SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

GNPOWER 2X600MW LNG-FIRED COMBINED-CYCLE

POWER PLANT PROJECT

IN THE

PHILIPPINES

April 2004

CURRENCY EQUIVALENTS

(as of 31 December 2003)

Currency Unit	–	pesos (PhP)
PhP 1.00	=	$0.018
$1.00	=	PhP 56.325

ABBREVIATIONS

AC	–	alternating current
ADB	–	Asian Development Bank
BOD	–	biological oxygen demand
BP	–	British Petroleum
CCGTT	–	combined-cycle gas turbine technology
CCR	–	central control room
CW	–	cooling water
DCS	–	distributed control system
DENR	–	Department of Environment and Natural Resources
DC	–	direct current
ECC	–	environmental compliance certificate
EIA	–	environmental impact assessment
EIS	–	environmental impact statement
EMB	–	Environmental Management Bureau
ESD	–	emergency shutdown system
HRSG	–	heat recovery steam generator
HVDC	–	high-voltage direct current
IEC	–	information education communication
LGU	–	local government unit
LNG	–	liquefied natural gas
LPOF	–	low pressure oil-filled
Meralco	–	Manila Electric Company
MMT	–	multipartite monitoring team
MOA	–	memorandum of agreement
NWRB	–	National Water Resources Board
PLC	–	programmable logic control
SEIA	–	summary environmental impact assessment
STS	–	sewage treatment system
TDA	–	United States Trade and Development Agency
Transco	–	National Transmission Company
TSP	–	total suspended particulate
US EPA	–	United States Environmental Protection Agency
US NFPA	–	United States National Fire Protection Association
XLPE	–	cross-linked polyethylene
WTS	–	wastewater treatment system

WEIGHTS AND MEASURES

°C	–	degree Celsius
μg/Nm^3	–	microgram per normal cubic meter
CO	–	carbon monoxide
dB(A)	–	decibel acoustic
DO	–	dissolved oxygen
kV	–	kilovolt
ha	–	hectare
hr	–	hour
km	–	kilometer
l	–	liter
l/hr	–	liter per hour
m	–	meter
m^2	–	square meter
m^3	–	cubic meter
m^3/sec	–	cubic meter per second
mg	–	milligram
mg/L	–	milligram per liter
mg/Nm^3	–	milligram per normal cubic meter
mm	–	millimeter
mps	–	meter per second
MW	–	megawatt
Nm^3	–	normal cubic meter
NO_x	–	nitrogen oxide
O_2	–	oxygen
PM_{10}	–	particulate matter 10 micrometers in diameter or smaller
sec	–	second
SO_2	–	sulfur dioxide

NOTE

In this report, "$" refers to US dollars.

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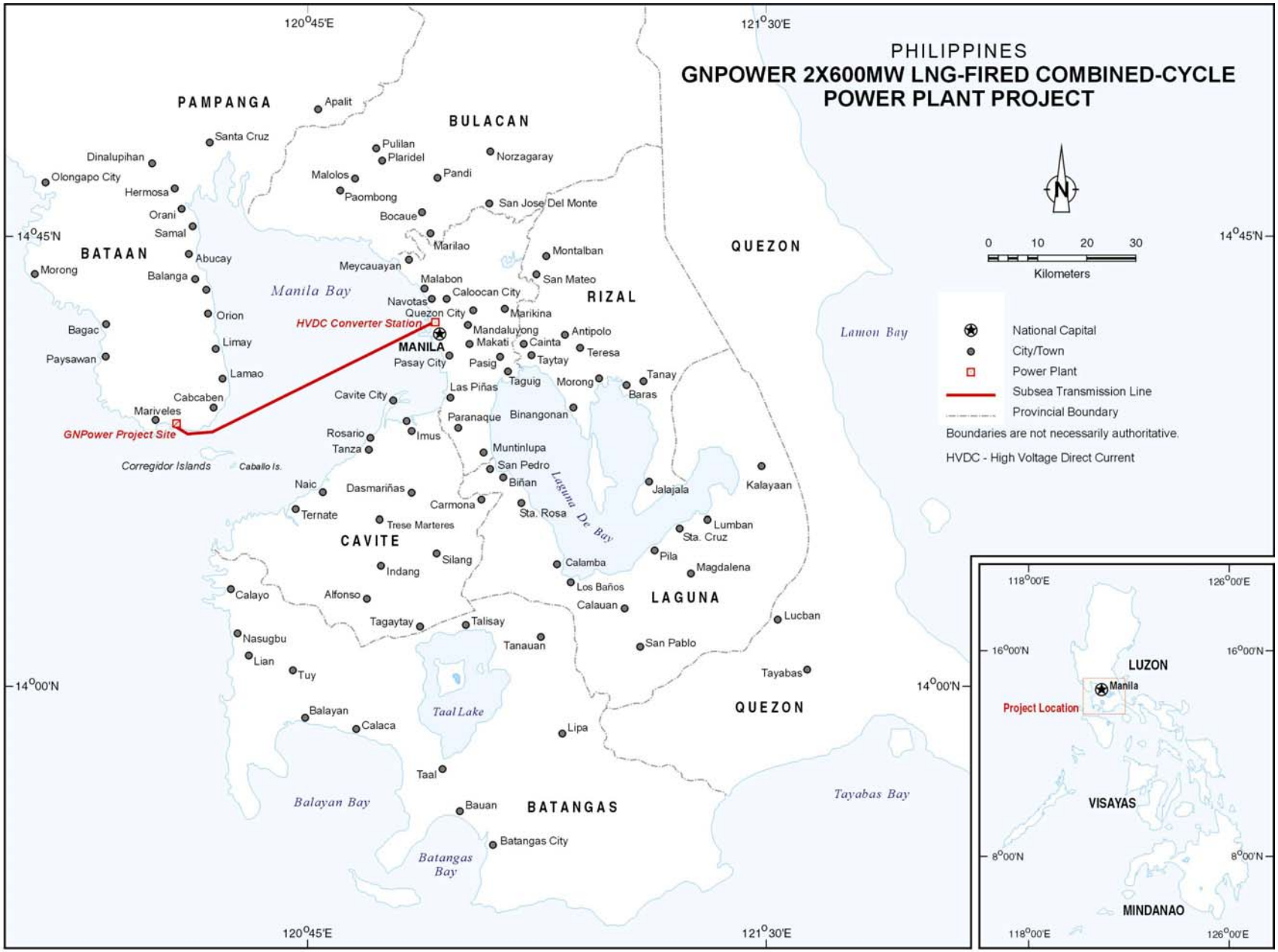

PHILIPPINES
GNPOWER 2X600MW LNG-FIRED COMBINED-CYCLE POWER PLANT PROJECT
120°45'E
121°30'E
14°45'N
14°00'N
PAMPANGA
BULACAN
BATAAN
QUEZON
RIZAL
CAVITE
LAGUNA
BATANGAS
MANILA
Apalit
Santa Cruz
Pulilan
Plaridel
Norzagaray
Dinalupihan
Olongapo City
Malolos
Pandi
Hermosa
Paombong
San Jose Del Monte
Orani
Bocaue
Samal
Marilao
Montalban
Abucay
Meycauayan
Morong
Balanga
Malabon
San Mateo
Manila Bay
Caloocan City
Navotas
Quezon City
Marikina
Orion
HVDC Converter Station
Mandaluyong
Antipolo
Bagac
Makati
Cainta
Limay
Teresa
Paysawan
Pasay City
Pasig
Taytay
Lamao
Taguig
Morong
Tanay
Las Piñas
Baras
Cavite City
Cabcaben
Paranaque
Binangonan
Mariveles
GNPower Project Site
Rosario
Imus
Tanza
Muntinlupa
Corregidor Islands
Caballo Is.
San Pedro
Biñan
Laguna De Bay
Jalajala
Kalayaan
Naic
Dasmariñas
Carmona
Sta. Rosa
Ternate
Trese Marteres
Lumban
Sta. Cruz
Silang
Pila
Indang
Calamba
Magdalena
Los Baños
Calayo
Alfonso
Calauan
Lucban
Tagaytay
Talisay
Nasugbu
Tanauan
San Pablo
Lian
Tuy
Tayabas
Balayan
Taal Lake
Calaca
Lipa
Taal
Tayabas Bay
Balayan Bay
Bauan
Batangas City
Batangas Bay
Lamon Bay
N
0 10 20 30
Kilometers
National Capital
City/Town
Power Plant
Subsea Transmission Line
Provincial Boundary
Boundaries are not necessarily authoritative.
HVDC - High Voltage Direct Current
118°00'E
126°00'E
16°00'N
8°00'N
LUZON
Manila
Project Location
VISAYAS
MINDANAO

04-0543 HR

I. INTRODUCTION

1. This summary environmental impact assessment (SEIA) report highlights the major findings of the environmental impact statement (EIS) for the 1,200-megawatt (MW) liquefied natural gas (LNG)-fired combined-cycle power plant and high-voltage direct current (HVDC) transmission system of GNPower Ltd. Co. (GNPower), which will be located in a 55-hectare (ha) coastal area in the town (*barangay*) of Alas-asin, Mariveles, Bataan.

2. The SEIA is being submitted to the Asian Development Bank (ADB) pursuant to GNPower's request for a loan and guarantees to fund the construction and commissioning of the first LNG project in the Philippines. The EIS for the project was prepared internally by GNPower with the assistance of two consulting firms—Tetra Tech EM, Inc. and GEOSPHERE Technologies, Inc.—and involved a number of highly qualified local and international experts.

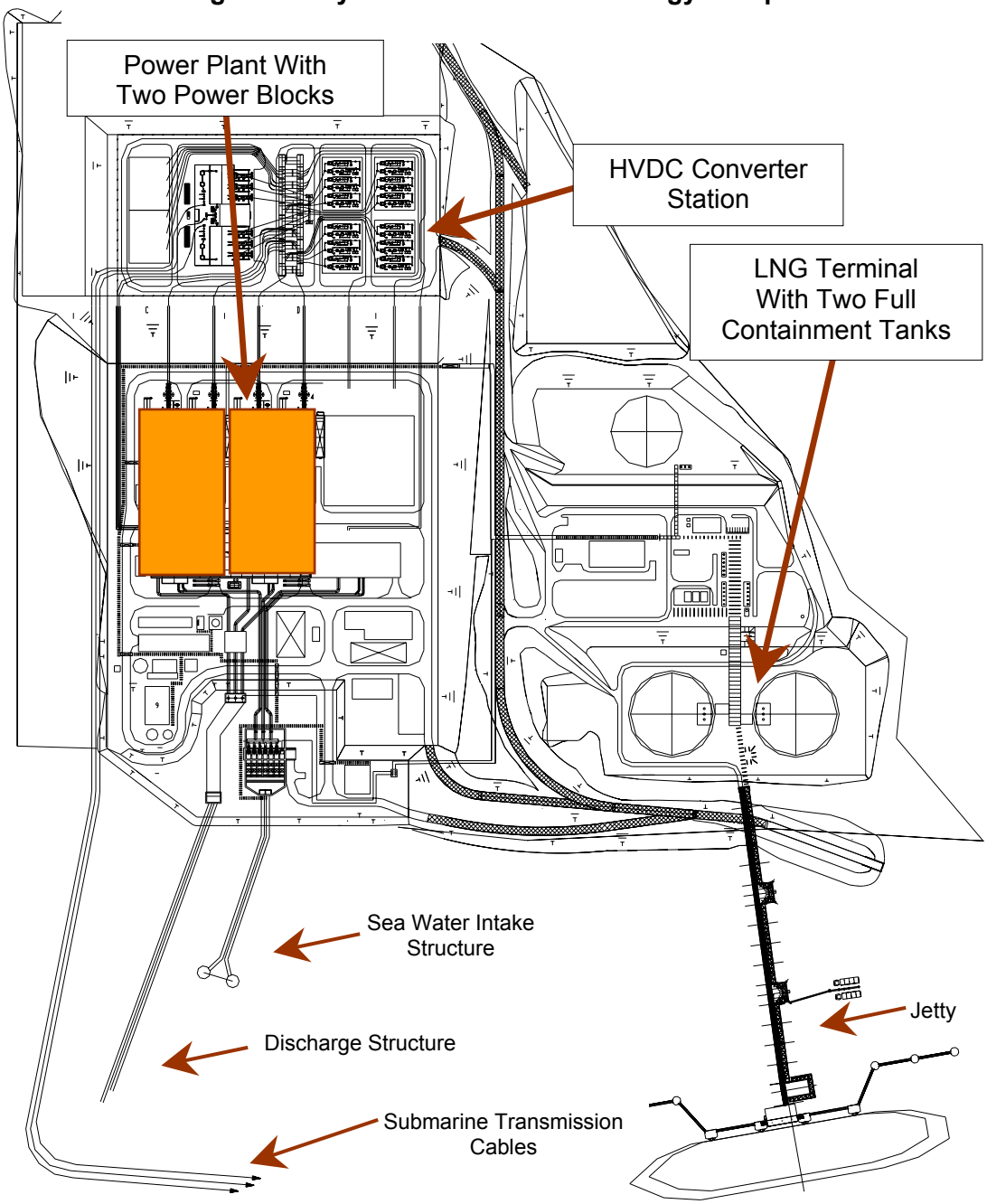
3. The results of the environmental impact assessment (EIA) were documented in June 2001. The EIS document was prepared according to the guidelines set by the Department of Environment and Natural Resources (DENR) pursuant to Administrative Order No. 37 Series of 1996 and submitted to the Environmental Management Bureau (EMB) on 11 July 2001. The DENR granted an Environmental Compliance Certificate (ECC) for the project on 24 April 2002.

