E-190

Environmental Assessment Report

for the Combined Cycle Development at Phumy-II, Vietnam

Volume : Main Report

VoL. 2

August 1995

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Reference: PE611-F12-1

Client: Electricity of Vietnam (EVN)

Report No: PE611-R2

Report Title: Environmental Assessment Report for the Combined Cycle Development (Phumy II) at Phumy, Vietnam

Volume 1 **of** 2

Approved:

Date: 4 September 1995

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CHAPTER 1

EXECUTIVE SUMMARY

Policy, Legal & Administrative Framework

1.1 This environmental impact assessment report (EIA) addresses the impacts of a project to develop power generating capacity at Phumy in the South of Vietnam. The proposed development will consist of two blocks of combined cycle plant of approximately 800 MW total. Each block will likely consist of gas turbines, waste heat boilers and a steam turbine. This project (Phumy II) is likely to be part funded by the International Bank for Reconstruction and Development (IBRD).

1.2 A separate power development project (Phumy I) consisting of 600 MW of conventional thermal plant is also planned for the site at Phumy and an EIA for this project has already been prepared. For completeness of information this EIA will address the impacts of the complete site development, i.e. Phumy I and Phumy II.

The Developer

1.3 The Developer of the proposed project is Electricity of Vietnam (EVN), a state owned company which is responsible for supplying power to all of Vietnam. Shortage of adequate base load capacity together with high growth in demand has led EVN to develop this additional power generation capacity. Natural gas from the offshore White Tiger gas field will be available to Phumy in 1997 making it an ideal site for development of combined cycle plant.

International Bank for Reconstruction and Development (IBRD) Requirements & Guidelines

1.4 This environmental assessment report is prepared for EVN according to the scope and format detailed in IBRD's Operational Directive OD 4.01. It is IBRD policy that all major projects shall be subject to an environmental assessment.

1.5 Environmental Guidelines have been issued by the IBRD to cover a wide range of specific industries. Each guideline contains emission limits as well as permitted ambient levels for all relevant media and likely contaminants. Values are intended as a guideline and mostly relate emissions to units of production. These guidelines are addressed where appropriate in assessing the impacts of the proposed development, and the ones relevant to this proposed project are summarised in Appendix IV. Suitable environmental control technology is also specified in this document. It is IBRD policy that where there exist different limits between its guidelines and national controls, the stricter of the two shall be applied.

Vietnamese Environment Policy And Regulations

1.6 A comprehensive environmental plan was adopted by Vietnam in 1991 called "The National Plan for Environmental and Sustainable Development: A Framework for Action". This plan provides the framework for establishing environmental issues. The implementation of this plan rests with the Vietnam State Committee for Science and Technology (SCTC).

1.7 Within this context national regulations and guidelines have been adopted giving permitted levels of contaminants in air, water and soils. These regulations are addressed where appropriate in this report and the relevant guidelines are summarised in Appendix IV. Several provincial centres including Ho Chi Minh City have also issued local environmental guidelines.

1.8 This law extends environmental impact assessment requirements to a broad range of public and private sector development activities, proposes procedures for screening and incorporating of mitigation plans into project design, and explicitly links EIA review to the project approval process.

1.9 The core agency with environmental mandate is the Ministry for Science, Technology and Environment (MSTE) which was formed in 1992 from the State Committee for Science. Within MSTE, the Department of Environment and Natural Resources (DENR) is the environmental arm with the main responsibility for carrying out these environmental functions.

EIA Review And Approval Process

1.10 Responsibility for project approval, for projects such as the current one under Vietnam's investment policy is given to the National Project Evaluation Board (NPEB) under the chairmanship of the State Planning Commission (SPC). As a member of the NPEB, the Ministry for Science Technology and Environment has the formal authority to comment on environmental aspects of the project. This function would normally be carried out by the Department of Environment and Natural Resources and a copy of the EIA has been submitted for their approval.

1.11 At the provincial level Environmental Committees also have formal authority to review and comment on environmental aspects of investment applications. The Environmental Committee at Vung Tau is the one of most relevance to the present proposed project and this EIA has been submitted for their approval. A copy has also been made available to the public in the municipality of Phumy where the project is being developed.

1.12 Within the IBRD EIAs are reviewed and assessed within the appropriate divisions. Both the EIA and the EIA summary are made available for public scrutiny.

Summary of Main Environmental Issues

1.13 The proposed development has major environmental benefits in the provision of an extra 800MW of combined cycle plant. Combined cycle plant is the most benign of thermal power plants with higher efficiencies and lower emissions per unit of

electricity generated. This extra generation capacity will allow the strengthening of the power supply system, the improvement of living standards and the development of industry and other economic activities in the region.

1.14 The overall development would directly affect 157 families in the Phumy area. A separate Rehabilitation Action Plan (RAP) is being carried out to World Bank (OD 4.30) guidelines.

1.15 The use of natural gas as a fuel and the availability of an extensive body of water for dispersing heat will ensure only minor impacts from stack emissions and cooling water emissions. A variety of mitigating measures will ensure that the impacts of all other emissions from the proposed plant will not be significant.

1.16 It is recommended that monitoring programmes during the construction and operating phases be put in place for the successful implementation of the Project. Recommendations are also made for the establishment of an environmental unit at Phumy as well as that of an environmental co-ordinator within EVN as its thermal program expands with the function of developing environmental policy and ensuring compliance with regulations. This co-ordinator would also liaise with other groups such as a Coastal Zone Management Group in order to promote the protection and sustainable development of the delicate coastal area. It is also stressed in the report that oil spills represent a particular hazard and that strict procedures, must be put in place to minimise this risk.

Project Description

1.17 The project is for the development of 800MW of combined cycle plant at Phumy in the South of Vietnam. Combined cycle plant consist of gas turbines which generate electricity directly as well as waste heat boilers which utilise the hot gases exhausted from the gas turbines to raise steam and generate further electricity in the steam turbines. Combined cycle plants have advantages in terms of higher efficiency and lower environmental emissions. Figures 3.1, 3.2, 3.3 illustrate the location and layout of the project.

1.18 The plant will burn natural gas which will be available in mid 1997. At this stage the only stack emissions of significance would be NOx (oxides of nitrogen) which will be maintained below a level of 50 ppm by use of low NOx burners. The first two gas turbines will, however, be commissioned in December 1996 and will burn distillate fuel oil for about 6 months until natural gas is available. During this phase emission of NOx will be rather high at about 300 ppm as it is not justifiable to install NOx reduction measures for such a short period.

1.19 A conventional thermal plant called Phumy I as also planned for the site and will consist of 3 x 200MW units. Phumy I will also burn natural gas. Residual fuel oil will be used for emergency standby. For completeness of information this EIA considers total emissions from the site, i.e. Phumy I and II.

1.20 Cooling water for the plants will be taken from the Sao stream at the rate of $60m^3/s$ and will be discharged to the Thivai estuary. Chlorination of the system in order to reduce fouling will be carried out so that the residual chlorine level at the discharge is <0.02 ppm.

1.21 Waste water streams will include water treatment plant waste, sewage, surface drains, boiler washings and other minor sources typical of a power station. They will be treated as appropriate so that the effluents will satisfy IBRD and Vietnamese regulations.

1.22 The plant will require fresh water for boiler make-up and domestic use at a maximum rate of about 2000 m^3/day. This will be supplied by wells on site. Gas will be delivered by pipeline and distillate and heavy fuel oil by tanker. A 4km power line will be constructed to join the existing transmission system.

Baseline Data

1.23 The Phumy site is located in a rural area about 70km south east of Ho Chi Minh City. The population of the small townlet is about 8000 and the main economic activities are farming and fishing. The average income is low even compared to nearby districts and infrastructure and services such as electrical supply, roads, health services and education are also poor.

1.24 About 157 families in Phumy will be directly affected by the project implementation consisting of:-

- 6 families who live on the site (Phumy I).
- 135 families who own land and farm on the site (47 for Phumy II, 88 for Phumy I).
- 16 families who will have to be rehoused because the construction of a transmission line (Phumy II).

1.25 A survey of these people showed that in general they welcomed the project as a source of jobs for their children, but were worried about the amount of compensation they would receive. A separate Rehabilitation Action Plan (RAP) report is being prepared which will include full details of all these affected people, including land, assets, crops, so that fair and adequate compensation can be agreed.

1.26 Given the rural nature of the site air quality is expected to be good. Limited measurements on the site show that this is so with levels of NO_2 of 0 - 0.06 mg/m^3 and levels of SO_2 of 0.010 - 0.02 mg/m^3.

1.27 Noise measurements carried out at 3 locations show levels of about 40 dBA at night and higher levels at day time, probably due to nearby construction activities for a harbour development. For power station design night time levels are the most significant as the permitted noise levels are lowest during night.

1.28 The most significant ecological system is that of the mangrove forest and associated fish, shell fish and other animal species. This appears under threat in this region as it does in many parts of South East Asia due to:-

- Excessive siltation and organic pollution
- Harvesting for firewood and charcoal manufacture
- Operation of shrimp and fish aquaculture enterprises which may involve clearing mangrove areas as well as, depending on the stocking level, water pollution from biocides and other wastes.

1.29 There is evidence of all the above activities near Phumy; however successful replanting of mangroves has also taken place in areas where they were cut down. Development of shrimp aquaculture probably represents the single greatest threat.

1.30 A survey of mangrove trees in the site and nearby study area indicated the presence of 32 species. The distribution depends on submersion and salinity levels as well as impacts of artificial replanting. The survey also found the following numbers of animal species which are largely associated with the mangrove areas;

- 30 species of birds
- 17 species of mammals
- 8 species of amphibians
- 16 species of reptiles

1.31 The site itself, which is 150ha in extent contain, about 20 ha of mangrove area. The rest is mostly cultivated for rice, cashew nut trees, eucalyptus and other crops. Apart from the mangroves there are no significant habitats or wild life areas on the site or in the surrounding area. A study carried out showed the presence of 201 species of plant in the study area of which 101 occurred in the actual site area.

