Palmar” archeological site in the study area will be partially impacted by the construction of some works. Then, the probability is high. Value is 10.

Intensity

Some sectors excavation, as well machinery circulation in the site will destroy part of the site, for this reason a moderate intensity is assigned to this aspect. Value is 5.

Extension

The archeological site is located inside the property. A specific valuation is assigned. Value = 2

Duration

Impacts over the archeological resources are immediate since they will occur during construction when excavation is carried out. Value is 5.

Reversibility

Once an archeological cultural heritage is altered, the information is not recoverable. The archeological resources are not recoverable. Value = 10.

Chart 5.20

Impact valuation of the archeological site Construction stage

Impacts	Probability	Intensity	Extension	Duration	Reversibility	V.I.A.
Archeology						
Project works	10	5	2	5	10	6.0

5.4 Substation impacts

Substation is located on a pasturing flat area next to the project works. The main construction activities for a substation are mentioned below:

Temporary works

Excavation

Drawing and foundation excavation

Building a plank, structural concrete

Pipes and trenches

Equipment setting

Structure assembling

Bars and drainage tubes
Cabling
Wiring
Start
Environment recovering

The substation construction work initiates with the clearance of site and the corresponding excavation, and then the related temporary facilities such as warehouse, rest rooms and offices built within same substation area. The excavation corresponding to the substation works is estimated in 20 000m³. Sections are minimal in order to avoid the level lowering of the substation that could be inclined to floods. A filling of at least 0.50 cm is expected, in order to elevate the floor final level. The excavation will be done using conventional equipment since difficulties are not expected. The northeast sector of the property can be used as a dump place, thus the soil set there can, if necessary, be re-used.

The new stages are excavation and drainage installation, excavation and ground mesh installation, excavation and cable pipeline construction, excavation for main foundations (transformers and towers), minor foundations excavation for different equipment (power switches). Those works are carried out using a back digger or by hand. It is used mechanic or wooden planks and, usually, the spouting is poured by hand on the site. Since the ground water level is very superficial at the substation site, the possibility of floods of the structural excavations is high.

Once the foundations are concluded, the structure forms or framings that support the cable entrance from transmitting lines can be settled down. It is composed of sections of latticing forms previously assembling on the floor. Following or simultaneously, the equipment (transformers, switches, etc) assembling will be carried out using several cranes of adequate capacity. Then the cabling and wire are installed. Once completed substation works, operation and start tests begin so that substation starts operations.

The entire substation surface will be covered with pebbles of 38mm and a thickness of 10 cm that will serve as insulation as well as protection to the workers who walk around the site, it will also serve to diminish grass growing, and dust controlling during the dry season, to protect the surface from erosion process related to superficial debris and to allow the debris circulation to the pluvial drainages. The pluvial waters will be guided to the natural streams using concrete pipes, but taking into account all the necessary precautions to avoid reloading the stream and swamping. The substation is always protected against run-off waters generated outside the site by parametric ditches. Simultaneously to this activity, the control building will be under construction.

The concrete aggregates are bought from local suppliers with an authorized development site. Also residual material product of excavations will be extended on free areas, or put in an adequate place.

5.4.2 Substation Impacts¹

It is important to especially mention the impacts substation will cause although it is part of the project. Since it is of an important size structure, it will cause particular impacts, which are important to identify and are described below

- Flood

The possibility that the substation gets flooded due extreme rain is low. However, it is probable because the location of the selected site which is in a flat area closed to the Ciruelas river mouth.

- Spill of insulation oil

The oil used as insulation in the substation transformers is of mineral origin. This oil requested by the ICE does not contain askarels (polychlorobiphenyl policloroterphenyl) which are highly toxic and which have been related to different effects on human health. However, the oil currently used is inflammable and can contain residues of heavy metals and other particles in suspension with different toxicity levels.

Eventually, if an oil spill occurs, the penetration of the insulted oil in the subsoil is difficult because the oil floatability in water. Despite the geomorphology of the substation site and without having experienced floods yet, the horizontal circulation of the pollutant can easily occur as a result of the zone frequent floods increasing the risk of contamination by water-oil mixture.

- Fire or transformer explosion

The probability of fire and/or a transformer explosion is extremely low, but they have happened in Costa Rica.

- For other substance emission

Sulfur hexafluoride is used as insulation for the switch boxes. This transparent and odorless gas at TPN is non toxic, but this gas provokes the ozone layer reduction and it is also considered a health risk in working environments. In other countries, this gas is determined as a dangerous residue. Normally, this gas is not released into the atmosphere, but accidentally. The gas in liquate estate constitutes a soil superficial and underground water pollutant.

- Noise generation during construction stage

The noise generated during the construction stage of the substation is moderate limited to the workshop equipment and minor construction equipment. This impact is moderate and temporal. It does not require a specific mitigation measure.

- For service demand

¹ Instituto Costarricense de Electricidad. 2000. Environmental Impact Stud of the Transmission Power Line Lindora-Tarabaca-Parrita-Substations Tarabaca-Parrita- San José, Costa Rica. ICE.225 pages.

Despite the substation is self sufficient in terms of electricity supply, it is possible that the substation produces an enhancement in the area of the electrical system due to the adequate maintenance to the transmitting lines. Other operation requirements of the substation can benefit the community such as telephone service, domestic trash collection by the local municipality. This will impact the place positively.

- Risk for pedestrians as a result of trucks circulation

The trucks will circulate on road which is the unique access to the plant and it is used by pedestrians too. The circulation of heavy trucks creates a risk for pedestrians. As a result, the road must be signalized and the contracts with the contract material suppliers must include a clause requesting speed limits while circulating in this area.

- Transformer transportation to the substation

Because their size and heavy weight, the transformers transportation from the landing port (Caldera) to the substation can produce various effects such us traffic hindering, damage or destruction of civil structure such narrow or difficult circulation bridges as the Mata de Limon bridge.

- Human risk or materials loss

The construction and operation of a substation imply some labor risks to operators. During the construction stage, the normal risks are objects falls, cuts, beats, noise exposure. During operation, the risks are electrocution, electromagnetic fields exposure, etc...

- Industrial and municipal sold waste

The construction of a substation will necessarily produce municipal solid wastes such as paper, office supplies, food, packs, and cans. It also generates industrial solid wastes related to the activity. During the construction stage of a substation, it will be generated a important amounts of ferrous and non ferrous materials (copper and aluminum cables , wire, pieces of metallic sheets) bags, cardboard, wood cradles, different types of packages, etc...

- Excavation

Excavations generate organic and inorganic residues. The quaternary geology that constitutes the local base has to be removed to a depth of 0.5 m. This excavation will generate an important amount of alluvial material that can be used in leveling the rest of the property.

- Superficial erosion while leveling and excavations

Precipitations and run-off waters produce erosion to the exposed ground surface once initiated the leveling off and the excavations of the substation site. This will temporally pollute nearby rivers streams with solids in suspension and eventually they can damage excavation.

The Puntarenas climate favors the decomposition of organic matters mentioned above. The solid waste management can not be carried out in the area because the lack of companies rendering these services.

Chapter 6

6.1.2 About air and gas emissions

The Environmental Management Plan of the study contains the principal mitigation actions (Chart 6.1). Furthermore;

- a) Guaranteeing that fuel to be supplied will have the necessary quality for proper functioning of the Plant equipment.
- b) Monitoring and control gas emissions (sulfur oxides and nitrogen oxides) and those solid particles in suspension so that they never exceed regulations. A first evaluation must be performed when plant starts operations previous to work delivery by the contractor whenever it is a turnkey contract to be able to immediately correct any aspect which may influence emissions. Control actions must be performed every three months.
- c) Establishing an adequate preventive maintenance program for Plant equipment.

6.1.3 About noise level

- a) Performing periodic measurements of noise levels in plant surroundings to guarantee emitted noise levels fulfill existent regulations (Regulations on Industrial Hygiene, articles 6 and 50).
- b) Providing silencer kits to equipment and acoustic isolation to Plant premises to comply with anything sets forth in current legislation.

6.3.1 About the socioeconomic aspect

Social and Environment Management

Social and environmental management is planned in two senses: data supply and contribution to surrounding preservation. During construction phase, data is oriented to workers and in operation phase is oriented to community; contribution to surrounding preservation will be done during project operation phase.

Data for workers, given through lectures, will cover topics on labor health, safety, established environmental guidelines by el ICE and themes related to handling of archeological patrimony. A pretty much relevant topic is social behavior of workers; they must behave respectfully and socially acceptable especially during free time. Lectures must be given at construction work beginning.

Data offered to community will be available through an office, especially set for it during construction and will offer general and diverse data about development of energy, electrical energy and environment.

ICE's contribution to environment preservation shall be a matter of proper coordination through the Project Director to comply with established environmental

guidelines and generate, as possible as it can be, participation in environmental programs with community organizations of communities close to the Generation Center.

Residential Usage

According to current usage of soils in Ciruelas, the Project area, trend is to use it for industrial purposes. Notwithstanding, it must be foreseen and planned not to promote urban gathering near the Center construction area in the future. Therefore; it will be of great help if the Municipality plans the land usage in the zone. An immediate action by the ICE is (as it has been planned) to build the engine room at a distance allowed by current norms. These steps must be done since construction phase of the CGE (Generation Center).

Socio cultural Dynamics

In general, whenever a big group of foreign people arrives to stay in a community, it generates a change in the daily life of it. In this specific case, a big group of workers will arrive to live during construction. It is advisable to call workers' attention regarding their behavior in their free time, especially. They will be expected to respectfully behave with community population to prevent conflicts.

Community Safety and Health

As a result of construction, there will probably be an increase in vehicle circulation towards the Project site and therefore; an increased pedestrian risk. We recommend that, before works start, a "bay" be built at site entrance of the Project and a Safety and Surveillance Plan be set and implemented to watch over the machinery and people flows limiting access to strangers from construction process.