4. ADB classifies the project under environmental category A, meaning that it may have significant impacts without appropriate mitigating measures. ADB has not endorsed or evaluated the EIS and the SEIA documents, which will be circulated to interested parties for comments and suggestions. ADB's evaluation of project impacts will include relevant comments and suggestions, which will be included in the loan document submitted to ADB's Board of Directors.

II. DESCRIPTION OF THE PROJECT

5. The project will be an energy complex with three primary components: (i) an LNG import and regasification facility, henceforth called the LNG terminal; (ii) a combined-cycle gas turbine (CCGT) power plant, henceforth called the power plant or generation facility; and (iii) an HVDC transmission system, henceforth called the HVDC transmission system. The project will provide generation capacity to the grid on the main Philippine island of Luzon by 2008, and will be an important component of the country's gas infrastructure, as indicated in the Philippine Energy Plan (2004-2013) of the Department of Energy, Philippines. The project could also provide natural gas to facilitate the conversion of the 600-MW CCGT Limay power plant, which is currently burning liquid fuel (bunker-C and diesel). A detailed layout of the Mariveles Energy Complex, showing the power plant, the LNG terminal, and the HVDC converter station is presented in Figure 1.

Figure 1: Layout of the Mariveles Energy Complex



HVDC = High Voltage Direct Current, LNG = Liquefied Natural Gas.

A. The LNG Terminal

6. The terminal consists of (i) one 300-m jetty, (ii) two 140,000-cubic-meter (m^3) full-containment LNG storage tanks, (iii) an LNG unloading system, (iv) a boil-off gas system, (v) an LNG vaporization system with three 120-metric-ton-per-hour shell and tube vaporizers, (vi) a thermal energy storage system with a 70,000 m^3 aqueous methanol storage tank, (vii) a back-up seawater-to-methanol-water heat exchanger, (viii) a 3.8-kilometer (km) gaseous methane accumulator along the access road, (ix) a flare system, (x) a fire water system shared by the

whole energy complex, and (x) the control and emergency shutdown system. Details of principal components are given below.

7. **LNG Storage Tank.** The LNG terminal includes two full containment LNG tanks with a net capacity of 140,000 m^3 each. Total usable storage capacity is 280,000 m^3. The LNG tanks are designed according to the US National Fire Protection Association Standard for the Production, Storage and Handling of LNG, (NFPA-59A), 2001 Edition, and other relevant international codes and standards.[1]

8. **Control and Emergency Shutdown Systems.** An integrated distributed control system (DCS) will be provided for the project, encompassing the power plant, the HVDC transmission system, and the LNG terminal. Emergency shutdown systems (ESDs) will be provided for the unloading area and the LNG storage and send-out area. The ESD will be functionally independent of the DCS system. All ESDs and subsystems will be capable of automatic initiation, by process point trip of hazard detection; and manual initiation, through hardwired push buttons in the designated control areas.

B. The Power Plant

9. The power plant consist of two power blocks, each made up of (i) two gas turbines with heat recovery steam generators (HRSG) and inlet cooling systems, (ii) one steam turbine, (iii) three generators, and (iv) three step-up transformers. The auxiliary systems shared by both power blocks consist of (i) the seawater cooling system with water intake and discharge structures, (ii) the water treatment facility, (iii) the wastewater treatment plant, and (iv) the control system.

10. **Combined-Cycle Gas Turbine Technology.** The project will utilize high-efficiency CCGT technology to generate power. The electricity will be generated at 16-18 kilovolt (kV) medium voltage, then increased to 230 kV with a generator step-up transformer.

The power will then be stepped up further by the converter transformer, then converted into +/- 500 kV direct current (DC) by thyristor valves for transfer through a submarine high voltage direct current transmission system to a receiving station in Manila. The DC electricity will then be converted back to an alternating current (AC) and stepped down to 230 kV to match the system requirements. The electricity will then be connected to designated Manila Electric Company (Meralco) substations via traditional AC lines.

11. **Emissions Control System.** Five continuous emissions monitoring systems (one system for each HRSG and one for the auxiliary boiler) will be installed to meet the DENR's guarantee air emission levels.

12. **Seawater Cooling System.** The power plant's steam condensers will use seawater for a once-through cooling system. Thermal modeling was performed using the Cornell Mixing Zone Expert System (CORMIX version 3.20) to design a discharge diffuser in order to minimize the size of the mixing zone—where temperatures exceed those of the surrounding waters by no more than 3 degrees Celsius (°C)—to DENR and World Bank standard (less than 100 m from point of discharge).

[1] The Philippine Government does not have safety standards for LNG at this time.

13. **Water Supply System.** During operation, an estimated 993 cubic meters per day (m^3/day) of fresh water will be needed for process and domestic water. The demineralized water treatment system shall be designed to treat the plant's raw water supply for storage and use as demineralized feed water makeup to the main steam cycle, the chemical feed system dilution water, and the gas turbine water wash systems; and to provide service water to the plant and fire protection system. Depending on the ambient air conditions, the dispatch of the generation facility, and amount of additional LNG the terminal regasifies, a significant percentage of the process water requirement could come from the condensation in the turbine air inlet coolers. Two alternate sources are the Export Processing Zone Authority dam, which is 6 km from the site, or a deep aquifer. The geologic study of the site indicates a possibility of aquifers with good water-bearing capacity at depths greater than 200 m. If a groundwater source is available, pertinent permits and approvals will be secured.

14. **Wastewater and Sewage Treatment Systems.** The function of the wastewater treatment system (WTS) is to treat (i) oily wastewater, such as fuel oil tank area drain and transformer area drain; and (ii) chemical waste, such as mixed bed polisher regeneration waste water and chemical area floor drain. The domestic sewage in the power plant will be directed to the sewerage treatment system (STS) and treated by aeration, sedimentation, and sterilization. The effluent will also be discharged into the CW discharge channel after conforming to the Philippines' and World Bank discharge limits.

15. **Fire Protection and Safety Systems.** The project will have a fire protection system that shall provide fire suppression and independent fire detection systems, standpipe and fire hose stations, a fire loop system, and portable fire extinguishers to protect the entire energy complex in the event of fire, excessive heat, or smoke.

C. HVDC Transmission System

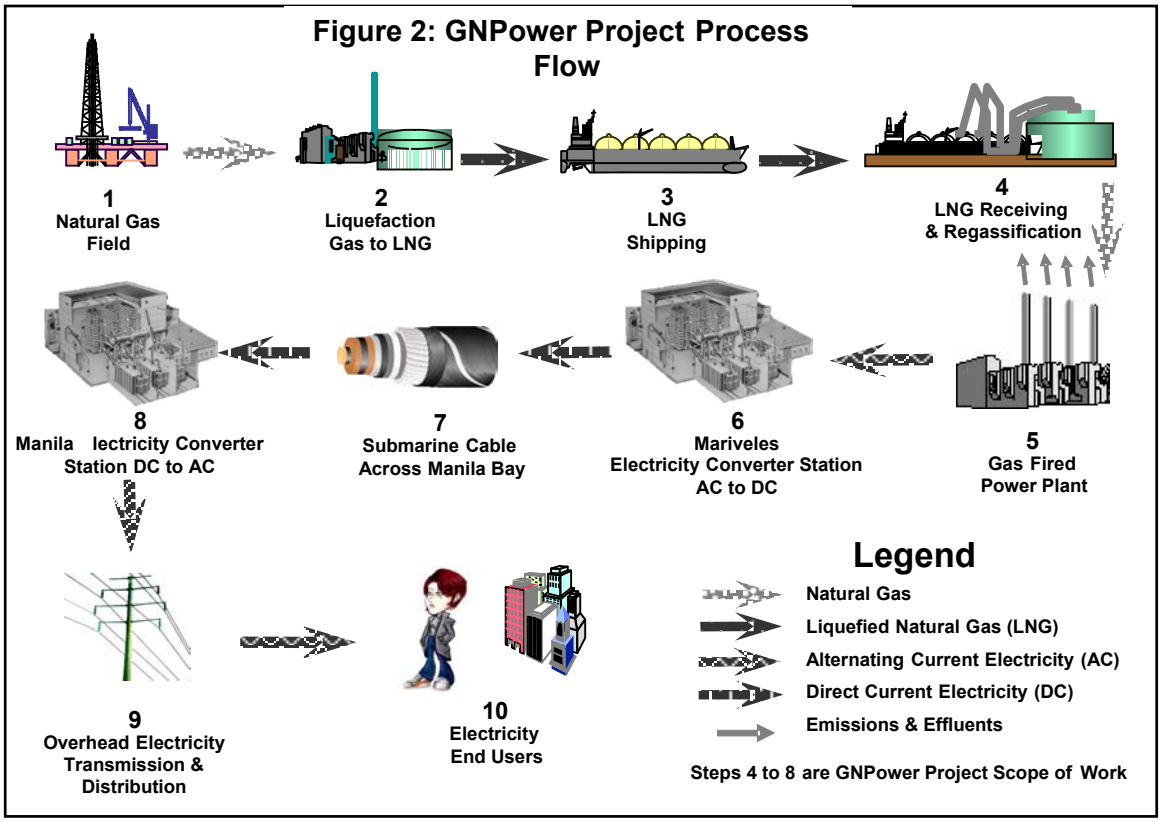
16. The transmission system consists of (i) two bipolar HVDC converter stations, (ii) auxiliary filter banks, (iii) a control system, (iv) two high-voltage, low-pressure, oil-filled (LPOF) marine cables, and (v) one low-voltage cross-linked polyethylene (XLPE) marine cable connecting the project site to Manila.