1.32 The Thivai river estuary, which runs by the site, will be utilised to disperse the heat in the cooling water discharged from the plant. It is wide (400m) and deep (15 - 30m) with a tidal variation of about 3m and a large tidal flow (10,000m^3/s). Analyses of the water quality of the Thivai estuary indicated the following main features:-

- High salinity levels, particularly in the dry season.
- Some evidence of oil pollution.
- Organic pollution from domestic sources.
- Moderate levels of dissolved oxygen.

1.33 Surveys of the aquatic ecosystem of the Thivai river indicate that it is typical of the nearby large area of delta. It is rich in numbers of species but with some evidence of an impact from organic pollution. The baseline surveys identified the following numbers of species:-

- 72 species of phytoplankton and 31 species of zooplancton.
- 60 species of fish and 22 species of shellfish.
- 42 species of zoobenthos (near site).

1.34 Fish eggs and larvae are considered particularly sensitive to environmental disturbance. A survey of eggs and larvae in the Thivai estuary showed numbers and species composition typical of the delta area. The larvae were found to migrate from surface layer to the bottom depending on the time of day.

Environmental Impacts

1.35 The positive impacts of the proposed project are summarised below. The negative impacts are summarised in tables 1, 2, 3, and 4 and described below.

1.36 The proposed project, consisting of combined cycle plant burning natural gas, is the most environmentally benign form of thermal power plant. It has a very high efficiency, close to 50%, and lower air emissions and cooling water requirements per unit of electricity generated than for conventional plant. In particular, when burning natural gas with a low NOx burner as is planned for this project, there are no significant emissions of NOx or SO_2 and emissions of carbon dioxide are 50% lower than for conventional plant burning fuel oil or coal.

1.37 A major and positive impact will be the provision of 800MW generating capacity. This will impact on a regional basis by strengthening the electricity supply network and allowing the connection of extra consumers and the development of industry and services in the region. The employment of large number of people during the construction and operation phase will also benefit the local economy.

1.38 The main groups of people directly affected by the overall development include six families, who live on the site, 135 families who own land on the site and 16 families who will be displaced from their homes because of power line construction. A separate RAP report will be carried out to IBRD guidelines which will detail the compensation to be awarded to those people for their land, houses, crops and other assets. The process will ensure that no families will suffer a drop in standard of living as a result of the project.

1.39 While some disturbance will be caused to the townlet of Phumy the overall impact should be positive by the provision of jobs and improvement of infrastructure.

1.40 During the construction phase there will be a permanent loss of 2 ha of mangrove forest due to the construction of a jetty and a loss of about 0.5 ha of mangrove at the cooling water intake. There will be a temporary loss of 1 ha due to construction of the cooling water outlet pipes. As these will be buried the areas can be replanted.

1.41 Dredging of the Thivai river in order to allow berthing of tankers of 10,000 dw tonnage as well as all the cooling water system construction will cause a local and temporary loss of benthnic animals as well as disturbance of fish and other organisms.

1.42 Impacts of other construction activities such as noise, dust, sewage, after taking into account mitigation measures, will be minor.

1.43 The Phumy I and II Power Stations will burn natural gas and the only stack emission of interest will be NOx. A dispersion analysis was carried out for the case of plants on full load and showed that the maximum hourly ground level concentration of NO_2 when burning natural gas would be 0.11 mg/m^3 while the maximum annual average will be 0.002 mg/m^3. These relatively low values will be well below IBRD and Vietnamese air quality regulations and will be of minor significance to air quality in the area.

1.44 For about six months the first two gas turbines to be commissioned will burn distillate until natural gas reaches the site. The rate of emission of NOx will be quite high at 300 ppm as methods of reducing NOx levels such as water injection are not considered feasible for this short period. However as they will be on open cycle for this period the high exit temperature will provide good dispersion characteristics. A dispersion analysis for this case showed that maximum hourly ground level concentrations of NO_2 would be 0.100 mg/m^3. This level will not break ambient air quality standards nor will it have a significant impact over the short period involved.

1.45 Specification for the proposed plant will be such that noise levels at the site perimeter will not exceed permitted levels for residential areas. This will ensure that no noise nuisance is caused at nearest residences.

1.46 Cooling water discharge will be at a maximum rate of 60m^3/s and a temperature rise of 7°C. The discharge will be deep into the Thivai estuary which has a large tidal flow of 10,000 m^3/sec. A thermal diffusion study indicates that the physical impact will be minor with, for the worst case, a thermal plume of 1°C extending across the estuary. Beyond the immediate outfall the maximum temperature rise will be 1.5°C.

1.47 Ecological impacts of the thermal plume are not predicted to be significant. However, because it is a deep discharge some scouring will take place at the outfall. No significant impacts will be caused to aquaculture or commercial fishery on the Thivai River.

1.48 Chlorination of the cooling water will take place at a rate that will leave a residual level of <0.02 ppm at the outfall. At this concentration the chlorine should not have any significant impacts beyond the discharge point.

1.49 A large number of organisms including fish eggs and larvae will be entrained by the cooling water system and significant mortality will occur due to pressure, temperature rise and chlorination. This is not predicted to have an overall impact on fish numbers in the area due to the large amount of similar habitat in the region and due to the small ratio of CW flow to overall tidal flow.

1.50 Other waste water streams from the plant include water treatment plant effluent, sewage, surface drains, boiler washes and acid cleans. These will all be treated as appropriate so that the effluents will satisfy Vietnamese regulations and will have no environmental impacts on the receiving water.

1.51 Oil spillage into the sensitive mangrove ecosystem represents a serious menace. In order to minimise this risk strict procedures will be implemented for the delivery, unloading, storage and handling of oil as well as an emergency response plan and clean up procedures.

1.52 Dredging will be required occasionally in order to maintain navigable depth at the jetty. This will create a local and temporary disturbance to biota in the area. The dredged material will be transported for land reclamation to an area not yet designated.

Summary of Alternatives

1.53 Alternatives to the proposed project should be seen in the context of a high predicted growth in electricity demand in the South Vietnam area over the next twenty years. This growth is required for economic development and improvement in standard of living. A mixture of thermal and hydroelectric power, which are complimentary to each other, is required to satisfy this demand. Alternative designs and sites were considered.

1.54 A natural gas fired combined cycle plant, such as the present design, has the following major advantage over other types of thermal plant which might be considered :-

- Lower capital cost
- Shorter lead times to power production
- Small land area requirements
- Higher efficiencies
- Lower air emissions per unit of electricity generated
- Lower cooling water requirements per unit of electricity generated.

1.55 A number of alternative sites were considered and evaluated on the following criteria:-

- Proximity to Bach-Ho - Thu Duc gas pipeline
- Distance to transmission lines
- Cooling water availability
- Environmental and socioeconomic issues
- Site area available
- Construction and engineering issues.

The site at Phumy was judged as the optimum available.

TABLE 1

Summary of Environmental Impacts During Construction Phase

Source	Environmental Impact	Mitigation Measures	Residual Impact
Site Acquisition	Displacement of people living and owning land on site	Adequate and timely resettlement and/or compensation	Temporary disturbance - no reduction in assets or income
Transmission line construction	Displacement of 16 families	Adequate and timely resettlement	Temporary disturbance only
Construction of Jetty	Loss of 2ha of Mangrove	None	Local but permanent
Construction of C.W. outlet	Loss of 1 ha Mangrove	Pipes are buried and area will be replanted	Temporary
Dredging activities	Loss of benthnic fauna	None	Local and Temporary loss
Sanitation facilities	Sewage discharge	Effluent will be treated to Vietnamese standards	Minor
Noise	Noise during piling and steam purging operations	Restrict piling to day light hours. Notify residents of steam blows	Minor and temporary
Dust	Dust generated	Spraying of access roads and truck tyres	Minor
Construction Work	Traffic Increase	Road Improvement	Minor
Work during construction	Short term employment for over 1000 workers		Beneficial short term

TABLE 2

Summary of Impacts of Atmospheric Emissions for Phumy I and II When Burning Natural Gas

Impact		Predicted	Vietnamese Regulations	IBRD
Nitrogen Oxide (NO_2)				
Ambient				
1-hour maximum	$\mu g/m^3$	110	300	---
24-hour maximum	$\mu g/m^3$		---	---
Max. annual average	$\mu g/m^3$	2	80	100
Sulphur Dioxide (SO_2) (a)				
Ambient				
1-hour maximum	$\mu g/m^3$	0	300	---
24-hour maximum	$\mu g/m^3$	0	---	500
Max. annual average	$\mu g/m^3$	0	80	100
Carbon Dioxide (CO_2) (a)				
Emission				
Tonnes/annum (total)		4.7×10^6	---	---
Noise (dB (A))				
Noise Levels at Boundary fence		55		55 (b)
Residential Area		<55	55/60 (b)	55 (b)
Particulates				
24-hour maximum	$\mu g/m^3$	<1	200	500

(a) 100% load factor

(b) Varies with day / night; indoors and outdoors and other factors

TABLE 3

Summary of Environmental Impacts
During Operation of Plant - Aqueous Emissions of Phumy I and II

Source	Environmental Impact	Mitigation Measures	Residual impact
Water Treatment Plant Waste	Contains strong acids and alkalis	Treated in neutralisation tank to pH 6-9. Effluent will comply with waste water standards (Ref.8)	Negligible
Oil Contaminated Surface Water	Adverse impact on marine organisms if discharged directly	All surface drains will be routed through oil interceptors. Effluent will comply with waste water standards (Ref.8)	Minor
Sewage	High BOD and micro biological pollutants	Sewage will be treated to <20 mg/l BOD before discharge	Minor
Boiler Blowdown	Contain very low concentration of contaminants	No treatment necessary	Negligible
Boiler Acid Clean	Utilises toxic chemicals. This process arises only rarely.	These will be treated with the waste removed off site for disposal. Effluent discharged will satisfy waste water regulations (Ref.8)	Minor
Chemical Spillage	Bulk chemicals stored on site, in particular acid and alkali	Stored bulk chemicals will be bunded so that any spillage will be contained and controlled	Negligible
Boiler Washing	If burning residual fuel oil can contain vanadium and other metals	Metals will be precipitated by chemical treatment and removed offsite to land fill	Minor

Table 4

Summary of Impacts of Cooling Water System Operation for Phumy I and II

Source	Environmental Impact	Mitigation Measures	Residual Impact
Intake of 60 m^3/s	Loss of fish eggs and plankton	None	Small in relation to overall abundance in the area
Intake screens	Loss of fish through impingement	Optimum measures not yet selected	Minor
Discharge of heated water	Impact on sensitive organisms	Discharge designed so that temperature rise will not exceed 1°C	Minor
Chlorination of C.W. system	Impact of residual chlorine on ecosystem	Residual chorine levels will be kept to < .02ppm	Negligible
Discharge of CW	Scouring of bottom	None	Permanent but local disturbance of area

Summary of Mitigation Measures

1.56 In order to reduce environmental impacts from the proposed development mitigation measures, summarised below, have already been put in hand or are planned. Apart from these, and taking into account the minor residual impacts of the proposed development, no further mitigation measures are considered necessary.

