

INTER-AMERICAN DEVELOPMENT BANK



MEXICO

MONTERREY COGENERATION POWER PLANT

ME-0228

ENVIRONMENTAL AND SOCIAL IMPACT REPORT

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I. INTRODUCTION

- 1.1 *Enron Energía Industrial de México S. de R.L. de C.V.* proposes to construct and operate a cogeneration plant in the Municipality of García in the state of Nuevo León. The Project will sell steam and electricity to "*Industria del Alkali*" (from Grupo Vitro). Electricity will also be sold to other industries of Grupo Vitro, Grupo Imsa, and Apasco, fifteen-year term contracts, throughout the existent energy distribution lines from the Federal Commission of *Electricity (Comisión Federal de Electricidad -CFE)*. *Enron Energia Industrial de Mexico, S. de R.L. de C.V.* ("Enron Mexico" or the "Project Company") executed power purchase agreements (the "PPAs") with *Vitro Corporativo, S.A. de C.V.* ("Vitro Corporativo") in December 1999; with *Cementos Apasco, S.A. de C.V.* ("Cementos Apasco") and *Corporativo Grupo Imsa, S.A. de C.V.* ("Corporativo Imsa") in April 2000. The PPAs account for all the installed capacity of the plant (245 MW).
- 1.2 The cogeneration plant is designed for a useful life of 30 years, with a capacity to generate 245 MW of electricity and 180 tons of steam on average per hour. The Plant will also include an auxiliary boiler with a rated steam capacity of 250 tons per hour. The cogeneration plant will include one low-NO_x gas turbine and one steam turbine. Preliminary total project costs stand at US\$184.1 million, of which US\$131.3 million (71.3 percent) corresponds to the turnkey engineering, procurement, and construction contract. The preliminary financial plan contemplates an equity participation of 25.9 percent (US\$ 47.6 million) and an IDB A/B Loan to fund the remaining 74.1 percent of Project costs (approximately US\$136.5 million).
- 1.3 The project is being developed and will be operated by Enron Corporation ("Enron"), whereas the Engineering, Procurement and Contract (EPC) will be performed by Mitsui & CO.,Ltd, also responsible for the start-up, commissioning and performance tests.

II. PROJECT DESCRIPTION

- 2.1 The proposed power plant will generate electricity and steam through a combined cycle cogeneration, with one gas turbine and one steam turbine for production of 245 MW of electricity and sufficient steam to meet Alkali's steam demand of 180 t/h (average) and 210 t/h (maximum). An auxiliary boiler with a capacity to produce 250 t/h of steam will also be constructed on site as a backup (for an average of two weeks per year at full load during maintenance period) to the gas turbine and steam generator. The plant will use natural gas as fuel, which will be supplied by *Petroleos Mexicanos (PEMEX)*. Daily fuel gas requirements are estimated at 1,474,000 m³ (52 million ft³) of natural gas per day, at pressure of 475 psia. Existing PEMEX pipelines are located adjacent to the power plant site.

- 2.2 Alkali will supply treated water to the Enron plant for steam production and will provide treatment of the industrial wastewater from the Enron plant at Alkali's existing effluent treatment plant. Alkali will shut down five existing boilers as a result of this project, maintaining them in a ready state as backup in the event that Enron plant ceases operation. More information on Alkali activities, water supply and wastewater treatment is provided in section V.

A. Location

- 2.3 The Project is located in the industrial zone of the Municipality of García, State of Nuevo León, approximately 6.6 km southeast of Villa de García, and about 20 km northwest of the City of Monterrey, in Mexico (Figure 2-1). The site is accessed via State Highway 16 García-Monterrey, which joins the Arco Vial of the Metropolitan Area of Monterrey. Also, there is the Mexico City-Nuevo Laredo railroad that crosses the industrial zone and the Alkali plant, in particular. The area is part of a larger property (approximately 300 hectares) belonging to Alkali, and included in a zone designated for industrial use by the Municipality of García Land Use regulations, where there are no permanent human settlements in the immediate vicinity.
- 2.4 Approximately 3 km to the west of the site are the facilities of other companies from *Grupo Vitro* such as *Vitro Flotado*, *Vitroflex* and *Autotemplex*. The area selected for the Project has approximately 7.5 hectares (300 x 250m or 75,000 m²), from which the Plant will occupy approximately 3.3 hectares (33,300 m²). Given the industrial use in the area, settlements such as houses or commercial facilities, agricultural or cattle grazing activities are not observed in the areas surrounding the site.
- 2.5 Main raw materials are natural gas for fuel and water for steam production and regeneration of demineralizing plant. An average of 1,474, 000 m³ of natural gas at 475 psia will be consumed daily. The natural gas will be supplied through two 254-mm pipelines¹ connected to the two existing PEMEX pipelines² adjacent to the Plant, therefore no storage will be required. The plant will have an utility room for the natural gas meter and regulator, which will be located at the outer perimeter of the plant, next to the existing PEMEX pipeline. The natural gas that will be supplied to the Plant has a minimum heat content of 35.42 MJ/m³ and a low sulfur content (a maximum total of 258 mg/m³ or approximately 0.02%), according to the Mexican specifications for pipeline gas composition.
- 2.6 The total average demand for water is estimated at 130 m³/hour for make-up water. According to the Steam Purchase Agreement, the water will be supplied by Alkali's reverse osmosis treatment through two new pipelines that will connect the two adjacent plants (Enron and Alkali). The water required corresponds to the

¹ One of the pipelines will serve as back-up during the maintenance of the other pipeline.

² Two existing PEMEX 558.8 mm and 609.6 mm (22 and 24 inch) pipelines. The 609.6 mm pipeline will serve as backup during maintenance procedures and outages on the 558.8 mm pipeline.

water currently used by Alkali for the five boilers that will be shut down, plus an additional 10%. Alkali has guaranteed water permits issued by the CNA (*Comisión Nacional del Agua*) for a total annual withdrawal rate of 4,457,000 m³/year, which translates to 508.8 m³/hour³.

- 2.7 Additionally, raw water will be required for service water and for the fire extinguishing system. It will be supplied to the Plant by water tank trucks. The water will be stored in one 1,136 m³ tank; 908 m³ of the stored raw water will be reserved for two hours of fire fighting capacity and 228 m³ will be stored for a 7-day supply of service water.

B. Project components

- 2.8 Equipment: The basic equipment for the electric power and steam generation will consist of one General Electric Combustion Turbine GE PG 7241FA coupled to a generator; one heat recovery steam generator with auxiliary burners; and one steam turbine coupled to a generator. Steam will be produced by the heat recovery steam generator and will be used for the generation of electricity (by the generator in the steam turbine). Steam will also be obtained from the intermediate pressure section of the steam turbine and will be supplied to Alkali through a pipeline that will run parallel to the water supply pipeline.
- 2.9 Other materials: Hydrogen will be used for the cooling system of the combustion turbine generators, at an estimated rate of approximately 0.4 kg of hydrogen per day. The hydrogen will be supplied in accordance with the specifications for Land Transportation of Hazardous Materials and Wastes (NOM-003-SCT2-1994). It will be securely stored in eighteen 5.5 m³ cylinders that will be inside a well-ventilated storage area.
- 2.10 Air will be used for steam cycle and instrumentation cooling. Hydrochloric acid (average of 23,678 kg per month.) and Sodium hydroxide (average of 22,584 kg per month) will be used in the water demineralization and the cationic and anionic regeneration treatment plant, respectively. Both products will be transported in tanks, following the above mentioned “Specifications for Land Transportation of Hazardous Materials and Wastes”. Once in the plant, each will be stored in a 23 m³ internally coated carbon steel tank. Carbon dioxide will be used in the fire protection system. Transportation will also follow the above mentioned specifications. This substance will be stored in sealed cylinders that have been placed in a well-ventilated storage area.
- 2.11 Amines will be used for chemical conditioning of the steam cycle in the Heat Recovery Steam Generator. It is estimated that 10 L will be consumed per day, which will be obtained in 200-liter drums. Anti-oxidants and dispersing agents will also be used for the chemical conditioning of the steam cycle. An estimated 115 L will be consumed per day. These substances will be stored in the chemical

³ These permits will expire in June 2014, but can be renewed upon availability of the resources.

storage area, in plastic hermetically sealed containers. Lubricants and hydraulic oils will be used in the equipment. An estimated 475 L/month will be consumed. The transportation of these oils will follow Specifications for Land Transportation of Hazardous Materials and Wastes. They will be stored in 200-L drums located in a well-ventilated storage area, away from ignition sources. Ethylene glycol will be used in the oil cooling system. Minimum consumption is estimated since this is a closed system (100 L/month).

- 2.12 Products: The plant will produce two main products, steam and electrical energy. On average, 180 t/h of steam will be produced at the plant for commercial sale (does not include steam utilized internally). This steam will be transported to Alkali through a pipeline that will run parallel to the water supply pipeline. This line will be designed and operated in compliance with the International Specifications for Steam Transportation.
- 2.13 The distribution of the energy generated by the Plant will be through transmission lines built to connect the different consumer centers. For the distribution and transmission of electrical energy, the Project intends to take advantage of the existing structures and rights-of-way, thus eliminating the need to clear new areas. At present, three transmission lines will connect the plant to different consumers in the García Nuevo León area as well as to the CFE system:
- One 115 kV transmission line will connect with the CFE substation at Villa García, approximately 7 km from the project site, installed on the CFE towers, making use of the existing towers and right-of way.
 - One 115 kV transmission line will connect with the existing Arco Vial CFE substation, approximately 5 km from the project site. Concrete or steel poles will support this line. The poles will be installed following the existing 13.8 kV CFE line, along the highway until it reaches the Arco Vial substation. The 115 kV cables will be suspended higher up the poles than the existing 13.8 kV cables.
 - One 115 kV transmission line will run in the direction of Alkali, Vitroflex, Vitro Flotado and Autotemplex industries located from 0.5 to 3 kms from the project site. This line will also follow the path of the existing 13.8 kV CFE line along the State Highway 16 García-Monterrey.
- 2.14 All necessary rights-of-way have already been granted by CFE. The construction of the lines will also be the responsibility of the EPC Contractor.
- 2.15 Wastewater will be produced in three different forms: industrial, run-off water with potential oil contamination and sewage. The industrial wastewater generated during the process is estimated at approximately 180 L/min and will be returned to Alkali for treatment⁴. Run-off water is anticipated in minimum quantities, given the climate pattern of the area. Run-off with oily discharges from equipment

⁴ Given that the Cogeneration Plant will replace the five boilers currently used by Alkali to produce steam, there will be no change in the effluent and effluent treatment requirements at Alkali.

rinsing and secondary containment dikes will be collected and treated in oil/water separators. The water free of oil will be sent to the Alkali plant for treatment. Sewage wastewater from approximately 30 employees (estimated at 4.8 m³/day) will be generated and treated at the Plant to comply with NOM-001-ECOL-1996 and recycled for irrigation purposes.

- 2.16 Generating process: Air will be drawn in at ambient pressure and temperature into a compressor. Natural gas is combined with the compressor discharge and then fed into a combustion chamber. Here the gases expand to a pressure higher than atmospheric pressure and the expanding gases drive the combustion turbine generator. Combustion gases discharged from the turbine are fed into a Heat Recovery Steam Generator (HRSG) to produce steam. Condensate returned from Alkali is used as the primary feed for the HRSG. Make-up water, also supplied by Alkali, will feed the HRSG⁵. The condensate and make-up water will be supplied through two pipelines.
- 2.17 From the HRSG, the combustion gases are sent to the stack and steam is fed to the steam turbine where it is expanded to activate the steam turbine generator. The steam exhausted from the steam turbine is cooled (condensed) by an air-cooled condenser. The steam produced by the HRSG will be used for the steam turbine generator as well as for export to the Alkali plant. The auxiliary boiler will be used as back-up in order to guarantee the supply of steam to the Alkali plant. In future years (last ten years of the contract) the auxiliary boiler will run 92 percent of the time at 25% capacity and produce additional steam for Alkali. The electric energy produced by the gas and steam turbine generators will be sent to step-up transformers for final distribution.

C. Project Schedule and Costs

- 2.18 The project is scheduled to start construction on January 2001, test the combustion turbine in April 2002 and initiate commercial operations in July 2002. Project investment will be of US\$ 184 million and construction will take a maximum of 24 months.

D. Workforce

- 2.19 During construction, the EPC will employ a maximum of 500 persons. Given the characteristics of the construction works a large number will be of non-skilled local people. During operation, the workforce will be limited to approximately 30 specialized and semi-specialized employees.

⁵ Alkali previously treats the raw water with an existing reverse osmosis system; the raw water that will be sent to Enron is currently used in the Alkali existing boilers that will be shut down once the Cogeneration plant becomes operational.

E. Project Alternative Analysis (including site selection)

- 2.20 The selected project alternative of a combined cycle power plant is one of most efficient in terms of electricity generated per unit of fuel used. The selected fuel alternative, natural gas, is the cleanest fuel and with greatest availability at the site, given the proximity to PEMEX main gas pipelines. Hence, no other alternative fuel was considered.
- 2.21 The main steam and electricity user is Alcali, who will also supply the required water for the cogeneration plant and will receive its wastewater discharges for treating and reuse. Therefore, regarding site selection alternatives, the main project's objectives are to ensure the shortest distance possible between Alcali and the Plant⁶ and to take advantage of the existing infrastructure and rights-of-way for the transmission lines. Two areas were analyzed (Area 1 and Area 2 - Figure 2-1) according to the following criteria: availability of land, proximity to steam user, proximity to the fuel source, transmission possibility, road access, and water availability. Both areas are part of a large Alcali property that surrounds the Alcali Plant. Area 1 is located east of the Alcali plant and Area 2 is in the northeast direction (from the Alcali plant). In both areas the vegetation is sparse and no human settlements exist.
- 2.22 Area 1 was selected given its closer proximity to the Alcali Plant, thus minimizing the length of the water lines between Alcali and the Plant, the fuel source connection, the CFE's transmission lines and the electrical line to Alcali's existing substation. Area 1 already has transportation access from Highway 16 García-Monterrey, which is considered to be the main access road to the site, whereas for Area 2, an access road would have to be constructed. Selecting Area 1 also eliminates the construction of new rights-of-way.

III. INSTITUTIONAL AND LEGAL FRAMEWORK

A. Institutional framework

Energy

- 3.1 The *Secretaría de Energía* (Secretary of Energy) is responsible for the national energy (power) policies. According to the *Plan Nacional de Desarrollo* (National Development Plan), it makes decisions on exploration and development activities of the electrical sector. PEMEX, CFE and the *Compañía de Luz y Fuerza del Centro* (Light and Power Company of the Center) are under the jurisdiction of the Secretaría de Energía.
- 3.2 The *Comisión Reguladora de Energía - CRE* (Energy Regulatory Commission) is the division within the *Secretaría de Energía* that authorizes permits regarding

⁶ Steam can only be economically transported over short distances.

electricity and natural gas. It also establishes the conditions under which electricity can be generated and exported, as long as it is not a public service provided by private individuals. The CRE can grant authorization or permits for the generation of electricity production (to sell to the CFE).