17. The power from the generation facility will be delivered through a bipolar HVDC transmission system with a peak rating of 1,600 MW. It will traverse Manila Bay to Manila Harbor Centre in Tondo, Manila. The transmission system will have two converter stations: one in Mariveles to convert the generated AC power to DC, and another at the Manila Harbor Centre to convert the transmitted DC power back to AC for delivery to the grid. The system will use at least three submarine cables. Two high-voltage DC cables will be used to transmit the power in bipolar mode and one low-voltage DC cable (neutral) would be primarily used for monopole operation if a high-voltage cable was damaged. The two high-voltage cables will be LPOF cables. The oil used (T3550) has a proven record in underground and submarine cables. It is insoluble in water and not classified as hazardous on the material safety data sheet. The low-voltage cable will be a XLPE cable with a copper conductor. A right-of-way will be marked on all nautical charts and reprints will be made available to the public.

18. **AC Route from the Manila Converter Station to the Meralco Substations.** The preferred power delivery scheme involves the construction of a Meralco substation in Manila Harbor Centre at Tondo, Manila and another at Katipunan, Quezon City. The AC power would be delivered at 230 kV to these new substations and to the existing substation at Paco, Manila. The process flow diagram in Figure 2 below shows the transition from natural gas to electricity

delivered to the end user. Indicated in the diagram is the scope of the GNPower project, from LNG in Mariveles to delivery of electricity in Manila.

Figure 2: GNPower Project Process Flow



III. DESCRIPTION OF THE ENVIRONMENT

19. The project is located within an industrial zone in a 55-ha coastal area of Mariveles, Bataan. The nearest built-up area is a fishing village composed of some 40 families, about 400 m east of the project site. The nearest developed industrial area is the Bataan Export Processing Zone. Its industries are about 6 km from the project site.

A. Physical Environment

20. **Climate.** The project area experiences a Type I climate, with two distinct seasons—wet from May to October and dry for the rest of the year. Average annual rainfall is about 2,105 millimeters (mm) with August, the wettest month, receiving a monthly average rainfall of 463.5 mm and February, the driest month, with an average of 5.5 mm. Annual average temperature is 28°C. April is the hottest month, with an average temperature of 33.4°C. January, the coldest month, has an average temperature of 23°C. Prevailing winds are northeast from November to January, southeast from February to May, southwest from June to September, and westerly in October. Average wind speed is about 3 meters per second (mps).

21. **Geology and Soils.** The geology of the site and its immediate environment is composed primarily of the Alas-asin pyroclastic flow deposits. The project site has a flat to moderate slope

of 2-5°. Relief is 80 m, with the highest point (80 m) at the northern apex of the project site. It is about 12-15 km from the present summit caldera rim of an inactive volcano, Mount Mariveles. The probability of unrest from the volcano is highly unlikely within the lifespan of the project. The soil type in the project area is the Antipolo soil, a member of the fine clay family.

22. **Hydrology and Water Quality.** The hydrologic settings of the project site and its immediate surroundings do not support a dependable source of surface water. All streams in the site's vicinity are dry during summer and exhibit low flows during the wet season, with discharge rates of 0.002-0.150 cubic meters per second (m^3/sec).

23. The water quality of the nearby Diguinin River is largely influenced by precipitation, which decreases its productivity with the dilution of nutrients during the rainy season. Some water quality parameters that exceeded DENR standards for Class C fresh surface waters were (i) lower dissolved oxygen (DO) at 3.8 milligrams per liter (mg/L) during summer; (ii) total dissolved solids exceeded twice the standard level of 1,000 mg/L during the dry season at the river mouth and estuary; (iii) oil and grease values for upstream at 2.8 mg/L during the dry season and all stations during the wet season with values ranging from 2.92–3.52 mg/L; and (iv) detected levels of lead at 0.091 mg/L at the river mouth during the dry season.

24. The project site is located in an area of local and less productive aquifers. The dug wells in the site's vicinity were found to have low flows, typically 0.1 L per second. The concentration values of the parameters obtained from a groundwater sample in the deep well were generally within the prescribed limits of World Health Organization standards and Philippines' national standards for drinking water.

25. **Oceanography.** Manila Bay is one of the most important bays in the country. The deepest part is at the mouth, where maximum depth is about 40 m. The depth gradually decreases towards the bay head and the shallowest areas are on the northeast of the bay, near Pampanga Bay. The tides in the bay are mixed-diurnal dominant.[2] The highest hindcasted significant wave height for the project site is 0.2423, with a wave period of 2.07, a speed of 3.26 mps, and an easterly direction. During typhoons and sustained southwest monsoons, wind wave heights along the Bataan coast are 2-3 m.

26. Vertical profiles of temperature and salinity against depth show that the bay water was more homogenous during dry season and had higher stratification during the wet season. Data shows that the high variability in the top 20 m of the waters suggests rapid exchange between the bay and the offshore waters. Coastal water is showing signs of pollution in terms of low DO levels (3.2 mg/L) during dry season, a high total Kjeldahl nitrogen value (3.7 mg/L), and elevated concentrations of heavy metals (lead levels average 0.46 mg/L throughout the year, and cadmium levels average 0.11 mg/L during dry season and 0.22 mg/L during wet season).

27. **Air Quality.** Based on an hourly sampling during dry season, air quality at the project site is typical of a rural environment: SO_2 and NO_x ambient concentrations are very low, and suspended particulate matter increases intermittently in some areas when winds pick up dust over unpaved roads and exposed surfaces. The sources of emissions come from vehicles plying the Roman Highway about 5 km from the project site. There are several industries located in the neighboring municipalities but they have not affected air quality at the site.

[2] Mixed-diurnal dominant tide consists of one high tide and one low tide per day. During neap tides, however—which occur during 1st and 3rd quarter moon—there are two high tides and two low tides per day.

B. Biological Environment

28. **Terrestrial Ecosystem.** Based on the floristic composition and existing land use, the terrestrial ecosystem of the project site and surrounding area is highly disturbed and degraded. It is predominantly grassland with strewn with shrubs and trees. There were about six plant species at the project site that are listed in the Convention for International Trade of Endangered Species as endangered or threatened. These are *tindalo* (Afzelia rhomboidea, 1 tree), *lanete* (Wrightia pubescens laniti, 3 trees), *molave* (Vitex parviflora*,* 2 trees), *bignay* (*Antidesma bunius,* 2 trees), *salingan* or (Crataeva religiosa*,* numerous trees) and *pandan dagat* or (Pandanus tectorius, the dominant species). The lone *tindalo* tree was burned when the northern portion of the area was razed by fire in January 2000.

29. These endangered species are fairly common in the Philippines' coastal areas, including the project site and nearby Corregidor Island, but they will be balled and replanted in a 1-hectare secondary forest that will be established in the northwest portion of the project site. Wildlife is dominated by birds. All resident wildlife at the project site is common and no species are endangered or threatened.

30. **Marine Ecosystem.** The marine environment is a disturbed because of rampant dynamite fishing. Up to 61% of the benthic life forms in the coastal waters of the project area and Corregidor Island are abiotics: nonliving ecosystem components such as rock and sand. There are no coral reefs, seagrass beds, or algal beds.

31. **Fresh Water Ecosystem.** The Diguinin River is a relatively pristine body of water as reflected in its phytoplankton communities. Its highest level of disturbance is at the estuary, because of the influence of rice fields and human settlements. Levels of phytoplankton, zooplankton, and benthic microinvertebrates suggest that the river is relatively unpolluted, in part because the river is not a fishing area and the open sea offers a more viable catch to the barangay's marginal fishermen.

C. Socioeconomic Environment

32. Bataan is considered industrial. Although Mariveles is predominantly agriculture (60%), it is home to the Bataan Economic Zone, Petrochemical Industrial Estate, Plastic City, Limay Power Plant, and many industries. As of 2000, the project host barangay had a total population of 4,265 with a population density of 4.09 persons/ha. As in the entire municipality, the prevalent causes of mortality are cerebrovascular accidents, heart disease, lung disease, and premature birth. Common causes of morbidity are acute respiratory infection and bronchitis.

33. The socioeconomic survey showed inadequate water, electricity, and health services. In particular, the fishing village of Barangay Alas-asin has no water connection, no electricity, no school (nearest school is about 3-4 km), no visitation had ever been made by medical staff from a rural health unit, and the majority of residents have no toilets (58% of population). A cursory survey of the plant site identified no archaeological or historical sites. There is no information to suggest that the area has any anthropological interest.

IV. ALTERNATIVES

A. No-Project Scenario

34. A “no-project scenario” was first examined. Without the project, power shortages would result in the areas served by the Luzon grid in 2008. A bleak scenario would be rolling brownouts and total blackouts, work stoppages, increases in pollution resulting from the use of small generators, reduced economic growth, increased poverty, and complete social inconvenience. Without the project, opportunity would be lost for 1,399 jobs for 3 years of construction, 119 permanent jobs during operation, and indirect jobs and business opportunities that the project would create. The substantial increase in local taxes and revenues, including the direct and indirect local benefits expected to accrue as a result of the project, would be foregone. The “no-project scenario” is not an attractive alternative.

B. Alternative Fuels

35. In view of the move towards cleaner energy sources and the need to diversify the Philippines’ energy supply mix, two alternative fuels were considered for the project: Orimulsion and LNG. Orimulsion is a new liquid fossil fuel consisting of about 70% bitumen (a naturally occurring heavy petroleum material) dispersed in about 30% water, plus small amounts of chemical surfactant (about 0.2% by volume) to prevent the two from separating. In recent years, this fuel has been proposed as a replacement for coal or heavy fuel oil in utility power plants throughout the world (United States Environmental Protection Agency (US EPA), 2001). Orimulsion is a possible replacement for heavy fuel oil because of its similarity in handling and combustion properties, and it is sold at a lower price per unit of energy than other liquid fuels.

36. Although Orimulsion meets environmental regulations through the use of proven state-of-the-art low emissions and environmental control technologies, it was evaluated the lesser option because of handling and procurement problems. An Orimulsion spill is much more difficult to contain and recover than a heavy fuel oil spill. There could also be procurement problems because Orimulsion would be imported from a sole supplier in Venezuela. The Bitumenes Orinico, S.A.—a subsidiary of the Venezuelan National Oil Company, Petroleos de Venezuela, S. A.—produces Orimulsion in the Orinico belt in Venezuela.

37. LNG was a superior alternative because it is the cleanest burning fuel, with least emissions per kilowatt-hour of electricity generated; it is odorless, nontoxic, and has very low level contaminant levels; it requires no environmental cleanup for spills; and there are no procurement problems.

C. Alternative Locations

38. Three potential locations were considered: the “Greenfield Site” in Limay, Bataan; the “Thai Site” in Cabcaben, Mariveles; and the “Alas-asin” Site in Alas-asin, Mariveles. Potential sites are all located along the coast, all within areas designated for industrial use, and all far from existing industries. These sites were examined and ranked on the basis of 22 criteria under the broad headings of engineering and/or technical, economic, and environmental.

39. The “Greenfield Site” would be the best for the transmission line owing to its proximity to the Manila Harbor Centre (about 43 km). However, the site has major disadvantages: (i) about 100 households living within 100 m of the site; (ii) the water is about 5 m deep at a distance of 500 m from the shoreline, making it less ideal for an LNG jetty and unloading facility; and (iii) the

project site cuts across the national highway to gain coastal access, meaning higher cost and a greater degree of difficulty in constructing the cooling system and the LNG pipes.

40. The “Thai Site” would only require about 47 km of transmission line to reach the Manila Harbor Centre, but it had limited availability of land for a buffer zone and expansion. With this site, it would become necessary to reclaim about 15 ha of coastal area to adequately accommodate the project. The closest residents—about 100 households—are approximately 200 m away.

41. The Alas-asin Site in Mariveles was the preferred site for the project because it was (i) isolated from populated areas; (ii) had no relocation or displacement issues (nearest residents, about 40 households, are approximately 400 m away); and (iii) water of about 15 m depth approximately 250 m from the shoreline.