1.57 About 157 families who own land, houses and other assets in the area will be impacted directly by the project. A Rehabilitation Action Plan (RAP) process will be completed to IBRD guidelines to ensure compensation will be given in a fair and timely way. This will ensure that all the people affected, will, at the end of the process, be at least as well off as they were previously.

1.58 Mitigation measures to apply during the construction phase include the following:-

- Provision of housing, clean water, sanitation facilities, health services to the construction workers.

- Sewage treatment.
- Dust suppression control
- Noise control

1.59 During the operation phase air emissions will be controlled by burning natural gas and installing low NOx burners.

1.60 Noise control will be by housing and acoustic cladding of noisy plant to ensure noise levels at the site perimeter are within regulations. Other noise reduction measures such as tree plantations may be used as appropriate.

1.61 Impacts of the cooling water system will be mitigated by:-

- Design of outfall to reduce extent of thermal plumes.
- Maintaining residual chlorine levels at less than 0.02 ppm.
- Measures to reduce impingement of fish at the intake.

1.62 All other waste water streams will be treated so that effluents will satisfy Vietnamese regulations and will not cause any significant impacts.

1.63 In order to avoid risks of ground water pollution or soil contamination all waste materials that will arise at the site will be monitored as to type and quantity and removed offsite for disposal or recycling.

Consultation with Affected Groups

1.64 The groups directly affected by the project are:

- 6 families who live on the project site (Phumy I).
- 135 other families who own land and other assets on the site (88 for Phumy I, 47 for Phumy II).
- 16 families who live in houses along the proposed route of the transmission line and who will have to move (Phumy II).

1.65 These people are represented by the Peoples Committee of Phumy who also look after their interests in relation to compensation and resettlement. The company responsible for this project (EVN) have had discussions with the Peoples Committee about plans for the project and compensation issues and the Peoples Committee have informed the families concerned. A representative of EVN has also spoken individually to each of the project affected families.

1.66 As already described in Chapter 4, a survey was carried out of the families affected by the project by Environmental Protection Centre (EPC), H.C.M City. This survey established details of the area of land owned by each family, the type and

quantity of crops grown on each property, the annual income as well as the attitude of the families towards the project and the preferred type of compensation. No objection was voiced to the project as long as proper compensation was agreed.

1.67 On July 15th Dr. C. McMahon of the Consultancy Company, ESBI, visited the Phumy area in order to have independent discussions with the affected groups. In an open discussion with the Peoples Committee the same views as above were expressed i.e. the project is welcome because of the provision of badly needed jobs in the community as well as improvements in infrastructure such as roads and electricity supply. There was an issue about compensation for land, crops and trees. It was felt that the preliminary amount suggested was not sufficient for people to purchase equivalent land elsewhere. Apart from this the only issue raised was that of dust from trucks passing by during construction and a request to hard surface the road. This is already planned.

1.68 Discussions were also held with several individuals who live or own land on the site. These all expressed the view that they were happy with the representation of the Peoples Committee and the way they were kept informed of the project, but were worried about the amount of compensation being talked about for their land, crops and other assets. No firm offers had yet been made. Apart from this they welcomed the project, particularly as regards the likelihood of providing jobs for their children.

1.69 It should be noted that a Rehabilitation Action Plan (RAP) is being finalised by EVN and is being done to World Bank (OD 4.3) criteria and guidelines. The criteria for resettlement/compensation is that overall no affected person should suffer in terms of standard of living and must be given full rights to participate in the RAP process.

Environmental Management and Training

1.70 It is recommended that an environmental unit be set up as part of the management structure in the new development at Phumy. The main function of this unit would be the monitoring and control of waste water streams and other emissions from the plant. This function could be combined with the already planned water quality analysis programme at little additional expense.

1.71 It is also recommended that as EVN expands its generation programme, an environmental co-ordinator be established with the function of developing environmental policy, issuing in-house guidelines and establishing compliance with standards and regulations and setting up an environmental management system.

1.72 It is further recommended that this co-ordinator would also liaise with other groups such as a coastal zone management group in order to promote strategies for the protection and sustainable development of the delicate coastal zone.

Environmental Monitoring

1.73 In order to fully control the implementation of the proposed project, it is recommended that the following monitoring programme be put in place:-

- Monitoring programme of the waste water streams from the new project.
- Extension of the existing air monitoring programme.
- Noise monitoring at the site perimeter.
- Monitoring of waste materials arising on site.
- A review of the baseline ecological study of the Thivai river estuary particularly in the area near the power plant site.

1.74 During the construction phase monitoring for dust levels, noise levels, sewage effluent should be carried out to ensure no nuisance is created.

1.75 Recommendations are made for training programs for management and staff at the proposed plant. Particular attention should be given to staff involved in environmental work, to those handling oil and chemicals and those involved in emergency and safety procedures.

CHAPTER 2

POLICY, LEGAL & ADMINISTRATIVE FRAMEWORK

Introduction

2.1 This environmental impact assessment report (EIA) addresses the impacts of a project to develop power generating capacity at Phumy in the South of Vietnam. The proposed development will consist of two blocks of combined cycle plant of approximately 800 MW total. Each block will likely consist of two gas turbines, two waste heat boilers and a steam turbine. This project (Phumy II) is likely to be part funded by the International Bank for Reconstruction and Development (IBRD).

2.2 A separate power development project (Phumy 1) consisting of 600 MW of conventional thermal plant is also planned for the site at Phumy. For completeness of information this EIA will address the impacts of the complete site development, i.e. Phumy I and Phumy II.

The Developer

2.3 The developer of the proposed project is Electricity of Vietnam (EVN), a state owned company which is responsible for supplying power to all of Vietnam. Shortage of adequate base load capacity together with high growth in demand has led EVN to develop this additional power generation capacity. Natural gas from the offshore White Tiger gas field will be available to Phumy in 1997 making it an ideal site for development of combined cycle plant (Ref. 14).

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2.4 This environmental assessment report is prepared for EVN according to the scope and format detailed in IBRD's Operational Directive OD 4.01 (Ref. 18). It is IBRD policy that all major projects shall be subject to an environmental assessment.

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2.6 A comprehensive environmental plan was adopted by Vietnam in 1991 called "The National Plan for Environmental and Sustainable Development: A Framework for Action". This plan provides the framework for establishing environmental issues. The implementation of this plan rests with the Vietnam State Committee for Science and Technology (SCTC) (Ref. 17).

2.7 Within this context national regulations and guidelines have been adopted giving permitted levels of contaminants in air, water and soils. These regulations are addressed where appropriate in this report and the relevant guidelines are summarised in Appendix IV. Several provincial centres including Ho Chi Minh City have also issued local environmental guidelines.

2.8 It is also under this plan that the new Law on Protection of Environment was enacted in December 1993. This law (a) identifies in general terms the responsibilities of the state, organisations and individuals to prevent and remedy environmental deterioration and pollution and carry out specified environmental protection functions; (b) provides for development of environmental criteria (standards) and submission of environmental impact reports on new and existing facilities; (c) provides for responsible parties to pay compensation for environmental damage; (d) establishes the right of individuals and organisations to petition for enforcement of environmental regulations; (e) calls for civil and criminal penalties for violations; and (f) encourages international co-operation. The full implementation of this law will require the issuing by the Government of detailed environmental regulations.

2.9 This law extends environmental impact assessment requirements to a broad range of public and private sector development activities, proposes procedures for screening and incorporating of mitigation plans into project design, and explicitly links EIA review to the project approval process.

2.10 The core agency with environmental mandate is the Ministry for Science, Technology and Environment (MSTE) which was formed in 1992 from the State Committee for Science. Within MSTE, the Department of Environment and Natural Resources (DENR) is the environmental arm with the main responsibility for carrying out these environmental functions.

EIA Review And Approval Process

2.11 Responsibility for project approval, for projects such as the current one under Vietnam's investment policy is given to the National Project Evaluation Board (NPEB) under the chairmanship of the State Planning Commission (SPC). As a member of the NPEB, the Ministry for Science Technology and Environment has the formal authority to comment on environmental aspects of the project. This function would normally be carried out by the Department of Environment and Natural Resources and the EIA has been submitted for their approval.

2.12 At the provincial level Environmental Committees also have formal authority to review and comment on environmental aspects of investment applications. The Environmental Committee at Baria/Vung Tau is the one of most relevance to the present proposed project and this EIA has been submitted for their approval. A copy of the EIA has also been made available to the public in the municipality of Phumy where the proposed project will be developed.

2.13 Within the IBRD EIAs are reviewed and assessed within the appropriate divisions. Both the EIA and the EIA summary are made available for public scrutiny.

CHAPTER 3

DESCRIPTION OF PROJECT

Geographical and Social Context of the Development

3.1 The Phumy site is situated in the Vung Tau Province of Vietnam about 65 km from Ho Chi Minh City. It is located in the administrative unit of Phumy with a population of about 8000 people. The site is 30 km from the town of Vung Tau which is the provincial capital and also a deep sea port taking ships up to 7000 dw tonnes. Figures 3.1 and 4.1 illustrate the location. The site is adjacent to the Thivai River estuary which is a source of cooling water for the proposed plant as well as a means of transportation to the site. The estuary is deep (15 - 30m) and developments planned for the area include a port and a rolling steel mill.

3.2 The site itself has an area of 1.5 km^2 as shown in figure 4.1. The elevation varies between + 1.0m and + 8.0m sloping down to the river estuary. The area of the site near the estuary is swampy and submersed in the rainy season and at high tide. This is a mangrove area with some shrimp, and fish ponds. The higher areas which compose the majority of the site are cultivated with rice, cashew nuts and eucalyptus being the main crops.