Labor Safety and Health

Risk of suffering work accidents and the noise increase associated are elements which are present in all construction processes especially such complex infrastructure works as this one. Safety norms and regulations must be applied. Essential requirements must include the application of the Law on Labor Risks and its rules, the General Safety and Hygiene at Work Regulation and usage of proper safety work equipment. Actions to follow:

- a) Installing small cabins or chambers for periodical isolation for workers from noise, high temperatures, gases and vibration.
- b) Performing periodical health check outs to determine auditory or respiratory illness patterns, etc.
- c) Making workers deal with methods and techniques about industrial safety and supply workers with minimum equipment required (masks, gloves, plugs, etc.)
- d) Designing the trajectory for control and inspection in warm areas to avoid abrupt changes of body temperature.
- e) Watching over norm, regulation and guideline compliance.

Quality of Life

Quality of Life deals with noise, vibrations and emissions produced by the Center operation. Effects must be monitored besides using proper technology to reduce and control them. To comply with it, an Inspection and Maintenance Plan must be

established for machinery and equipment and those Mitigation Actions described in Work Design and anything set forth in the Work Reception Protocol must be complied with and verified.

Services

There will probably be a service demand increase that the ICE could contribute to improve through its Generation Center. Thus, it will manage to install the telephone line number required; in addition, it will cooperate with construction of a pedestrian bridge in La Calle del Arreo to which the Municipality of Montes de Oro in coordination with Community Development Association could provide maintenance.

Work

Especially with Project construction, work offers will increase in the zone. The Project Director will take care to contract most number of local workers.

In the Environmental Management Plan section, a detail of anything related to social environment is included. (Chart 7.1)

CHAPTER 7 ENVIRONMENTAL MANAGEMENT PLAN

The steps to environmental control for each impact are characterized accordingly (preventive, alleviating or corrective), and the location and responsible entity of each measure is assigned once the steps for each impact are defined. The result of this process is summarized in Table 7.1, which includes the corresponding environmental management plan at the end of the document.

Table 7.1 also contains the estimated costs of each proposed measure. Many of those alleviating and prevention activities are tightly related to the constructive and operating process of the plant itself. Therefore, this goal will be met with the control and monitoring of the environmental manager. The manager's functions as well as other implementation topics are discussed in Table 7.2. In these cases, the cost of the manager's work and an expert's report will be assigned only when management needs assessment.

The contractor referenced in the following management plan is the person who performs construction works as well as the installation of equipment. It may (or not) be the same person.

7.1 ENVIRONMENTAL MANAGEMENT PLAN

Social and Environmental Management

Social and environmental management is established in two directions: contribution with information and environmental conservation. In the project's construction phase, the information will be oriented towards its workers and during

the operational phase, to the community; the contribution to environmental conservation will take place in the operational phase.

The information, which is given to workers by means of lectures, will include occupational health, safety at work, environmental policies set by ICE and other aspects related to archeological patrimony. A very important topic is the worker's social behavior. They must be respectful and have a socially-accepted behavior, mostly in their spare time. These lectures must be delivered before any construction project starts.

The information will be offered to the community from a specially-equipped office, in the construction phase, which will have information about generalities of the energetic development and other topics that deal with electrical energy and environment.

ICE's contribution to environmental conservation should be appropriately coordinated through the project's Director in order to meet the pre-established environmental policies and generate, as well as possible, the participation in environmental programs with community organizations near CGE.

Residential Use

According to the current use of land in Ciruelas –Project's area-, the trend goes to industrial use. However, there must be careful prevention and planning to avoid built-up urban areas near the construction area of the Center. Therefore, a way to plan residential use is the study of expansion options or, as it is being done, the construction of the engine room at a legal distance. These formalities must begin in the construction phase of CGE.

Sociocultural Dynamics

In general, a big group of foreigners living in a community generates a change in the community's daily living. In this particular case, a considerable amount of workers settle down in the town throughout the construction process. In consequence, it is recommended that workers behave properly and be respectful to the population at all times and specially in their time off to avoid conflicts.

Community Health and Safety

As a consequence of the construction process, there might be an increase of traffic on the way to the project's site and, as a result, an increment in the pedestrian's risk. Before the work starts, it is advisable to build a "bay" at the entrance of the project's site and to establish and implement a Security and Surveillance System that takes care of the machinery and people flow, with restricted access to people who are not part of the construction process.

Safety and Health at Work

The risk of suffering accidents at work and the increase of noise are permanent elements in the construction process, mainly if we are talking about complex infrastructural projects, like this one. Therefore, safety measures, such as Ley de Riesgos del Trabajo and all its regulations and Reglamento General de Seguridad

e Higiene del Trabajo must be applied and suitable safety equipment has to be used.

Quality of Life

The effects of noise, vibrations and the emissions produced by the Center's operation must be monitored, as well as reduced and controlled by suitable technology. As a result, periodical Maintenance and Inspection Plan on the Center's machinery and equipment must be established, mitigation actions described in the project's design have to be carried out and the Reception Protocol of the project must be complied with.

Services

A boost in the demand of some services is expected and ICE may improve them, through Centro de Generación. It will negotiate the agreed number of telephone lines and contribute with the construction of a pedestrian bridge on La Calle del Arreo, which must be supported by Municipalidad de Montes de Oro, in conjunction with the community's Asociación de Desarrollo.

Employment

The Project's construction will generate job offers in the area. The Director of the Project will watch over the hiring of the highest amount of workers.

Archaeology

There must be an intensive archaeological research at AP, particularly in areas where archaeological features were detected. Moreover, an archaeologist must be hired in the excavation phase to oversee earth movements; if a pre-Columbian feature were found during this activity, the area would be cordoned off and rescue would take place in coordination with Museo Nacional de Costa Rica.

When the excavation phase begins, the staff will receive training lectures and workshops directed to analyze the importance of archaeological patrimony and the need of scientific studies that identify how our ancestors lived.

Landscape

The visual change due to dump, excavations and location of the work will lead to native-plant-and-tree growth and vegetable screens, as well as to the compliance with mitigation steps pointed out in Chapter 6, section 6.2.5.

Geomorphology

The change in the micro topography due to the presence of the project works leads to the relocation of the antinoise-barrier design, the project works that suit the area's topography and the alteration in the runoff's behavior due to changes in the microrelief. As a consequence, there must be water management systems in excavations and material collection through deposit traps.

Soil/Oil and Fuel Spillage

Soil's ecology maintenance needs oil traps, control and leak management, as well as storage and correct use of fuel. For that, the Reglamento sobre la Regulación sobre el Sistema de Almacenamiento y Comercialización de Hidrocarburos (Regulations on the Hydrocarbon Storage and Trade System) Decree 30131-MINAE-S must be complied with.

Surface Water and Runoff

Install permeable granular-base materials in bearing surfaces and pedestrian traffic if allowed. Install ditches, drainage boxes, sewage and sidewalks. Use permeable granular-base materials around the work area, entrances, parking lots, etc. Perform physical, chemical and biological monitoring of Ciruelas river water.

Generation of combustion gases (emissions)

Control the quality of supplied fuel ($S < 1\%$, H_2O , mineral salts, etc). In general, observe what has been stipulated in Gaceta 236 on December 6, 1999 about decree No. 28280-MOPT-MINAE-S, related with the regulation of control and vehicle check-up for polluting-gas emission, generated by motor vehicles. Establish a frequent-measurement protocol of chimney-emitted gases: once a month during the first year of operation and every quarter afterwards. Comply with the Canadian federal policy on emissions and Decree N° 30221-S on inmissions, in the plant's perimeter.

Air temperature

Distribute equipment so the hotspots are as concentrated as possible and thermically isolate them to the design's extent, matching the selected technology.

Noise Pollution

The equipment must guarantee that the property's limit does not exceed 45 dBA 24/7 outside the nearest house in the direct-influence area, since the corresponding alleviation is contemplated in the design.

Perform a noise study (isophonic) of the location before and after construction. This study will be performed again every five years during the operation period to check for changes in the environment. Monitor noise in the plant and the area of direct influence every quarter in the first year of operations and yearly from the second year of operations on (summer).

Substation

In terms of soil and landscape, one must work to avoid major changes in the environment by: cleaning, collecting and treating solid waste and controlling gaseous-substance dumping.

Table 7.2 (see end of the document) summarizes the most common problems that combined-cycle thermal plants raise, with the most frequent polluting sources and the precautions that must be taken from the plant's design. This allows the study of previous impact and that is why they are not included in the final environmental management plan. However, these problems are mentioned to point out they have

been considered in the plant's design. Other impacts have been taken into account in the post design and a strict monitoring program that ensures compliance is created to improve the environmental quality of the project.

7.2 ENVIRONMENTAL MANAGEMENT ORGANIZATION

This section includes the minimum specific environmental functions, which must be respected during the construction of Centro de Generación Eléctrica de Garabito. Some specifications extend to the operation and maintenance of the plant (Production) and describe the programs and subprograms that tend to prevent, alleviate or compensate for the possible impact that might show up about the environmental components of the project's influence area, as a result of construction, operation and maintenance of the plant. The environmental management programs should get settled during the project's detail-engineering stage by complying with functional specifications and efficiency of different systems. They should also be implemented during the construction and operation stages.

According to Plan de Gestión Ambiental (PGA) or Environmental Management Plan, there must be an Environmental Manager who executes and supervises the functionality and progress of each and every environmental management project, plan and program as well as of other steps, considered by Secretaría Técnica Nacional Ambiental –SETENA or the ones that come up along the project's construction and operation. They must submit periodical reports about the progress in environmental engineering, problems and solutions that are coordinated with ICE environmental inspection, in accordance with Costa Rican legal framework.