D. Transmission System Alternatives

42. Meralco is expected to contract for the power from the project. As such, transmission solutions must transport the power to Meralco’s distribution grid. One possible transmission solution is to have the National Transmission Company (Transco) perform all transmission system upgrades necessary to connect and accommodate the power generated and transfer it to the Meralco grid. Transco would have to guarantee, and be willing to pay, liquidated damages equivalent to the capacity payments needed by GNPower for any delay in providing the required upgrades and necessary right-of-way issues in a timely manner. In return, Transco would charge an appropriate wheeling rate that would not disadvantage the project. Given the uncertainty surrounding the status of Transco's privatization, and the significant capital expenditures already programmed by Transco merely to maintain system reliability, GNPower considered it prudent to develop a viable alternative transmission solution.

43. A transmission system from the project site to a Transco substation, where GNPower would be paying both the Transco wheeling rate and the cost of the transmission system, is not economically viable. In order to be viable, a solution must rely solely on Transco or be directly connected to the distribution grid.

44. A direct-connect transmission solution that would connect GNPower to the Meralco distribution grid with minimal right-of-way issues, and have a wheeling rate similar or less than the Transco rate and enhance grid stability, is considered the most prudent solution. To achieve a direct connection, many options were evaluated. Combinations of submarine cables and overhead lines, as well as AC and DC solutions, were considered.

45. Based on many considerations—grid stability, reliability, redundancy, minimal right-of-way issues, predictable cost, and schedule—a submarine cable to North Port was the preferred option. The proposed three-cable link will use direct current cables under Manila Bay with a voltage of +/-500 kV, and transmission capacity sufficient for the 1,200 MW with one cable offline. The length, depending on the final route, will be approximately 55 km. The intended route will not pass through any protected areas.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Preconstruction and Construction Impacts

46. **Alteration of Topography.** The initial effect on the onshore topography will be dramatic: changes expected include land clearance, cut and fills, diversion of the creek, construction of power plant facilities, and installation of LNG tanks. The physical environment offshore will be altered, as well, with the construction of the jetty and loading facility.

47. **Preventive and Mitigation Measures.** Modification of topography is a residual project impact. To reduce the time impact and restore the aesthetic quality of the area, careful reshaping, landscaping, revegetation, and establishment of a 1-hectare secondary forest will be undertaken after construction is completed.

48. **Impacts on Hydrology.** The project site was not found to be prone to flooding. The existing topography practically isolates the site from the nearby Diguinin River and the Aguaguan Creek, which is about 1 km west of the project site. The hydrological study concluded that topographic changes from hydrological causes would likely be minimal, insignificant, and short-term because of the relatively small volume of water that flows through the site. The impact of the creek diversion on the area's overall hydrology will be insignificant because the creek conveys an average flow of 0.002 m^3/sec, lasting only a week after rainfall.

49. **Preventive and Mitigation Measures**. Measures will include scheduling of earthwork activities during the dry season, putting in place erosion control measures before grading the site, controlling surface runoff, ensuring suitability of cuts and fill slopes, and preventing siltation from reaching Manila Bay.

50. **Loss or Removal of Vegetation.** A site of approximately 55 ha of abandoned dryland pasture will be permanently lost to project development. The project will create unavoidable adverse impacts on the terrestrial ecosystem because of the destruction of grassland, tree clumps, and tree-shrub communities at the project site. Wildlife at the site will inevitably be driven out. Likewise, a portion of the coastal area will give way to the construction of the jetty and similarly destroy coastal vegetation. Resident fauna will be driven from the site during construction, but they will return when construction is complete.

51. **Preventive and Mitigation Measures.** The loss of vegetation is not considered significant. The shrubs and trees will serve as planting materials to create a new secondary forest, to stabilize bare and steep slopes of the banks of the rerouted waterway(s) and coastal cliffs, and to landscape the site. There will be no need to purchase planting materials for revegetation and landscaping. The project will secure permits for any trees to be cut.

52. **Reduced Water Quality.** During construction of the power plant, the LNG tanks, the jetty, the loading facility, and the submarine cable, local water quality will be subjected to a localized increase in turbidity as a result of earthmoving, dredging, and trenching. About 1 km along the coast is likely to be affected, based on the sediment transport modeling of Ekebjaerg and Justesen (1991). However, with appropriate control of soil erosion and increased runoff, it is unlikely that adverse impacts will occur further than 500 m from the proposed jetty construction and 500 m along the corridor of the submarine cable installations.

53. An oil spill from cargo vessels delivering construction materials is another possible impact. Heavy metal pollution from petroleum byproducts is also possible.

54. **Preventive and Mitigation Measures.** An erosion protection program will be developed to cover specific engineering, protective construction, and planting rules, as well as requirements in the terms of reference of construction companies. Major earthworks (site clearing and land cutting, filling, and grading) during construction will be scheduled to coincide with dry season as much as possible. During earthwork, temporary collector drains and interceptors will be provided to prevent accumulation of rainwater in low areas. Such discharges will not be allowed to drain down slopes unless measures are provided to prevent erosion.

55. **Oil Spill and Fire Risks.** The project will require a land base for stocks of fuel and other supplies for the marine operations. This can lead to spillage of fuel oil, lubricants, and other such substances. It also increases the risk of fire.

56. **Preventive and Mitigation Measures.** In order to prevent or reduce the risk of oil spillage and fire, the land-based storage will be properly designed and managed. The workforce will be required to implement good housekeeping practices on the marine vessels and especially at the land base. Since human error and neglect does happen, a contingency plan will be developed to deal with both fire and hydrocarbon spillage. These measures will form part of the document contract of all contractors involved in the project. [3]

57. **Smothering of Habitats and Benthic Organisms.** Dredging operations, improper disposal of dredged spoils, and trenching activity in cable-laying have the potential to smother the marine ecosystem. Smothering destroys the habitats and benthic organisms so that they cannot recolonize the new surface. However, the impact is assessed to be negligible inasmuch as there are no sensitive habitats or species in the coastal areas of Mariveles and the North Port. In addition, there will be less environmental impact of the cable installation in Manila Bay since much of the seabed is soft-sediment substrates. This substrate is preferred in cable-laying because burial is made simpler and faster through the use of plow-like devices or water jets. There would be no excavation, as is usually done on rocky and difficult seabeds.

58. **Preventive and Mitigation Measures.** Smothering of habitats and benthic organisms must be considered prior to implementation of an offshore project. One of the most effective means to mitigate this impact is to consider the location and sites of structures. As previously mentioned, there are no sensitive habitats and/or species to be affected in the nearshore area of the project site. The EIS affirmed previous studies of poor species diversity and low productivity along Mariveles waters owing to uncontrolled dynamite fishing in the North Channel.

59. **Increased Noise and Dust Emissions.** During the onshore construction phase, heavy trucks and earthmoving equipment will operate on the site and there will be a consequent production of increased noise and short-term fugitive dusts. Noise and exhaust emissions will result even during, dredging, trenching, and operation of the cable-laying vessel and attending vessels. Short-term, intermittent, construction-related noise will be localized because noise attenuates at a distance of about 240 m.

60. **Preventive and Mitigation Measures.** All heavy equipment, delivery trucks, vessels, and noise-generating equipment will be inspected and maintained to reduce noise and exhaust emissions. Use of noise suppressors or mufflers will be required for heavy equipment. Power

[3] There will be a main contractor for each of the primary project components. Contracts will be signed in which the contractor will be defined.

generators and compressors will be provided with enclosures. A speed limit will be imposed along roads in the project area to minimize dust. Unpaved roads will be watered twice a day.

61. **Accidents and Health.** The construction of onshore structures can produce construction-related hazards and health risks that can affect workers and nearby residents. However, since no high infrastructure is to be constructed, except for the heat recovery steam generator stacks and LNG storage tanks, there would be fewer physical hazards and less likelihood of accidents. However, health hazards may be anticipated if a temporary construction camp is constructed. This can be a source of health hazard in the project area in terms of improper disposal of waste and poor sanitation.

62. **Preventive and Mitigation Measures.** To prevent disease and accidents, contractors and their workers will undergo an environmental and safety briefing on safety, sanitation measures, and emergency rescue procedures before development begins. The project commits to hiring construction workers who come from and live in the surrounding community so there will be no need to build a workers' camp. In order to avoid or reduce the occurrence of diseases among its workers, the project will provide adequate sanitary facilities, potable water, and garbage bins. A "clean bill of health" will be required for incoming workers. Safety rules and regulations will also be implemented during construction. All workers will be required to wear protective gear and equipment that conforms to safety standards. Security of the project site will be imposed at all times.

B. Operational Phase Impacts

63. **Alteration of the Marine Habitat.** The jetty and loading facility will create a new habitat of different biological character. The submerged structures and wharf piles of the pier will have positive local biological impact because these can serve as artificial reefs for reef-dwelling invertebrates and fishes. There is also the likelihood for fishermen to get more fish because coastal areas along Alas-asin would be protected from blast-fishing and overfishing.

64. **Air Pollution.** The use of LNG will reduce adverse impacts of major emissions such as NO_x, SO_2, CO, and TSP. Very low emissions are expected from the plant since LNG is inherently a clean fuel. At turbine load regime of 60-100%, each stack will emit 1.7 milligrams per normal cubic meter (mg/Nm^3) of SO_2, 103-125 mg/Nm^3 of NO_x, 19-75 mg/Nm^3 of CO, and 5-15 mg/Nm^3 of TSP. These levels are considerably lower than the DENR's prescribed limits of 700 mg/Nm^3 for SO_2, 500 mg/Nm^3 for NO_2, 500 mg/Nm^3 for CO, and 150 mg/Nm^3 for TSP. The project does not produce any of the heavy metal toxics like mercury that are emitted by coal-fired power plants. Air quality modeling, using Trinity Consultants' breeze industrial source complex suite model, predicted ground level concentrations of SO_2, NO_x, TSP, and CO significantly below DENR and World Bank standards.

65. **Preventive and Mitigation Measures.** Although atmospheric emissions will not be a major concern for the project, continuous monitoring of the stack emissions and ambient air quality will be undertaken during operations. NO_x emissions will be controlled using a dry low NO_x combustor.

66. **Increase in Noise.** Although the project's operational noise will not affect residents, who live more than 800 m from the power plant, the plant will be designed so that ambient noise at the perimeter fence will not exceed DENR standards for heavy industry of 65 decibel acoustic (dB[A]) at nighttime, 70 dB(A) in the morning and evening, and 75 dB(A) during the day.

67. **Preventive and Mitigation Measures.** The project will be designed to meet DENR noise standards for a heavy industrial area. The site compound will be fenced off and planted with trees to further reduce noise. Silencers will be provided to steam-blowing equipment, and power plant enclosures will act as soundproofing.

68. **Reduced Water Quality.** The most significant impact on the environment is the discharge of untreated effluent into Manila Bay. Sanitary and domestic effluent in the waters will lead to the decrease of DO, increase in BOD, and an increase in nutrients near the discharge area. Possible oil spills and leaks during project operation could also have a potential negative impact on water quality and productivity. Marine impacts are expected to be localized and negligible because of the characteristic high turbulence, strong current, and water dispersion in the North Channel area. There are no sensitive habitats such as coral reefs or seagrasses in the coastal waters that may be affected by the project.

69. LNG spills have no impact on water quality because LNG is not toxic and does not contain any contaminants or pollutants. For this reason, there is no required environmental cleanup for LNG water spills.

70. The oil-filled submarine cables could be damaged and leak oil into Manila Bay. The oil (T3550) is chosen for its electrical stability and minimal environmental impact. It is nonsoluble in water and is not classified as a hazardous substance (no short-term acute hazards or long-term environmental hazards). If it is released into the sea, it will float to the surface and evaporate over time, leaving minimal environmental impact. For these cables, the worst-case flow rates for a damaged section have been calculated. The initial flow rate after damage will start at 600 liters per hour (L/hr), reducing to 15 L/hr by 48 hours until the repair crew can locate and cap or seal the damaged cable. The relatively short cable (55 km) and shallow water of Manila Bay (5-40 m) will allow for short location and repair time.