Description of Phumy II

3.3 The scope of this project is the development of two blocks of combined cycle power plant providing a total capacity of 800 MW. Each block is likely to consist of gas turbines (100 - 150 MW size) waste heat boilers and a steam turbine.

3.4 Combined cycle plants utilise the following process:-

- Gas turbines burn either gaseous or liquid fuels with the hot gases driving a turbine linked to a generator, to produce electricity.
- The exhaust gases from the gas turbines, typically at a temperature of over 500°C, pass through heat recovery boilers to generate steam. The exhaust gas then leaves the boilers through stacks, in this case 50m high, and at a temperature of about 140°C.
- The steam generated in the heat recovery boiler is used to drive a steam turbine which in turn drives a generator to produce further electrical energy.
- The steam is condensed in the condenser by water cooling and the condensate is returned to the boilers. The cooling water thermal load is dissipated in the estuary.

The benefits of combined cycle plant are:-

- High overall efficiency which is 49% compared with about 36% for conventional thermal plant or 30% for stand alone gas turbine plant.
- As a result, low consumption of fuel per unit of electricity produced and lower emissions of pollutants.
- Low capital cost and fast erection times.
- Low rejection of heat per overall unit of electricity generated.

Figure 3.3 illustrates the combined cycle process.

Structures Required By The Proposed Development

3.5 The development will involve the erection of the following structures:-

- Gas Turbines and heat recovery boilers each enclosed in a building.
- Two steam turbine buildings.
- A laboratory and water treatment plant.
- Electrical building and switch yards.
- Raw water reservoir and treated water storage tanks.
- Unit and auxiliary transformers.
- Unloading Jetty
- Distillate oil storage tanks
- Cooling water intake and outfall system
- Offsite developments including gas pipeline, road improvement, transmission line.

A preliminary layout is shown in Figure 3.2.

Description of Phumy I

3.6 A conventional thermal power plant called Phumy I is also planned for the site This will consist of 3 x 200 MW units burning natural gas. Residual fuel oil will be used as a standby fuel source (Ref. 3).

Phumy I will include boiler and turbine houses, 3 x 200m high stacks, and tanks for storage of residual fuel oil. It will share the cooling water system, jetty unloading facilities, gas intake system, as well as other facilities on the site with Phumy II.

For completeness of information total discharges from the site, i.e. Phumy I and II are considered in this EIA in assessing environmental impacts of the proposed combined circle project of Phumy II.

Description of Proposed Cooling Water System

3.7 Cooling water for all the proposed plant on the site will be taken from the Sao river estuary and discharged, after passing through condensers, into the Thivai estuary (fig 3.2). The maximum flow rate will be $60m^3$/sec with a temperature rise across the condenser of 7°C to a maximum temperature of 37°C. Screens will protect the intake from debris and fish. The cooling water will be chlorinated in order to protect against slime and mollusc growth in the system. Dosage of chorine will be limited to maintain residual levels at the outfall to < 0.02 ppm. The cooling water discharge will be via a 1km canal into deep water where there is no danger of recirculation and where the heat will be dispersed by large tidal flows.

Sources of Air Emissions from the Proposed Project

3.8 For the combined cycle development of Phumy II the main fuel (except for the first several months) will be natural gas. Distillate will be used for standby with an expected load factor of 2-3% with a sulphur content of 0.7%. The plant will be equipped with dry low NOx burners for gas but not for distillate (Ref. 14). Emissions concentrations for relevant pollutants will be:

Phumy II (Combined Cycle Plant)		
	Gas	**Distillate**
NOx (mg/Nm^3)	50	600
NOx (ng/J)	83	500
SO_2 (mg/Nm^3)	0	360
Particulate (mg/Nm^3)	0	< 5

3.9 The first two gas turbines at Phumy are expected to be commissioned in late 1996. They will burn distillate in an open cycle operation (i.e. without waste heat boilers) for about six months until natural gas is available at the site in mid 1997. For this period NOx levels in the emissions will be rather high at about 300 ppm, as it is not considered feasible to install NOx reduction measures such as water injection for such a short operating period. During this short period NOx emissions in terms of ng/j will be higher than IBRD guidelines of 130 for liquid fuels. After natural gas reaches the site distillate will only be used for emergency standby.

3.10 For the conventional plant of Phumy I the main fuel will also be natural gas with residual fuel oil, with sulphur content of 2.8% max., used as back up (Ref. 3). The plant will be equipped for low NOx burners and will have the following emission concentrations:

Phumy I (Conventional Plant)		
	Gas	Fuel Oil
NOx (mg/Nm³)	240	335
NOx (ng/J)	70	100
SO_2 (mg/Nm³)	0	4962
SO_2 (t/day)	0	175
Particulate (mg/Nm³)	0	250

These emission factors, even for residual fuel oil, will not break IBRD guidelines assuming, as is the case, that the site is unpolluted.

Sources and Treatment of Aqueous Emissions

3.11 Regular sources of effluents include:

- Water Treatment Plant effluent which will be treated by neutralisation.
- Sewage discharge for staff of about 500 employees which will be treated biologically and by filtration.
- Surface drains which will be treated through oil interception.
- Boiler Blowdowns which require no treatment.

The resulting effluent, will satisfy Vietnamese and IBRD regulations.

3.12 Irregular sources of effluents include:

- Boiler Gas Side Wash which will be treated for precipitation of metal contaminants.
- Acid wastes which will be treated by neutralisation
- Boiler storage effluents which arise very rarely and usually do not acquire any treatment.

The resulting effluents will satisfy Vietnamese and IBRD regulations.

Sources of Waste Materials

3.13 Waste materials which will arise on site will include waste oils, sludges from sewage and oil interceptors, chemical precipitates, solvents, electrical, chemical, civil and domestic waste. In order to avoid risk of contamination this will be segregated into hazardous and non-hazardous waste and removed offsite for disposal or recycling.

Consumption of Natural Gas, Oil, Fresh Water

3.14 Phumy 1 will burn natural gas at a maximum rate of 33 kg/sec. Standby residual fuel oil, which will only be used when gas is not available, will be burned at a maximum rate of 38 kg/sec. Phumy 2 will burn natural gas at a maximum rate of 35 kg/sec. Standby distillate oil which again will only be used when gas is not available will be burned at a minimum rate of 35 kg/sec. Load factors for standby fuels are expected to be less than 5%. Fresh water requirements for boiler make up and domestic use will be about 2000m³/day. This will be obtained initially from wells on site and will require treatment by clarification, filtration and de-ionisation. Eventually a municipal source of water is planned for the year 2000.

Offsite Developments Associated with the Project

3.15 Offsite developments include:

- Improvement and hard surfacing of about 1.8km of road leading from the site to National Road 51.
- A new gas pipeline extending 5km from the existing Bach Ho - Thu Duc pipeline to the site. The pipe will be buried and its proposed route is shown in Figure 4.1.
- Construction of 4km of 220 kV transmission line to connect the plant to the existing power distribution system.

These are shown in Fig. 4.1.