In the test-and-reception stage, environmental inspection must be complemented with an environmental manager of the contractor's executive unit and an Environmental Manager from environmental management who will inspect and review the compliance, performance and functionality of every system and Environmental-Management-Plan programs. The inspectors will issue a compliance-with-environment (trial protocol) certificate for every subprogram of the Environmental Management Plan and a global compliance certificate, only when the Environmental Management Plan is 100% acceptable.

The Contractor and PYSA's Project Manager shall take the necessary steps to prevent, alleviate and compensate environmental impacts in the community's social, financial and cultural aspects. He must also assume and carry out social and ICE's community and information policies, as well as keep good terms with the community and civil authorities.

It is the Contractor, subcontractor, and project employees' responsibility to keep a respectful attitude for traditions, religious, social and cultural customs of community people in the project area and avoiding any economic alteration or speculation.

The Contractor must maintain and operate a contingency plan to eliminate, minimize or take on risks that have been identified in the risk analysis of the project. The unidentified risks that might come up during the construction and operation of the project, additions or changes of the detail engineering of the contingency plan must be consulted and approved by ICE.

7.2.1 Strategies for the Implementation of the Environmental Management Plan

The suggested general structure for the implementation of the environmental management programs consists of the contractor's counterpart environmental manager and the monitoring and follow-up manager for the project's inspection. In order to carry out the environmental alleviation measures, plans and programs, there must be a well-defined management organization to lead, execute and control the Environmental Management Plan. This structure was developed by ICE and its Environmental Manager, who should have a counterpart within the organizational chart of the construction-and-assembly contractors and subcontractors, who are involved in its execution and inspection, in case of being hired by a third party.

The contractor must have someone in charge of Environmental Management to coordinate and watch over the execution of the Plan. This manager will be held responsible for the implementation of the works, environmental controls and programs; that same manager must coordinate with the ICE's Environmental Manager before SETENA. This structure will ensure that controls and programs designed in the Environmental Management Plan and approved by Secretaría Técnica Nacional Ambiental (SETENA) comply with the objectives of environmental protection and preservation and sustainable development.

Environmental Management

Environmental Management is a tool to implement different programs of recovery, restoration, alleviation, prevention and compensation pointed out in the environmental management plan. It also performs adjustments in the detail design stage, based on the feedback on environmental inspection from the ICE executive-unit and SETENA's.

The objectives of the project's Environmental Management are:

To execute the project's environmental management, embodied in the measures, work designs, construction procedures and complementary programs.

During the execution of the project's works, guaranteeing the compliance with the environmental policies included in the environmental-impact study and its specifications, and with the environmental laws and regulations from competent environmental authorities.

Be an essential tool for management awareness with the contractor's and ICE staff, identify environmental problems that had not been initially considered in the Environmental Management Plan and suggest as well as implement their solutions.

7.2.2 Spatial Coverage

Environmental Management will be implemented in all items included in the Environmental Management Plan and the areas near the project's site or communities that might be affected with any direct or indirect action derived from the generation-plant's construction and operation.

7.2.3 Methodological Policies

The general project's environmental management structure consists of two individual and independent but complementary environmental managers. The first one is the construction-and-assembly contractor, who should assign an environmental manager to execute the programs of the Environmental Management Plan. The second one, from ICE, would perform the environmental inspection. He can hire a third one or contact the project's consultants. This structure was generated since some work bids can be given to different subcontractors, with the aim of speeding up the execution of the project and performs it -through professional expert firms. However, it could be simplified, depending on the real awarding conditions of construction and electromechanical assembly.

7.2.4 Minimum Functions of the Environmental Manager

- Execute specific management works and measures
- Prepare periodical reports for the inspection and environmental authority about the project and environmental management project's progress
- Give the community reports, together with the Project's Manager, about the amount of jobs that will be generated and the requirements to hire labor force as well as good-and-service contractors.
- Coordinate with contractors and subcontractors the details for personnel hiring, their contractual liabilities and the mandatory level of its compliance
- Train all the personnel who is linked to the construction
- Reinforce the bonds between the community, the Project, the contractors and subcontractors in the hiring stage
- Design and coordinate the delivery and release of information about activities related to the project
- Coordinate Project-Community relations through the permanent exchange with the settlers (deciding organizations, influential people and general population) to guarantee the execution of all the different activities and the community's participation
- Implement tools and means that favor clear, efficient, direct and timely information

- Broadcast short, mid and long-term benefits generated by the Project's execution
- Coordinate project's environmental management, who will be the head before the environmental inspection of ICE and SETENA
- Perform general monitoring to the procedures in each of the project stages
- Work on obtaining additional permits and licences that are not included in SETENA's environmental approval
- Provide information to high management decision groups and ICE's execution unit
- Be the negotiator between ICE's Project Manager and the contractor, about its environmental-management issues
- Organize and preside the meetings called by high organizations and for reports and follow-ups on the different activities
- Identify additional resources, such as specialists and consultants, control equipment, etc, necessary for the compliance with the Environmental Management Plan
- Inform the project manager and ICE about the problems that may require corrective actions or contingency-measure management
- Approve recommended strategies on biotic, physical and sociocultural topics to solve problems that have not been identified in the Environmental-Impact Study
- Guarantee the integrity in management and the support in each activity
- Identify environmental effects that have not been considered in the Environmental-Impact Study of the thermal plant in the construction or operational stage with the following activities:
 - If the problem can be solved, it will be corrected through the design of works or the execution of mitigation steps. Otherwise, the authorities (Centro de Gestión Ambiental) will be asked for support.
 - Relevant environmental authorities will be informed about the problem and its possible solution. While the issue is finally solved, there will be emergency steps to minimize the impact in order to avoid the cancellation of the construction.

Reports

The environmental manager of the contractor's will submit reports about his/her work to the environmental manager at SETENA, so the manager can structure the reports that have to be handed in to the environmental authority (SETENA). The reports must contain, at least, the following information:

Activities

Describe activities that have been developed throughout that period, progress on each and every program of the Environmental Management Plan. Comparative schedules (programming vs real execution), percentage of progress, used resources and effectiveness tests for environmental-impact control will be included.

Events

Describe unexpected events that have occurred during the construction time that are related with the environmental component.

Environmental Costs

Submit the costs of implementing the Environmental Management Plan during the construction of the project.

Annexes

Show all the bibliography used in the execution of environmental management and the field formats, meeting minutes, drawings, photographic and video recordings and all the information that should be included to make a clear report.

Communication/Information

External and internal communication is essential to achieve the environmental objectives.

Internal communication: environmental topics should be discussed in Project Management meetings and in regular communications with Inspection and the project's contractors. They must communicate the requirements that deal with the environment and the way to execute them through written instructions, procedures and norms. In addition, employees and contractors have to be informed and trained on ICE's environmental policies.

External communication and cooperation: Communication, dialogue and cooperation with third parties who are interested in the ecosystem where construction, community and local or nationwide activities occur are required to materialize the plans proposed in the conversation about environment. This communication must be open to third-party questions. Explanatory pamphlets will help to inform authorities and the community.

Adjustments

Feedback is the means to find out if the environmental-impact control system is effective; the execution, control or test, as well as the adjustments, guarantee feedback in the implementation cycle.

Short and long-term actions should consider the initial situation of the environment and the consequences from other projects; the standards and objectives have to be developed in coordination with a long-term goal policy. The real short-term objectives must be defined taking into consideration the environmental-legislation objectives and the final characteristics of the generation plant. The standards and objectives could change during the operation, in the light of a new discovery or process that drives to better-environmental-quality-long-term goals.

7.2.5 Monitoring and Tracking Plan

The Monitoring and Tracking Plan is part of the project's general inspection. They are a group of activities to control and monitor the execution of the Environmental Management Plan to develop construction, installation and operation of Garabito's Eléctrical Generation Center.

Objectives

The main objectives of Monitoring and Environmental Tracking Plan are:

- Watch the compliance with the environmental management plan, embodied in management policies, work design, construction procedures and complementary programs.
- Perform systematic monitoring of the programs included in the environmental management plan. Evaluate and record the recommendations for improvement.
- Watch the compliance with the ruling established for environmental and natural-resource conservation issued by qualified environmental authorities.
- Participate, together with the Project Director and the contractor, in the management of relations with external entities and officers in charge of environmental surveillance, project-development reports and environmental management.
- Verify the execution of the training to the contractor's personnel and the community that have been directly involved in the project.
- Establish immediate-response mechanisms to the deviations in the altered-ecosystem behaviour, due to project activities in the construction and the operation stages.
- Identify environmental and social problems, which had not been considered in the initial environmental-impact study, that arise during the construction of the project and authorize the relevant institution to offer appropriate solutions.
- Demand and certify tests to verify the efficiency and effectiveness of the systems and environmental-control policies necessary for construction and operation activities.
- Design and apply test-and-application protocols for each of the environmental management programs.
- Generate periodical reports for general work inspection and project management that inform, every three months, about the compliance, inconveniences, adjustments and progress of the Environmental Management Plan.

- By no means, the Environmental Manager will be held responsible of monitoring and tracking, performing tasks and activities that counteract one another or make project duties redundant.

Contractor's Environmental Management

Environmental supervision must coordinate and design specific procedures and tools that allow the compliance with this mission, without interfering with the contractor's environmental-management functions or confusing the community, due to the difficulty in differentiating between the various actors that participate in the management of environmental matters. Therefore, both parties must work together.

In general, the support group of the Environmental Management Center can settle away from the project's area. The participation of its members and their transportation will depend on the actual project requirements and will be defined in accordance with the coordinator's request on monitoring and tracking.