- 3.3 The permits granted by the CRE for generation under cogeneration system are for undetermined periods, with the exception of those for independent production, which are granted for a maximum term of 30 years. Enron's project request for a cogeneration permit from CRE was approved on the 2nd of June 2000, under number E/167/COG/2000. The permit allows for the maximum capacity of 284.016 MW. The permit also lists the associate companies that can receive this electrical power from the cogeneration plant. Any additional electrical power must be delivered to the CFE. According to the permit, construction must start by October 2000 and the plant must be in operation by July 2002.

Environment

- 3.4 The main environmental agency in Mexico is *Secretaría de Medio Ambiente, Recursos Naturales y Pesca - SEMARNAP* (Environment, Natural Resources and Fisheries Secretariat). SEMARNAP was created in 1994 to centralize and streamline federal policy-making related to natural resource management and environmental protection and to achieve sustainable development. SEMARNAP regulates a broader spectrum of environmental protection issues including the formulation of the national environmental policies, called *Normas Oficiales Mexicanas* (NOM - Official Mexican Standards). It also ensures that all sectors (including the electrical sector) comply with environmental standards and regulations. Of the many SEMARNAP decentralized divisions, the following are particularly relevant to the Project:
- a. The *Comisión Nacional del Agua* (CNA) (National Water Commission) which is responsible for issuing permits for water withdrawal from, and discharge to, federally chartered bodies of water (such as rivers and lakes).
 - b. The *Procuraduría Federal de Protección al Ambiente* (PROFEPA) (Federal Attorney General's Office of Environmental Protection), the primary federal agency authorized to enforce environmental laws in Mexico, including the regulations for the management and disposal of hazardous and industrial waste, air emission and water pollution. All projects involving electricity generation and all high-risk activities (such as those including hazardous waste) are under federal jurisdiction through PROFEPA.
 - c. The *Instituto Nacional de Ecología* (INE) (National Institute of Ecology) is responsible for the federal evaluation of project environmental impacts and risks. It is also responsible for the development of environmental policies and regulations and the issuance of permits and licenses.
- 3.5 The state and local governments are responsible only for land use licensing, construction permitting and regulation of solid waste disposal. The Ecology

Secretariat of the State of Nuevo Leon, where the proposed project site is located, is responsible for issuing environmental permits for all state facilities not under federal jurisdiction and for the non-hazardous solid waste management and disposal within the state.

Health and Safety

- 3.6 The *Secretaría del Trabajo y Previsión Social* (Department of Labor and Social Safety) is responsible for the implementation of legislation related to labor issues and ensures that they are fulfilled according to the *Ley Federal del Trabajo* (Federal Labor Law) and other related legal dispositions. It also sets the safety and health requirements that must be met in any work environment.

B. Legal framework

Energy

- 3.7 The legal framework for private generation of electricity in Mexico is still being developed. The Public Electric Energy Service Law (or Electricity Law), in effect since 1975, outlines that the State, as a general rule in accordance with the Mexican Constitution, has the exclusive authority to generate, transport, distribute and supply electricity for the purpose of rendering a public service. The Electricity Law was amended in 1992. Key modifications enacted in 1992 excluded the generation of electricity for self consumption, cogeneration, or small production (the Project category) from the definition of "public service".
- 3.8 The Regulations of the Electricity Law, in effect since 1993, establish the requirements for generation of electricity by private producers as well as the requirements to issue permits for self-generation to satisfy the power needs of power plant owners. In 1995, the Electricity Law granted the CRE, among others, the authority to issue and revoke permits for self-generation, and to authorize the transfer of the rights derived from such permits. Recent resolutions by the CRE have applied the regulatory framework to private cogeneration and self-generation activities. Such advances include the approval of contract models for interconnection, transmission and sale of surplus electricity to the CFE (January 23 and February 11, 1998), as well as the development of the methodology for establishing power transmission charges (May 15, 1998).

Environment

- 3.9 The *Ley General del Equilibrio Ecológico y la Protección al Ambiente* (LGEEPA) (General Law of Ecological Equilibrium and Protection of the Environment, or Ecology Law) passed in January 1988 establishes the legal framework for environmental management and federal EIA legislation in Mexico.
- 3.10 The General Directorate of Ecological Zoning and Environmental Impacts of INE

is responsible for implementing the federal EIA evaluation. The LGEEPA and the Regulations on Environmental Impact Issues require that an EIA (known in Mexico as *Manifestación de Impacto Ambiental - MIA*) be prepared by all activities or operations likely to have negative impacts on the environment or exceed standard limits and conditions defined in the norms. Depending upon the project, the INE will request one of the three levels of MIA: general, intermediate, or specific (most detailed). When the activity or operation is likely to use hazardous materials or substances considered being harmful to the environment and human health, INE also requires a Risk Study, under either one of the modalities of Risk Analysis or Preliminary Risk Report. A resolution of approval of the MIA (and the Risk Study, when applicable) must be obtained prior to starting any construction activity. INE issues the authorization in a maximum timeframe of 60 working days after all the required information is provided. The authorization issued by INE may have the following characteristics: (a) authorize the project to be implemented according to the MIA that was presented; (b) authorize the Project to be implemented according to conditions to reduce or compensate negative environmental impacts; (c) deny the authorization given severe environmental impacts. The authorization from INE establishes specific conditions that must be met by the project during construction, operation and abandonment. All information presented to INE become public.

- 3.11 Associated with the Ecology Law and related regulations are more than 250 environmental standards (NOMs). These NOMs have been established to regulate areas in air emission, wastewater discharge, hazardous waste, health and safety, etc. A summary of the principal environmental, health and safety applicable regulations is provided in Table 3-1.
- 3.12 Relevant to this Project are the Mexican Standards and the World Bank guidelines for air emissions and noise (Tables 3-2 and 3-3, respectively) for new thermal power plants, and the Mexican Standards and the World Bank general guidelines for ambient air quality (Table 3-4).
- 3.13 Also to be mentioned is the *Ley Federal sobre Monumentos y Zonas Arqueológicas, Artísticas e Históricas* that establishes that anyone who finds archeological sites must inform the closest civil authority, which will inform the INAH within 24 hours.

Health and Safety

- 3.14 Article 123 of the Mexican Constitution states that all citizens have a right to work in a manner that is dignified and socially useful and requires all employers to implement those measures which are necessary to ensure workplace safety and hygiene. The occupational health and safety provisions of Article 123 of the Constitution are implemented under the *Ley General de Salud* (General Health Law), the *Ley Federal del Trabajo* (Federal Labor Law) and more specifically, *Reglamento Federal de Seguridad e Higiene y Medio Ambiente en el Trabajo*

(Federal Regulations of Safety, Hygiene and Work Environment).

C. Project Compliance Status

- 3.15 The MIA (General modality) and the Risk Study (modality Risk Analysis) were delivered to INE and to SEMARNAP's regional office in Nuevo León on December 10th, 1999, and were made available to the public that same month⁷. On May 11, 2000 INE issued the authorization to develop the project under specific the terms and conditions described in the MIA and the Risk Study. The INE approval provides for a 2-year construction window and 25 years of operations thereafter.
- 3.16 On June 2 2000 CRE issued the Cogeneration approval permit to Enron for the cogeneration plant that includes electrical and steam production and the consumption of natural gas. Other approvals and permits were granted to Enron by CFE for the use of CFE's existing rights-of-way for the distribution lines: one line to transport energy to the "local grid" to serve Vitro companies located in the vicinity of the Plant; a second line directed to CFE Villa de Garcia substation, and a third line directed to CFE Arco Vial substation. Enron is authorized by Alcali to build the required steam, condensate, water and waste-water connections between the Plant and Alcali. Other required permits such as land use and construction were also granted. A summary of the most relevant project authorizations needed for the construction and operation of the Plant and the compliance status of each are included in Annex 2.
- 3.17 Enron provided evidence that the Project will be designed and operated to comply with applicable Mexican Standards and legislation and the guidelines set forth in the World Bank Pollution Prevention and Abatement Handbook, Thermal Power: Guidelines for New Plants and General Environmental Guidelines (1998).

IV. ENVIRONMENTAL AND SOCIAL CONDITIONS

A. Environmental conditions

- 4.1 Land Use: According to state and municipal development plans, the Project is located in an Industrial Zone established by the Municipality of García in the early 50s. Within a radio of approximately 3km from the project site there are a number of large industrial complexes, such as Vitro Flotado, Vitroflex, Autotemplex and the Alcali plant, all of Grupo Vitro. The industrial zone occupies a large area of approximately 300 hectares west situated between the Cerro de la Mitras, the Pesquería River and the railroad (refer to Figure 2-1). The slopes of Cerro de las Mitras are intensively exploited for quarry. Given the intense industrial use, there are no residences or commerce in the vicinity.

⁷ Section VII contains detailed information regarding the public participation and consultation processes that were conducted for this project.

- 4.2 The agricultural land of the Municipality covers less than half of its surface area because of the presence of hills and rocky plains that do not support agriculture. The main limiting factor is the ground slope, which prevents the use of irrigation, essential for this area because of the hot and dry climate. Presently, only 22 km² of the area has developed temporary agriculture. The remnant 2,981.90 km² hosts different types of vegetation such as rosetophyle and microphyle dessert thickets. Agriculture is for subsistence use only and takes place during certain periods of the year. There are presently no agricultural or ranching activities on the Enron cogeneration plant site and no evidence of any historical agricultural use.
- 4.3 Climate: According to the Köpen-García climate classification, the site is located in a “dry, semi-warm climatic zone with low rainfall throughout the year”. The annual average precipitation in the Municipality falls between 211 and 585 mm according to Rinconada and Monterrey meteorological stations, respectively. The months with greatest precipitation are August and September with 80 to 90 mm, and the months with lowest precipitation are November and January, averaging between 10 and 15 mm. The average temperature in the Municipality of García is approximately 21°C, with highest temperatures in June, July, and August. The average lowest temperatures are about 14°C, in December and January. The predominant wind direction is from the east. The wind velocity is higher during the spring and summer, reaching values of 15 km/h. During the winter and anti-cyclone periods the wind speed drops considerably, and the wind direction is also from north and northwest.
- 4.4 Air Quality: The main fixed sources of air emissions in the vicinity of the site are the neighboring industries including Alkali, Solvay, Autotemplex, Vitroflex and Vitro Flotado. State Highway 16 García-Monterrey is a linear source of emissions from vehicles traveling in both directions. With regard to particulate matter, the main sources of pollution are the existing quarries and the traffic on some of the unpaved roads around the site, which produces large quantities of suspended particles. With regard to NO_x, there is no representative background data or specific monitoring network in the project area. However, the wind regime in the area is such that the proposed project is upwind of most of the other existing sources in the area (which are a few in number). Also, the other major sources in the general area have much taller stacks, on the order of 74-90 meters (at the glass manufacturing plant) plus higher exhaust temperature, and thus, the dispersion characteristics of these sources are such that they would likely not be additive to the proposed project maximum impacts.
- 4.5 The closest monitoring station is located in Santa Catarina, approximately 13 km upwind (Southeast from the site). This station is part of the five-station automatic atmospheric monitoring program implemented, since 1992, by the Monterrey Metropolitan Area government (Secretary of Ecology) known as *Sistema Integral de Monitoreo Ambiental (SIMA)* and that measures SO₂, CO, NO₂, O₃ and PM₁₀. According to the *1998 Annual Report on Environmental Conditions* prepared by

SIMA, there were 226 hours when air quality standards were exceeded in the Monterrey region. Of these, 91.3% correspond to PM₁₀ suspended particles and the remaining 8.7% to ozone. The remaining measured contaminants did not exceed the air quality standards. Air quality in the Monterrey Metropolitan Area is impacted primarily by suspended particles and secondarily by ozone. Higher contaminant concentrations emitted from eastern and central Monterrey have an effect on the western area of the Monterrey Metropolitan Area. Given the predominant wind directions, the air quality in the Monterrey Metropolitan Area (located about 20 km upwind from the Enron Plant) is not likely to be affected by the Project.

- 4.6 Noise:. The main noise sources are the industrial activities of Alkali and the vehicles of the Monterrey-García highway. As mentioned before, there are no residences or commerce in the vicinity of the site. Enron conducted an ambient noise monitoring event to document the existing background levels in the vicinity of the proposed plant site. The measurements were conducted during two days, near each of the four boundaries at the site. The highest noise level recorded during the daytime survey was a one-hour Leq of 67.9 dB(A) at the southwest corner of the site, near Alkali's plant and the García-Monterrey highway. At night, the highest recorded one-hour Leq was 57.7 dB(A) on the southeast corner of the site. This indicates that the ambient noise levels close to Alkali's boundary are below the World Bank industrial receptor limit of 70 dB(A).
- 4.7 Surface water and groundwater: The Project will be located in the Bravo River – San Juan Hydrological Region and the basin of the Pesquería River. The Pesquería River, located two kilometers north of the site and flowing to the east, is the only hydrological body of importance nearby. The hydrological sub-basin of the Pesquería River consists of two permanent creeks: Grande Creek and the Pesquería River itself. The rest of the flows are intermittent. The run-off coefficient in the area is between 0% and 5%, typical of dry areas. Therefore, in this area there are no reservoirs and other water retaining structures. The closest reservoir is Presa Rodrigo Gómez (La Boca) located over 50 Km southeast from the Plant site, in the river basin of River San Juan.
- 4.8 The industrial development and the increasing demographic explosion of the metropolitan area of Monterrey have increased the water needs of the region. Because of the scarce availability of this resource and its irregular distribution during the raining season, there is a low recharge rate of the aquifers and reservoirs. The largest groundwater exploitation is located in the Monterrey area (fields Mina, Monterrey, Buenos Aires y Topo Chico), where wells of 2000 meters deep produce good quality water. However, in the Project's region, the area is rich in mineral salts and the groundwater has high salt content and is, therefore, unsuitable for human consumption or for irrigation. Alkali is dedicated to the exploitation of these salts. Because water consumption, supply and use are major environmental and social issues within the region, the Project will not

depend nor demand additional water supply, but will use water provided by Alcali's reverse osmosis treatment system and that is already being used for its boilers that will be shut down when the Plant becomes operational.

- 4.9 Geology, Geomorphology and Soils: At the Project site and, in general, in the whole State of Nuevo León, sedimentary rocks of marine origin are the most common (clastic and chemical deposits of the Mesozoic Age). The most recent deposits are of conglomerate and alluvial soils that belong to the Quaternary period. The site's average altitude is 715 meters above sea level (a.s.l) and it is surrounded by the extreme western end of the Sierra Las Mitras to the east, to the west by the mountains that contain La Mota Peak (at 1,540 meters a.s.l), to the north is the Sierra El Fraile, and to the south is the basin of the River Las Tinajas. Due to the geological characteristics and location within the eastern Sierra Madre Province, the area is not susceptible to earthquakes, landslides, cave-ins, volcanic activity, or any other earth or rock movements. The prevalent soil at the site is haplic xerosol, with haplic yermosol being secondary, with low depths and/or limited by gravel and rock.
- 4.10 Flora and Fauna: The Project site is located in an area where the microfil desert bush is the dominant vegetation. Although much of this bush area has been principally cleared for the installation of the industrial facilities, roads and railroad, on the site itself there are few vegetation plots that apparently are unaltered. However, none of the plant species that were found during the EIA fieldwork are listed as endangered, protected, rare or endemic species, as listed in the NOM-059-ECOL-1994. No wildlife included in that same regulation was found on the site, probably because of the ongoing industrial and road activity.
- 4.11 Natural Protected Areas: During the last few years, SEMARNAP has promoted the consolidation of Protected Natural Areas as an important tool for environmental protection and ecological organization for the country. The closest natural protected area to the site is the Cerro de la Silla, considered a Natural Monument, located approximately 25 km southeast of the Monterrey City.