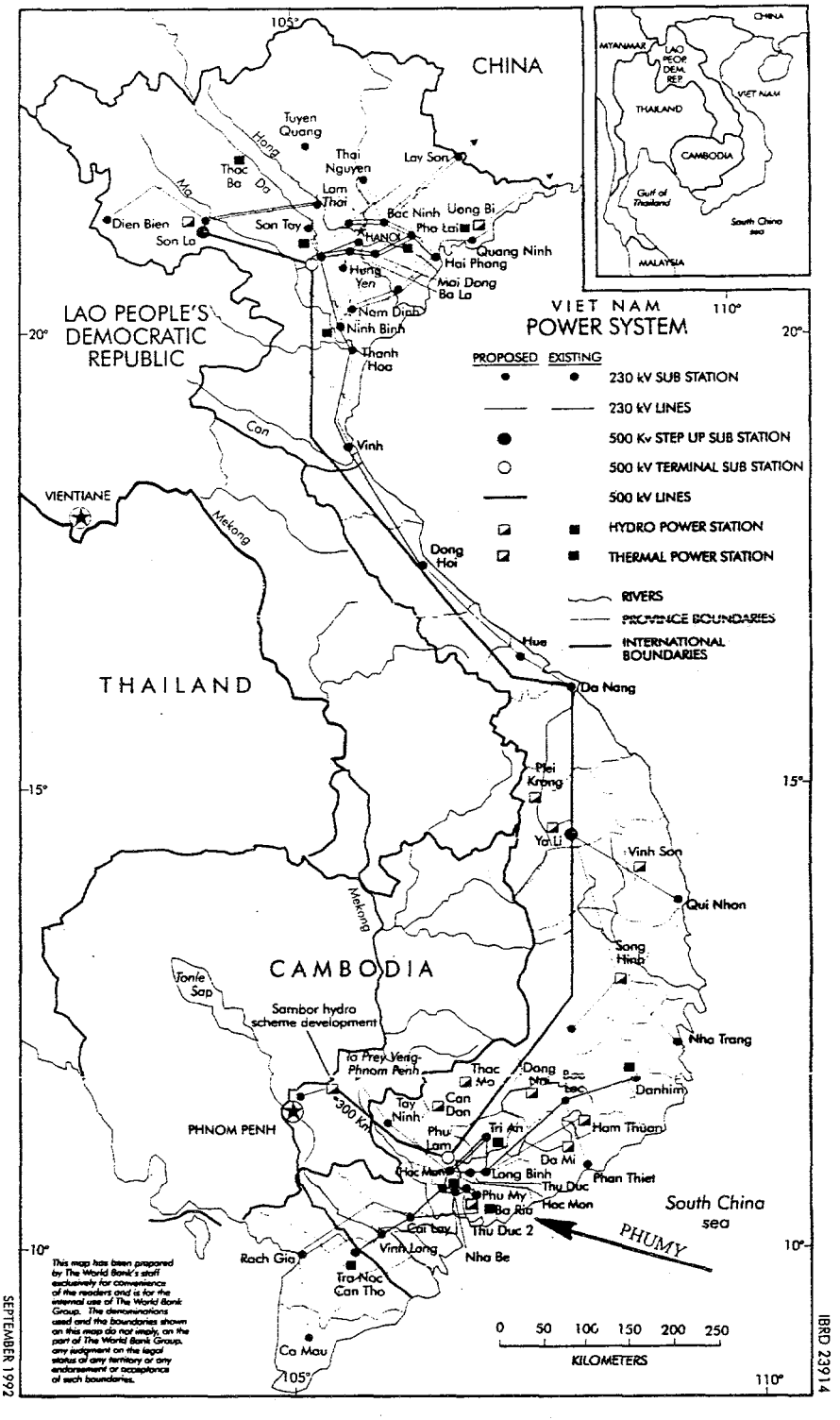
Schedule of Construction

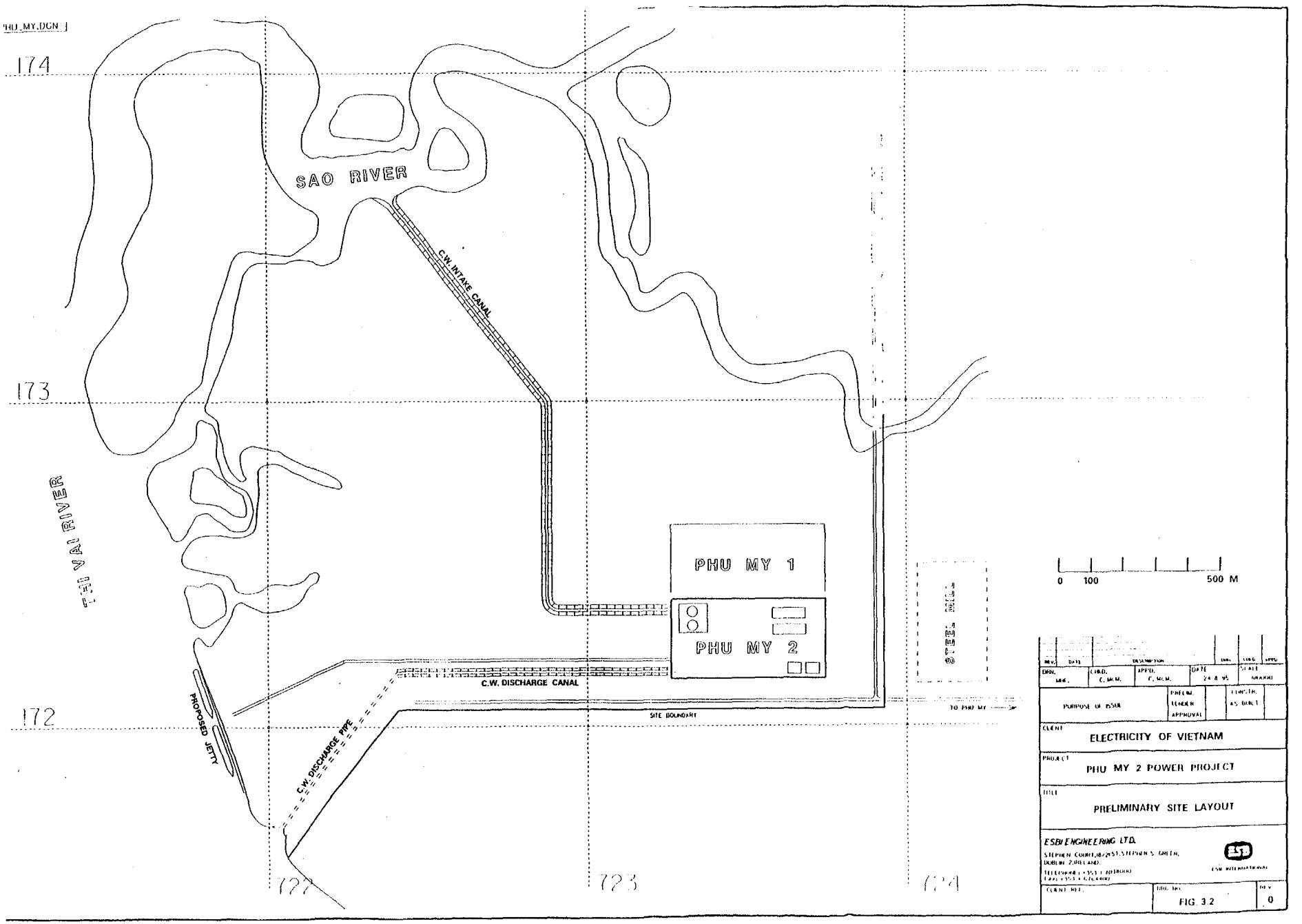
3.16 The first two gas turbines are planned for commissioning in December 1995. While no other plant has as yet a definite commissioning date, a likely schedule for their commissioning is as follows:

Phumy II	two gas turbines (1st Phase)	December 1996
Phumy II	waste heat boilers/steam turbine	December 1998
Phumy II	gas turbines (2nd Phase)	Mid 1999
Phumy II	waste heat boiler/steam turbine	Mid 1999
Phumy I	Unit 1	2000
	Unit 2	2000
	Unit 3	2001

Natural gas will be available on site in mid 1997 and after that all units will burn gas apart from breakdowns in the gas supply system.

Figure 3.1 Vietnam Power Grid




PHU_MY.DGN
174
173
172
SAO RIVER
C.W. INTAKE CANAL
PHU MY 1
PHU MY 2
C.W. DISCHARGE CANAL
SITE BOUNDARY
TO PHU MY
C.W. DISCHARGE PIPE
PROPOSED JETTY
0 100 500 M
ELECTRICITY OF VIETNAM
PHU MY 2 POWER PROJECT
PRELIMINARY SITE LAYOUT
ESB ENGINEERING LTD.
FIG. 3.2
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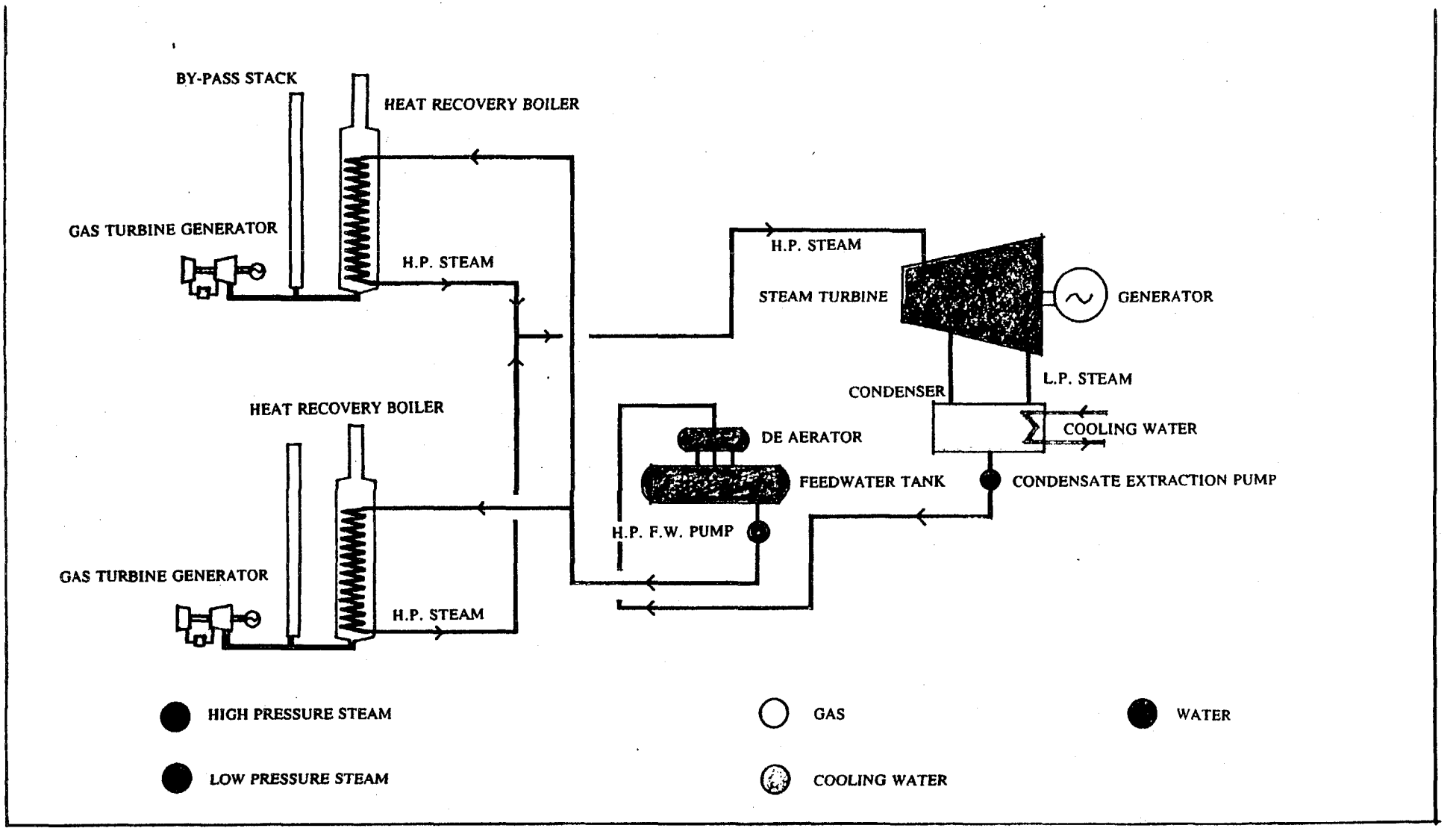


ESB International Consultants Stepehn Court, 18/21 St. Stephen's Green, Dublin 2, Ireland. Telephone: +353-1-785155 Fax: +353-1-616600	CLIENT E.S.B. OPERATIONS	PROJECT Combined Cycle Development	TITLE Typical Combined Cycle Plant - SCHEMATIC	PROJECT ARCHITECT N. Matthews DRAWN CHKD APPR. SCALE DATE June '94 REV JOB NO 4Y003C DRWG NO Figure 3.3

CHAPTER 4

BASELINE DATA

Study Area

4.1 For socioeconomics the study area includes the site itself and Phumy Townlet which are shown in Figures 4.1. For terrestrial ecology the study area includes the site and relevant surrounding areas - particularly mangrove forests along the river banks. For aquatic ecology the study area stretches from the start of the tidal area of the Thivai river to the mouth of the estuary as shown in figure 4.3; although concentrating on the area near the proposed cooling water discharge. The ambient air measurements concentrate on the site itself while ambient noise measurements extend to the site boundary and nearest residences. Much of this baseline data had been carried out for the preparation of the EIA.