71. **Preventive and Mitigation Measures.** To prevent submarine cable damage, a survey will be performed to choose the safest route. A water jet will be used to bury the cables approximately 1 m as they are installed. A crew will be trained to patrol the cable route and educate the people in the vicinity regarding the cable. To mitigate the environmental impact of a damaged cable, the amount of time to locate and cap a damaged cable must be minimized. Electrical fault location equipment will be installed and used with acoustic detectors to locate any fault quickly and precisely. The project will also have trained staff for cable repair operations and the jetty tugboat will have modifications to facilitate rapid cable repair.

72. During operation, all process wastewater, domestic sewage, and contaminated runoff will be properly treated in the WTS, STS, and oil-water separator, respectively. These treatment systems will be designed, regularly inspected, and maintained to meet the effluent standards of the DENR for Class SC marine waters[4] prior to discharge into the North Channel. Shipping operations will include proper treatment and disposal of bilge water and domestic waste.

73. In order to avoid spills both in the plant complex and onshore, the project will comply with requirements to install an extensive system to detect LNG spills, including gas detectors,

[4] Class SC marine waters support three beneficial usages: recreational water class II, fishery water class II, and mangrove areas declared as fish and wildlife sanctuaries. Effluents from domestic sewage and industrial wastewater treatment plants, when discharged into this class of marine water, should comply with standards for toxic and other deleterious substance, as well as standards for conventional and other pollutants.

fire detectors, smoke or combustion product detectors, and low-temperature detectors. These sensors are equipped with automatic valve and machine shutdown that isolate the spill and shut down equipment. It will also implement strict operational procedures and practices.

74. **Thermal Pollution.** The discharge of heated water can elevate seawater temperature and this can affect fish larvae and other minute organisms near the outfall. However, impact is predicted to be localized and insignificant. The twin-pipe outfall with six diffuser nozzles is efficient, as demonstrated by plume centerline temperatures that fall below the mixing zone limit in all cases of different maximum tidal velocity before discharged water reaches the surface. DENR standards require that the temperature increase outside the mixing zone—the area where the initial mixing and dilution of the heated water takes place—should not be more than 3°C. When the mixing zone is not defined, the World Bank standard prescribes 100 m from the point of discharge when there are no sensitive aquatic ecosystems within the distance.

75. Results of the thermal dispersion modeling using CORMIX Version 3.20 show that the strong dilution of the currents quickly brings the plume temperatures below 3°C above the ambient within 0.52-33.91 m of the outfall. By the time the plume spreads to the shoreline about 700 m downstream of the outfall, the maximum warming will have decreased to about 0.45°C. There are no highly valued ecosystem components that may be harmed by the warm water.

76. **Increase in Biodiversity.** The undeveloped portion of the project site, particularly northwest of the project site, will be earmarked for ecological restoration, reforestation, landscaping, and open space. Revegetation will compensate habitats lost during construction and have a positive impact on wildlife. The displaced and new wildlife from surrounding areas are expected to move into the manmade forest and increase biodiversity in the project site.

77. **Entrainment and Impingement of Organisms.** The draw-in velocity of seawater cooling intake can lead to entrainment or capture of marine organisms such as plankton, fish eggs, larvae, and invertebrates. The likelihood of entrapment is especially high during invertebrates' peak reproduction period, usually during the wet season.

78. **Preventive and Mitigation Measures.** To reduce entrapment of macromarine organisms in the intake structure, the heads of the intake pipes will be designed with large-screened surface areas to maintain inflow of less than 30 centimeters per second. The project will employ velocity caps that would reorient flow patterns to serve as a behavioral barrier and onshore screens that would provide a physical barrier to organisms able to enter the intake. It will also enforce frequent cleaning of the pipe so as to avoid obstructions, which can reduce the pipe diameter and increase intake velocity.

79. **Control of Biological Growth at the Intake Structure.** The major operational problems for power plants are the establishment of biological communities on the intake and discharge structures and microbial fouling of condenser tubes, so the proliferation and growth of these communities will be inhibited or controlled through the use of an electrical hypochlorite generation system. This is a system that converts the sodium chloride (salt) in seawater into sodium hypochlorite, a safe but potent biocide.

80. **Preventive and Mitigation Measures.** To inhibit biological growth in the seawater cooling system and to avoid any adverse impacts, the project will comply with DENR and World Bank standards. World Bank prescribes a maximum value of 2 mg/L for up to 2 hours—not to be repeated more frequently than once in 24 hours—with a 24-hour value of 0.2 mg/L (World

Bank Group, 1998). A sensor mechanism will be installed to control dosage at the intake that would limit the sodium hypochlorite level.

81. **Safety Hazards.** Safety is the major environmental concern for the project. For this reason, an extensive assessment of risks was undertaken during the EIA. A hazard analysis showed that the thermal radiation flux that would be generated in the unlikely event of catastrophic failure of the LNG tank would be confined to the site itself. There is no risk of explosion or fire for LNG since it is stored at cryogenic temperatures and is not stored under pressure. Should an LNG leak result in a gas vapor cloud, it will not explode because of the fuel's low laminar flame.

82. **Preventive and Mitigation Measures.** There are three effective means to mitigate the risks identified for an LNG terminal. One is to consider the alternative locations. The proposed location of the energy complex on the coastal area of Barangay Alas-asin completely isolates it from communities and industry. The project site has an adequate buffer zone so that hazard zones produced by the environmental risk assessment models are within the limits of the property. It is also devoid of ecologically sensitive habitats. Another measure to avoid and reduce risks is to design and construct facilities to meet international standards. The storage tanks, piping system, vaporizers, and other structures will be designed according to US NFPA 59A standards. The project will include safety features developed through years of global experience operating LNG projects: (i) the fire protection system, (ii) hazard detection and emergency shutdown, and (iii) emergency procedures and natural gas flare.

83. **The Impact of Dynamite Fishing on the Submarine Cable.** Stakeholders raised a concern about the impact of dynamite fishing on the cables. The impact on the cable depends on its proximity to the explosion. This is the primary reason for burying the entire length of the cable during installation. To protect the cables, they will be buried 1-1.5 m below the sea floor. Burial would minimize the likelihood of damage from dynamite fishing, storms, fishing gear, and anchorage. A regular patrol of the jetty area and the submarine cable route would discourage most dynamite fishing. The project will also consider dynamite fishers for priority employment. It will also include the adverse impact of dynamite fishing as relevant information in the information education communication (IEC) program.

84. **Decrease in Aesthetic Value.** The project will be visible from the Roman Highway, the residential areas north of the project, the fishing village, and Corregidor Island. Passengers on ferry boats in the North Channel will also be able to see it. The visual impacts of the jetty, the LNG tanker, the smoke stacks, and the LNG tanks are considered significant, but viewers are expected to become accustomed to the new landscape over time. The project site will be buffered and screened as much as possible by planting indigenous trees, especially on the east and west boundaries of the site. The site will be extensively landscaped and a 1-hectare secondary forest will be established northwest of the project site.

C. Abandonment or Decommissioning Impacts

85. **Improved Air Quality.** If the plant were abandoned, air quality would improve because of fewer pollutants and less noise. In the event of demolition, particulate matter is expected to increase, but only temporarily.

86. **Improved Biodiversity.** After the useful life of the project, the manmade forest would have developed. It would contain a variety of forest plants and birds. The project commits to

retaining the forest for conservation and biodiversity. Abandonment of the project will conform to the requirements of the local government, DENR, and other relevant agencies.

87. **Contaminated Soil.** Soil contamination may be possible even long after a project is abandoned. This is a result of fuel leakage, spills, and improper disposal of waste during operation. Possibility of soil contamination will be assessed through a soil-testing program, especially in the vicinity of storage areas. If positive for contamination, the area will be subject to remediation or decontamination. Toxic or hazardous materials remaining in the site will be collected along with the contaminated soil for appropriate disposal. An accredited treater or transporter will be contracted to undertake the required treatment and proper disposal.

88. **Disposal of Demolition Waste.** Poor management of wastes can lead to visual and aesthetic problems, as well as health and ecosystem impacts from possible contamination of land and water. The project commits to emphasizing management of demolition and solid wastes, especially hazardous ones. The project will implement an integrated solid waste management during demolition where the approach of handling wastes will be through (i) waste segregation into recyclables and nonrecyclables, (ii) reuse or resale of recyclables, and (iii) collection and proper disposal of nonrecyclables in approved landfill sites. The disposal of hazardous wastes by an accredited contractor will follow DENR requirements.

VI. ECONOMIC ASSESSMENT

A. Project Costs

89. **Capital Costs.** The distribution utility is expected to undertake a competitive energy supply procurement process before awarding the long-term supply contract. Project sponsors must maintain confidentiality with respect to project costs and tariffs until solicitation is concluded. Given the project's low capital costs, achieved through competitive selection and direct negotiations with contractors for each of the major project components, the price of energy and the project capacity are expected to be extremely competitive with the Philippines' current largest coal and natural gas power plants. The project's fuel supply, which can account for as much as 50% of total cost of generation, was competitively bid in 1999 and went through extensive screening negotiations, resulting in a significantly lower price and greater delivery flexibility than the original supply proposals.

90. **Operating and Energy Costs.** Operating and maintenance costs, including administrative expense, are expected to average $87 million on an annual basis. Fuel costs, including import duties and tariffs, could peak at $365 million per year, depending on the final fuel indexation formula and market conditions.

B. Project Benefits

1. Quantifiable Benefits to Host Community

91. Given the project's estimated average annual net generation capacity, taxes—including income taxes and other duties—could average as much as $100 million per year. In addition to the basic business taxes, Philippine energy regulations require generation companies to set aside an amount for the direct benefit of the host community. Given the current project size, the amount is estimated at $29 million over an assumed 15-year period.

2. Indirect Benefits

92. **Employment.** The project intends to employ about 1,399 people during construction, 1,350 of which are estimated to be local hires. Priority will be given to qualified persons from the host community, followed by nearby communities then Bataan province in general. These people cannot be given permanent jobs since construction will only last 38 months, but skills gained through project training programs and actual job experience will make them highly employable once their contracts expire. Fewer people will be needed during operation and abandonment, and qualified locals will be hired then as well.

93. **Material and Supplies.** Construction materials and supplies will be sourced from local communities and nearby towns when available at the required specifications. The existence of a quarry in the area makes it convenient for the province to supply gravel and sand, further increasing economic activity in the area. Preliminary estimates indicate that the province can provide up to 2.5% of the construction materials and supplies.

C. External Environmental Economic Costs

94. The site is basically barren, zoned as industrial land, so there is minimal opportunity cost in terms of loss of agricultural production or recreational value. There is absolutely no relocation involved in securing the site, therefore no relocation cost. Private individuals who are not ranchers own the project site and the surrounding properties up to the Roman Highway. Since the project area is completely isolated and devoid of development, there are no residents or property at risk in the unlikely event of an LNG fire. Even the alignment of the submarine cable route would not entail losses to the aquaculture production or recreational income.

VII. ENVIRONMENTAL MANAGEMENT PLAN

95. GNPower is committed to minimizing any adverse impacts that could arise from the construction, operation, and decommissioning of the project. To achieve this, an environmental management plan (EMP) was formulated to manage impacts, to adopt the best available proven control technologies and procedures, to ensure a continuing process of review and positive action in the light of available monitoring results, and to consult with local communities on a continued basis. An environmental and safety officer will be hired to oversee implementation of the EMP, the environmental monitoring program, and compliance with ECC conditions. He or she will closely coordinate with the plant general manager, the management staff, and the multipartite monitoring team (MMT).