B. Social and economic conditions

- 4.12 Population: According to the Municipal Statistics Records of García (where the Project is located), in 1995 the population was 26,791 people, representing 0.75% of the total population of the State of Nuevo León. In 1990, 57.9% of the people worked in the secondary sector. This sector includes mining, oil and gas extraction, manufacturing industry, electricity generation and construction activities.
- 4.13 Indigenous people: Indigenous presence in the Municipality of García is almost non-existent. According to the data from the INEGI, of the 11,590 people that lived in the Municipality of García in 1993 only seven spoke an Indigenous Tongue.

- 4.14 Archaeological, Artistic and Historical Heritage: The *Instituto Nacional de Antropología e Historia* (INAH) (National Institute of Anthropology and History) has registered three archeological sites in the Municipality of García, approximately 10 km northeast of the Enron site, and it is not believed that more sites are likely to exist, due to the prevailing conditions, especially the scarceness of water and vegetation.

Infrastructure and Transportation

- 4.15 Water and sanitation: According to the 1995 Census, 85% of the registered houses in the Municipality of García have drinking water services. The water is obtained directly from deep wells (none of which are located near the Project site) and is only chlorinated prior to distribution (García does not have a water treatment plant for potable water). The industries in the area have their own deep wells, like Alkali's, for their internal water supply. The 1995 Census of the State of Nuevo León indicate that only 38% of the houses have sewage service. In Villa de García the sewage and drain system services exist mainly in the old area of the municipality, the neighborhoods on the west and some of the neighborhoods south of the Pesquería River. The sewage system discharges to three oxidation lagoons with a total capacity of 25 L/s and operating at an efficiency of 65 percent. The municipality has one trash collection truck that transports solid wastes to the metropolitan sanitary landfill located in the Salinas Victoria municipality and that has the required environmental permit.
- 4.16 Energy and transportation: According to the Urban Development Plan of the Municipality, 85 percent of the houses of the urban areas have electricity supply, and 79 percent of the total houses (rural and urban) are supplied with electricity. There are also two PEMEX buried pipelines used to supply natural gas to the area. Seventy-five percent of the streets of the municipal capital and surrounding suburbs are paved as are a number of highways throughout the region. Access to the Enron site is made by State Highway No. 16 García-Monterrey that passes just south of the site. The Monterrey-Salttillo Railroad crosses the municipality on the southern side of the *Cierro de las Mitras* next to the industrial zone located along the García highway. There are no urban transportation services within the Villa de García as the municipal capital may still be covered on foot. Transportation services operate toward the surrounding areas, where a large number of the population work, and toward the Metropolitan Area of Monterrey.

V. ENVIRONMENTAL AND SOCIAL IMPACTS

A. Construction phase

- 5.1 The potential negative environmental and social impacts associated with the construction phase of the project are typical of medium-size construction works,

such as increased dust, noise and vehicle emissions, clearing of vegetation and loss of habitats originated by earth movements (site preparation), excavations and circulation of heavy equipment and vehicles. Water and soil contamination are other potential negative impacts related to spills and discharges of oils and raw sewage into the ground or water bodies. Disturbances of local community by workers and construction works are also to be mentioned as potential negative impacts from construction works. However, construction related impacts have been evaluated and were considered to be of medium magnitude, mitigable with standard environmental practices, and temporary, since the construction period will be only about 24 months.

- 5.2 Air Quality: During construction, the air impacts of the project will be generated during the excavation and leveling of the terrain, the clearing activities, truck traffic and other typical construction activities. These activities will increase the amount of suspended particulate, since the project is located in an area where there is very little vegetation and where the presence of suspended particulate is presently high. However, the overall impact of these emissions is considered to be low since the construction activities are temporary and will be taking place only on the site and the transmission lines rights-of-way. The use of vehicles, machinery and equipment with internal combustion gasoline and diesel engines will emit combustion gases to the atmosphere. These emissions will be low and are not considered to be significant due to the limited size of the work site, and limited duration of works.
- 5.3 Cogeneration equipment testing during the construction phase will result in intermittent emissions of NO_x and CO₂ to the atmosphere. All emissions will meet the appropriate standards and will be similar to the operational levels (see Section V.B).
- 5.4 Noise: Intermittently, during construction, the noise levels will increase due to construction activities and vehicles used to transport materials. There are no settlements within the area of noise propagation from the construction activities. Therefore, no residential impacts are anticipated. The potential impacts of the intermittent increase in noise levels on construction workers, the neighboring plant employees and the wildlife near the site is not considered to be significant as the noise levels will be intermittent and temporary. Also, Enron's Health and Safety policies (that, by contract, will be followed by the EPC Contractor) require staff to wear noise protection equipment in areas with identified high noise levels. Noise impacts on wildlife are not expected, given that the area has been of industrial use since the 50s and no important wildlife is found in the site.
- 5.5 Surface and groundwater: There are no likely impacts foreseen to the water bodies (surface and groundwater) during the construction phase, as the closest water body is one kilometer away from the site and the Project construction does not contemplate the need for new wells. Additionally, no significant impacts on the natural run-off pattern are expected. During construction, tanker trucks will bring

in the necessary raw water estimated at 35m³ per day. Potable water for drinking will be supplied in bottles and is estimated at 3,000 liters per day during the period of maximum site labor force (6 liters per person, 500 persons). Sewage from workers will be treated according to NOM-001-ECOL-1996. And, the construction of access roads, as well as the civil works, will include drainage systems as to not modify the pattern of natural runoff within the property.

- 5.6 Geology, Geomorphology and Soils: During the site preparation and construction phases, it will be necessary to level and fill the site and to excavate and compact trenches that will modify the natural topography of the site area. Surface and subsurface impacts are expected to be insignificant in a regional context. The natural topography of the project site is relatively flat and leveling activities will be minimal. Occasionally, it may be necessary to use quarry materials obtained from sources located outside the site. All additional construction fill material will be obtained from authorized sources. The construction of access roads, clearing activities, civil construction work and the connection to the gas pipeline will modify the soil, which is in a relative natural state with scattered plots of vegetation. The site is zoned for industrial use and, therefore, changes to the soils as a result of these activities are not considered significant.
- 5.7 Flora and Fauna: The construction of the cogeneration plant will require the clearing of the site, which implies the removal of the some of the existing vegetation cover and will modify natural habitats and cause the displacement of fauna species dwelling within the project area. Such impacts to the flora and fauna will not be significant given that previous activities, such as the construction of the highway, the pipeline rights-of-way and other industries have already modified the immediate area; moreover, the site is located within an industrial area where existing activities are already taking place. The remaining natural vegetation on the site is thicket type and animal species under protection status were not observed on the site. Agro-chemicals will not be used during clearing activities.
- 5.8 Land Use and Agriculture: The site is zoned for industrial use and no land use change is required for the construction of the cogeneration plant. The cogeneration plant will not impact any existing agricultural activities because none are being undertaken within the environmental area of influence of the plant.
- 5.9 Socio-economic: The construction activity will not lead to a large mobilization of people or an increased demand on the existing infrastructure (it will involve a minimum of 250 and a maximum of about 500 workers during the preparation and construction of the site). Because the construction of the plant will be done in stages, the impact on the unemployed workers of the Municipality of García will be scattered throughout the 19-month construction period (maximum of 24 months), thus allowing the absorption of the working force in other activities. The increased traffic of heavy vehicles will not modify substantially the existing traffic pattern of the industrial area. Therefore, a significant increase in noise,

congestion, air pollution and traffic and/or pedestrian accidents is not anticipated.

B. Operation phase

- 5.10 Operation activities include power production, steam production, transport of equipment and materials, water storage and treatment and waste handling. The main environmental concerns regard impacts on air quality, noise and groundwater. Additional environmental issues assessed include impacts of wastewater discharges, soil contamination, waste disposal, impacts on flora and fauna, and socio-economic impacts. Current environmental management practices at Grupo Vitro in general, and existing liabilities at Alcalí, in particular, were also assessed.
- 5.11 Air Emissions (In-stack): During the testing of the cogeneration equipment and the operation of the plant there will be air emissions, which will mainly be the products of the combustion of natural gas (NO_x , CO, CO_2 , particulate and unburned hydrocarbons). The contaminant of main concern is NO_x , given that the Plant operates with low-sulfur content natural gas as both main fuel and back-up fuel. Therefore, other contaminants will be emitted in very low concentrations. Based on the daily average fuel rate of 1,474,000 m^3 , the Plant will emit 21.35 mg/Nm^3 of SO_2 far below the World Bank guideline of 2,000 mg/Nm^3 . Mexican Standard NOM-085-ECOL-1994 does not establish a limit for SO_2 emissions for gas fired power plants. CO stack emissions are estimated at 45 mg/Nm^3 . Neither the Mexican Standards nor the World Bank guidelines have established limits for CO emissions for gas-fired power plants. Particulate (PM_{10}) stack emissions are estimated at 6.42 mg/Nm^3 , below the 50 mg/Nm^3 limit of the World Bank guidelines for stack emissions. Mexican Standard NOM-085-ECOL-1994 does not establish a limit for PM_{10} emissions for gas fired power plants. A maximum NO_x emission of 60 ppm is guaranteed by the EPC Contractor, thus complying with the World Bank guidelines of 125 mg/Nm^3 (approximately 61 ppm), more stringent than the Mexican Standards of 261 mg/m^3 (127 ppm). Table 5-1 presents the estimated emissions from the Plant and comparison with the Mexican Standards and the World Bank guidelines.
- 5.12 Air quality (Ambient Air): A screening-level air dispersion modeling analysis was conducted using the United States Environmental Protection Agency (USEPA) SCREEN3 air dispersion model in order to assess the potential environmental impacts due to NO_x and SO_2 emissions to determine the fulfillment of the Mexican Standards and World Bank guidelines ambient air quality, under different operating scenarios. The SCREEN3 model was selected for this modeling analysis based on its ability to estimate maximum ground-level pollutant concentrations due to point sources such as the power plant stack⁸. The

⁸ The SCREEN3 model is a conservative model, which utilizes hypothetical worst case meteorological conditions. If a modeled emission rate evaluated using this technique result in downwind impacts less than the Mexican air quality standards and World Bank guidelines, then it is very likely that actual air emissions will be well below these standards and guidelines. Similarly, if the screening-level analysis results indicate

dispersion model was run for different operation and maintenance scenarios: Combustion turbine alone (producing the average Alkali steam demand of 180 tons per hour and 245 MW electricity demand); Auxiliary boiler at full load (when the combustion turbine is under maintenance), and combustion turbine at base load and auxiliary boiler at 15% load (producing the *maximum Alkali demand* of 210 t/h of steam and 245 MW of electricity). The analysis focused on the impacts of the equipment alone, given that there is no representative background data for the area and the other existing sources in the area are located upwind, have much taller stacks, and higher exhaust temperature, therefore greater dispersion, not likely to be additive to the proposed project maximum impacts. It also to be noted that the analyses is based on plant equipment which has not yet been purchased; thus, worst case emission rates have been presented. It is anticipated that actual emissions and thus impacts from the cogeneration facility, when operational, will be much improved from that which is now conservatively presented.

- 5.13 Based on the estimated NO_x emission values from the operation of only the combustion turbine, the calculated one-hour ground level NO₂ concentration⁹ is estimated at 346 µg/m³ (Mexican Standard is 395 µg/m³ and World Bank Guidelines are not established). Simultaneous operation of the combustion turbine (100 % of capacity) and the auxiliary boiler (15 % of capacity) will result in a calculated one-hour ground level NO₂ concentration estimated at 359 µg/m³ (Mexican Standard is 395 µg/m³). For all the scenarios run, at the maximum estimated NO_x emission values, the resulting calculated NO₂ ground level concentrations are within the Mexican Standards and World Bank guidelines. As the SCREEN3 model is conservative, no further air modeling is necessary. A comparison of the calculated ground level NO₂ values with the applicable standards is presented in Table 5-2. The SCREEN3 model and the results of the modeling are summarized in Annex 3.
- 5.14 Noise: The existing background noise levels¹⁰, are below the World Bank ambient noise limits.. Ambient noise measured at the site is generated primarily by activities at Alkali followed by motor vehicle traffic from the adjacent Monterrey-Garcia Highway as well as other natural noise from wind and wildlife. Mexican Standards do not regulate ambient noise and, since the plant is not yet in existence, these Standards do not apply until the plant is in construction or operation when fixed source noise emissions will be regulated. Enron is committed to designing the major equipment to have noise levels less than 65 dB(A), measured at the site boundary to comply with Mexican Regulations.

that potentially a standard or guideline value is exceeded, further analysis must be conducted using other models that are less conservative and more detailed.

⁹ The regulated pollutant by the World Bank guideline for gas-fired power plants and the Mexican Standards is Nitrogen Dioxide (NO₂ ≡ NO_x – NO). Most of the NO_x emitted from the turbine and the boiler is nitrogen oxides (NO). Some of the NO is converted to NO₂ by the time the plume reaches its maximum downwind concentration. The conversion of NO_x to NO₂ is detailed in Annex 3, section 2.1

¹⁰ The highest daytime level measured was 67.9 dB(A) at the fence line between the existing Alkali plant and the Enron cogeneration plant site. The highest nighttime value was 57.7 dB(A).

Based on the design criteria and the existing background levels, the daytime noise levels could reach a maximum of 67.9 dB(A) and nighttime noise levels will be less than 65 dB(A)¹¹. This value is measured at the site boundary between Alcali and Enron (according to Mexican Standards) and not at a receptor as defined in the World Bank guidelines. Therefore, the result is considered to be not significant, as the potential receptors are industrial activities (for which the World Bank guidelines are 70 dB(A) for both daytime and nighttime - refer to Table 3-4).

- 5.15 Groundwater: The project will replace equipment of equivalent steam capacity presently located and operated on the Alcali site. The Project demand for water of 130 m³/hour will be supplied by Alcali utilizing the existing groundwater supply sources and volumes (used by the equipment that will be replaced, plus an additional water requirement estimated at 10 percent). The required demand is within the capacities of the Alcali deep wells approved by CNA (508.8 m³/hour). The annual rate of exploitation is monitored through the annual COA. Impacts of all the exploitation permits (to Alcali and other industries) on the area on the existing aquifers are monitored yearly by CNA (through the *Comité Estatal del Agua*) to ensure their appropriate rate of recharge and permits are suspended if significant impacts to the groundwater are identified. Alcali is a subsidiary of Grupo Vitro¹² and produces mainly Sodium Chloride, Sodium Carbonate, Sodium Bicarbonate, Calcium Carbonate and Calcium Chloride. Therefore, the maintenance of the aquifer levels is necessary to support their industrial activity at this location.
- 5.16 Wastewater: The industrial wastewater generated during the process is estimated at approximately 10.8 m³/hour and will be returned to Alcali for treatment. After treatment, the effluents are re-injected at Alcali's industrial process (980m below ground level into a saline deposit, for the production of *salmuera*, which is the raw material for the production of Calcium Carbonate by Alcali), in compliance with the requirements of Alcali Operation Permit. Therefore, there will not be any new industrial wastewater discharges sources as a result of the operation of the cogeneration Plant. In addition, minor quantities of sewage wastewater from approximately 30 employees (approximately 4.8 m³/day) will be generated and treated at the plant. The effluent will be used to irrigate landscaped areas at Enron's property. Run-off water with potential oil contamination (minimum, given the climate pattern) will be collected and, after treatment in an oil/water separator, it will be sent to the Alcali plant for treatment.