Ambient Air Quality

4.2 Hourly measurements over a 24 hour period were carried out in February 95 at 3 locations near the site for Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2), Carbon MoNOxide (CO) and particulate matter. NO_2 levels varied between 0.00 and 0.06 mg/m^3 with higher level occurring during daytime possibly due to traffic and construction activities.

4.3 SO_2 levels varied between 0.01 and 0.02 mg/m^3 also with the higher concentration at day time. Particulate matter concentrations varied between 0.1 and 2.4 mg/m^3. This are high values and reflect local activities of day time. CO values were close to zero. These ambient air measurements are not satisfactory in giving an overall picture of spatial and temporal variation in air quality at the site which appears to be in a rural unpolluted setting. The Environmental Protection Centre, Ho Chi Minh City, (EPC) are carrying out continuous measurements at 3 locations (see Figure 4.2) on the site in order to rectify this situation.

Meteorological Data

4.4 A local meteorological station at Phumy, just 2km from the project site has been recording data for several years. Typical Data for the wet season (May - November) and dry season (December - June) are summarised in Table 4.1 Details are given in Appendix V.

4.5 Monthly wind speed averages are 2.3 - 3.6 m/s in the wet season and from a South West direction. Monthly means in the dry reason are 2.3 - 4.0 m/s with winds from a North East direction. For the purposes of dispersion calculation atmospheric stability is considered in the C - D category at day and D for night-time.

TABLE 4.1

Meteorological Data of Phumy Monthly Average

	Temp °C Mean	Solar Radiation Daily Total kcal/m^2	Atmospheric Pressure Mean mb	Humidity % Mean	Monthly Mean (mm)
Wet season	27.2	110	1013	86.6	250
Dry Season	26.1	160	1009	76	15

Noise

4.6 From an environmental point of view the base line noise data of most relevance is that at the site perimeter and particularly at the nearest residence. The site is of a rural nature with little man made sources of noise. The exception is construction activities nearby for the development of port facilities and a steel mill.

4.7 Noise measurements carried out by E.P.C at the site perimeter indicate values in the range 40 - 70 dBA and these are given in Appendix IV. The rather high levels which occurred during day time reflected construction activities at a nearly steel mill.

4.8 The Vietnamese regulations (ref. 7) put the permitted levels of noise at public places at 60 dBA during day time and 55 dBA at night where dBA is the measured sound pressure in decibels corrected to the A scale in order to reflect the perception of the human ear. These levels are permitted to rise depending on the percentage of time spent at a particular location and other factors (see Appendix III). The permitted levels indoors are 40 dBA during day time and 30 dBA at night.

4.9 The IBRD guidelines for noise state that the limits at residences should be L_{dn} 45 indoor and L_{dn} 55 outdoors where L_{dn} is the day - night average A weighted equivalent sound level with a 10 decibel weighting applying to night time levels. (Ref.20)

4.10 At the moment the ambient levels of noise do not break the guidelines for residential levels. Because of the large site area there is flexibility in the control of noise at the site perimeter from the proposed plant by distance, insulation or planting of trees for noise shielding.

Terrestrial Ecology - Plants

4.11 Mangrove forests form the most significant ecosystem in the region and these are extensive along the estuarine region shown in the Figure 4.2. These forests are one of the main primary producers in the coastal region providing nutrients, food, shelter and habitat to many species of fish and shellfish. Mangrove forests and the natural fisheries associated with them are under increasing threat here as in many parts of South East Asia from:-

- Increased siltation in rivers.
- Pollution levels, particularly sewage and herbicides.
- Harvesting of mangroves for firewood and charcoal.
- Coastal development.
- Shrimp aquaculture.

The greatest single threat probably comes from the development of shrimp farms which are a fast growing activity in many parts of South East Asia as well as the Thi Vai estuary area. The damage comes from the cutting down of mangrove trees to construct the ponds for shrimp aquaculture as well as the polluted water, containing biocides and other waste material, released back into the estuary. (Ref. 6, 10, 15)

4.12 As indicated in Table 4.2 there are various levels of shrimp aquaculture and it is the intensive levels with very high stocking rates of shrimps which cause the main environmental damage described above. With the low to medium intensity systems of aquaculture which are currently practiced in these areas environmental damage is much less and mangrove trees are an essential part of the aquaculture system in providing stability for the dikes and shade and habitat for the shrimps. The areas of shrimp farming near the proposed power station site are shown in Table 3.47, Appendix 1X. The total area is 1749 ha.

TABLE 4.2

CULTURE SYSTEMS OF SHRIMPS (REF 15)

	Traditional	Extensive	Semi-Intensive	Intensive
Stocking rate (per ha)	10 000	<10 000-30 000	<30 000-100 000	<100 000-300 000
Feed	natural food	natural food + occasional supplement	natural food + supplementary (unprocessed or formulated feed)	formulated feed
Water management	tidal	tidal, pumping optional	tidal + pumping, aerational optional	pumping + aeration
Production yr^{-1} ha^{-1}	100-500 kg	0.6-1.5 tons	2-6 tons	7-15 tons

4.13 A base line study found 32 species of mangrove in the area with distribution of species varying according to levels of submersion and salinity. The mangroves growing on the Phumy side of the estuary form a natural forest consisting of a mixture of species such as Phoenix Paludose, Acriennia, Sonneratia and Bruguiera. On the far side of the estuary it consists of Rhizophara Aciculate which has been planted since 1975. Some of these mangroves have been exploited for charcoal production leading to a reduction in numbers and problems with erosion. Details of mangrove species found in the study are given in Appendix VI.

4.14 In the site area itself mangroves grow to a small extent in the lower areas along the Thi Vai, Muong and Sao streams. These are indicated in figure 4.1. The baseline studies did not indicate the presence of any endangered species on the site itself or nearby.

4.15 Apart from the mangrove ecosystem there are no other natural or unusual habitat areas either in the site itself or nearby. These areas are intensely cultivated for rice, cashew nuts, eucalyptus and other crops. In a base line study of the area over 200 species of plant were identified in the study area of which 101 were also found in the site area itself. They are listed in Appendix VI along with an indication of the type of plant, its usage and the extent of its distribution.

Terrestrial Ecology - Animals

4.16 30 species of birds were identified in the site area, mostly associated with the mangrove forests as well as water fowl that feed in tidal areas of the Thi Vai estuary. These are listed in Appendix VI. None are considered particularly rare or endangered.

4.17 17 species of mammals were identified in the area including wild pigs, wild cat, otters, rabbits, monkeys that mostly live in higher areas of mangrove forest and shelter under the canopy. Eight species of amphibian and 16 of reptile were found and these are all listed in Appendix VI.

Physical and Chemical Characteristics of the Thivai River

4.18 The Thivai River is about 40km in length originating from Long Thanh in Dong Nai province, running through Tan Thanh district and discharging into the South China Sea as shown in figure 4.3. The flow in the river is substantial during the wet season but negligible in the dry season. The Thivai estuary is tidal up to the Godan station which is about 10km upstream of Phumy site. At Phumy site the estuary is about 400m wide and varying in depth from 15 - 30m. Tidal range is about 3m. Tidal flows are recorded as up to 10,000 m^3/s. (Ref. 5, 14).

4.19 Water quality in the Thivai River estuary was assessed by EPC in 1993 based on samples taken at 6 locations at high and low tide. Parameters measured included, pH, colour, suspended solids, total solids, dissolved oxygen (DO), chemical oxygen demand (COD), anions, metals, oil and coliforms. Further analyses near the Phumy site were carried out in 1995. The results are given in Appendix VII.

4.20 The main points to emerge were as follows:

- Salinity levels are high at an average of 25ppt with a minimum of 21ppt in the wet season and a maximum of 32ppt in the dry season.

- Organic pollution of the river is significant as indicated by high COD (10-19 mg/l) and BOD (5-15 mg/l) levels. The likely sources are waste water from cities and industries upstream as well as natural biomass decay. In the dry season pollution is much less evident.

- There is no evidence of contamination by heavy metals or phenols.

- There is some evidence of oil pollution.

- The presence of pathogenic bacteria is high in some places in the rainy season indicating pollution from human sources.

4.21 A separate survey of dissolved oxygen (DO) was carried out at 3 locations and several depths near the site. Results are given in Appendix VII. They show DO levels from 3.2ppm to 4.7ppm with relatively little variation between depths. This represents oxygen saturation levels of just over 50%.

4.22 Samples of river sediment were taken at 3 locations and analysed for heavy metals and organochlorines. Relatively high concentrations of chromium (Cr) and cadimium (Cd) were found in some samples. The source of the contamination is not known. Details are given in Appendix VII.

Physical and chemical characteristics of the Sao Stream

4.23 The Sao stream originates from the Thivai mountain, flows by the Northern boundary of the project area and joins with the Muong creek before discharging to the Thivai river. See figures 4.2 and 4.3. Flow rates are 0.2 - 0.5 m^3/s in the rainy season and zero in the dry reason. (Ref. 3)

4.24 Results of water quality analysis show that this stream is significantly polluted by organic matter with BOD values ranging from 6-19 mg/l and COD values from 8-23 mg/l. Iron concentration at 1.3 - 3.6 mg/l are relatively high and high counts of coliforms shown contamination by domestic waste.

Ecology of River Systems

4.25 Baseline studies of the ecosystem of the Thivai River show that overall it is typical of the vast area of delta in the region as shown in Figure 4.3. It is rich in numbers of species of fish, plankton and other organisms but shows some evidence of degradation from pollution.

4.26 Studies carried out by Institute for Ecology and Biological Resources showed the presence of 79 phytoplankton species and 31 zooplankton species in the general area of Thi Vai estuary. Differences in abundance between studies carried out in 1989 and 1995 indicate a possible reduction in population perhaps related to an increase in water pollution. See Appendix VIII for details. The study did not indicate the presence of any endangered species.