7.3 MINIMUM ENVIRONMENTAL SPECIFICATIONS

The specifications have been organized in three big groups of programs that cover all physical, biotical and social aspects for the construction and operation stage. The programs complement with the Environmental Management Plan and are made up of specific subprograms for the construction and operation stage (Adapted from EsIA Report by Compañía Nacional de Fuerza y Luz, 1999).

7.3.1 Construction Stage

This stage includes all the preliminary activities, ground preparation, civil works, electromechanical assembly, tests and implementation. Some of the works have to be designed in detail and approved by the project's inspection group. Its execution must fit the final chronogram that the contractor submits (see cards).

Stage: Construction

Program: Control and treatment of sewage water

Aspects: Physical

Subprogram: Sewage Water Treatment

Objectives:

Prevent the pollution of water surface currents as a result of waste construction materials.

Description and specifications: Sewage water that comes from washing mixers, equipment and tools, required for the preparation of concrete mix, should be deposited in ditches dug in the ground, which comply with sedimentation and filtering of waste-content water. The following measurements are required: 1m deep, 1.5m wide and 4m long. These dimensions guarantee a 5m³-waste-storage capacity with a 0.15m free edge. In these conditions, the ditch will treat production-washing-water for 800m³ of concrete. Once the ditch is full, it should be covered with the material that was removed at excavation (the contractor must adjust the design with ICE's approval, coordinated with the Project Manager).

This system acts as a sedimentator and filter for similar sewage-water treatments. The efficiency of these ditches is about 80%, depending on the soil-filtration capacity. The number of ditches to be installed hinges on the amount of concrete required for the construction of the plant, considering the treatment capacity already mentioned.

Applicable policies: Ley orgánica del ambiente –environment organic law- (Law 7554) Sec 65 and 66

Conformity and tests: The contractor will inform the environmental inspection group about the opening and location and use of each ditch. The inspection may demand the opening or closure of ditches and even demand compensation and repair of environmental damages due to inadequate disposal of concrete and cement-mix wastes.

Execution manager: will be the contractor in charge of construction of the plant. The inspection group can verify its compliance at any time.

Execution period: from the beginning of the plant construction works. They should be used throughout the whole construction period.

Card 2-
Construction – Control and Treatment of Oily-Sewage-Water Treatment

Stage: Construction

Program: Control and treatment of sewage water

Aspects: Physical

Subprogram: oily-sewage-water treatment

Objectives: Prevent contribution of grease and oil to bodies of water, generated by vehicle and machinery maintenance and washing in the construction area.

Description and specifications: For the control against pollution due to grease and oils, a 20-metter-wide-by-ten-metter-long-concrete plaque that might be used for washing, changing oil and maintaining vehicles and machinery for construction. This plaque will have a concrete perimeter channel which will lead the water into a grease trap, that can act as a sedimentation effect, Once the water go through this system, it can be driven to the perimeter channels on the ground that pick up the runoff water and, then, take it to a sedimentation lake (see figure 7.1).

The grease and oils collected in the grease trap will be prepared or mixed with liquid combustibles, such as fuel oil.

The transversal section of the channels must be trapezoidal and the slope of the lateral batters should be 1V:1H, depending on land condition. The minimum longitudinal slope of the channels should not be lower than 0.5% or higher than 2%. It is recommended that, for the location of the land with a slope higher than 2%, the creation of concrete or stone stairs that allow for maximum adjustment of the slope. The minimum width of the channel base is 0.4m.

The grease trap will be designed for a retention period of 15 to 20 minutes and in accordance with the estimated water level this area will handle or, if it is found according to the climate records of maximum-yearly-precipitation, (the contractor could adjust the design, with ICE's approval, along with the Project Manager).

Applicable Policies: Ley orgánica del ambiente (Environment Organic Law) (Law 7554) Sec.65, 66 and others.

Conformity and tests: The contractor will submit to the inspection group the designs, the concrete plaque, the channels, draining areas, grease and oil traps and unloading structures to the runoff system. The contractor will directly verify the state of the channels and grease and oil trap as well as the channel and trap maintenance. The contractor will be in charge of the execution of these tasks.

Card 3
Construction – Handling and Disposal of Industrial Solid Waste

Stage: Construction	Aspects: Physical
Program: Solid-Waste Management and Disposal	Subprogram: Industrial-Solid Waste Management and Disposition
<p><i>Objectives:</i> Prevent the water and soil pollution due to industrial solid waste in the plant's construction stage.</p> <p><i>Description and specifications:</i> The type of solid wastes that are produced during the construction of a thermo electrical plant are: paint leftovers, thinner, industrial grease and oil, chemical products and their containers, plastic and wood packaging, ferrous and non-ferrous-metal remnant, welding butts and others. Many of those leftovers are toxic or hazardous; others can be used or recycled.</p> <p>The Contractor shall prepare a detailed classification and record system of that waste (characteristics, quantity, storage and final disposal) and a temporary place for storage and disposal within the construction, before its final disposal. The hazardous or toxic leftovers will be encapsulated in sealed, water resistant packages, atmospheric agents and handed to a health authority for their final disposal. Those wastes must be kept away from sunlight and water, sufficiently ventilated so gases and odors do not concentrate, as well as extinguishers for the extinction of potential fires. The access to the area should be restricted only to the personnel in charge of its collection, record and disposal.</p> <p><i>Applicable policies:</i> Ley orgánica del ambiente (Ley 7554), Sec 68, Ley de uso, manejo y conservación del suelo Sec 33.</p> <p><i>Conformity and tests:</i> The contractor will submit to the inspection group his program for industrial-waste management, location and container design and storage areas. This can be adjusted as the construction progresses. ICE will recommend anything that is best for the system redesign or for workers.</p> <p><i>Execution manager:</i> the contractor in charge of construction of the plant; the inspection group will control the operation.</p> <p><i>Execution period:</i> The activities for industrial-solid-waste management and disposal in the construction stage will take place since first month of plant construction.</p>	

Card 4
Construction – Environment

Stage: Construction

Program: Social and Environmental Management

Aspects: Social

Subprogram: environmental

Objectives: Inform ICE workers and contractors and the community about environmental policies for the project's efficient management.

Train contractor and subcontractor's workers on the project's Environmental Management Plan.

Avoid actions that threaten the integrity and the environment. Incentive the responsible management of environment from every position at work.

Delegate environmental responsibilities to each and every project worker on industrial safety and occupational health.

Training workshops will be delivered by an expert or a group of experts on: a) Justification and national need of the project, c) ICE and Contractor's environmental policies, d) Project's environmental effects in construction and operation, e) Environmental management of the project, pouring, emissions, solid wastes, fauna and flora, social management, etc, f) Project's advances, g) Environmental problems and solutions, h) Environmental planning and corrective actions. i) Industrial safety and occupational health.

Applicable policies: Ley orgánica del ambiente (Ley 7554) Sec 12 and 13

Conformity and tests: The workshop's content, design and planning will be performed by the contractor and ICE's environmental manager. There will be a statement and a photographic record of each workshop with recommendations, suggestions and corrective measures that should be taken into account for the solution of environmental problems.

Execution manager:

It will be the contractor or whoever the contractor assigns for that purpose; the inspection group will take over control.

Execution period:

Environmental training will take place since the beginning of the project and the training program will remain throughout the construction; programming can be adjusted depending on the personnel recruitment at the beginning of the work
Ley orgánica del ambiente (Ley 7554) Sec 65 and 66.

7.3.2. Operation stage

The environmental-management systems and works for the operation stage should be designed and built by the construction contractor, who would deliver them to the environmental inspection group.

In the test and implementation stage, the efficiency of each environmental management system would be inspected and received if it meets the requested specifications. The contractor will give the necessary training for an accurate operation. He will also hand the operation and maintenance manuals over to the execution-unit's inspection group or whoever is assigned.

Cards 5 to 12 summarize eight environmental programs about prevention and mitigation of potential environmental effects the plant could generate in its operation stage.

The operator assigned for the plant will attend as an observer to the conformity and test stage of the plant, receive training by the contractor on the appropriate operation of environmental-management-system operation. He will submit a detailed environment management plan, in accordance with the minimum specifications and other requirements the execution unit sets, before final delivery of the plant for its revision and approval.

Card 5
Operation – SOx, NOx, HC, CO emission control

Stage: Operation	Aspects: Physical
Program: Atmospheric Emission and Noise Control	Subprogram: SOx, NOx, HC, CO Emission Control
<p><i>Objectives:</i> Ensure compliance with norms on pollutant emissions (SOx, NOx, HC, CO), with the aim of preventing the deterioration of air quality due to the increase of its concentration in the atmosphere.</p>	
<p><i>Description and specifications:</i> The main regulation for the control of SOx emissions during the operation of the plant consists of fuel quality control (Fuel Oil N°2), more specifically about the amount of sulphur, in fuel storage containers; the mix of fuels with low and high amounts of sulphur should take place in a way that the final mixing guarantees the emission limits set by law and for the plant.</p> <p>The control of NOx will happen through an injection of water into the turbine. For that effect, the NOx control system will consist of a collecting system, a sand trap, a clarifying system or primary-treatment plant, demineralising system, demineralized-water-storage tank (for a minimum of 7 days of normal operation). ICE and the manufacturer will evaluate the final dimensioning and demineralized-water-injection system to the turbine. Moreover, it must have mud-and-sewage-water-treatment-and-disposal systems that originated from the water-supply collecting, treatment and demineralization systems for the injection to the turbine, as described in the industrial-sewage-water treatment subprogram.</p> <p>For the control of non-burned hydrocarbon emission, there should be a direct control over combustion processes. A large portion of the carbon-monoxide emissions comes from defective combustion. Therefore, it is not necessary to implement an additional control system for the reduction of non-burned hydrocarbon and carbon monoxide emissions, different from the efficient operation of combustion.</p> <p>The contractor should install a NOx measuring system, on line, to measure and record the NOx emissions during the plant's normal operation. The system must be successfully calibrated and operated in the conformity-and-test phase. SOx, HCL, CO and PTS will be measured with a measurement portable system that will be supplied along with the turbines. Each chimney shall contemplate staircases, resting and extras for the sampling (piping for the drill). The contractor is responsible for the implementation of NOx reduction system.</p> <p><i>Applicable policies:</i> Canadian and national policies, if they available.</p> <p><i>Conformity and tests:</i> The contractor, in coordination with the environmental manager, will perform, in normal operation, at least ten NOx emission measurements, through EPA's method number 7. The results of the NOx emission measured by EPA's method 7 must satisfy the demanded emission</p>	

limit. The on-line measurement system will be calibrated and received.