- 5.17 Soil: The impact on the soils and drainage patterns from compaction for

¹¹ Mexican Standards are 68 dB(A) for daytime and 65 dB(A) for nighttime at perimeter; WB guideline is 70 dBA for both nighttime and daytime, at receptor.

¹² Vitro manufactures glass and plastic recipients, aluminum cans, flat glass for automobiles and architectural use, domestic glass, home artifacts, chemistry utensils, and fiberglass products. Vitro is comprised of different companies that provide a variety of products, from raw material to several types of finished products.

construction is estimated to be minimal, given the size of the site, the area that will be occupied by the Plant¹³ and the future use of the area (industrial).

- 5.18 Wastes: The magnitude of the impacts of hazardous and non-hazardous waste generated at the site will not be significant. Administrative wastes are estimated at 40 kg/day and consist of paper, cartons, wood shavings, cans and miscellaneous materials, 40% of which are recyclable. The operation and maintenance of the plant will generate industrial waste (lubricants and additives for machinery and equipment, chemical containers) in quantities that are not significant: It is estimated that 40 L of degreaser will be used annually for maintenance. During the Plant's major overhaul (once every six years) about 200 L of degreaser will be used and disposed.
- 5.19 Flora and Fauna: Given the existing industrial use in the surrounding area, and the lack of relevant (endangered or protected) species of flora and fauna, no incremental impacts are expected on the flora or fauna during the operations of the Plant.
- 5.20 Environmental management at Grupo Vitro and existing liabilities at Alkali: Grupo Vitro has environmental management policies that extend to all the associated companies. Grupo Vitro is undergoing a process of environmental management certification (ISO 14000). At present, 20 of the associated companies have been audited and 5 are about to be certified. In November 1999, Vitroflex obtained the Clean Industry certification issued by SEMARNAP. No environmental liabilities were identified at Alkali. The company complies with the required monitoring through the *Cédula de Operación Annual (COA)*. The COA does not show any non-compliance. Same information was obtained at PROFEPA.
- 5.21 Socio-Economic: The demand of workforce (about 30 permanent jobs) will be minimal and not likely to increase the service demands on the Municipality or the other communities. As the site is already zoned for industrial use, no significant negative social impacts are expected.

C. Risks

- 5.22 A "Risk Identification Matrix" was submitted as part of the Risk Study. It focused on risk to personnel and facilities with some mention of potential for contamination. The Hazop methods of "What if" and "Trial and Error" were used for the identification and prioritizing of plant risks. With regard to potential risks the main substances that have been used in the simulation models were hydrochloric acid (for toxicity) and natural gas and hydrogen (for explosiveness and inflammability). The risk levels vary from 1 (minor) to major (16), according to the risk levels criteria as presented in Table 5-3. The events with greatest risk potential are: (a) hydrochloric acid spills from the de-mineralizing system of the

¹³ The plant will occupy less than half of the site's area - 3.3 hectares out of 7.5 hectares.

Plant (risk level 6); (b) hydrogen leak in the generator cooling system or from the head of the hydrogen storage cylinders (risk level 3); and (c) natural gas leak in the distribution and turbine combustion system intake line, in the heat recovery steam generator, and the back up boiler (risk level 3).

C. Positive Impacts

- 5.23 The main positive impact of the project will result of the substitution of the Alkali boilers by Enron's Plant equipped with modern low-NO_x burner. Another positive impact is that natural gas results in minimum greenhouse gas emissions. When considering the Climate Change impact of a project, the emission effect falls into one of three categories: emissions can be avoided, offset or reduced. The Cogeneration Power Plant will be used to satisfy an energy demand that otherwise would not be supplied. By installing a cogeneration plant instead of any other conventional power system, greenhouse gas emissions are being avoided compared to other hydrocarbon fuels. Carbon emissions will be significantly less than from conventional systems because of the higher efficiencies of cogeneration systems. According to the U.S. Energy Association, cogeneration produces a certain amount of electricity and process heat with roughly 10%-30% less fuel than if separate processes produced heat and electricity¹⁴. Table 5-4 shows a comparison of CO₂ emissions per unit of fuel consumed between cogeneration and alternative processes (natural gas, oil and coal technologies). Two scenarios are considered one in which the cogeneration plant consumes 10% less fuel than either of the other technologies and second when the fuel consumption is 30% less in cogeneration. The estimation of CO₂ emissions was done following the guidelines developed by the IPCC and adapted to project-specific circumstances by the Environmental and Social Unit of the Inter-American Development Bank's Private Sector Department (PRI)¹⁵. Only CO₂ emissions are considered in Table 5-4 because other greenhouse gas emissions (for instance methane and nitrous oxide) are very small compared to carbon dioxide.
- 5.24 Direct positive socio-economic impacts will also be produced at the construction and the operation phases of the Plant. The project will generate between 250 and 500 temporary jobs during construction (unskilled and specialized personnel, mainly from the local population) and approximately 30 permanent jobs during the operation of the Plant.
- 5.25 Indirectly, the Project will also contribute to marginally increase the economic growth in the region, by creating indirect jobs in the electrical and consumer sectors (since Enron proposes to acquire operational materials and supplies mainly from local and regional providers) and by redirecting the energy currently

¹⁴ USEA/USAID. 1999. *Handbook of Climate Change Mitigation Options for Developing Country Utilities and Regulatory Agencies*. Document prepared by Energy Resources International, Inc.

¹⁵ PRI/IDB. 2000. *Greenhouse Gas Assessment: Guidelines to Estimate Greenhouse Gas Emissions from Large-Scale Infrastructure Projects*.

being supplied to Grupo Vitro facilities to other industrial or domestic consumers in the Municipality and the region, to support the growth of economic activities.

VI. ENVIRONMENTAL AND SOCIAL IMPACT MITIGATION AND MONITORING MEASURES

- 6.1 The prevention and mitigation measures established for each of the identified environmental impacts will be consolidated in an Environmental and Social Management Plan (ESMP) for both the construction and the operation phases. Trained personnel will be responsible for the verification and supervision of the compliance with the preventive and mitigation measures established for each stage of the Project. The ESMP will include a monitoring program of air emission, air quality, wastewater, and noise levels. The monitoring results will be used to assess the effectiveness of the mitigation measures and to verify compliance with the applicable Mexican Standards and World Bank guidelines.

A. Mitigation measures

Construction Phase

- 6.2 The proposed mitigation measures will be consolidated in an Environmental and Social Management Plan (ESMP) for the construction phase, as part of the EPC Contract.
- 6.3 Air Quality: During the construction period, the contractor will apply conventional measures for environmental control in order to reduce the possible environmental impacts. The EPC's ESMP will contain environmental requirements such as: (a) areas that will be excavated or filled, as well as access roads will be watered to reduce dust; (b) trucks that transport superficial materials (soil) will be covered to prevent the dispersion of the material while being transported; (c) the excavation material will be reused as much as possible in the filling and grading activities; (d) all of the stockpiled excavation material will be adequately disposed of in order to avoid dispersion by wind or rain; (e) vehicles used for the material and equipment transport, as well as the equipment with internal combustion motors will comply with the NOMs in addition to original specifications in order to reduce the amount of emissions generated.
- 6.4 Noise: The EPC's ESMP will contain requirements regarding appropriate management and control of noise, such as (a) vehicles will operate with exhaust systems and at low speeds while driving on the access roads or on the site; (b) vehicles will meet the NOM-080-ECOL-1994 regulations regarding the maximum permissible noise emission limits for vehicles, motorcycles and motorized tricycles.

- 6.5 Surface and groundwater: The design of the cogeneration plant contemplates the installation of specific drainage to capture and direct rainwater to areas outside the property, making sure these discharges do not modify the natural runoff patterns of the surrounding areas. To avoid interfering with the natural drainage, no soil and/or plant debris will be accumulated outside the right-of-way or the site or on the natural surface drainage channels of the site. During site preparation and construction, tanker trucks will provide the water supply, therefore water used during construction will not be taken from any surface or groundwater source within the site. Bottled water will be used as the source of potable water. The EPC's ESMP will also contain requirements to avoid groundwater contamination, such as treatment facilities for all the sewage wastewater and prohibition of discharge of any kind of liquid or solid residues on open fields, without appropriate treatment.
- 6.6 Soils: The EPC's ESMP will contain requirements regarding control of environmental impacts, such as: (a) whenever possible the material obtained from excavations and clearing will be used during the filling and grading of the area within the property; (b) the project will comply with the standard NOM-003-RECNAT-1996 that refers to the procedures, criteria, and specifications for the use, transport and storage of soil; (c) any excess material will be sent to areas previously authorized by the Municipality, and will be disposed of in accordance with standards and regulations to prevent it from being dispersed by wind and rainfall; (d) all the material necessary for the leveling and road preparation will be obtained from authorized sources.
- 6.7 Wastes: The EPC's ESMP will contain requirements regarding control of environmental impacts, such as: (a) a collection, classification, packing, labeling, temporary storage and disposition program for all the conventional and special residues will be established to avoid the physical-chemical contamination of the soil during construction; (b) the domestic solid residues generated during construction will be stored in special containers with lids to prevent soil contamination and public health issues; (c) the wastes will be sent to the municipal landfills (the García landfill has been approved by the environmental authorities) for final disposal; (d) to avoid soil and water pollution, the areas where the fuels and lubricating oils are stored will be designed to contain spills; (e) there will be equipment for fire fighting; (f) chemical containers and other hazardous wastes will be treated according to Mexican Regulations (NOM-052-ECOL-1993 through NOM-058-ECOL-1993); (g) authorized Monterrey waste handling companies¹⁶ will dispose of chemical containers and other hazardous wastes.

¹⁶ Present there are two companies: (a) ECO-MASSH: INE-SEMARNAP permit number 1946-PS-I-51-99 issued on September 17, 1999 with INE letter No. 6061, extended on June 2, 2000 with INE letter No. 3035, and SCT permit number 12421 (for transportation), issued on May 17, 1999 and extended with permit number 12741. (b) ECOQUIM, INE-SEMARNAP permit number 1921PSV0494 and SCT permit number 31871 (for transportation), issued on March 3 1999.

- 6.8 Flora and Fauna: No plant or animal species mentioned in the NOM-059-ECOL-1994 were found. However, as a precautionary measure, the EPC Contractor will complete a detailed inventory and thorough inspection of the area four weeks prior to the start of construction to confirm the absence of any protected species. If a relevant species is found, a rescue program for the species will be implemented. After construction the site will be revegetated in specific areas with local native species that will maintain the diversity of species (thus compensating for the loss of any vegetation and providing vegetation shelters for the existing fauna). During construction, the EPC's ESMP will establish procedures and internal regulations to (a) prevent the construction employees from damaging the vegetation and from disturbing, hunting and/or trapping native fauna within the site and surrounding areas; (b) avoid the use of agrochemical during clearing activities..
- 6.9 Social: Given the small number of construction workers needed and the proximity to a supply of labor from nearby cities , the project will not provide housing in the campsite during construction. Workers will be transported daily to and from the work site. The EPC's ESMP will contain requirements such as to give hiring preferences to personnel from neighboring communities, and to provide transportation for workers. Inconveniences and disturbances to the neighboring community will be limited, given that there are only industries in the vicinity. No additional mitigation measures are anticipated.
- 6.10 Archeology: Although the potential for finding archeological sites is minimal, given the lack of vegetation and water, and the more recent intense industrial use in the area, the EPC Contract will require that, in accordance with the *Ley Federal sobre Monumentos y Zonas Arquelógicas, Artísticas e Históricas* (Federal Law for Archeological, Artistic and Historic Monuments and Zones), all clearing and grading activities be suspended if artifacts or buildings of historic value are unexpectedly uncovered, and the Regional Center of the National Institute of Anthropology and History be immediately notified.

Operation phase

- 6.11 Enron, the operator, is committed to implementing standard good practices to mitigate potential impacts during the operation of the cogeneration plant. Specific mitigation measures proposed by Enron will be consolidated in an Environmental and Social Management Plan (ESMP) for the Plant's operational phase, as described below.
- 6.12 Air Quality: All equipment that emit air pollutants have been designed to meet the applicable Mexican Standards and the World Bank guideline limits. The cogeneration plant equipment will be equipped with low NO_x burners producing emissions that will range from 33 ppm to a maximum of 60 ppm of NO_x, (maximum guaranteed by EPC Contract). The use of natural gas with low-sulfur content guarantees low emissions of SO₂, particulate and CO.

- 6.13 Noise: In order to comply with the Mexican Standards and with the World Bank guidelines (and as defined in the EPC Contract) the Project's equipment will be equipped with noise mitigation devices based on a design maximum noise of 65 dB(A) measured at the site property boundary. Should the monitoring indicate any violation of these limits, the Company will implement additional corrective measures.
- 6.14 The EPC's ESMP will also contain specific requirements regarding compliance with the standard NOM-011-STPS-1993 concerning the health and safety of employees working within areas where noise is generated. To be compliant with the Mexican health and safety requirements, the Contractor will provide hearing protection in the areas identified as having high noise levels.
- 6.15 Groundwater: Given that no impacts in the groundwater (from water extraction) are anticipated, no mitigation measures have been designed other than the monitoring of the groundwater table level, which is currently performed by CNA. To avoid groundwater contamination, sewage wastewater will be treated before use for landscape watering (See paragraph 6.16 for details).
- 6.16 Wastewater: The Plant will not generate any industrial wastewater discharge, given that all the process water will be treated at Alkali¹⁷ and then injected into Alkali's industrial process. Alkali already has been granted the Operation Permit (*Licença Ambiental Única*) and complies with the annual monitoring reporting via the *Cédula the Operación Annual* (COA). According to the COA, Alkali has a closed circuit and no wastewater discharges into any water body. Additionally, to ensure the efficiency of the Alkali treatment, the Steam Purchase Agreement establishes the wastewater quality standards that must be met by the Plant's wastewater in order to be treated at Alkali, for a number of parameter (10 in total), as presented in Table 6-1. In order to comply with these parameters, Enron will handle the wastewater by two separate discharge systems, one for the demineralization flow and the other for the boiler and turbine purges. Both will be neutralized before they are sent to the Alkali wastewater treatment.
- 6.17 The design of the cogeneration plant also includes the installation of specific drainage features to capture and direct run-off water with potential oil contamination (rainwater that falls on or transverse the boiler, turbine and transformers areas) to oil-water separator before they can be discharged to areas outside the property, making sure the effluent complies with the NOM-001-ECOL-1996, for effluents discharged on the ground. Main parameters regulated by the Norm are: Oil and grease, and Heavy metals (See Table 6-2).
- 6.18 Sewage from the approximately 30 employees will be treated by a sanitary sewage treatment package to be installed at the Plant. The sanitary package is not

¹⁷ Wastewater discharge will be of equivalent quality and quantity as the Alkali wastewater from the boilers that will be "shut down".

yet defined, but it will be designed as to guarantee that the final effluent will comply with the requirements of NOM-001-ECOL-1996, for effluents discharged on the ground ¹⁸ (the effluents will be used to irrigate lands on the Plant's site, as approved in the Environmental Permit).