4.27 Samples taken at transects in the vicinity of Phumy site identified 42 zoobethnic species consisting of the following families:-

Polychacta	25 species
Crustarea	10 species
Mallusca	6 species
Lanodermata	1 species

4.28 Unlike many parts of the river the bed near the project area is soft and a good habitat for these species. Many of these animals live in nests made from mangrove plant debris. Overall population density is similar to the adjoining Saigon - Dongnai rivers (100 - 500 individuals/m^2).

4.29 The population density of certain species indicate that the river is contaminated by organic substances and if this continues it could lead to development of a zoobenthos distribution typical of polluted rivers (high frequency of Nephtlys Polyhranchia, Ceratonereis Burmensis, Scolophos Armiger and low levels of

Bispira Polymorpha). It is noted that two specifies of Zoobentha i.e. Balance Amffritrite and Ostrea spp. may cause damage to underwater structures and ships. Details are given in Appendix VIII.

4.30 From examination of local fish catches and independent sampling, sixty two specifies of fish and 20 species of shrimps and crabs were identified in the estuary areas as detailed in Appendix VIII. Fish species are distributed throughout the area but with a higher population down stream. Shrimps have a higher population density upstream. Twenty species of fish and 11 species of shrimp and crab are of economic importance.

4.31 Fish species may be broken down broadly into two groups:-

- Brackish water fish families living in the river estuary and rarely migrating to the ocean or fresh water regions. They include Eleotridae, Gobiidae, Apocryptidae, Contropomidae, Scatophagidae.

- Groups of saline water fish families usually living in the sea but migrating periodically into the river estuary. The major families are Engraulidae, Ariidae, Scian idae, Mugilcidae.

The sea fish species may breed in the estuary or the sea while the brackish water fish breed and grow only in the estuary.

4.32 A survey carried out in 1982 identified the composition of fish eggs and ichthyplantston in the delta area as shown in Table 4.3. (Ref. 3)

Table 4.3

No.	Family		Percentage (%) in total planktons	Density (individuals/ 100 m³
	Scientific Name	Vietnamese Name		
1	Gobiide	Bong trang	22.0	16.5
2	Bregmacerotidae	Tuyet te giac	17.4	13.0
3	Cymoglossidae	Bon cat	11.3	8.5
4	Engraulidae	Trong	9.4	6.0
5	Ambassidae	Son bien	7.2	5.4
6	Clupeidae	Trich	6.5	4.9
7	Sciaemidae	Du	5.7	4.3
8	Synodotidae	Moi	4.1	3.1
9	Leiognathidae	Liet ngang	3.6	2.7
10	Carangidae	Khe	2.5	1.9
11	Decagiterus	Nuc	No detectable	0

The composition is typical for estuarine fish specifies as are the concentration levels.

4.33 Further studies on fish eggs and ichthyoplankton in the vicinity of the project site were carried out in 1991, 1992 and 1995 and details are given in Appendix VIII. The results show that members of the Gobiidae family predominate, occupying 83 - 98% of the total number of ichthyplankton. Members of Ambassidae comprised 6.7% of the total while other fish families took up only 6% of the total.

4.34 The results also show that the ichthoplankton concentration varies with the depth and time of day. At noon time and night time they concentrate mainly at the surface layer with densities of 233 and 100 individuals per m^3 and with only 13 and 50 individual / m^3 respectively at the bottom layer. In the afternoon they concentrate at the bottom layer with a density of 157 individual per m^3.

Socioeconomics of Phumy Area

4.35 Phumy townlet is a recently set-up administration unit of Tan Thanh district, in Ba Ria - Vung Tau province. It covers an area of about $20km^2$ with a population of 8126 and a total number of house-holds of 1481. The population growth rate is about 1.9%. Phumy Peoples Committee, which administers the area, is a locally elected body and this committee will represent the interests of people affected by the project.

4.36 The main industries are agriculture, fishing, salt production, forestry as well as service and handicrafts. Over 60% of the inhabitants live on agricultural activities concentrated on cashew nuts, rice and aquaculture. Soil conditions are not favorable to rice cultivation and the output, at 2 tonnes/ha, is low. Annual income of farmers, quoted at about 89$US, is lower than the average in the province.

4.37 Aquaculture is widely practiced in ponds along the Thivai River. The major shrimp species grown is Penaeus merguiensis as well as several types of saline fish and crabs. Details of fish and shrimp production as well as pond areas are indicated in Appendix IX. The total area of shrimp pond along the Thevar River is 1749 ha of which about 20 ha occurs on the site itself.

4.38 Fishery production on the Thi Vai river is about 2600 tonnes per annum with details of the catch and fishing gear given in Appendix IX. Not all this is carried out by people from Phumy Townlet.

4.39 Infrastructure services are poor with just two thirds of house holds having electricity supply and with 60 wells, funded by UNICEF's clean water programme, providing a water supply to the area. One health service clinic, staffed by 4 assistant doctors, provides a limited service. Malaria still occurs in families living along the river but is decreasing in prevalence. There is an elementary and secondary school; most students do not finish secondary school and are forced to work due to economic necessity. There is high unemployment and underemployment.

Socioeconomics of Families directly affected by the Project

4.40 The groups directly affected by the project are:

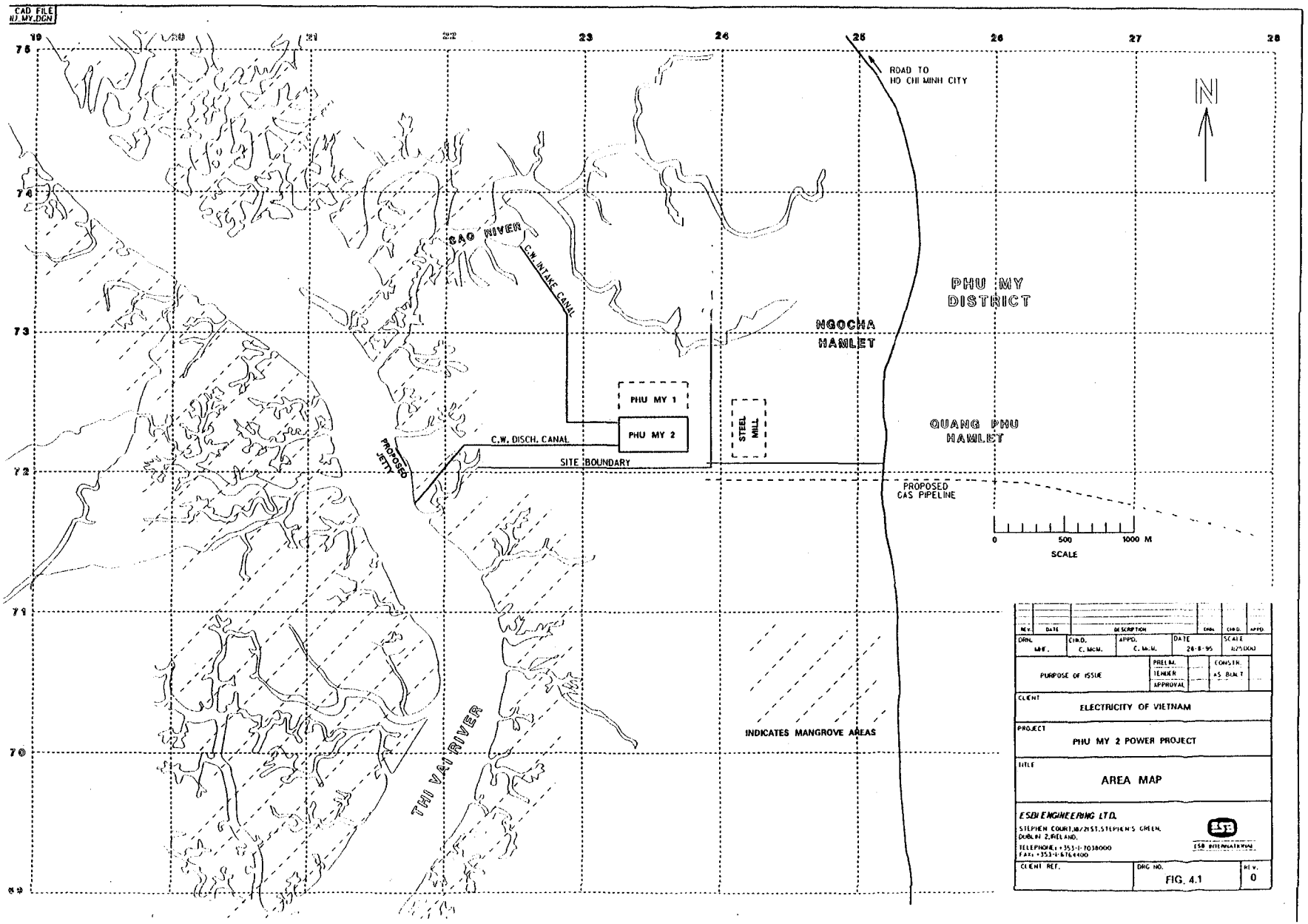
- 6 families who live in the site area (Phumy I)
- 135 families who own agricultural land and other assets on the site (88 for Phumy I, 47 for Phumy II).
- 16 families who have to relocate their houses due to construction of transmission lines (Phumy II).

4.41 Most of these families are dependent on agriculture for their income which is mostly from cashew nuts, fruit crops, rice and aquaculture. In general the only worry about the project expressed by the families affected has been that of adequate compensation for their land, houses and crops.

4.42 A socio economic survey of the families who own land on the site has been carried and some of these findings are presented in Appendix IX. Consultations with these groups have also taken place as out-lined in Chapter 8. A separate Rehabilitation Action Plan (RAP) is being undertaken and will detail exactly the land, crops, income and other assets owned by all affected families as well as the compensation process which will ensure they do not suffer any loss in standard of living as a result of the implementation of the project.