Card 6

Operation - Control and Treatment of Domestic Sewage Water

Stage: Operation	Aspects: Physical
Program: Control and treatment of sewage water	Subprogram: Control and treatment of domestic sewage water
<p>Objectives: Reduce and prevent the impact on the water-quality alteration due to the contribution of domestic sewage water in the project's operation stage.</p> <p>Description and specifications:</p> <p>For the operation stage, there must be a treatment system of domestic sewage water, in stages, like so: <i>Grease trap</i>: removes, by flotation, saponified or emulsified grease. The grease trap is a concrete chamber, where grease is deposited at the top, through flotation. It prevents grease and soaps from bathrooms and kitchens from reducing their efficiency in the following stages of the treatment. Its design depends on the amount of served people, water consumption and return per person, retention time. The tributary runs through the septic tank, where a digestion process takes place – decanting of two-chamber suspended means. It will be a one-to-three day retention period. Solids will settle at the bottom of the tank and an anaerobic digestion of the organic matter will take place, helped by a foam layer that develops at the surface of the liquid (see figures 7.2 and 7.3).</p> <p><i>Digester</i>: fixed-means percolator (anaerobic-ascendant filter). Since tributary of the septic tank doesn't have the physical-chemical and organoleptic quality to be discharged in a superficial source, yet, it must be treated. The anaerobic filter produces the final methanization or decomposition of carbonaceous organic matter dissolved in the waste. It should be placed after the septic tank and consists of a concrete or brick tank, fed at the bottom, through a diffusing chamber. The waste runs through a thick porous or filtering means (2"-diameter-angular stone) and rises up through the leftover interstices from the material, forming a biologically active film that anaerobically degrades an important part of the organic matter. For its dimensioning, a 0.05m³-filter-unitary volume per served inhabitant can be applied. <i>Applicable policies</i>: Ley del Ambiente (Ley 77554). <i>Conformity and tests</i>: The treatment system of domestic sewage water (grease trap, septic tank and anaerobic filter) must comply, at least, with the policy about pouring and reuse of sewage water (n° 26042-S-MINAE). The inspection group will approve the treatment system and recommendations to the contractor for a system adjustment, if it were not operating in accordance with the specifications. For the system design, CFIA's Código y Reglamento Sanitario of Costa Rica should be considered. The final design will be reviewed and approved by ICE. <i>Execution manager</i>: is the contractor and the inspection group of the project will take control.</p>	

Execution period: The construction of the domestic-sewage-water treatment will take place the last semester of construction, before the plants begins operations.

Card 7

Operation – Control and Treatment of Industrial Sewage Water

Program: Control and Treatment of Industrial Sewage Water

Subprogram: Control and Treatment of Industrial Sewage Water

Objective: Reduce and prevent the impact on water-quality due to the contribution of industrial sewage water.

Description and specifications: Oily and acid (alkaline) waters from the demineralization system are treated through the following subsystems: *Grease and Oil API/PPI Separator:* this structure would be built to collect industrial sewage waters with grease, oils and liquid-fuel-content concentrations, as well as rainwater and floor-siphon waters from the following areas: fuel-treatment system, fuel-tank-spillage retaining dam and collection of rainwater from the same area; equipment-maintenance areas (garages), tubegroup area, substation yard, other areas that are prone to generating waters with oils and fuels. API consists of a rectangular area where free oil and sedimentable oils are removed, due to gravity differences, from oily waters. These units do not break emulsions or remove soluble substances. The equipment includes a pool, through which oily water flows slowly, so oil rises to the surface to create a film that is retained by a baffle and removed by a skimmer, The equipment is provided with a removal system of solids that sediment in the separator. Before the API separator, a tank, where different piping systems lead to oily-water tributaries of different areas, must be found. For the design of an API separator, one must consider: specific gravity and absolute viscosity of water, specific gravity of oil and oil's particle size (see figure 7.4). *Neutralization system:* the water demineralization process for cooling systems generates acid or alkaline sewage water, which must undergo treatment in a neutralization tank. This tank should be cylindrical, built in concrete, covered in epoxic resins or acid/alkaline-substance-resistant and buried. The tank must also have agitators in order to get more homogenized mixture, automatic tributary-neutralizer-acid-or-alkaline-substance dosifier, until pH values between 6-and-9-pH units. The neutralization equipment will include dosifying pumps for acids and alkali, turbine-type electroagitator, structural-profile metallic support for the agitator, piping, accessories, valves and others for required power and flow. *Applicable policies:* Ley orgánica del Ambiente (Law 7554), 1996 World Bank Guidelines and national guidelines, if any. *Conformity and tests:* The contractor is the execution manager. The grease-and-oil-separation-system tributary will show equal or lower concentration than 10mg/l, in five (5) samples. The tributary pH will be from 6 to 9.

Card 8
Operation-Management and Disposal of Domestic Solid Waste

Stage: Operation Aspects: Physical	
Program: Management and Disposal of Solid Waste	Subprogram: Management and Disposal of Domestic Solid Waste
<p><i>Objectives:</i> Avoid water and soil pollution due to domestic-solid disposal during the plant's operation stage.</p> <p><i>Description and specifications:</i> The types of domestic solid waste that is usually produced during the operation of a thermo electrical plant are: food leftovers, food packs, polypropylene paper and bags, among others. For a correct disposal of this waste, the following activities must take place: Store leftovers in the production source in appropriate containers, resistant to animal (rodent and canine) attacks. For practical effects, the use of five-gallon-thrown-away barrels is acceptable or similar elements capable of no more than 25kg. In the inside there will be a plastic bag that holds the waste. The bag should periodically be taken away. The disposal and density of garbage cans per area will vary depending on the use: office, maintenance, food or rest.</p> <p>After that, in the recollection period, the person in charge will take the waste, in a bag, to a confinement ditch, specially built for this purpose. This activity must be performed as soon as the containers are full or every three days (whatever takes place first). The storage room should be away from work, leisure or eating areas and properly marked. Finally, waste will be delivered to the nearest company in charge of sanitation, for its final disposal, in no more than a week. For the ditch dimensioning, it must be taken into consideration the amount of people that stay during plant operation, assuming a per-capita production of 0.5kg/inhab-day (TCHOBANOGLIOUS, 1994) and a 400kg/m³ density that corresponds to non-compacted waste.</p> <p><i>Applicable policies:</i> Ley orgánica del ambiente (Law 7554) Sec 69</p> <p><i>Conformity and tests:</i> The operator will design and operate a program for waste management. Container location and design and storage areas will be adjusted to the number of employees and temporary workers at the plant. The execution unit's inspection group will recommend anything they consider necessary for the system redesign or the education-program implementation to workers whenever they consider it is necessary. <i>Execution manager:</i> it will be the operator; control will be handled by the inspection group of the project.</p> <p><i>Execution period:</i> Activities must take place since the first month in operation of the plant.</p>	

Card 9
Operation-Management and Disposal of Industrial Solid Waste

Stage: Operation	Aspects: Physical
Program: Management and Disposal of Solid Waste	Subprogram: Management and Disposal of Industrial Solid Waste
<p><i>Objectives:</i> Prevent water and soil pollution due to industrial-solid-waste disposal during the plant's operation stage.</p> <p><i>Description and specifications:</i> The type of industrial solid waste that are commonly produced during the operation of the thermo electrical plant are: paint leftovers, thinner, industrial grease and oil, chemical products and their containers, plastic and wood packaging, ferrous and non-ferrous-metal remnant, welding butts and sediments and mud originated from water-treatment systems. During the operation, there should be a detailed classification and record system of that waste (characteristics, quantity, storage and final disposal) and a temporary place for storage and disposal within the construction, before its final disposal.</p> <p>The hazardous or toxic leftovers will be encapsulated in sealed, water resistant packages, atmospheric agents and handed to a health authority for their final disposal. Those wastes must be kept away from the sunlight and water, sufficiently ventilated so gases and odours do not concentrate, as well as extinguishers for the extinction of potential fires. The access to the area should be restricted only to the personnel in charge of its collection, record and disposal.</p> <p>The stabilization lake shall be empty when the sediment volume reaches two thirds of the useful volume. Lake solids will be piled up in a ditch until it's dried up and later on, disposed in the city's landfill. Mud and sediments that have been taken away from the API separator or from any other system will be treated and disposed likewise. Grease and oils that have been taken away from API separator can be mixed up with used fuel for the plant's operation. Grease and oils collected in the sewage-water-treatment-system grease traps will be dried up along with the mud and disposed in the city's landfill.</p> <p><i>Applicable policies:</i> Ley orgánica del ambiente (Law 7554) Sec 68, Ley de uso, manejo y conservación del suelo Sec 33. <i>Conformity and tests:</i> The operator will redesign the system or implement the programs. <i>Execution manager:</i> the operator. <i>Execution period:</i> activities must take place since the first month of plant operation.</p>	