96. The EMP will aim to achieve an exemplary environmental performance during construction, operation, and decommissioning. To meet this goal, the following activities, measures and programs will be implemented: (i) GNPower's environmental policy; (ii) application of all mitigation and management measures; (iii) an environmental monitoring program; (iv) a social development program; (v) an LNG terminal facility in conformance with the US NFPA 59A; (vi) an emergency and contingency plan; (vii) an IEC plan; (viii) an institutional plan, and (ix) an environmental and safety officer.

97. To carry out GNPower's environmental policy, the project commits to regularly evaluating the environmental impacts of power plant, terminal, and transmission line throughout construction and operation, and to maintaining good communication and relations with local communities.

98. The project will also issue work instructions and controls to define the manner in which activities may be conducted, as well as inspection procedures to ensure application of mitigation measures. Documentation of the supervision and monitoring results will test the effectiveness of mitigation measures and impact controls. The project will inform the community and the local government about its environmental policies and program through its IEC program.

99. Environmental monitoring is an important component of the EMP. It provides the information for periodic review and refinement modification of the EMP as necessary, ensuring that environmental protection is optimized at all project phases. Through monitoring, unwanted environmental impacts are detected early and remedied effectively. It will also validate the impacts predicted in the EIS and the effectiveness of the proposed mitigation measures. Lastly, it will also demonstrate compliance with regulatory requirements.

100. A comprehensive monitoring program for the plant complex and the submarine cable has been developed, covering the measurement of relevant environmental indicators. At the plant, it will involve noise, safety concerns, site drainage, cooling water discharge, solid waste and wastewater disposal, groundwater abstraction, and structural integrity of the tanks and buildings. For the jetty and submarine cable, it will include water quality, safety issues, and marine biota, including wharf communities. The results of the monitoring program, which will be implemented by the MMT to be created for the project, will be used to optimize plant operations and adjust to management practices.

101. In the event that monitoring indicates that any environmental quality is deteriorating to unacceptable levels, the proponent will correct operation procedures that are contributing to the problem and/or undertake necessary engineering installations. Appendix 1 shows the project's main environmental requirements. The EIS summary matrixes for the EMP and the environmental monitoring program are provided as Appendix 2 and Appendix 3, covering preconstruction to abandonment.

102. The proposed initial environmental monitoring fund for the project amounts to $7,000. This is replenished regularly based on the annual monitoring work and financial plan approved from time to time by the MMT. The proposed environmental guarantee fund for the purpose of immediate rehabilitation of areas damaged as a direct consequence of the project—and for just compensation of parties and communities affected by the negative impacts of the project—amounts to $222,000 with the following breakdown: (i) an environmental guarantee cash fund of $44,000 (replenishable when the amount goes below $18,000); and (ii) an environmental guarantee trust fund of $178,000 (replenishable when the amount goes below $89,000).

VIII. PUBLIC CONSULTATION AND DISCLOSURE

103. Consultation with various local stakeholders started early, during prefeasibility in July 2000. GNPower made early contact with the Government; first, with local government units at all levels, then environmental authorities—the EMB and the DENR—and other relevant government agencies. Early meetings with government agencies were to ensure dissemination of advance information about the project.

104. Intensive information dissemination started in early January 2001 to prepare the local community for a formal scoping meeting on 10 February 2001. Meetings were also undertaken with key stakeholders and various concerned agencies to give an initial overview of the project.

The project distributed brochures highlighting the project and its components to the host barangay and surrounding Barangay Sisiman, Barangay Mountain View, and Barangay Baseco.

105. On 27 January 2001, a general meeting with the local governments and local community was conducted at the barangay hall of Barangay Alas-asin to discuss the project and to brief the stakeholders about the EIS system. The total number of participants was 75. The formal scoping with the stakeholders was held on 10 February 2001, also at the barangay hall of Barangay Alas-asin. A total of 56 stakeholders participated in the scoping process.

106. The EMB conducted a public hearing for the project as part of the EIA process on 8 September 2001 in the same venue. Newspaper announcements were published in the Bataan Journal newspaper (6-12 August 2002) and the Malaya newspaper (15 and 30 August 2001). More than 50 people attended.

107. The scoping technical requirements of the EMB and the review committee—as well as the issues and concerns of the local people during the formal scoping and public hearing—were integrated in the EIA and the preparation of the EIS. The stakeholders' consultation influenced the project planning through the following design changes: (i) use of the full containment for LNG storage, (ii) redesigning of the seawater discharged pipes with the six diffuser nozzles to reduce the area of the mixing zone to 60 m in diameter, and (iii) the use of LNG as the sole fuel

108. Social acceptability for the project was manifested through (i) written endorsements by local governments, from the barangay to the Office of the House of Representatives, (ii) the passage of subsequent resolutions by all local governments, and (iii) the results of the EIA social perception survey showing an overwhelming support (80%) for the project and its siting.

IX. CONCLUSIONS

109. The project is indispensable in view of the forecasted energy shortage in Luzon by 2008. The impact on the social environment is positive given the job and business opportunities created for local residents and the substantial taxes and revenues from the project. The project will help the municipality and the province realize their aim of industrialization, accelerating socioeconomic growth, and improving quality of life.

110. The project was designed to comply with the country's environmental controls and regulations, especially on air emissions, ambient air quality, wastewater effluent, ambient water quality, and noise. Given the management measures, monitoring by the MMT, and commitments for the project—including the ECC conditions set by the DENR—the project's impacts on the biophysical environment will be manageable. The project will ensure that it meets the World Bank's environmental standards.

111. The most critical issue for the project is safety. This will be adequately addressed through (i) good siting, away from residential areas, with no sensitive habitats, and appropriately zoning; (ii) incorporating the recommendations of the geotechnical study in planning and design; (iii) hazard zone modeling, which showed compliance with the US NFPA standards for production, storage, and handling of LNG, including the space requirements; and (iv) commitment to use a full-containment storage tank.

112. Finally, the project's benefits and advantages outweigh any disadvantages. It is the first LNG project in the country, so it will serve as a catalyst for industry to switch to natural gas, and

will result to a long-term net beneficial impact on air quality. In sum, the project is a positive contribution to local government, the region, and the country.

MAIN ENVIRONMENTAL REQUIREMENTS

Item	Unit	Project Commitment	Philippine Standards	World Bank Guidelines
Emissions[a]				
NO_x as NO_2	mg/Nm^3	125	500	125
SO_2	mg/Nm^3	2[b]	700	2000
TSP	mg/Nm^3	15	150	50
Ambient Air Quality				
NO_2				
1-hr average	mg/Nm^3	0.26	0.26	—
24-hr average	mg/Nm^3	0.15	0.15	0.15
annual average	mg/Nm^3	—	—	0.10
SO_2				
1-hr average	mg/Nm^3	0.34	0.34	—
24-hr average	mg/Nm^3	0.18	0.18	0.15
annual average	mg/Nm^3	0.08	0.08	0.08
Suspended Particulate Matter				
TSP				
1-hr average	mg/Nm^3	0.30	0.30	—
24-hr average	mg/Nm^3	0.23	0.23	0.23
annual average	mg/Nm^3	0.09	0.09	0.08
PM_{10}				
1-hr average	mg/Nm^3	0.20	0.20	—
24-hr average	mg/Nm^3	0.15	0.15	—
CO				
1-hr average	mg/Nm^3	35	35	—
Noise				
Morning and Evening	dB(A)	70	70	70
Daytime	dB(A)	75	75	70
Nighttime	dB(A)	65	65	70
Wastewater discharge				
Ph	—	6-9	6-9	6-9
BOD_5	mg	100	100	—
COD	mg	200	200	—
TSS	mg	150	150	50
Oil and Grease	mg	10	10	10
Residual chlorine	mg	—	—	0.2
Cooling Water Discharge				
Temperature	°C rise	≤3 outside 100-m mixing zone	≤3 outside mixing zone	≤3 outside 100-m mixing zone
Total Residual Chlorine	mg	0.2	—	0.2[c]

— = not available, °C = degree centigrade, BOD = 5-day biochemical oxygen demand, CO = carbon monoxide, COD = chemical oxygen demand, dB(A) = decibel acoustic, hr = hour, m = meter, mg = milligram, mg/Nm^3 = milligram per normal cubic meter, NO_2 = nitric oxide, NO_x = oxides of nitrogen, pH = measure of acidity or alkalinity, PM_{10} = particulate matter 10 micrometers in diameter and smaller, SO_2 = sulfur dioxide, TSP = total suspended particles, and TSS = total suspended solids.

[a] Equipment manufacturer's preliminary guarantee.

[b] Based on maximum expected sulfur content of Tangguh liquefied natural gas at 25 mg/Nm^3.

[c] The maximum value for "chlorine shocking" is 2 mg/L for up to 2 hours, not to be repeated more frequently than once in 24 hours, with a 24-hour average of 0.2 mg/L.

Source: GNPower Company Limited.

SUMMARY MATRIX OF POTENTIALLY SIGNIFICANT ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES (Environmental Management Plan)

Activity and Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
A. Preconstruction and Construction			
1. Onshore Structures			
Influx of workers	• Generation of sewage and solid waste	• Provision of portalets/latrines, septic tank, no litter signs, and waste cans • Waste minimization, waste recycling and/or reuse • Proper disposal of nonrecyclable wastes through an accredited contractor	GNPower Contractor
	• Introduction of disease by migrant workers	• Clean bill of health a condition for employment • Regular medical monitoring of workers	GNPower Contractor
Transporting equipment, materials & supplies	• Increase in traffic/navigation	• Scheduling of deliveries during off-peak hours • Installation of proper traffic signs and warning • Coordination with local government units (LGUs) and relevant authorities	GNPower Contractor
	• Generation of noise that disturbs wildlife and people	• Use of exhaust silencers and noise suppressors • Keeping vehicles under good condition	GNPower Contractor
	• Generation of dust and particulates that affect vegetation, wildlife, and people	• Watering of unpaved/dusty roads • Sprinkling and covering of stockpiles • Covering of top of delivery trucks • Speed reduction to 10 kilometers per hour (kph)	GNPower Contractor
Construction activities	• Removal of vegetation/habitat • Wildlife disturbance • Disturbance of rare and endangered species	• Revegetation and landscaping • Translocation of all species to the area earmarked for the secondary forest Cost is P25,000/hectare (ha)	GNPower Contractor Consultant
	• Generation of dust	• Immediate use of construction spoils as filling materials • Immediate disposal and sale of excavated materials • Continuous watering of bare areas • Revegetation	GNPower Contractor
Operating Equipment	• Generation of noise	• Use of noise suppressors and mufflers in heavy equipment • Enclosure of power generators and compressors • High maintenance standards	GNPower Contractor

Activity and Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Limitation of working hours during daytime	
	• Accidents	• Regular inspection and maintenance of equipment • Environmental health and safety briefing • Provision of protective gear	GNPower Contractor
	• Spills and leaks lead to soil and water contamination with hydrocarbons and polycyclic aromatic hydrocarbons (PAHs)	• Good housekeeping • Proper handling of lubricating oils and fuel • Training in proper handling and disposal of petroleum products • Collection, proper treatment, and disposal of spills	GNPower Contractor
Solid waste disposal	• Soil surface water contamination • Diseases, rats • Decrease in aesthetic value	• Immediate use of construction spoils as filling materials • Commercial sale of excavation spoils • Stabilization of temporary storage of construction spoils • Solid waste reduction, recycling/reuse, and proper disposal of nonrecyclables	GNPower Contractor
Sewage disposal	• Eutrophication of water body • Soil and water (surface and groundwater) contamination • Generation of obnoxious odor • Disease	• Proper treatment of sewage and compliance of effluent with Department of Environment and Natural Resources (DENR) standards • Disposal of septage through an accredited contractor	GNPower Contractor
Machine ervicing and maintenance	• Reduced water quality because of oil, grease, and hydraulic fluid spills	• Good housekeeping • Proper handling of lubricating oils and fuel • Training on proper handling and disposal of petroleum products • Collection, proper treatment, and disposal of spills	GNPower Contractor
Temporary storage of fuel	• Reduced water quality because of oil and petroleum compound spills and leakages	• Construction of secondary containment units around fuel storage tanks • Immediate cleanup of spills • Immediate stoppage of leakages • Provision of secure container and disposal to a secure landfill	GNPower Contractor
2.	**Offshore Structures**		
Attending Vessels	• Decrease in air quality due to exhaust emissions	• None required. Impact is minor and localized due to the natural dispersion of air emissions on the open sea	GNPower Contractor
	• Reduced water quality because of domestic	• Environmental safety briefing of contractors and workers • Compliance with International Convention for the Prevention of Marine Pollution	GNPower Contractor