- 6.19 Wastes: The ESMP for the operational phase will include a collection, classification, packing, labeling, temporary storage and disposition program for all the residues generated during the operation stage will be established to avoid the contamination of the soil because of potential impacts such as infiltration. Domestic wastes generated in the plant will be collected and sent to the municipal landfill. Hazardous wastes (containers used for grease, oil, solvents, additives, lubricants and flammable substances) will be managed according to the Guide on Hazardous Waste Issues of the LGEEPA and sent to authorized companies to handle hazardous wastes in Monterrey.
- 6.20 Flora and Fauna: Although no impacts to the wildlife and plants were identified, given that the area has long been used for industrial purposes, procedures and internal requirements will be established in the ESMP for the Plant's operational phase to prevent the employees of the cogeneration plant from disturbing the vegetation species and from damaging, hunting and/or trapping native fauna within the site and surrounding areas.
- 6.21 Existing liabilities: Given that no existing liabilities were identified at Alkali, no Corrective Action Plan was required.
- 6.22 Socio-economic: Given that no negative social impacts from the operation activities were identified, no special social mitigation measures are planned for the operation phase of the Project.

B. Monitoring

Construction Phase

- 6.23 The monitoring program will allow the evaluation of the efficiency of the mitigation measures designed for the construction phase and compliance, by the Contractor, with the ESMP and Enron's environmental policies. This section describes the monitoring procedures for air quality and noise emission levels, given that these are the most relevant parameters to be affected during construction.
- 6.24 Air Quality: In order to establish NO_x background data representative to the area, as well as to monitor compliance with Mexican Standards and World Bank guidelines for ambient air quality, an automatic monitoring network for ambient NO_x and meteorological parameters will be installed upon initiation of

¹⁸ The effluent will comply with the requirements for agricultural use, though it will only be used for landscaping and garden.

construction activities. Continuous ambient NO_x monitoring will be performed at two monitoring points, one located upwind and one at the point of predicted maximum downwind concentration. One of the monitoring stations will be equipped with a 10 meter meteorological tower with continuous measurement sensors to determine real time wind speed and direction, temperature, relative humidity and atmospheric pressure. The locations of the air quality stations will be determined utilizing the contaminant dispersion study performed for the Project area. In addition to establishing the background NO_x for the area (the main parameter affected by the Plant's operation), the Company will consider the feasibility of contributing to extend the SIMA monitoring network in order to obtain background data for some other parameters measured by SIMA (CO, NO₂ and PM₁₀) that are relevant to the Industrial Zone where the Project is located.

- 6.25 Noise: During the construction of the Plant, the ambient noise levels will be measured at least four times per year. Enron will perform the quarterly monitoring at the property fence line in order to verify compliance with Mexican Standards (since they are more stringent than the World Bank guidelines). Measurements will be conducted over a two-day period during times of normal construction activities.
- 6.26 Socio-Economic: Given that no negative social impacts are expected during construction phase, no socio-economic monitoring is planned during that stage.

Operation Phase

- 6.27 The monitoring program is designed to verify compliance with and the efficiency of the mitigation measures designed included in the ESMP for the operation phase. It includes verification of compliance with the applicable Mexican Standards and the World Bank guidelines for the operation of new engine-driven gas fueled power plants. This section describes the monitoring procedures for air emissions, ambient air quality, noise emission levels, and wastewater, the most relevant parameters to be affected during operation of the Plant.
- 6.28 Air emission: Enron will install in-stack Continuous Emissions Monitoring System (CEMS) in order to monitor emission of NO_x and O₂ levels during the operational stage of the Plant. The CEMS will provide daily, monthly and annual reports in addition to having warning alarms to notify the operators of potential problems. The emissions must meet the maximum allowed values of the Mexican Standards and the World Bank guidelines (refer to Table 3-2). Particulate and SO₂ emissions will not be monitored given that due to the Plant's characteristic the estimated emissions are very low (refer to Table 5-1).
- 6.29 In addition Enron, in compliance with applicable standards for the operation of combustion equipment, will maintain a record log for combustion, measuring, and emission analysis equipment, and the fuel quality certificates. This log will include at least the following information: Operation control (date, shift, report

time, steam pressure, gas temperature, intake water temperature, combustion temperature and pressure, smoke color, depth purges, level purges, safety valve ignition, fuel consumption, pressure controls, intake water pump, start-up, and shut-down due to flame failure) and contaminant emission control (efficiency, gas temperature, excess air, O₂, smoke opacity, fuel data according to certificate, emission analysis, smoke analysis, nitrogen oxide, intake water analysis).

- 6.30 Air Quality: In order to monitor environmental air quality compliance with Mexican Standards and World Bank guidelines, the automatic monitoring network for NO_x installed upon initiation of construction activities will continue in operation during the lifetime of the Project. At the end of the first year of operations the monitoring program will be reviewed and modified as necessary.
- 6.31 Noise: During the first year of the operation of the Plant, the source noise levels will be evaluated at least once a year based on modifications implying noise level changes. Since NOM-081-ECOL-1994 establishes maximum permissible levels of noise emission from fixed sources and its method of measurements, Enron will ensure that maximum permissible levels are not exceeded at the property boundaries. The surveys should be undertaken when the two plants are both operating near capacity (minimum 90%). In addition, measurements should be made during the loading of a train at Alcali and when the Alcali conveyor belt is in operation. According to the results of the noise monitoring, the frequency of monitoring will be either increased or decreased (no less than twice a year) during the following years of operation of the Plant.
- 6.32 Wastewater: Three wastewater-monitoring programs will be conducted by Enron. ENRON will continuously monitor the quality of the industrial wastewater effluent before sending it to Alcali for treatment. In order to ensure the effectiveness of the treatment, Enron will monitor the parameters established by Alcali under the Steam Purchase Agreement (refer to Table 6.1). Because this monitoring is before the treatment, there is no requirement to comply with either Mexican norms or World Bank guidelines. Once treated at Alcali, these effluents re-enter into Alcali industrial process. Hence, no discharge exists. Therefore, no further monitoring is required from Alcali, according to the existing Operation Permit and the COA. Also, because the cogeneration Plant is substituting similar equipment and processes with equivalent wastewater discharge that are currently in operation at Alcali, no change in the Operation Permit and COA is required from Alcali.
- 6.33 The Plant's run-off water with potential oil contamination will be monitored, after passing through the oil-water separator (and before entering Alcali's plant for treatment) to verify compliance with Alcali's wastewater quality requirements established in the Steam Purchase Agreement (refer to Table 6.1). In addition, designated environmental personnel from the Plant will perform visual inspections on routine tours around the site, to ensure immediate identification

and correction of any non-compliance. These observations will include the presence of floating material on the water surface, suspended solids in the water flows, grease or oil stains, discoloration and odors.

- 6.34 The third monitoring program relates to sewage effluent. After treated, the effluent will be monitored to verify compliance with NOM-001-ECOL-1996 (for irrigation of landscaped areas).
- 6.35 Socio-Economic: Given that no negative social impacts are expected no socio-economic monitoring is planned during the operation phase of the Project.

C. Supervision and Control of Project Mitigation and Monitoring

- 6.36 The main function of Environmental Supervision will be to monitor the ESMP for construction and operation activities in such a way that all prevention and mitigation measures will be effectively, timely and properly implemented. A work plan for implementation of Environmental Supervision will be developed to establish personnel responsibilities, field logistics training, monitoring prerequisites, monitoring report sheets and communication and information.
- 6.37 During the construction phase, the Contractor will supervise and document all activities that relate to environmental protection, including erosion control, waste management and spill control. During operational phase, the Environmental Manager (EM) will set inspection priorities, maintain a database and gather field data. The EM will supervise the ESMP implementation and will participate in the public relations program that will be developed to maintain a link with the surrounding community. In addition, the Bank will perform its own monitoring and supervision of the Project, during construction and operation, by contracting an environmental consultant, sponsored by the Project Company.

D. Contingency Plan and Procedures

- 6.38 The plant has been designed as to reduce the risks of accidents. Anti-corrosive protection, installation of instrumentation and control devices and accessories for the natural gas utility room, oil seal system to ensure a constant oil/hydrogen differential pressure; generator system equipped with detectors and sound alarms for oil seal system failures; leak detection and alarm systems. In addition, under the ESMP, specialized personnel will be assigned responsible for the verification and supervision of the prevention and mitigation measures. They will ensure that these are met and respected at each of the different stages of the project.
- 6.39 Emergency Plan: Although the Plant's design characteristics minimize the risk of an accident, the establishment of an Emergency Plan (emergency procedures that would minimize the effects of a large-scale accident) is one of Enron's safety policies. Emergency procedures are addressed in both the MIA and the Risk Study and will be consolidated in the Emergency Plan. The Emergency Plan will

include personnel training, the pertinent emergency response procedures and sufficient human resources. The Emergency Plan will be developed to control or combat emergency situations in order to minimize losses in: (a) human lives (be it at the Plant or the vicinity); (b) material resources of the Plant and neighboring facilities; (c) ecosystems (due to deterioration and contamination); (d) production (damages to the equipment and machinery); and (e) the Plant image or aesthetic.

- 6.40 Personnel Training: Plant personnel will be trained on: (a) the emergency procedures and the contingencies plan; (b) the location of the emergency equipment; (c) the identification of potential and real emergency situations; (d) proper uses of First Aid, fire fighting, spill control and operation of rescue equipment. Training for new personnel will be of high priority in order to maintain a training and experience level that will guarantee optimal performance during emergencies. In addition, First Aid, fire fighting, spill control and rescue equipment will be maintained on site.

E. Health and Safety

- 6.41 The Safety and Hygiene in the Workplace Program will be developed and implemented as part of a Health and Safety Plan, for both the construction (as part of the EPC's ESMP) and the operational phases. This program will include protection procedures for all the personnel, especially those who work near areas of high temperature or noise sources and areas of hazardous material or waste. This program will establish (i) the training requirements for the workers, (ii) the hygiene and safety requirements and (iii) the prevention, reduction and accident control and emergency and contingency plan development. Enron will operate the plant respecting all Mexican environmental, safety and hygiene legislation as well as its own internal standards.

F. Environmental, Health and Safety Management Systems

- 6.42 As part of the Bank's Environmental Requirements and according to its Environmental Policy, Enron will implement an Environmental, Health and Safety Management System (EHSMS), in accordance to the principles of ISO 14000 and BS 8800 (for environment and health and safety, respectively). This will include training, record keeping and reporting, supervision and auditing programs that will ensure that the environmental requirements are constantly met in the four key areas:
- Legislation and regulation requirements.
 - Identification of significant environmental aspects.
 - Review of existing environmental management practices and procedures.
 - Assessment of feedback from incident investigations. The review will include verification lists, interview, inspection and direct measurements, prior audit's results or other reviews depending on the nature of the activities.

6.43 Appropriate records forms and records keeping procedures will be developed as part of the EMS. The environmental records will include:

- Environmental legislation or other applicable requirements
- Complaint records
- Training records
- Process and product information
- Inspection, maintenance and calibration records
- Contractor and supplier information
- Incidents reports
- Emergency preparation and response information
- Records of significant environmental impacts
- Audit results
- Management inspections

VII. PUBLIC CONSULTATION

- 7.1 The public consultation process for the Project started in September of 1999 when Enron published an information notice in the “El Norte” newspaper concerning the project and a notice regarding the availability of a Preliminary Environmental Impact Assessment (preliminary EIA, prior to the MIA) for public review at the Municipality of Garcia. The Preliminary EIA was presented to the IDB and the Municipality of Garcia on September 1, 1999 as part of the U.S. International Development and Finance Act of 1989 public disclosure requirements to initiate the 120 day review period. The IDB made the preliminary EIA available to the public at the Public Information Center (PIC) on September 24, 1999.
- 7.2 On December 10, 1999, to comply with INE requirements for the Environmental Impact and Risk Authorization, Enron presented the MIA and the Risk Study to the consideration of the General Directorate of Ecological Zoning and Environmental Impacts of the INE as well as the Direction of Ecology of the Municipality of Garcia, and to the State Delegation of the SEMARNAP in Nuevo Leon. The Municipality of Garcia made the MIA and Risk Study locally available to the public for comments from 11 January to 4 February. The Final EIA and the MIA were also made available through the Public Information Center (PIC) on March 9, 2000. Information regarding this document is available to the public through the IDB web site.
- 7.3 The Public Consultation Plan included an Information and Public Consultation Meeting held in the Municipality of García on February 4th, 2000. Invitation for the event was published in the "El Huasteco" on the 8th, 15th and 22nd of January 2000). During the meeting, conducted by a representative of Alcali, the two speakers (from Enron de Mexico and Dames & Moore de Mexico) presented the

general characteristics of the Project and the summary of the results of the environmental studies performed for the Project, respectively. At the end of the presentation all questions from the public were answered. The event was recorded and documented with photographs and video, including the questions, comments and suggestions received, as well as the answers provided.

- 7.4 Based on the results of the Information and Public Consultation Meeting, no opposition or disagreements were identified from the community, local industries, local and regional authorities, or from the potentially affected and/or interested parties. Public opinion concerning the development and operation of the cogeneration plant was positive and the project was accepted as being of benefit to the community. The representative of SEMARNAP was particularly impressed with the environmental and social advantages of the Project.
- 7.5 Enron will develop and maintain a social communication and relations program, which will address the following objectives: (a) to maintain contact with the public during construction; (b) to develop a project information program for the public, and (c) to educate the construction working force in the maintenance of the correct relationship with the host communities.