Card 10
Operation – Management and Protection of Wildlife

Operation	Aspects: Biotic
Program: Wildlife Protection and Biotic Quality of the Water	Subprogram: Management and Protection of Wildlife
<p><i>Objectives:</i> Prevent the impact on wildlife in the influence area of the project.</p> <p><i>Description and specifications:</i> For the compliance with the objective and the protection of wildlife restoration, the operator and the environmental manager will delimit the reforestation areas and restrict access. They will get rid of weed where necessary, also in ornamentation and gardening areas. There will be restricted access for the personnel out of project-designated areas. They will announce the use and restriction of delimited areas to the staff through an environmental-education program. Hunting and fur-and-live-animal traffic, as well as weapon carriage will be prohibited to personnel, other than security guards. Nets and traps for personal use will be forbidden. People will be warned through information signs and those who break the law will be fined or fired if they are second offenders. There will be a record of the animal species that repopulate the area appointed for reforestation.</p> <p><i>Applicable policies:</i> Ley orgánica del ambiente (Law 7554), Chap 9, Sec 46, subsect a. Ley de Conservación de Fauna y Vida Silvestre. Ley Forestal. Other environment-application laws.</p> <p><i>Conformity and tests:</i> The operator will inform to the inspection group, the distribution of restricted areas. He will discuss the convenience or need to protect the different areas, depending on their ecological value. Environmental inspection will be informed about incidents with seized, run-over, dead animals. The record of those incidents will include number of individuals, species, cause of incident and measures taken. Inspection can demand the dismissal of people who break the rules of this subprogram.</p> <p><i>Execution manager:</i> It is the plant's operator. Inspection will take over through the Environmental Manager.</p> <p><i>Execution period:</i> activities will be performed since the plant begins to operate and throughout the life cycle of the plant,</p>	

Card 11

Operation – Relationship with the Community and Community Information

Stage: Operation	Aspects: Social
Program: Social Management	Subprogram: Relationship with the Community and Community Information
<p><i>Objectives:</i> Prevent conflicts between the community and environmental authorities. Keep the community and environmental authorities informed about the project's environmental management.</p> <p><i>Description and specifications:</i> The Environmental Manager will handle the requested community information: prepare and present periodical reports, together with Inspection –optional- about the progress and environmental implementation of the project to the environmental authorities and the community. To receive, record and implement the community's complaints and demands due to actions throughout the project; coordinating actions with Inspection for the environmental improvement.</p> <p>All the complaints, demands or observations that the community, environmental authorities or Inspection submit will receive a prompt answer. The response will clearly include the legal justification and policies that lead the Environmental Manager to take direct action.</p> <p><i>Applicable policies:</i> Ley orgánica del ambiente (Ley 7554), Chap 2, Sec 6</p> <p><i>Conformity and tests:</i> It is the Environmental Manager's responsibility to let Inspection know about complaints, demands and requests from the community and environmental authorities. Likewise, he should answer promptly and formally regardless of its origin and wait for the approval of Inspection. There should be a detailed record of complaints, demands, requests and solutions. The Manager will submit periodical reports on the plant's activities and coordinate with ICE's Centro de Gestión Ambiental (Environmental Management Center).</p> <p><i>Execution manager:</i> the Environmental Manager and Director of the plant</p> <p><i>Execution period:</i> The Environmental Manager will maintain and operate the information-and-exchange subprogram since the beginning of the operation and throughout the project's life cycle.</p>	

Card 12
Operation – Environmental Education

Stage: Operation

Aspects: Social

Program: **Social Management**

Subprogram: **Environmental**

Objectives: Inform plant workers about the environmental policies on environmental management. Train plant workers on the project's Environmental Management Plan. Prevent actions that threaten the integrity and the environment. Incentive responsible management of the environment from every job position. Assign environmental responsibilities to every worker of the plant. Train plant workers on industrial safety and occupational health-

Description and specifications: Throughout the project, the environmental manager will have a training program for the workers. The purpose of the program is to encourage a responsible and efficient management of all the environmental variables and to broadcast the project's Environmental Management Plan. Training workshops will be delivered by an expert or a group of experts, experts in environmental management and thermo-electrical-generation plant industrial safety. The following topics must be covered: a) Technical and Operative Characteristics of the Project; b) Environmental Policies and Legal Responsibility of the Project; c) Project Environmental Effects; d) Environmental Management of the Project, Pouring, Emissions, Solid Wastes, Fauna and Flora. Social Management, etc; e) Previous Environmental Problems and Solutions; h) Environmental Planning. Future-Problem Solutions and Corrective Actions; i) Industrial Safety and Occupational Health. *Applicable policies:* Ley orgánica del ambiente (Law 7554) Sec 12 and 13 and other national environmental legislation. *Conformity and tests:* The workshop's content, design and planning will be performed by the environmental team of the plant and the inspection group. There will be a statement and a photographic record of each workshop with recommendations, suggestions and corrective measures that should be taken into account for the solution of environmental problems. *Execution manager:* Environmental manager. *Execution:* since the first month of operations.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations that we will indicate next are extremely important for the good operation of the Garabito Electrical Generation Center, because they guarantee the good functioning of the Plant, the correct use of the resources of the zone and the harmonious relation with the surroundings.

8.1 GENERAL CONCLUSIONS

1. The Municipality of the County of Montes de Oro does not have a Regulation Plan for the County of Montes de Oro; therefore, the potential use of the land is not defined as residential or as industrial but it does contemplate or visualizes a future approach to the industrial zones. Besides, the land where the Electrical Generation Center will be located is very large and ICE has taken all possible precautions regarding impact and closeness with nearby populations in order to guarantee the best environmental quality.
2. The Electrical Generation Center will need for its operation a constant water volume for cooling purposes. In this sense, there are several proposals for the project. A series of technical and water chemical quality alternatives indicate the use of this resource coming from superficial sources as well as from the Ciruelas River and from wells of ground waters in the area of the project.
3. In the work area of the project there is not any settlement or town so close that it would suffer any direct impact; besides, the land for the project has an extended damping zone.
4. The site presents favorable access conditions for the transportation of heavy equipment as well as for accessing the work areas, with a fairly flat topography.

5. The use of technologies in the generation of electric power, like the combined cycle technique, allows the optimal use of the energy resource, such as the use of residual heat in a steam turbine, significantly reducing the release of hot vapors into the atmosphere with the resulting energy savings.
6. With respect to the use of superficial waters, the flows in the Ciruelas River during the low water season are enough, water pollution is very low and the suspended sediment drag, though low, is later treated in a treatment plant.
7. Regarding noise, the operation of the plant supposes a very low impact on populated locations such as La Calle el Arreo and Ciruelas, as a result of the distribution and distance of the equipment.
8. The emission of gases with the permanence of high constructions (chimneys) does not represent negative impact on the nearby neighborhood; therefore, the community will not suffer significant impact.
9. The EsIA of this Electrical Generation Center raises the need to formulate institutional environmental procedures and techniques for the thermal development of the country in an integral and organized manner.
10. The Combined Cycle alternative proposed for this Electrical Generation Center entails a thermal production never seen before in the Central Pacific zone of the country; it is now convenient to start thinking about an Electricity Development System that will integrate the different regional thermal generation instances (Barranca, Moín, etc.) with central instances (Colima, San Antonio, Garabito Project) and with decision makers.
11. Finally, and summarizing the considerations detailed in the document, the environmental feasibility of the project studied is possible, as long as the costs of corrective and compensation and mitigation measures are taken

into account in order to minimize the environmental impact caused by the project.

12. Flora and fauna in general, according to the impact assessment analysis done in this study, will suffer no significant impact from the works of the project, because it is located in grazing land that is highly intervened. Rather, the mitigation measures proposed will highly benefit the area.
13. The grounds of the property have two basic soil profiles: Profile I, where most of the structures are located, constituted by layers of lime-clayey and predominantly clayey materials with high levels of plasticity, of medium to high consistency and the thickness of which ranges between 2 and 8 m that overlie a horizon of pyroclastic rock alteration. This meteorization horizon initially constituted by limey - sandy and very compact limey - sandy soils was detected very superficially towards the south sector of the property. Profile II corresponds to alluvial terrace on the banks of the Ciruelas River, basically constituted by a dirty alluvium with a clayey, high – plasticity matrix with expansive properties.

The ground water level was detected around 7.5 m in the high zone, close to where the tanks would be located, and superficially in the lower zone in the place topographically called “ditch”, apparently not very close to the location of important structures. It was also detected, in the alluvial terrace, between 3 and 4 m deep. This aspect of the investigation must be strengthened, facing the final design of the foundation.

Specific tests were conducted in order to determine the potential expansion of the clays detected in the study, considering the ones corresponding to Profile I to have normal activity. The clays that made up the matrix of the alluvium indicated as Profile II, in the terrace of the Ciruela River, present much higher activity; therefore, it is not recommended to found structures on said materials, or to use them as filling material.

Collapsible silts were not detected or sandy materials prone to generating soil-liquefying phenomena during an earthquake.

In the first three meters of lime-clayey and clayey soil, a significant amount of rounded and sub-rounded blocks were found, probably of igneous origin, of up to 0.30 m in diameter, in very healthy conditions.

For the purpose of estimating the bearing power, the results obtained in UU triaxial tests done to type- CH materials were basically used, and they were conducted between 2 and 4 m deep. The load capacity was estimated between 124 and 652 tons according to different levels of excavation, and relations of plate breadth (B) / plate length. Annex B of annex 9, volume 3, shows graphs 1.2,3 and 4 from which it is possible to infer different foundation geometries and levels of excavation for the load or stress requirements of each structure. As it was previously said, these estimations do not include the influence of the ground water level, because there is no conclusive information with regard to its location in the areas where the main structures will be located. On the other hand, work loads are not known either, or the eccentricity and inclination of the same. For the final evaluation of the bearing power and final design of the foundation, it is obviously necessary to have said parameters. For preliminary purposes it is possible to consider a stress level of 2.00 m

Primary consolidation slumps were estimated, based on the results of one-dimensional consolidation tests, conducted in unaltered samples, for depths between 2 y 4 m. within this range it was preliminarily considered that the materials are preconsolidated, and that the slumps possibly generated are of small magnitude. Once the corresponding estimations were made, slumps were obtained that ranged between 2 and 4 cm. These slumps were obtained for square plates between 1 and 4 m wide, for the different load levels, which were established in the calculation of the bearing power.