Activity and Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	discharge and bilge water	from Ships (MARPOL 73/78), Philippine Coast Guard (PCG) Memorandum Circular 01-94, DENR Department Administrative Order (DAO) No. 35S 1990 to be stipulated in the Contract	and vessel operator
Pile driving at the jetty area	• Seabed destruction • Littering of sea floor • Loss and smothering of sedentary benthic life • Reduced water quality and increase in turbidity because of resuspension of sediment • Sedimentation	• Work to minimize destruction to seabed • Control trenching works • Use of geotextile curtains to control the spread of sediment • Application of occupational safety measures	GNPower Contractor
Dredging operations at the Manila Harbor Centre	• Seabed destruction • Reduced water quality and increase in turbidity because of resuspension of sediment • Sedimentation	• Use of suction dredge, which is less likely to stir up bottom deposits • Use of geotextile curtains around dredger head to control spread of sediment • Use of the spoil discharge point of the R-II Builders Inc., the company that reclaimed the land where the high voltage direct current converter station will be built in the Manila Harbor Centre • Apply occupational safety measures	GNPower Contractor
Transport/ Laying of cable lines	• Seabed destruction • Reduced water quality and increase in turbidity because of resuspension of sediments • Smothering of habitats and benthic organisms • Sedimentation	• Detailed seabed survey along the cable route • Avoidance of sensitive areas • Avoidance of alignment through hard strata, which requires blasting and tunneling • Avoidance of trenching activities where there is nearby aquaculture • Use of geotextile curtains to control spread of sediment • Good housekeeping	GNPower Contractor
Operation of equipment	• Noise disturbance • Reduced water quality because of spills and leaks affecting marine fauna and flora	• Limit hours of operation • High maintenance standards of equipment • Installation of noise suppressors in equipment • Provision of silencer and muffler • Good housekeeping • Proper handling of lubricating oils and fuel • Training on proper handling and disposal of petroleum products • Collection, proper treatment, and disposal of spills	GNPower Contractor
Obstruction to navigation	• Temporary inconvenience to fishermen and navigators due to the need of diverting sea	• Coordination with local government units (LGUs), relevant maritime authorities, and resource users regarding construction schedule and restrictions to areas • Navigation signs/warnings	GNPower Contractor

Activity and Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	traffic from active operation area	• Part of information, education, and communication plan	
B. Postconstruction			
1. Onshore Structures			
Site rehabilitation and revegetation Landscaping of yards and avenues	• Creation of secondary forest • Return of wildlife • Control of soil erosion • Attraction of wildfowl	• Elimination of exotic species that pose high risk of runaway weeds, influence the vector of pests and diseases, and harm other plant and wildlife species Cost is P25,000/ha	GNPower Contractor
2. Offshore Structures			
Removal of equipment and attending vessels	Generation of noise	• Installation of noise suppressors and mufflers • Limiting demolition activities during daytime	GNPower Contractor
C. Operation Phase			
1. Onshore Structures			
Power generation	• Gas emission	• Use of a clean fuel – liquefied natural gas (LNG) • Use of 50-meter-high stacks • Use of low nitrogen oxides burners • Installation of continuous computerized stack emission monitoring for major criteria pollutants • Validation of air dispersion model for ground level concentrations • Planting of instant tall indigenous trees and shrubs to absorb air emissions	GNPower
	• Generation of noise	• Provision of silencers for generators and turbines • Acoustic treatment of rotating equipment • Planting of indigenous trees and shrubs as noise filters • Annual plant maintenance • Regular noise monitoring	GNPower
	• Discharge of heated water	• Design of twin pipeline outfall structure with a diffuser to comply with the 3°C rise in temperature	GNPower

Activity and Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	• Discharge of liquid wastes (process effluent and sewage) and contaminated runoff	• Installation of water treatment system (WTS) and sewage treatment system (STS) • Installation of oil-water separator	GNPower
Water consumption	• Depletion of ground water that competes with water supply of nearby ranch	• Tapping of deep aquifers, which will not compete with shallow wells • Regular monitoring so as not to exceed allocation limits set by National Water Resources Board	GNPower
Waste Generation	• Discharge of sewage causing eutrophication • Generation of solid waste including sludge from demineralizer, WTS, and STS • Use of transformer oil and decommissioned transformers from switchyard operation • Spills and leaks of petroleum compounds from motor pool areas • Disposal of medical wastes (from clinic), expired chemicals, empty containers	• Formulation of waste management plan for GNPower • Ensuring proper storage, treatment, and disposal of all solid and scheduled waste and wastewater • Good housekeeping	GNPower Accredited contractor
LNG Storage	• Health and safety risks due to possible LNG fires or explosions	• Compliance with US National Fire Protection Association (NFPA)–59A • Formulation of contingency response plan and emergency procedures • Fire protection system • Hazard detection and emergency shutdown	GNPower
LNG spills and leaks	• Fire hazards	• Design conformance to NFPA–59A • Immediate stoppage of minor spills and leaks to minimize hazards • Shutdown of all equipment and elimination of possible ignition sources • Use of portable gas detector to determine extent of flammable air-gas mixture	GNPower
Operation of oil-water separator	• Spillage increases hydrocarbon and PAHs in water and sediment	• Training of operators on proper disposal of oil from separators or contracting disposal through and accredited contractor	GNPower Accredited contractor
Operation of WTS and STP	• Leakage from pipe resulting in contamination of surface	• Use of suitable prescribed pipe materials and suitably spaced sewer lines • Good housekeeping for the STS and WTS	GNPower

Activity and Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	and groundwater • Odor nuisance • Generation of sludge that is a potential source of trace metals and hydrocarbon odor • Noise from centrifuges, pumping stations, extractor fans • Workers and accidents	• Regular surveillance to maintain efficiency and prevent malfunction • Ventilation/aeration to minimize generation of unpleasant gases • Use of intermittent cycle extended aeration system, which produces highly stabilized sludge without further treatment • Alarms for pump failure • Use of buffers, acoustic screening within the building • Installation of noise and odor control equipment • Safe operations through the use of safety management system, protective gear and clothing, and environment and safety training	
Maintenance of transformers	• Spills of transformer oils that increase hydrocarbon in sediments and receiving water	• Contracting an accredited contractor for the disposal of waste transformer oils • Good housekeeping	GNPower Accredited contractor
2. Offshore Structures			
LNG transport	• Increase in navigation traffic • Reduced water quality because of spills and discharge of bilge water • Accidents	• Prior notice to LGUs and maritime authorities regarding LNG transport schedule • Policy on no disposal of bilge water in the waters • Development of a manual of protocols for cleaning activities and waste disposal of tankers and ships in the jetty site • Use of protective gear • Environmental, health, and safety briefing	GNPower LNG supplier
LNG unloading and jetty operations	• Change in coastal processes • Reduced water quality because of spills and discharge of bilge water from LNG tankers and other delivery vessels • Recolonization of benthic communities because of colonization of wharf piles by reef-dwelling biota • Generation of noise	• Pier structure could serve as new artificial habitat for reef-dwelling invertebrate and reef-associated fish • Policy banning disposal of bilge water • Implementation of safe operating procedures during unloading of fuel • Provision of noise suppressors	GNPower LNG Supplier
Cooling system	• Entrainment and impingement of marine organisms at the intake structure	• Maintaining velocity rate of pipe at 30 centimeters per second • Use of velocity caps to reorient flow patterns • Fitting of screens at the bottom of the ceiling intake • Frequent cleaning of pipes	GNPower

Activity and Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	• Thermal pollution affects fish larvae and other minute organisms near the outfall	• Modeling results shows compliance with the maximum 3°C rise outside of the mixing zone using the twin-pipe outfall with six diffuser nozzles	GNPower
	• Use of biocides (hypochlorite) are toxic to marine life	• Installation of sensor mechanism to control dosage at the intake, limiting sodium hypochlorite levels at the outlet to two parts per million.	GNPower
	• Use of anti-corrosion protection (zinc or aluminum) for pipeline is toxic to marine life	• Use of minimum amount of zinc or aluminum to maintain pipeline structural integrity. Anticipated impact to water quality is negligible because of high dispersion and rate of dissipation in the water. • Compliance with RA 6969 or otherwise known as "Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990"	GNPower
Submarine cable	• Altering navigation access • Loss of illegal dynamite fishing in the area due to tightened security	• Coordination with LGUs and marine authorities regarding LNG transport schedule • Employment of dynamite fishers	GNPower
D. Abandonment Phase (Onshore Structures)			
Dismantling and removal of power plant facilities and structures	• Generation of noise, dust, and exhaust, which affect workers, vegetation, and wildlife at risk • Exposed soil prone to erosion and more surface	• Use of noise suppressors/mufflers • Limiting noisy activities during daytime • Expand natural forest to create wildlife habitat • Introduction of indigenous forest tree species • Watering during dismantling to minimize dust • Proper maintenance of vehicles • Revegetation to prevent soil erosion and runoff	GNPower Contractor
Removal and disposal of wastes	• Spills and discharges of contaminants affecting water quality and aquatic ecology • Improper waste disposal impact on people and biota	• Collection of spills • Removal and/or neutralization of chemicals • Continued water quality monitoring	GNPower and Contractor
Site rehabilitation and revegetation	• Increase in biodiversity	• Mitigation required if weed, pest and diseases arise, threatening offsite farms Elimination of introduced species that put agriculture at high risk	GNPower

ENVIRONMENTAL MONITORING PROGRAM FOR THE PROJECT

Issues and Concerns	Parameter and Indicator	Frequency	Location or Station	Applicable Standard or Threshold Impact	Responsible Person
A. Preconstruction/Construction					
Mass movement along the coastal area	Conduct of slope stability analysis	Prior to construction	Project site	NA	GNPower Contractor Multipartite monitoring team (MMT)
	Diversion of surface runoff water away from failure-prone zones	During construction	Project site	NA	GNPower Contractor MMT
	Installation of vertical drainage wells and drainage tunnels	During construction	Project site	NA	GNPower Contractor MMT
Increase in total suspended particulates	Total suspended particles (TSP) and particulate matter 10 micrometers in diameter or smaller (PM_{10}) using high volume-gravimetric method of analysis	Once a week – one hourly sample (morning and afternoon) One 24-hour (hr) sample Investment cost for monitoring and laboratory equipment is $30,000 Weekly operating cost of P20,000	Sampling stations in the environmental impact statement (EIS)	TSP (Hourly): 300 microgram per normal cubic meter ($\mu g/Nm^3$) (24-hour): 230 $\mu g/Nm^3$ PM_{10} (Hourly): 200 $\mu g/Nm^3$	GNPower MMT
Increase in noise level	Noise using noise meter with range from 45 decibel acoustic (dB[A]) to 150 dB(A)	Once a week (morning, daytime, evening, and nighttime) (Inclusive of above cost)	EIS stations	Daytime: 75 dB(A) Morning/Evening:70dB(A) Nighttime 65 dB(A)	GNPower MMT
Increase ambient levels of gases	Sulfur dioxide (SO_2) using gas bubbling and pararosaniline method Nitrogen oxide as nitrogen dioxide (NO_2) using gas bubbling and Griess-Sitzman	Once a week- One hourly sample 24-hr sample (Inclusive of above cost)	EIS stations	SO_2-(Hourly):340 $\mu g/Nm^3$ (24-hour):180 $\mu g/Nm^3$	GNPower MMT