VIII. RECOMMENDATIONS

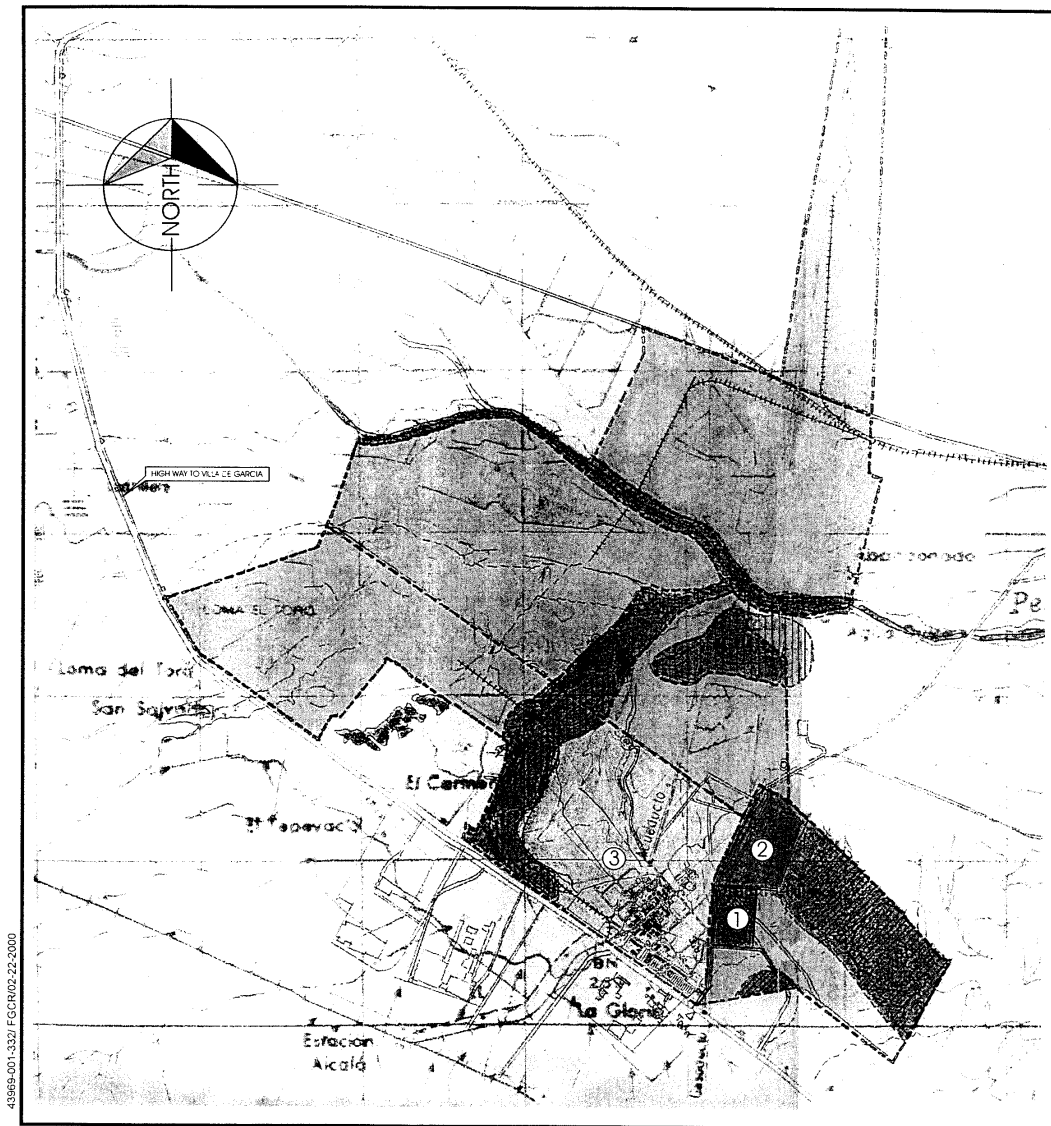
- 8.1 The Bank (IDB) will require as part of the Loan Agreement that Enron and all portions of the Project shall, at all times during the life of the Loan Agreement, comply with each of the following:
1. All applicable environmental, health and safety Mexican regulatory requirements, in particular all the conditions established in the environmental permit issued by INE.
 2. All requirements associated with any environmental, health and safety related permits, authorizations, or licenses that apply to the Project or the Company.
 3. All environmental, health and safety requirements of the Project contracts, and any subsequent modifications.
 4. All aspects and components of the entire Project's environmental, health and safety documents.
 5. Applicable aspects of the World Bank Thermal Power Guidelines for New Plants (World Bank Pollution Prevention and Abatement Handbook, 1998).
 6. Applicable aspects of the World Bank General Environmental Guidelines (World Bank Pollution Prevention and Abatement Handbook, 1998)
 7. Applicable aspects of the International Finance Corporation General Health and Safety Guideline (1998).
 8. Consult with IDB before approving or implementing any and all substantive changes to the Project or its timetable which could potentially have negative environmental, social, or health and safety effects.

9. Send written notice of any and all noncompliance with any environmental requirement of the loan agreement and any significant environmental, social, or health and safety accident, impact, event or environmental claim.
 10. Ensure that all companies contracted for construction or operation activities comply with the applicable environmental and social requirements of the loan agreement.
 11. Implement ongoing information disclosure and consultation activities related to environmental, social, and health and safety aspects of the project.
 12. Implement an environmental, health and safety management system that is consistent with ISO 14001 and BS 8800 (for environment and health and safety, respectively).
- 8.2 Prior to the date of Financial Closure, the Company must fulfill the following condition:
1. Present a formal commitment from Alcali to not operate the five existing boilers when the Cogeneration Project becomes operational.
 3. Present information regarding the feasibility of contributing, either directly or indirectly, to expand the existing SIMA Ambient Air Quality monitoring program in the area where the Project is located.
- 8.3 Prior to First Disbursement of the Loan, the Company shall fulfill the following conditions:
1. Submit to IDB, in form and substance satisfactory to IDB, the final Environmental and Social Management Plan (ESMP) for construction phase, including the detailed mitigation measures and monitoring programs, their estimated costs, the designated responsibilities for each individual component and the schedule for implementation. The ESMP must include the Social Communication Plan for the construction phase.
 2. Submit to IDB, in form and substance satisfactory to IDB, the final Health and Safety Plan (HSP) for construction phase, including the detailed procedures, the designated responsibilities, the necessary human and operational resources, the required training, estimated costs, and the schedule for implementation.
 3. Submit to IDB, in form and substance satisfactory to IDB, the final Contingency Plan for construction phase, including the detailed procedures, their estimated costs, the necessary human and operational resources, the required training, designated responsibilities, and the schedule for implementation.
- 8.4 Prior to each disbursement, the Company must certify compliance with all environmental and social requirements in the loan agreement.
- 8.5 The Company shall as a specific requirement prior to initiation of commercial operations:

1. Submit to IDB the evidence that the appropriate environmental permit has been issued by SERMARNAP (*Licencia Ambiental Única*).
 2. Submit to IDB, in form and substance satisfactory to IDB, a Construction Phase Environmental and Social Report. This report will also include results of all required air, noise and water construction phase monitoring, including emissions testing, as well as the social communication activities performed.
 3. Submit to IDB, in form and substance satisfactory to IDB, the Environmental and Social Management Plan (ESMP) for the project's operational phase, including the detailed mitigation measures and monitoring programs, their estimated costs, the designated responsibilities for each individual component, and the schedule for implementation. The ESMP must include the Social Communication Plan for the operational phase of the Project.
 4. Submit to IDB, in form and substance satisfactory to IDB, the Contingency and Emergency Plans for the project's operational phase, including the detailed procedures, the necessary human and operational resources, designated responsibilities, the required training, estimated costs, and the schedule for implementation.
 5. Submit to IDB, in form and substance satisfactory to IDB, the Health and Safety Plan for the project's operational phase, including the detailed procedures, the designated responsibilities, the necessary human and operational resources, the required training, estimated costs, and the schedule for implementation.
- 8.6 During the life of the Loan Agreement, the Company must prepare and submit an Environmental and Social Compliance Report, in form and content acceptable to IDB. During Project construction and the first year of operations, the Company must prepare quarterly reports and the reports must be received by the IDB within the subsequent month. After the first year of operations, the report must be prepared annually and must be submitted within 60 days after the close of the Calendar Year.
- 8.7 The Bank will monitor the Project's environmental, social, and health and safety aspects via internal Bank supervision actions (e.g., site visits, review of documentation, etc.) and will contract an external independent environmental consultant to perform more detailed supervision/monitoring actions during project construction and first year of operation. In addition, the Bank will have the right, as part of the Loan Agreement, to contract for the performance of an independent environmental, health, and safety audit.

FIGURES

FIGURE 2-1 - Location



Source: Enron

NOT TO SCALE

LEGEND

- Industria del Alcalá property
- ① Selected Site
- ② Alternative Site
- ③ Industria del Alcalá

Figure 1 - Location of Proposed Site

TABLES

TABLE 3-1 - List of Main Environmental Regulations Applicable to the Project

Air Quality Regulations

NOM-041-ECOL-1996	Establishes maximum permissible levels for contaminating gas emissions produced by circulating motor vehicles that use gasoline as fuel.
NOM-043-ECOL-1993	Establishes maximum permissible levels for atmospheric emission of solid particles generated by fixed sources.
NOM-045-ECOL-1996	Establishes the maximum permissible levels of opacity for smoke coming from the exhaust of motor vehicles in circulation that use diesel or mixtures that include diesel as fuel.
NOM-050-ECOL-1993	Establishes the maximum permissible levels of emission of contaminating gases coming from the exhaust of the motor-vehicles in circulation that use as fuel petroleum liquid gas, natural gas or other liquid fuels.
NOM-085-ECOL-1994	This norm defines atmospheric contamination for fixed sources that use solid, liquid, or gaseous fossil fuels, or the combination of any of these. It also establishes the maximum permissible levels of atmospheric emissions of smoke, total suspended particles, sulfur dioxide and nitrogen oxides. The requirements and conditions for the operation of equipment with indirect heat combustion, as well as the maximum permissible levels of emission of sulfur dioxide from equipment with direct heat combustion are specified.
NOM-086-ECOL-1994	Atmospheric Contamination – Specifications for environmental compliance for fossil, liquid and gas fuels used by fixed or mobile sources.
NOM-020-SSAI-1993	Ambient Air Quality with respect to ozone (O ₃) for protection of the public health.
NOM-021-SSAI-1993	Ambient Air Quality with respect to carbon monoxide (CO) for protection of the public health.
NOM-022-SSAI-1993	Ambient Air Quality with respect to sulphur dioxide (SO ₂) for protection of the public health.
NOM-023-SSAI-1993	Ambient Air Quality with respect to nitrogen dioxide (NO ₂) for protection of the public health.
NOM-024-SSAI-1993	Ambient Air Quality with respect to total suspended particulate for protection of the public health.
NOM-025-SSAI-1993	Ambient Air Quality with respect to particles of less than 10 micros (PM ₁₀) for protection of the public health.

Water Quality Regulations

	Ley Federal de Derechos en Materia de Agua (Federal Law of Rights Related to Water)
	Ley Estatal del Agua (State Water Law)
	Ley de Aguas Nacionales (National Waters Law)
	Reglamento de la Ley de Aguas Nacionales (Regulations of the National Water Law)
CE-CCA-001	Ecological criteria for Water Quality.
NOM-CCA-001-ECOL/96	Sets the maximum permissible limits of contaminants in the discharges of wastewater into recipient bodies for conventional power plants.
NOM-001-ECOL-1996	Sets the maximum permissible limits of contaminants in the discharges of wastewater into national waters and assets.

Noise Emission Regulations

	Reglamento para la Prevención Ambiental Contra la Contaminación Originada por la Emisión de Ruido (Regulations for Environmental Prevention against Pollution Generated by Noise Emissions).
NOM-080-ECOL-1994	Establishes the maximum noise emission limits from motor vehicles, motorcycles, motorized tricycles and its measurement method.
NOM-081-ECOL-1994	Sets the maximum noise emission limits from fixed sources and methods of measurement.
NOM-080-STPS-1993	Work Environment –Industrial Hygiene. Defining of continuous sound level equivalent to the one the laborers of the work centers are exposed.

Flora and Fauna Regulations

	Ley Forestal (Forestry Law)
NOM-059-ECOL-1994	Specifies the Species and Subspecies that are identified as Rare, Threatened, in Danger of extinction, or subject to Special Protection between land and aquatic flora and fauna in Mexico.

Hazardous Wastes

NOM-052-ECOL-1993	Establishes the characteristics of hazardous wastes, and the lists and limits that identify this waste as a hazardous waste due to its toxicity to the environment.
NOM-053-ECOL-1993	Establishes the procedure to carry out the extraction test to determine the toxic substances that identify the waste as hazardous to the environment.

NOM-054-ECOL-1993	Sets the procedure to determine the incompatibility between two or more hazardous wastes classified as such by the Official Mexican Standards NOM-052-ECOL-1993.
NOM-055-ECOL-1993	Sets the requirements to be fulfilled by the sites dedicated to the controlled confinement of hazardous wastes, except radioactive wastes.
NOM-056-ECOL-1993	Establishes the prerequisites for the design and construction of the complementary activities of a controlled confinement of hazardous wastes.
NOM-057-ECOL-1993	Establishes the prerequisites that must be met for the design, construction, and operation of the units of a controlled confinement for hazardous wastes.
NOM-058-ECOL-1993	Sets the requirements for the operation of controlled confinement of hazardous wastes.
NOM-083-ECOL-1996	Requirements of sites destined for the final confinement of municipal solid waste.
NOM-002-STC2-1994	List of hazardous wastes and substances commonly transported.
NOM-003-SCT2-1994	For land transportation of hazardous materials and wastes.
NOM-005-SCT2-1994	Emergency information for the transportation of hazardous materials and wastes.
NOM-006-SCT2-1994	Basic aspects for visual inspections of the unit transporting hazardous materials and wastes.
NOM-007-SCT2-1994	Labeling of packages and recipients containing hazardous materials and wastes to be transported.
NOM-043-SCT2-1994	Loading document for hazardous substances, materials, and wastes.

Power Plants Environmental Related Regulations

DE-OESE-002	Ecological criteria for Site Selection and Preparation of Conventional Thermal Power Plants, as well as the construction and operation of these Systems.
NOM-113-ECOL-1998	Establishes the specifications of environmental protection for the plans, design, construction, operation and maintenance of high voltage electric energy substations or for distribution that are projected for their development in urban, suburban, rural, agricultural, and industrial areas, for urban equipping or of services and tourism.
NOM-114-ECOL-1998	Establishes the specifications of environmental protection for the plans, design, construction, operation and maintenance of electric transmission lines and of the electric substations that are projected for their development in urban, suburban, rural, agricultural, and industrial areas, for urban equipping, or of services and tourism.

Health and Safety Regulations

NOM-012-SSA1-1993	Health requirements for water supply systems developed for public and private human use and consumption.
NOM-048-SSA1-1993	Establishes the method for the evaluation of risks to health as a result of environmental agents.
NOM-056-SSA1-1993	Establishes health requirements of personal protection equipment.
NOM-127-SSA1-1994	Environmental health. Water for human use and consumption, permissible limits for water quality and treatment waters must be submitted to for potable use.
NOM-001-STPS-1993	Concerning safety and hygiene conditions of the buildings, areas, facilities and work areas.
NOM-002-STPS-1993	Concerning safety conditions for the fire prevention and protection in the working areas.
NOM-004-STPS-1993	Concerning the protection and safety device systems of the machinery, equipment, and auxiliary equipment in the working areas.
NOM-011-STPS-1993	Relates to the conditions of security and hygiene in the workplace.
NOM-016-STPS-1993	Concerning the safety and hygiene conditions in the working areas, with respect to ventilation.
NOM-017-STPS-1993	Concerning personal protection equipment for employees in working areas.
NOM-080-STPS-1993	Industrial Hygiene, Work Environment Determination of the equivalent continuous noise level, to which the workers are exposed in the workplace.

Other Regulations

	Ley Federal de Meteorología y Estandarización (Federal Law of Meteorology and Standardization)
NOM-034-ECOL-1993	Establishes the measuring methods to determine carbon monoxide concentrations in environmental air and the procedures to calibrate measuring equipment.
NOM-035-ECOL-1993	Establishes the measuring methods to determine the concentration of total suspended particles in environmental air and the procedure to calibrate measuring equipment.
NOM-037-ECOL-1993	Establishes the measuring methods to determine the concentration of nitrogen dioxide in environmental air and the procedure to calibrate measuring equipment.
NOM-038-ECOL-1993	Establishes the measuring methods to determine the concentration of sulphur dioxide in environmental air and the procedure to calibrate measuring equipment.
NOM-001-SEMP-1994	Concerning the facilities destined for the supply and use of electric energy.
NOM-008-SCFI-1993	General System for Measuring Units.