The instantaneous or elastic slumps, which are possibly generated during the laying of the load, were estimated based on the distortion modules obtained from the stress - distortion curves in the UU triaxial tests. These slumps would take place in a range between 1 and 4 cm, according to the plate loads and widths established for the calculation of slumps by consolidation. An additional evaluation was made, using the presiometric modules obtained from the tests "in situ" made with a Menard Presiometer and slump values between 1 and 3 cm were obtained for depths between 4 and 7 m, which correlates well with the first data obtained from laboratory tests.

As with the estimation of the bearing power, the values obtained for instantaneous slumps as well as for slumps by consolidation must be checked when the real work loads are available and the foundations are definitively sized.

A preliminary analysis was made to evaluate the relationship between the frequency of operation of a turbine of the type of those installed in the Moín Thermal Plant and the natural frequency of the system, taking into account the dynamic parameters of the soil inferred from the seismic refraction tests. The results show a relation between 1.40 and 1.70 between both, lightly above the limit of ± 1.20 that is usually recommended. This is a very "a priori" estimation and it is necessary to basically interpret it as a reference that must be reviewed when the definitive characteristics of the machines to be installed at the Combined Cycle Garabito Plant are available.

The cuts eventually made, according to the topography of the area, will present heights of about 5.0 m, in which, taking into account the nature of the materials, quite consistently lime - clayey and clay, can be considered slopes of between 1.0H:1.0V and 0.5H:1.0V.

The materials produced by the excavation will be mostly silts and very plastic clays, which will need a very rigorous control of moisture and of the use of sheepfoot rollers during the compacting process if they are intended for use in fillings. Towards the south part of the property (Trench 6) sandy- clayey and sandy- limey materials were detected that present conditions of very good compaction capability.

The deep drainages that are needed in most of the property will be located in Layers 2 and 3 that correspond to practically impermeable materials and that do not allow a suitable natural drainage. Therefore, drains of granular material and/or the use of geotextiles may be necessary.

14. Regarding seismicity, the central pacific region of the country presents a high level of seismic activity. Historically, earthquakes have been registered the main sources of which have been both local flaws and the subduction process. In case of earthquakes caused by flaws, due to their short depth and their closeness to population centers, they have caused more damage than those caused by subduction, even if their magnitude is not as large. In the 20th century, this region experienced important earthquakes as those of 1905, 1916, 1924, 1939, 1950 and 1990, some with maximum intensities of around VIII and IX degrees (Mercalli Mod.)

like those of 1950 and 1924 that caused very severe damage.

The seismicity registered in recent times (last 10 years), shows that there are more events related to the process of subduction and that the majority of them are of low or moderate magnitudes. Earthquakes of superficial character (depth lower than or equal to 20 km) that can be associated to active flaws, are relatively scarce.

For this study, the main seismic sources have been determined, the activity of which might affect the works of the thermal plant if they are not well designed. These are: the subduction of the Cocos plate under the Caribbean plate and the Barranca and Tárcoles flaws. The severest intensities are expected to be around VIII (MM) for the location of the thermal plant. This means that the site may experience very strong quakes that can cause some damage to civil works if the necessary precautions are not taken.

Estimation was made of the probable accelerations through the deterministic and probabilistic methods for the zone where the plant will be located. With the deterministic analysis, average peak accelerations were estimated around 50% g in the place for soil condition, caused by seismic events happening in a local flaw or due to subduction. Peak accelerations were estimated with the probabilistic method of around 36% and 54% g for a return period of 100 and 500 years respectively.

15. Regarding the emission of residual gases, because the place is immersed in the central section of the property shaped by two rivers (Ciruelas and Naranjo), the dispersion of gases along the site will be favored. This depression serves as a passage to the fronts of the dominant winds of the marine coast, according to the predominant weather season. Considering the height of the chimney, the height of the emissions and the local topography, the sector that is most exposed to the emission of gases corresponds to the places that are currently around the La Peña Hill, one km away from the Inter-American highway.
16. The location of the Plant close to the inter-American highway also favors the mitigation and dispersion of the levels of noise emitted. In this case especially, the noise perceived will be more due to the daily circulation of vehicles, than that caused by the operation of the Plant.

8.2. GENERAL RECOMMENDATIONS

Thinking that a detailed evaluation was made of the most favorable site from the environmental point of view, taking into account the aftereffects of the project towards the environment as well as from the environment to the project, and that from the environmental exploration of the surroundings, it was possible to identify the site as suitable for the installation of the Electrical Generation Center. As a result of the study it is recommended to develop the project in the location proposed. Among other reasons:

- 1) To install the new Electrical Generation Center, according to the topography of the area, which is relatively flat, and with a sufficiently large area for the design of the works
- 2) To maintain the works of the project as far as possible from the perimeter of the property, in order to reduce visual and noise impacts; although there are no communities so near as to be affected by the project, or perspectives of future settlements, that may generate any risk.
- 3) The fuel will be transferred from RECOPE, through an oil pipeline, to the storage tanks of the new Generation Center and from there it descends by gravity to the work site, eliminating the transfer of heavy machinery.
- 4) To construct, as long as it is possible, those large works or buildings away from the entrance to the inter-American highway, which will allow working better on the landscape and doing better screening works, which prevents and reduces noise and reduces visual obstruction from the inter-American highway.
- 5) To maintain the development of the project away from inhabited settlements, in order to reduce potential points of conflict with the settlers of the area of influence. Being located in the center of the property of ICE and being less accessible to the local community, the place is very attractive for electrical development.
- 6) To try to locate the debris generated by the project, always inside the property, which reduces costs and facilitates the construction works (compaction and leveling of soils).
- 7) The Ciruelas River can be used for the water needed by the plant, by means of the derivation of a small intake 1 km away from the work site. Obviously, it would be necessary to build a treatment plant to use this water in the plant. Another nearby water supply alternative is the Naranjo and Aranjuez rivers.

- 8) In the event of a temporary operation outage of the water intake and of the flow that would supply it (Ciruelas River), it is necessary to have an alternate water reservoir that will offer temporary operative independence to the Electrical Generation Center. This disadvantage can be solved if the reservoir feeds on water coming from wells, which could be drilled inside the property, since the ground water level, in accordance with the study of soils, reaches 7 meters deep in some places.
- 9) To design the works in such a way that they will improve the environmental conditions of the area, since the same is largely devoid of tree coverage, and therefore reforestation, the handling of slopes and of rain waters will be very important activities in the environmental restoration of the place, also remarkably helping to diminish the impact on the flora and fauna.
- 10) Installing the plant in the new site is suitable because it is most appropriate since it has easy access to transportation, to energy and water and fuel supply sources.
- 11) It is recommended not to use the Electrical Generation Center as a dump site of solid and liquid waste, such as cement bags, electric transmission cables, wood, posts, wires, reels and insulators, as well as hydrocarbon oils and fuels.
- 12) Building recreation works. Some materials that are currently garbage such as wooden electricity posts, and the wood of the trees that have to be cut, can be used to construct works for the recreation of visitors and workers. For example, rustic cabins and benches and signals with permanent paint.
- 13) The quality of air and the environmental quality in the area around the Project will be modified by the inmission and emission of gases, and by the effect of noise and of the vibration of the turbines. Since there are information gaps, with the purpose of correcting these shortcomings and mitigating the effects that these will have on the environment, the following is recommended:
 - The physical height of the chimneys, both of the generating units and of the heat recuperators, does not have a major effect on the amount of dispersion of gases, but it does on the opening of the same. Due to the conditions of the site, to the slightly irregular topography and to the conditions of the winds in the area, it is convenient to use the highest possible chimneys, in accordance with the international standards, both

for the units and for the heat recuperators. In this sense, a height between 25 and 40 m is acceptable, because it allows the gas column to move above the La Peña hill at 5 km, where the project is located, during the day time, and at the same time it allows the gas column to move further into the ocean, which lengthens the return time to the coast during the night time, and increases the time of mixture of gases, and greater dispersion is favored.

- Increasing the height of the chimneys involves additional problems related to noise, weight and cost. The chimneys will need to have muffling equipment to reduce noise and vibration, to have acoustic insulation in the most problematic places, to be properly identified with white and red colors in bands (in accordance with the specifications of the General Direction of Civil Aviation) and to be provided with night air lighting at half the height and on the tops. The stability of the chimneys will be a matter that the bidder will have to solve fully. The costs will certainly be higher, but the action will allow reducing the possibility of threat of non- controlled emissions in towns inside the zone of influence of the project.
- To coordinate with the respective EBAIS, the establishment and implementation of a public health monitoring plan focused on respiratory illnesses.
- To install telemetric atmospheric monitoring equipment based on 24 hour measuring, in the combined cycle chimneys will allow keeping a record of the quantities actually emitted. The control of this variable will allow establishing and defining policies, procedures and specific actions applicable to the entire current and future Electrical Generation Center. The measurements will be made every day, and a monthly report will be prepared during the first year of operation of the plant, and every three months during the following years. The monitoring, the maintenance and the preparation of the reports will be the responsibility of the production UEN of ICE. It is the responsibility of the environmental administrator to coordinate that said measurements and reports are made, in coordination with the contractor and the director of the project.
- To install and to operate a type- B automatic meteorological station in the area, which significantly benefits environmental management, and helps the insufficiency of climatologic information in the zone? Particularly in the case of wind, it is suggested to install at least two sets of speed and predominant direction sensors, one installed at the height of the opening of the chimney and the other installed at the standard level. The information of station B is currently available, which is the property of ICE,

located 8 km away, in the Barranca Thermal Park.