Issues and Concerns	Parameter and Indicator	Frequency	Location or Station	Applicable Standard or Threshold Impact	Responsible Person
				NO_2- (Hourly): 260 µg/Nm^3 (24-hr):150 µg/Nm^3	
Seawater Quality	pH, temperature, turbidity, total suspended solid (TSS), oil and grease, 5-day biochemical oxygen demand (BOD_5), dissolved oxygen (DO), polycyclic aromatic hydrocarbons (PAHs) and heavy metals	Quarterly to Biannually P50,000 per sampling	EIS stations	Baseline data DENR DAO 34	GNPower MMT
Sediment contamination	Analysis of grain size, trace metals, hydrocarbons, and PAHs	Every 3 years P60,000 per sampling	EIS stations	Baseline data	GNPower MMT
Marine Biota	Phytoplankton, zooplankton, primary productivity, benthic lifeforms, benthos-coral-associated fish, and soft-bottom communities or meiofauna	Biannually P180,000 per sampling	EIS stations	Baseline data	GNPower MMT
Freshwater quality (Diguinin River & project site drainage canal)	Turbidity, TSS, total dissolved solids, oil and grease, BOD_5, DO, total coliform, nitrite (NO_3) as nitrogen (N), phosphate (PO_4) as phosphorus (P), coliforms	Biannually P 30,000 per sampling	EIS Stations	DENR DAO 34 for Class C fresh waters	GNPower MMT
Freshwater biota (Diguinin River)	Phytoplankton, zooplankton, primary productivity, algal biomass (chlorophyll a), macroinvertebrates, aquatic macrophytes	Biannually P100,000 per sampling	EIS Stations	Baseline data	GNPower MMT
Groundwater quantity	Water levels, flow rate	Biannually P20,000 per sampling	Proposed well and nearby wells	Usage not to exceed annual abstraction limit	GNPower MMT
Groundwater quality	Temperature, electrical conductivity (EC), salinity, pH, TDS, TSS, BOD, COD, DO, NO_3 as N, PO_4 as P, heavy metals, total coliform	Biannually P60,000 per sampling	Proposed well and nearby wells	National drinking water standards	GNPower MMT
Proper treatment/ disposal of sewage	BOD_5, DO, TSS, oil and grease, coliform content	Quarterly P5,000 per sampling	Project site	DENR DAO 35	GNPower MMT

Issues and Concerns	Parameter and Indicator	Frequency	Location or Station	Applicable Standard or Threshold Impact	Responsible Person
Fuel spills and leakage	Visual inspection and portable gas detector	Upon report, stoppage of spills	Project site and offsite	NA	GNPower MMT
Vegetation	Balling and translocation of rare and endangered species	During construction	New stations	NA	GNPower Contractor MMT
	Shrub-tree vegetation, tree clumps, and grassland, (diversity index and evenness)	Two sampling seasons per year P180,000 per sampling			
Wildlife	Diversity index and evenness	Two sampling seasons per year Inclusive with vegetation monitoring	North-to-south transect at middle of project site	NA	GNPower Contractor MMT
B. Postconstruction					
Dismantling of temporary structures	Continue monitoring as above	Two sampling seasons per year	Project site	NA	GNPower Contractor MMT
Establishment of 1-hectare forest	Diversity index and evenness Inclusive with vegetation monitoring	Annually	Project site	NA	GNPower Contractor MMT
C. Operation					
Gaseous and particulate emissions	TSP using United States Environmental Protection Authority (USEPA) methods 1 to 5	Continuous Investment cost for monitoring and laboratory equipment is US$30,000 Weekly operating cost of P20,000 to include SO_2, NO_2, TSP, PM_{10} and CO ambient monitoring	Stacks 1,2,3, and 4	150 milligrams per normal cubic meter (mg/Nm^3)	GNPower MMT
	SO_2 using USEPA Methods 1 to 4 and 6 or 8 as appropriate	Continuous (Included in the above cost)	Stacks 1,2,3, and 4	700 mg/Nm^3	
	NO_2 using USEPA Methods 1 to 4 and Method 7	Continuous (Included in the above cost)	Stacks 1,2,3, and 4	500 mg/Nm^3	

Issues and Concerns	Parameter and Indicator	Frequency	Location or Station	Applicable Standard or Threshold Impact	Responsible Person
Increase in ambient gas and particulate concentration	SO_2	Once a week One hourly sample One 24-hr sample (Included in the above cost)	Stations 1 to 4	Hourly: 340 µg/Nm^3 24-hr:180 µg/Nm^3	GNPower MMT
	Particulates and PM_{10} Using high volume sampling-gravimetric method of analysis	Once a week One hourly sample One 24-hr sample	Stations 1 to 4	TSP- (Hourly): 300 µg/Nm^3 (24-hr): 230 µg/Nm^3 PM_{10} (Hourly): 200 µg/Nm^3 (24-hr): 150 µg/Nm^3	GNPower MMT
	CO	Once a month	Stations 1 and 2	Hourly 35,000 µg/Nm^3	GNPower MMT
Noise	Noise level Inclusive with air quality monitoring	Quarterly	EIS stations	Daytime:75 dB(A) Morning/evening 70 dB(A) Nighttime65 dB(A)	GNPower MMT
Seawater Quality	Turbidity, suspended solid, oil and grease, BOD_5, DO, PAHs, and heavy metals	Biannually P80,000 per sampling	EIS stations	DENR standards for Class SC marine water	GNPower MMT
Marine Biota	Phytoplankton, zooplankton, primary productivity, benthic lifeforms, benthos-coral-associated fish, and soft-bottom communities or meiofauna	Biannually P200,000 per sampling	M-1, M-3, and M-6 stations	None	GNPower MMT
Fish tissue analyses for heavy metals	Chromium, mercury, cadmium, and lead	Annually (Inclusive with marine biota)	Nearshore	None	GNPower MMT

Issues and Concerns	Parameter and Indicator	Frequency	Location or Station	Applicable Standard or Threshold Impact	Responsible Person
Freshwater quality (Diguinin River, and project site drainage canal)	Salinity, turbidity, TSS, TDS, oil and grease, BOD_5, DO, total coliform, NO_3 as N, PO_4 as P, coliforms , PAHs, heavy metals	Biannually to annually P30,000 per sampling	EIS stations	DENR standards for Class C fresh water	GNPower MMT
Freshwater Biota	Phytoplankton, zooplankton, primary productivity, algal biomass (chlorophyll a), macroinvertebrates, aquatic macrophytes	Biannually to annually P100,000 per sampling	EIS stations	NA	GNPower MMT
Groundwater Quantity	Water levels, flow rate Included with groundwater quality	Biannually to annually	Monitoring bore hole and nearest wells in the site	Consumption not to exceed annual allocation and abstraction limit	GNPower MMT
Groundwater Quality	Temperature, EC, salinity, pH, TDS, TSS, BOD_5, COD, DO, NO_3 as N, PO_4 as P, heavy metals, total coliform	Biannually to annually P30,000 per sampling	Monitoring bore hole and nearest wells in the site	National drinking water standards	GNPower MMT
Maintenance of restored forest	Diversity index and evenness to include growth rates and biomass	Two sampling seasons per year, as required P200,000 per sampling	Northern portion protected area	NA	GNPower Consultant MMT
Grassland	Diversity index and evenness	Two sampling seasons per year/as required (Included in vegetation cost)	Northern portion protected area	NA	GNPower Consultant MMT
Wildlife	Diversity index and evenness	Two sampling seasons per year, as required (Included in vegetation cost)	Project site; Malinta Tunnel on Corregidor Island and mangrove area 1 kilometer north of project site	NA	GNPower Consultant MMT
Offsite vegetation	Diversity index and evenness Included in vegetation cost	Annually	Around Malinta Tunnel on Corregidor island	NA	GNPower Consultant MMT

Issues and Concerns	Parameter and Indicator	Frequency	Location or Station	Applicable Standard or Threshold Impact	Responsible Person
Offsite vegetation in mangrove	Ocular inspection and listing of species	Two sampling seasons per year, as required (Included in vegetation cost)	One kilometer north of project site	NA	GNPower Consultant MMT
Proper treatment and disposal of domestic sewage	BOD_5, DO, TSS, oil and grease, coliform content	Quarterly P5,000 per sampling	Project site	DENR standards DAO 34	GNPower Consultant MMT
Proper treatment and disposal of process effluent	Color, temperature, pH, COD, BOD_5, TSS, TDS, surfactants, oil and grease, phenolic substances, and total coliforms	Monthly P5,000 per sampling	Project site	DENR standards DAO 34	GNPower Consultant MMT
Public health	Morbidity and mortality data	Annually	Municipality and affected barangays	NA	GNPower MMT
D. Abandonment (Decommissioning)					
Air Quality	TSP and PM_{10} Using high volume sampling-gravimetric method of analysis	Upon abandonment One hourly sample (AM & PM) One 24-hr sample Investment cost for monitoring and laboratory equipment is $30,000 Weekly operating cost of P20,000 to include SO_2, NO_2, TSP, PM_{10} and CO ambient monitoring	EIS stations	TSP (Hourly): 300 µg/Nm^3 and (24-hr): 230 µg/Nm^3 PM_{10} (Hourly): 200 µg/Nm^3 (24-hr): 150 µg/Nm^3	GNPower Consultant MMT
Noise	Once a week (morning, daytime, evening and nighttime) using noise meter with range from 45 dB(A) to 150 dB(A)	Upon abandonment One hourly sample (AM & PM) One 24-hr sample	EIS stations	Daytime 75 dB(A) Morning/evening 70 dB(A) Nighttime 65 dB(A)	GNPower Consultant MMT
Chemical contamination	Soil and water	Upon abandonment P50,000	Project site, Manila Harbor Centre	DENR standards	GNPower Consultant MMT
Freshwater quality	Turbidity, TSS, TDS, oil & grease, BOD_5,	Upon abandonment	Diguinin River &	Baseline data	GNPower

Issues and Concerns	Parameter and Indicator	Frequency	Location or Station	Applicable Standard or Threshold Impact	Responsible Person
	DO, Total coliform, NO_3 as N, PO_4 as P, coliforms	P30,000 per sampling	drainage canal	DENR standards	Consultant MMT
Freshwater biota	Phytoplankton, zooplankton, primary productivity, algal biomass (chlorophyll a), macroinvertebrates, aquatic macrophytes	Upon abandonment P100,000 per sampling	Diguinin River	Baseline data DENR standards	GNPower Consultant MMT
Seawater quality	pH, temperature, turbidity, TSS, oil and grease, BOD_5, DO, PAHs, and heavy metals	Upon abandonment P50,000 per sampling	EIS stations	Baseline data DENR standards	GNPower Consultant MMT
Sediment contamination	Analysis of grain size, trace metals, hydrocarbons, and PAHs	Upon abandonment P60,000 per sampling	EIS stations	Baseline data DENR standards	GNPower Consultant MMT
Marine Biota	Phytoplankton, zooplankton, primary productivity, benthic lifeforms, benthos-coral-associated fish, and soft-bottom communities/meiofauna	Upon abandonment P180,000	EIS stations	Baseline	GNPower Consultant MMT
Vegetation and wildlife	Diversity and evenness index	Upon abandonment	EIS stations	Baseline	GNPower Consultant MMT