NMX-CC-001: 1995 IMNC	Management of the quality assurance, terminology (equivalent to ISO-8402: 1994).
NMX-CC-003: 1995 IMNC	Quality systems-model for quality assurance in the design, development, fabrication, installation and service (equivalent to ISO-9001: 1994).
NMX-CC-017: 1995 IMNC	Quality assurance requirements for measuring equipment. Part 1: system for checking measuring equipment (equivalent to ISO-10012-1: 1992).
NMX-CC-018: 1996 IMNC	Method for development of quality manuals (equivalent to ISO-10013: 1995).
NMX-CC-002/4: 1996 IMNC	Quality management – Part 4: operating safety (equivalent to ISO-90004: 1993).
NMX-CC-019: 1997 IMNC	Quality management-Guide for quality plans (equivalent to ISO-10005: 1995).
NMX-CC-007: 1993 SCFI	Guidelines for auditing quality systems. Part 1: Audits (equivalent to ISO-10011-1: 1991). Part 2: Management of auditing programs (equivalent to ISO-10011-3: 1991).
NMX-CC-008: 1993 SCFI	Qualification criteria for quality system auditors (equivalent to ISO-10011-2: 1991).

TABLE 3-2 - Emission Standards Applicable to the Project

Parameter	Mexican Regulation (a)	World Bank (b)
Sulfur dioxide (SO ₂)	NA	2.000 mg/Nm ³
Nitrogen oxides (NO _x)	261 mg/Nm ³ (c) (0° C, 15% O ₂) 2 (127 ppm)	125 mg/Nm ³ (d) (61 ppm)
Particulate	NA	50 mg/Nm ³ or >99% efficiency
CO		NA

(a) Mexican Regulation NOM-085-ECOL-1994

(b) World Bank's "Pollution Prevention and Abatement Handbook – Part III". Thermal Power – Guidelines for New Plants, 1998.

(c) NO_x concentration of the Mexican Regulation NOM-085-ECOL-1994 (375 ppm at 25° C, 5% O₂) converted to the Normal condition of the World Bank Guidelines (0° C and 15% O₂).

(d) For gas fueled combustion turbine units, dry at 15% O₂.

NA = There are no requirements for gas-fired power plant.

TABLE 3-3 - Noise Standards Applicable to the Project

Standard Mexican Regulations (a) (Perimeter Fix Sources Leq dB(A))		World Bank's Standards (b) (Industrial Receptor Leq dB(A))*	
Day from 6:00 to 22:00 hrs	68	Day From 7:00 to 22:00 hrs	70
Night From 22:00 to 6:00 hrs	65	Night From 22:00 to 7:00 hrs	70

(a) Norma Oficial Mexicana NOM-081-ECOL-1994

(b) World Bank's "Pollution Prevention and Abatement Handbook – Part III". Thermal Power – Guidelines for New Plants, 1998. The World Bank's guideline state that the noise levels on the receptors may not pass the established values or increase the existing level in more than 3 dB(A).

*There are only industrial receptors in the area (Industrial Zone), therefore only the standards for industrial receptors were considered.

TABLE 3.4 - Ambient Air Quality Standards Applicable to the Project

Parameter	Mexican Regulation (a)	World Bank (b)
Nitrogen dioxide (NO₂)		
Annual average	NA	100 µg/m ³
24 hours average	NA	150 µg/m ³
1 hour	395 µg/m ³	NA
Sulfur dioxide (SO₂)		
Annual average	79 µg/m ³	80 µg/m ³
24 hours average	341 µg/m ³	150 µg/m ³
Particulate (PM₁₀)		
Annual average	50 µg/m ³	50 µg/m ³
24 hours average	150 µg/m ³	150 µg/m ³

(a) Normas Oficiales Mexicanas de la Secretaría de Salud (Official Mexican Regulations of the Health Department)

(b) Thermal Power Guidelines for New Plants, 1998

TABLE 5-1 - Plant Emissions and Compliance with Mexican Standards and World Bank Guidelines

Pollutant	Emission concentration	Mexican Regulation (a)	World Bank (b)
Nitrogen oxides (NO _x)	67.7 mg/ Nm ³ (33 ppm)	287mg/Nm ³ (140 ppm)	125 mg/Nm ³ (Approx. 61 ppm)
Sulfur Dioxide (SO ₂)	21.35 mg/Nm ³	NA	2.000 mg/Nm ³
Carbon Monoxide (CO)	45 mg/ Nm ³	NA	NA
Particulate (PM10)	6.42 mg/ Nm ³	350 mg/ Nm ³	50 mg/Nm ³ or >99% efficiency

(a) Mexican Regulation NOM-085-ECOL-1994

(b) World Bank's "Pollution Prevention and Abatement Handbook – Part III". Thermal Power – Guidelines for New Plants, 1998.

TABLE 5-2 - Air Dispersion Modeling Results (NO₂, in µg/m³)

Pollutant	Averaging Period	Emissions as NO _x	Estimated NO ₂ Concentration	Mexican Standards	World Bank Guidelines
Combustion Turbine at capacity					
Nitrogen dioxide	1 hour	772	346 ^a	395	NA
	24 hours	193	77 ^b	150	150
	Annual	62	46 ^c	100	100
Auxiliary Boiler at 210 tons per hour					
Nitrogen dioxide	1 hour	271	271	395	NA
	24 hours	68	27 ^b	150	150
	Annual	22	16 ^c	100	100
Combustion Turbine (100% capacity) and Auxiliary Boiler (15% capacity)					
Nitrogen dioxide	1 hour	772 + 126	359 ^a	395	NA
	24 hours	193 + 32	90 ^b	150	150
	Annual	62 + 10	54 ^c	100	100
Auxiliary Boiler at Full Load					
Nitrogen dioxide	1 hour	295	295	395	NA
	24 hours	74	30 ^b	150	150
	Annual	24	18 ^c	100	100
Combustion Turbine (100% capacity) and Auxiliary Boiler (40% capacity)					
Nitrogen dioxide	1 hour	772 + 176	364 ^a	395	NA
	24 hours	193 + 44	95 ^b	150	150
	Annual	62 + 14	57 ^c	100	100

Note 1

(a) The Ozone Limiting Method was used to develop this concentration (269 µg/m³ plus 10% of NO_x).

(b) The combined impact was multiplied by a NO_x to NO₂ conversion factor of 0.40.

(c) The combined impact of was multiplied by a NO_x to NO₂ conversion factor of 0.75.

Note 2

Data provided by Dames and Moore.

TABLE 5-3 - Risk Prioritizing Criteria

PROBABILITY	DAMAGES	RISK LEVEL
Minimum (1)	Minor (1)	Minor (1)
Low (2)	Moderate (2)	
Average (3)	Severe (3)	
High (4)	Catastrophic (4)	Major (16)

TABLE 5-4 - Potential Emission Avoided by Installing Cogeneration

POTENTIAL EMISSION AVOIDED BY INSTALLING COGENERATION						
Technology Used		[2] Units of Fuel Consumed	[3] Emission Factor ^(a)	[4] Total Carbon Emissions	[5] Net CO ₂ Emissions	[6] Emission Avoided by Cogeneration
		TJ	ton C / TJ	Ton C	Ton CO ₂	(compared to other technologies)
Gas Cogeneration	30% less fuel	0.7	15.3	10.71	39.07	--
	10% less fuel	0.9	15.3	13.77	50.24	--
Natural Gas		1	15.3	15.3	55.82	10% - 30%
Fuel Oil Combustion		1	21.1	21.10	76.59	34% - 49%
Coal Combustion		1	25.8	25.80	92.71	46% - 58%

Notes:

(a) Data for emission factors were obtained from IPCC, 1996. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual, Volume 3.

Column 4 (Total Carbon Emissions) is the result of multiplying columns 2 (Fuel Consumed) and 3 (Emission Factor). Most of the carbon released to the atmosphere (over 99% of the total expressed in column 4) will react with oxygen and form carbon dioxide. The carbon emissions are finally converted to tons of CO₂ (column 5) emitted by using the molecular weight ratio of CO₂ to C¹⁹. A molecular weight of carbon dioxide and carbon is 44 and 12 respectively, therefore column 5 is obtained by multiplying column 4 by the ratio 44/12 and correcting for oxidized carbon.

The table shows that for every unit of coal burned (in TJ), 92.7 tons of carbon dioxide will be released. If instead fuel oil is burned, CO₂ emissions will reduce to approximately 76.6 tons per unit burned. Finally, every unit of natural gas burned will release 55.8 tons of CO₂. If a gas cogeneration plant is installed, CO₂ emissions can be as low as 39.07 tons per unit of energy burned. The difference in emissions between the cogeneration plant and the conventional natural gas plant lies in the fact that the cogeneration plant consumes less fuel, therefore its net emissions to produce the same level of usable energy are lower (as shown in column 5).

The last column presents the percentage emissions avoided by using natural gas in a cogeneration plant compared to other technologies. Emission reductions range from 10%-30% from using cogeneration instead of a traditional natural gas technology, up to 46%-58% when it is used instead of a conventional coal fired technology.

¹⁹ Molecular weight is defined as the sum of the atomic weights of all the atoms in a molecule. The atomic weight of carbon is 12, and the atomic weight of oxygen is 16, both of these compared with the hydrogen atom as a standard. In other words, when 12 grams of carbon react with 32 grams of oxygen, 44 grams of carbon dioxide are obtained. Therefore, every 12 tons of carbon released to the atmosphere can react with available oxygen and produce 44 tons of carbon dioxide.

TABLE 6-1 - Plant Wastewater Discharges Requirement (as per the Steam Purchase Agreement)

CONSTITUENT	REQUIREMENT (in ppm, except pH)
Calcium	106.1
Magnesium	0.0
Sodium	7550.2
Potassium	36.8
Bicarbonate	1,346.1
Carbonate	19.1
Chloride	9,175.0
Sulfate	68.5
Nitrate	0.0
PH	6.0 - 9.0
Silica Species Colloidal	13.8
Silica Species Reactive	13.8

TABLE 6-2 - Mexican Wastewater Standards for Effluents - Discharge on Surface Land (NOM-001-ECOL-1996)

PARAMETERS (mg/l)	DISCHARGE (on surface land) (Agriculture use)	
	Monthly Average	Daily Average
Oil and grease	15	25
Floating solids	Absent	
Arsenic	0.2	0.4
Cadmium	0.05	0.1
Copper	4	6.0
Chromium	0.5	1.0
Mercury	0.005	0.01
Nickel	2	4
Lead	5	10
Zinc	10	20

ANNEXES

ANNEX 1 - Summary of Relevant Required Authorizations

Authorization or requirement	Appropriate Mexican Governmental Authority	Estimated Time for Obtainment ²⁰	Responsible Party	Date
Registration of the deed of conveyance of the Site	Public Registry of Property	2 months	P	Completed
Registration of the deeds evidencing the rights of way for the gas pipeline and transmission lines	Public Registry of Property	2 months	P	Completed
Environmental Impact Authorization ("MIA")	SEMARNAP (INE)	8-12 months	P	Completed
Sole Environmental License	SEMARNAP	30 days	P	06/01/02
Annual Operation Card	SEMARNAP	15 days	O	02/01/03
Notification of the project to the INAH	INAH	2 months	C Construction	Completed
Notification of Commencement of Operations of the Gas Pipeline	CRE	15 days	P	07/31/02
Cogeneration Permit	CRE	3 to 4 months	P	Completed
Importers' Registry	SHCP	45 days	C	Completed
Customs and Import Authorizations	SECOFI/Customs	8 days	C	07/01/01
Notice of verification of hydrostatic tests	CRE	NA	C	07/31/02
Municipal Operation License	Ecology Department of the State of Nuevo Leon	3 weeks	C Construction	N/A
Land use license	Municipality	20 days	C Construction	Completed
Construction license	Municipality	20 days	C	Completed
Notification of Completion of the Construction	Municipality	3 days	C	06/01/02
Fire-Prevention Permit	Municipal Fire-Prevention department	3 weeks	C Construction	In Process

CRE	Energy Regulation Commission (<u>Comisión Reguladora de Energía</u>)
INAH	National Institute of Anthropology and History (<u>Instituto Nacional de Antropología e Historia</u>)
INE	National Ecology Institute (<u>Instituto Nacional de Ecología</u>)
SECOFI	Ministry of Commerce and Industrial Development (<u>Secretaría de Comercio y Fomento Industrial</u>)
SEMARNAP	Ministry of the Environment, Natural Resources and Fisheries (<u>Secretaría de Medio Ambiente, Recursos Naturales y Pesca</u>)
SHCP	Ministry of Finance and Public Credit (<u>Secretaría de Hacienda y Crédito Público</u>)

²⁰ Time counted from the date of admission of the permit application

ANNEX 2 - Summary of Air Dispersion Model

1. OBJECTIVES

The air dispersion model addresses specific air quality questions expressed by IDB and E2 for the development of the cogeneration power plant project in the industrial area of Garcia, Nuevo Leon, Mexico. IDB and E2 requested that the emissions from auxiliary boiler also be considered into the air dispersion model to verify compliance with the ambient air quality per the World Bank Guidelines and the Mexican Official Standards. The air dispersion model also addresses the net NO_x emissions in the area after the proposed new cogeneration (electric power/steam generation) project initiates its operation. When this project is operational, the adjacent facility *Industria del Alkali, S.A. de C.V.* (Alcali), a chemical process plant, will discontinue the operation of five existing steam boilers. The air dispersion model allowed the assessment of a Comparative Air Quality Analyses, which presents the emissions and predicted impacts of the auxiliary boiler (at full load) to those of the Alcali boilers and the emissions and predicted impacts of the combustion turbine, plus the auxiliary boiler, to the Alcali boilers.

1 DESCRIPTION

A screening-level air dispersion modeling analysis was conducted using the United States Environmental Protection Agency (USEPA) approved SCREEN3 air dispersion model to assess the potential environmental impacts due to airborne NO_x from the proposed project. The model was run in the regulatory default mode. The SCREEN3 model is a very conservative model, which utilizes hypothetical worst case meteorological conditions. If a modeled emission rate evaluated using this technique results in downwind impacts less than the applicable World Bank or Mexican guidelines or standards, then it is very likely that the actual air emissions impacts will be well below these guidelines and standards, and thus no further analysis should be necessary.

The SCREEN 3 model was selected for this modeling analysis based upon its ability to estimate maximum ground-level pollutant concentrations due to point sources such as power plant stacks. In the point source mode, the SCREEN 3 model can estimate maximum ground-level concentrations in both simple and complex terrain. It incorporates the effects of building downwash in simple terrain calculations. The simple terrain results from the model are estimated as maximum 1-hour concentrations, which may be compared to 1-hour averages or converted to other averaging periods using USEPA-approved conversion factors (listed in the previous Dames & Moore report of March 2000 of Appendix B). The complex terrain results are estimated as maximum 24-hour concentrations. Note: All 24-hour impacts from the SCREEN3 model were multiplied by a factor of 4x to convert to a maximum 1-hour concentration.