- 14) There will need to be periodic control of emissions. In order to know the behavior of this variable in the environment, a total of 240 simulation runs were made of pollutant dispersion, in accordance with the conditions previously established. Since the definitive technology to be used, the availability, distribution and general characteristics of the equipment is in the process of being developed, this study that is in a phase previous to the entire bid process, more scenarios than those theoretically real have been assumed, in order to cover any possible situation. The results of the runs have to be multiplied by the total number of units that will be installed in the site, under the assumption that there are no synergic effects in the addition of the emissions.

From the simulation analysis, it is found that only in two cases the proposal of inmission norm for Costa Rica is exceeded, in the specific case of the nitrogen oxides, under very particular conditions of high atmospheric instability, considered under the scheme of Combined Cycle, and under the assumption that the equipment is provided with NO_x reduction injectors. Nevertheless, making the assumption on the behavior of two or more units, the value exceeds the draft of the norm. The results of the runs, as well as their respective graphs are shown in ANNEX N° 3.

Other norms are not exceeded, as can be observed in the runs. It was decided to use the inmission norm draft for Costa Rica because it is the strictest. If it is met, any other international regulation that is required by potential external financial entities would be satisfactorily covered.

In terms of other pollutants studied (CO, SO_x and PST), the norm was not exceeded in any case. Notice that CO₂ is not considered an atmospheric pollutant, although it is an important element in the greenhouse effect.

A second gas dispersion simulation study was conducted using a “box” model, the internal calculation variables of which are different from the ones used in the first study. The results of this study, for an intermediate chimney mouth opening gap (3.83 m) are similar to those found in the initial study, unless the concentrations of the pollutants differ in relation to distance. From this second study it is suggested that the height of the chimney satisfactorily complies with the dispersion criteria with a height of 25 m.

From the behavior of the winds of the Pacific coast of Costa Rica, the phenomena of current inversion favors the gas column, which during the night periods deflects towards the ocean, but in a short distance, perhaps approximately 500 m from the shore, the column is inverted down, returning to the coast, but at a much lower height. The phenomenon is easily observable taking as a reference the chimney of the agricultural fertilizer factory (FERTICA), whose hole, 50 m high, expels dense gases that can be observed during the night with the naked eye with the public illumination system lights from the main dock of Puntarenas.

Considering the height of the site, the gases return to a height that ranges between 8 and 12 m. specifically, it was observed that the gases longitudinally cross the Puntarenas Hospital, affecting from the third floor up, in particular after 21 hrs.

As for the noise measurements in the area of the current Garabito Electrical Generation Center Project, there is little non- representative information that could allow establishing with certainty the current noise emission conditions in the area. Additionally, in lack of a final definition of the equipment to be installed, (because the bidding processes did not take place) the level of noise that the above mentioned equipment could generate is not known. However, whichever the chosen option is, it will have to fully comply with the legislation regarding noise, and therefore the following is recommended:

- Periodic measuring in the plant, in the perimeter of the plant and in the nearby margins, during operation of the plant as well as with the plant switched off. These measurements will be carried out at least once a month during the first twelve months of operation, and then every three months in the following years of operation, as indicated in the environmental management plan. Noise emissions will be recorded in a database that will be regularly updated, and there must be proof of the records of such measurements, so that the levels of emitted noise do not exceed the current legislation. The corresponding preparation of half-yearly noise reports, as well as the application of the mitigation measures necessary to satisfy the national legislation, will consist and be an essential part of the noise monitoring program. The responsibility for following up these measurements will be for the ICE Energy Production Business Unit UEN, in coordination with the environmental expert.
- The equipment will have to be provided with acoustic isolation, as far as it is possible and allowed, as well as the facilities of the Plant, so as to comply with the provisions of the Department of Health for labor and

residential purposes.

15) To contemplate in the current project all the guidelines as for the aspects of Safety and Hygiene and Occupational Health, in order to guarantee a suitable labor execution of the works. They are indicated according to the stages of the project:

- *Construction Stages*

Basically, the following regulatory provisions will have to be respected when it applies, without excluding other regulations that may be applicable:

Law of Work Risks
Construction Safety Regulations
Work Safety and Hygiene Regulations
Noise and Vibration Regulations

At the internal level of the institution it is necessary to additionally respect the following provisions:

Technical Manual for the Development of Public Work Projects, subsection 5,14
Circular letter from the Management ICELEC 1061, of December 09, 1998

- *Operation Stage*

It is necessary to contemplate the following:

Law of Work Risks.
Construction Safety Regulations.
Work Safety and Hygiene Regulations
Noise and Vibration Regulations
Technical Manual for the Development of Public Work Projects, subsection 5,14
Circular letter from the Management ICELEC 1061, of December 09, 1998

In the works made by means of the administration, the provisions above mentioned will have to be respected. And when they are done by hiring, in addition to the provisions, it is necessary to respect the indications of the current national regulation.

16) To respect construction norms and regulations, because the central Pacific region of the country presents a high seismicity level. Historically, there have been earthquakes, the main sources of which have been local flaws and subduction process. In the case of the earthquakes caused by flaws, due to their short depth and because of their closeness to the population centers, they have caused more severe damage than that caused by subduction, even if their magnitude is lower. In the 20th century, this region experienced important earthquakes as those of 1905, 1916, 1924, 1939, 1950 and 1990, some with maximum intensities of around VIII and IX degrees (Mercalli Mod) as those of 1950 and 1924, which caused very severe damage.

The seismicity registered in recent times (last 10 years), shows that there are more events related to the process of subduction and that the majority of them are of low or moderate magnitudes. Earthquakes of superficial character (depth lower than or equal to 20 km) that can be associated to active flaws are relatively scarce.

17) To take the necessary precautions for the safety and stability of the works of the plant, because main seismic sources have been determined in this study, the activity of which might affect the works of the Electrical Generation Center if they are not well- designed. These are: the subduction of the Cocos plate under the Caribbean plate and the Barranca and Tárcoles flaws. The severest intensities are expected to be around VIII (MM) for the location of the Electrical Generation Center. This means that the site may experience very strong quakes that can cause some damage to civil works if the necessary precautions are not taken.

Estimation was made of the probable accelerations through the deterministic and probabilistic methods for the zone where the plant will be located.

With the deterministic analysis, average peak accelerations were estimated around 50% g in the place for soil condition, caused by seismic events happening in a local flaw or due to subduction. Peak accelerations were estimated with the probabilistic method of around 36% and 54% g for a return period of 100 and 500 years respectively.

18) During the stage of earthquake-proof design of the civil works of the Garabito Electrical Generation Center, it is recommended to consider, given the seismic potential of the zone, the possibility of damage such as:

- Overturn and sliding of transformers
- Overturn and sliding of cabinets, frames and control panels
- Failure of the metallic support bases of the equipment
- Breakage of connectors between equipment units due to excessive displacement
- Fall of transformers, posts and platforms
- Piping system failure
- Breakage of transmission lines.
- Deformity or breaks in fuel storage tanks
- Danger of explosion and fire if spillage of fuel occurs

19) To consider for construction and installation of the equipment of the project, the climatic analysis (although the same is based on monthly information from the meteorological station of Puntarenas and Barranca, it is valid for the site in Miramar) because it determines a climatic behavior for the zone, typical of the coasts of the Costa Rican Pacific slope, and it might somehow modify the specifications of some equipments and systems. This analysis indicates a well defined dry season for the zone from November to April, a rainy season from May to October with a decrease of rainfalls in July. The influence of the wind flow along with local conditions of moisture and temperature determine the behavior of other analyzed parameters.

The basic purpose of the climatic analysis is oriented to the construction of the Electrical Generation Center for the generation of electric energy, which requires the analysis of the hourly behavior of parameters such as: winds, atmospheric pressure, relative humidity and temperature of humid bulb, all of them in the place where the plant will be located. Because some of these meteorological parameters are affected by the location of the Puntarenas and Barranca station, in a narrow strip of ground surrounded by water, which is different from that of the place in which the Electrical Generation Center will be located, the installation of a type B station is advisable in a place close to this one, with a parameter reading programming and recording of information in accordance with specific needs, especially in winds, atmospheric pressure and temperature of humid bulb (Notice: The installation of the type B station was already carried out in the Project, since August, 2002, by ICE).

20) Regarding scenery, keep in mind the arrangement of the works for their respective screening and camouflage, according to the surroundings. A great advantage of the project is its physical space for conducting beautification and scenery works that will shape the environment with its

works and at the same time allow to mitigate and to improve the currently deteriorated environment, as is the policy of ICE.

The vegetation screens and live fences mentioned in the mitigation measure and Environmental Management Plan serve to enrich and to improve the scenery along the inter-American Highway. Both mitigation works must be carried out before and during the construction of the project as it allows, since it not only assures landscape improvement but it also provides screening of the works.

- 21) To give maintenance to the existing mango plantations since they provide excellent refuge to the scarce fauna of the zone, as well as to reforest those areas that the project does plan to use and that are abandoned, practicing enrichment techniques or ecological succession.

- 22) To maintain continuous communication with the communities around the project, as well as with their development associations, municipality, community committees, non- government organizations, local government institutions and education centers.

=====Last Line =====

IN WITNESS THEREOF, I issue the current translation from Spanish into English which is made up of 130 folios. I sign and date in the city of San José, Costa Rica on July 29, 2008. Stamps are added and cancelled.