2.1 NO_x to NO₂ Conversion

Since the auxiliary boiler and the combustion turbines are natural gas fired (with low sulfur content -0.02%), the only pollutant of concern that results from this operation is Nitrogen Oxides (NO_x). In comparison, the emissions of other criteria pollutants such as suspended particles and CO are negligible. The regulated pollutant by the World Bank guidelines for natural gas-fired new thermal power plants and the Mexican standards is however the Nitrogen Dioxide (NO₂ ≡ NO_x – NO).

An important consideration for the evaluation of nitrogen dioxide (NO₂) ambient air quality impacts is the ultimate conversion of NO_x to NO₂. Most of the NO_x emitted from the turbine and

the boiler at the power plant is nitrogen oxide (NO). Some of this NO is converted to NO₂ by the time the plume reaches its maximum downwind concentration. The USEPA's Modeling Guidelines allow the use of a 0.75 NO_x to NO₂ conversion factor as a default screening value to estimate annual average ambient NO₂ impacts from a combustion source of NO_x. There are no United States short-term NO₂ standards; therefore, the USEPA has not established similar conversion factors for short-term NO₂ concentrations. The state of New Mexico, however, does have a 24-hour ambient air quality standard for NO₂. Accordingly, the New Mexico Air Pollution Control Bureau has developed a screening technique for estimating the 24-hour NO₂ concentrations from NO_x point sources. (*New Mexico Air Pollution Control Bureau, Dispersion Modeling Guidelines*). The technique allows a partial conversion rate of 40%, which is applicable only to the 24-hour average concentrations. The Ozone Limiting Method (OLM) more accurately assesses NO₂ concentrations; however, this method requires detailed ozone monitoring data, which are available from the Metropolitan Zone of Monterrey. The OLM is used to estimate the maximum one-hour NO₂ concentrations in the vicinity of the proposed power plant site. The OLM assumes that 10% of the NO_x in the stack exhaust is converted to NO₂ by thermal reactions and no further conversion by this reaction occurs, once the exhaust leaves the stack. The remaining 90% of the NO_x emissions are assumed to be nitric oxide (NO), and this NO can be converted to NO₂ in the presence of ozone, but only up to the extent of the maximum ozone concentration.

The SCREEN3 model was used to estimate the maximum ground level concentration of NO_x. A representative maximum ozone concentration is required to estimate the NO₂ concentration by the use of the following general equation:

$$[\text{NO}_2]_{1\text{-hour}} = (0.1) \times [\text{NO}_x]_{\text{pred}} + [\text{O}_3]_{1\text{-hour max}}$$

where:

$[\text{NO}_x]_{1\text{-hour}}$	is the predicted 1-hour NO ₂ concentration
$[\text{NO}_x]_{\text{pred}}$	is the model-predicted 1-hour NO _x concentration from the SCREEN model
$[\text{O}_3]_{1\text{-hour max}}$	is the maximum 1-hour ambient ozone concentration (269 ug/m ³ for the Monterrey area).

For the following analyses, the 0.75, 0.40, and the OLM NO_x to NO₂ ratios and methods will be used for the annual, 24-hour, and 1-hour concentrations, respectively.

3. AIR QUALITY SCENARIOS

The evaluation considered two operating scenarios in each of the two Phases of Operation as described below. SCREEN3, to assess the air quality impacts associated with operation of this equipment. The focus of this impacts analysis is for the pollutant of Nitrogen Oxides (NO_x). There is no representative background NO_x data in the project area, so the impacts presented are for the proposed equipment alone. Due to the conservative results of this modeling and the distance (approximately 13 kilometers) to the major Monterrey urban area, the background concentration at Alcalí would not likely cause the ambient standards to be exceeded since it should be relatively low. This analysis considers the applicable Mexican ambient air quality standards and the World Bank guidelines for ambient air quality. The impacts analysis only considers the operation of the above-described equipment. Actually, five existing Alcalí boilers will be idled as a result of the operation of this new equipment.

PHASES	SCENARIO 1	SCENARIO 2
Phase I Operations	Auxiliary Boiler at Full Load	Combustion Turbine (Base Load)/Auxiliary Boiler at 15% Load
Phase II Operations	Auxiliary Boiler at Full Load	Combustion Turbine/Auxiliary Boiler at 25% Load

The comparative air quality analysis was conducted by comparing two scenarios in two phases of operation, in terms of total tons per year of NO_x and maximum offsite air quality impacts (µg/m³). The two scenarios are presented below:

PHASES	SCENARIO 1	SCENARIO 2
Phase I Operations (Total steam production assumed to be 210 tons per hour; plant operational factor assumed to be 94% on an annual basis)	Comparing the emissions and predicted impacts of the auxiliary boiler (at full load) to those of the Alkali boilers	Comparing the emissions and predicted impacts of the combustion turbine, plus the auxiliary boiler, to the Alkali boilers
Phase II Operations (Total steam production assumed to be 235 tons per hour; plant operational factor assumed to be 94% on an annual basis)	Auxiliary Boiler at Full Load	Combustion Turbine/Auxiliary Boiler at 25% Load

For purposes of dispersion modeling, there is a downwash consideration. For the Alkali boiler stack, the nearby Alkali building with dimensions of 21.3 meters (70 feet) height, 30.4 meters (100 feet) length, and 35.0 meters (115 feet) width was the dominant structure used for purposes of downwash.

4. INPUTS

The Hidalgo G14C15 Mexican topographic map from the *Instituto Nacional de Estadística, Geografía e Informática* (1:50,000 scale) was used to supply terrain information for input to the model.

The Heat Recovery Steam Generator (HRSG), with dimensions of 28.0 meters (92 feet), 12.0 meters (39 feet), and 34.0 meters (112 feet), was the dominant structure for the combustion turbine downwash consideration.

The SCREEN3 model was run in the rural mode, which is appropriate for this location.

The combined air quality impacts for the combustion turbine and the auxiliary boilers were developed by running the SCREEN 3 model separately for each of these two sources, and then adding the impacts (as appropriate for each operating scenario) together for each of these sources.

A. Phase I Operations

Table 1 - Auxiliary Boiler Stack Characteristics

Description	Characteristic
NO _x Emission Rate	57.7 pounds per hour (0.09 pounds NO _x per MM BTU heat input and 63ppmvd @ 5% O ₂)
Height	40 meters (131 feet)
Diameter	3.05 meters (10 feet)
Temperature	446°K (343°F)
Velocity	13.61 meters per second (44.7 feet per second)

The following are the emission and stack characteristics for the combustion turbine/duct burners at full load and auxiliary boiler at partial load (about 15 % load; 40 tons/hr of steam production):

Table 2 - Combustion Turbine/Duct Burners Stack Characteristics

Description	Characteristic
NO _x Emission Rate	279 pounds per hour (about 60 parts per million NO _x)
Height	40 meters (131 feet)
Diameter	5.5 meters (18 feet)
Temperature	362°K (192°F)
Velocity	18.78 meters per second (61.6 feet per second)

Table 3 - Auxiliary Boiler Stack Characteristics

Description	Characteristic
NO _x Emission Rate	16.1 pounds per hour (0.09 pounds NO _x per MM BTU heat input and 63ppmvd @ 5% O ₂)
Height	40 meters (131 feet)
Diameter	3.05 meters (10 feet)
Temperature	446°K (343°F)
Velocity	3.4 meters per second (11.2 feet per second)

B. Phase II Operations: Scenario 1- Auxiliary Boiler at Full Load

The following are the emission and stack characteristics for the auxiliary boiler at 235 tons per hour steam production with 0 MW from the cogeneration facility:

Table 4 - Auxiliary Boiler Stack Characteristics

Description	Characteristic
NO _x Emission Rate	64.6 pounds per hour (0.09 pounds NO _x per MM BTU heat input and 63 ppmvd @ 5% O ₂)
Height	40 meters (131 feet)
Diameter	3.05 meters (10 feet)
Temperature	446°K (343°F)
Velocity	15.22 meters per second (49.9 feet per second)

C. Phase II Operations: Scenario 2 - Combustion Turbine/Auxiliary Boiler at 25% Load²¹

²¹ The SCREEN3 model was run separately for the combustion turbine and the auxiliary boiler and the impacts were added together to assess the impacts of this scenario.

The following are the emission and stack characteristics for the combustion turbine/duct burners at full load and auxiliary boiler at partial load (about 25 % load; 65 tons/hr of steam production):

Table 5 - Combustion Turbine/Duct Burners Stack Characteristics

Description	Characteristic
NO _x Emission Rate	279 pounds per hour (about 60 parts per million NO _x)
Height	40 meters (131 feet)
Diameter	5.5 meters (18 feet)
Temperature	362°K (192°F)
Velocity	18.78 meters per second (61.6 feet per second)

Table 6 - Auxiliary Boiler Stack Characteristics

Description	Characteristic
NO _x Emission Rate	26.2 pounds per hour (0.09 pounds NO _x per MM BTU heat input and 63 ppmvd @ 5% O ₂)
Height	40 meters (131 feet)
Diameter	3.05 meters (10 feet)
Temperature	446°K (343°F)
Velocity	5.52 meters per second (11.2 feet per second)

5. CONCLUSIONS

5.1 Air Quality Impacts

The following Tables show the results of the analysis under different scenarios:

A. Phase I Operations: Scenario 1- Auxiliary Boiler at Full Load

Table 7 -Auxiliary Boiler Air Dispersion Results

Averaging Period	Predicted Impact NO ₂ mg/m ³	Mexican Standard/World Bank GuidelinNO ₂ mg/m ³
1-Hour	271	395
24-Hour	27 ^a	150
Annual	16 ^b	100

a) The predicted impact of 68 µg/m³ was multiplied by a NO_x to NO₂ conversion factor of 40%.

b) The annual impact of 22 µg/m³ was multiplied by a NO_x to NO₂ conversion factor of 75%.

B. Phase I Operations: Scenario 2- Combustion Turbine (Base Load)/Auxiliary Boiler at 15% Load²²

Using the SCREEN3 air dispersion model, with accompanying terrain height data from a topographic map, the following impacts were produced:

Table 8 - Combustion Turbine/Auxiliary Boiler Air Dispersion Results

Averaging Period	Predicted Impact, NO ₂ mg/m ³	Mexican Standard/World
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²² The SCREEN3 model was run separately for the combustion turbine and the auxiliary boiler and the impacts were added together to assess the impacts of this scenario

	Turbine Boiler		Total	Bank Guideline, NO ₂ mg/m ³
1-Hour	772	126	359 ^a	395
24-Hour	193	32	90 ^b	150
Annual	62	10	54 ^c	100

* The Ozone Limiting Method was used to develop this concentration (269 µg/m³ plus 10% of 898 µg/m³).

* The combined impact of 225 µg/m³ was multiplied by a NO_x to NO₂ conversion factor of 0.40.

* The combined impact of 72 µg/m³ was multiplied by a NO_x to NO₂ conversion factor of 0.75.

C. Phase II Operations: Scenario 1 - Auxiliary Boiler at Full Load

Using the SCREEN3 air dispersion model, with accompanying terrain height data from a topographic map, the following impacts were produced:

Table 9 - Auxiliary Boiler Air Dispersion Results

Averaging Period	Predicted Impact NO ₂ mg/m ³	Mexican Standard/World Bank Guideline, NO ₂ mg/m ³
1-Hour	295	395
24-Hour	30 ^a	150
Annual	18 ^b	100

a) The predicted impact of 74 µg/m³ was multiplied by a NO_x to NO₂ conversion factor of 40%.

b) The annual impact of 24 µg/m³ was multiplied by a NO_x to NO₂ conversion factor of 75 %.

D. Phase II Operations: Scenario 2- Combustion Turbine/Auxiliary Boiler at 25% Load

Using the SCREEN3 air dispersion model, with accompanying terrain height data from a topographic map, the following impacts were produced:

Table 10 - Combustion Turbine/Auxiliary Boiler Air Dispersion Results

Averaging Period	Predicted Impact, NO ₂ mg/m ³			Mexican Standard/World Bank Guideline, NO ₂ mg/m ³
	Turbine	Boiler	Total	
1-Hour	772	176	364 ^a	395
24-Hour	193	44	95 ^b	150
Annual	62	14	57 ^c	100

*The Ozone Limiting Method was used to develop this concentration (269 µg/m³ plus 10% of 948 µg/m³).

*The combined impact of 237 µg/m³ was multiplied by a NO_x to NO₂ conversion factor of 0.40.

*The combined impact of 76µg/m³ was multiplied by a NO_x to NO₂ conversion factor of 0.75.

From the above results and the work developed in the March 2000 report, the following conclusions are drawn:

- It has been shown that the auxiliary boiler operating at full load, both in Phase I and Phase II, meets the applicable Mexican ambient air quality standards and World Bank ambient guidelines for NO_x;
- The combustion turbine/duct burners and the auxiliary boiler at partial load, in both Phase I and Phase II, meet the applicable Mexican ambient air quality standards and World Bank ambient guidelines for NO_x;

- (c) As shown in the above tables, there is also “room” for a reasonable amount of background source contributions to NO_x, such that when adding this proposed project to other sources in the area, the standards and guidelines should not be exceeded; and that is because: The wind regime in the area is such that the proposed project is upwind of most of the other existing sources in the area (which are a few in number); thus, the meteorology is favorable in this respect. Also, the other major sources in the general area have much taller stacks, on the order of 250-300 feet (at the glass manufacturing plant) plus higher exhaust temperature, and thus, the dispersion characteristics of these sources are such that they would likely not be additive to the proposed project maximum impacts. The reductions from the fact that the Alkali boilers will no longer operate further assures that the applicable ambient air quality standards and guidelines will not be exceeded;
- (d) The high efficiency and low emissions operation of the state of the art combined cycle combustion turbine/auxiliary boiler to produce electric power and steam should be considered a benefit when compared to the older, less efficient and higher emitting per MW equivalent of energy produced by the Alkali boilers;
- (e) It should be noted that the above analyses includes plant equipment which has not yet been purchased; thus, worst case emission rates have been presented. It is anticipated that actual emissions and thus impacts from the cogeneration facility, when operational, will be much improved from that which is now conservatively presented;
- (f) The results from the March 2000 air quality report and this report show that the air emissions from the combustion turbine and the auxiliary boiler will not exceed the maximum allowable in-stack concentrations established in the Mexican Official Standard, NOM-085-ECOL-1994 for this area as it is classified;
- (g) The results from the March 2000 air quality report and this report both show that the air emissions from the combustion and the auxiliary boiler will not exceed the maximum allowable in-stack concentrations established in the Mexican Official Standard, NOM-085-ECOL-1994 for a critical zone, should the Municipality of Garcia be included in the future as part of the Metropolitan Area of Monterrey;
- (h) The emissions from the combustion turbine and the auxiliary boiler will not exceed the maximum allowable in-stack concentrations established in the World Bank Guidelines for new Thermal Power Plants; and
- (i) Several sites were evaluated for placement of this new power plant, and the site in Vila de García was best suited from an air quality perspective based upon its upwind location from the Metropolitan Area and its proximity to the Alkali boilers.