New Developments not associated with the Project

4.43 It is planned to develop the area along the Thivai estuary near Phumy and to attract appropriate industries. A harbour is already under construction about 2km downstream of the Phumy site. A nearby rolling steelmill is also under construction.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PROJECT
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TITLE
AREA MAP
ESB ENGINEERING LTD.
STEPHEN COURT, 18/21 ST. STEPHEN'S GREEN,
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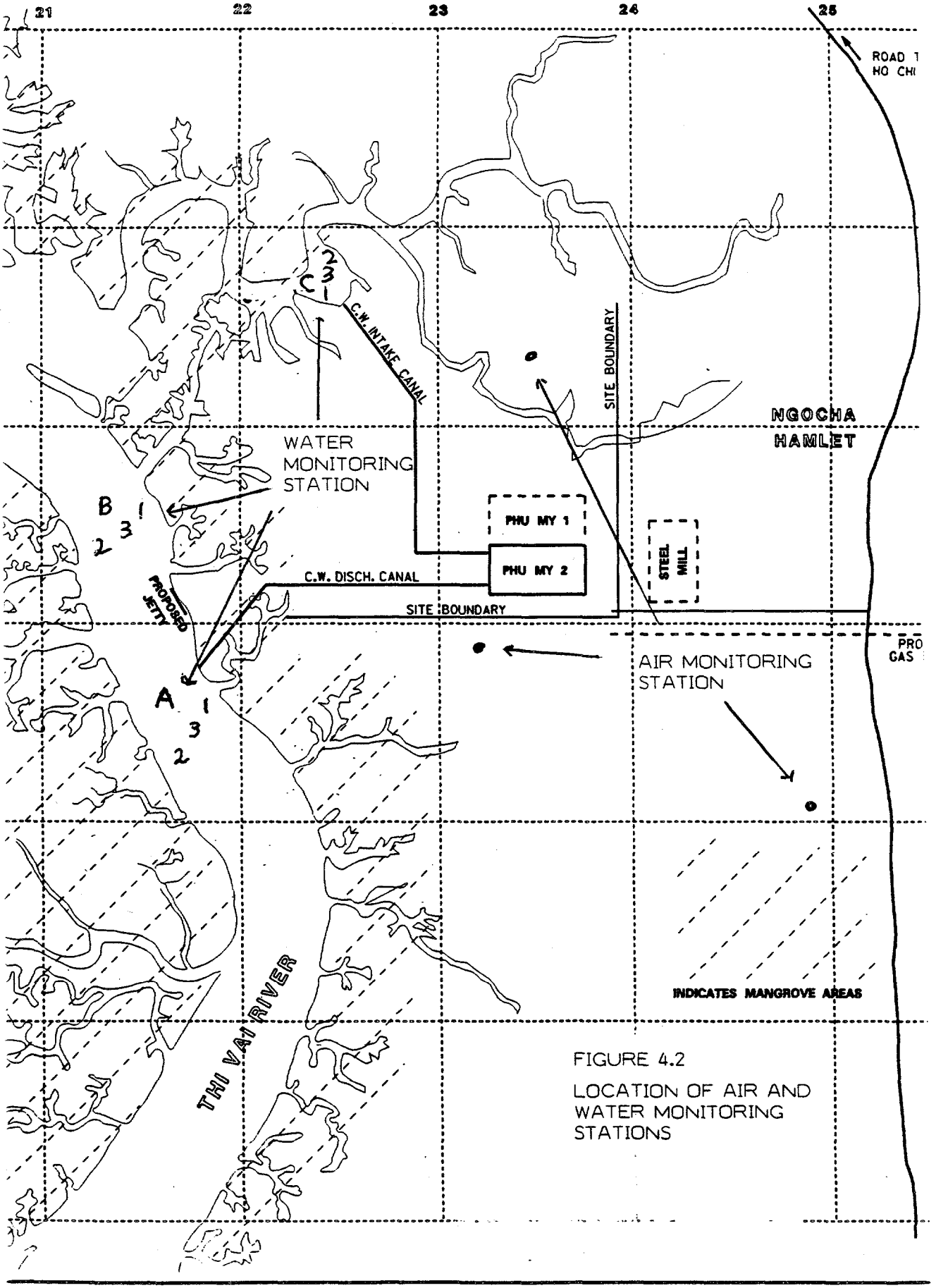
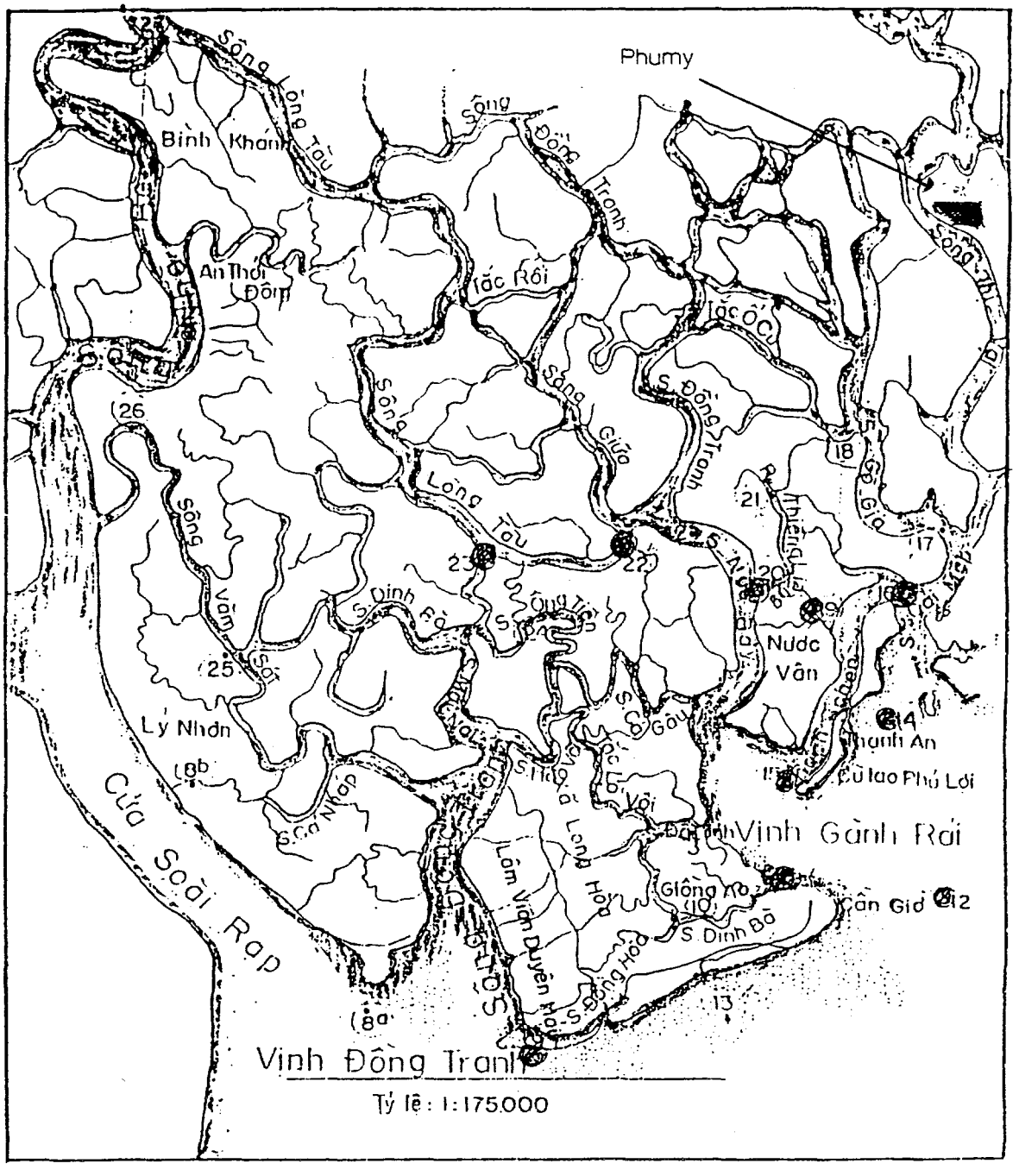


FIGURE 4.2

LOCATION OF AIR AND WATER MONITORING STATIONS

FIGURE 4.3

DELTA AREA NEAR PHUMY



CHAPTER 5

ENVIRONMENTAL IMPACTS

Summary Of Positive Impacts

5.1 The proposed project, consisting of combined cycle plant burning natural gas, is the most environmentally benign form of thermal power plant. It has a very high efficiency, close to 50%, and lower air emissions and cooling water requirements per unit of electricity generated than for conventional plant. In particular, when burning natural gas with a low NOx burner as is planned for this project, there are no significant emissions of NOx or SO_2 and emissions of carbon dioxide are 50% lower than for conventional plant burning fuel oil or coal.

5.2 A major and positive impact will be the provision of 800 MW generating capacity. This will impact on a regional basis by strengthening the electricity supply network and allowing the connection of extra consumers and the development of industry and services in the region. The employment of a large number of people during the construction and operation phase will also benefit the local economy.

Summary of Negative Impacts

5.3 Impacts during construction and operation of the proposed plant are summarised in Tables 5.1, 5.2, 5.3, 5.4 as well as described below.

Construction Phase Impacts

Socioeconomic Impacts

5.4 The main groups of people affected are those who live or own land in the site area. Six families, will have to move from the site (Phumy I). They will be fully compensated for their land, their crops and their houses enabling them to acquire equivalent land nearby, build houses, and continue their livelihood without any loss of income. A separate Rehabilitation Action Plan (RAP) will give full compensation details of these and other families affected by the project implementation.

5.5 A total of 135 individuals also own land, but do not live on the site (Phumy I and II). Full details of the areas of these plots and the quantities of rice, cashew nuts and other crops are given in the RAP report as well as details of the compensation process and the actual compensation awarded for each family.

5.6 Sixteen families live in houses which will be affected by transmission line construction (Phumy II). These will be relocated to equivalent or better houses nearby.

TABLE 5.1

Summary of Environmental Impacts During Construction Phase

Source	Environmental Impact	Mitigation Measures	Residual Impact
Site Acquisition	Displacement of people living and owning land on site	Adequate and timely resettlement and/or compensation	Temporary disturbance - no reduction in assets or income
Transmission line construction	Displacement of 16 families	Adequate and timely resettlement	Temporary disturbance only
Construction of Jetty	Loss of 2ha of Mangrove	None	Local but permanent
Construction of C.W. outlet	Loss of Mangrove	Pipes are buried and area will be replanted	Temporary
Dredging activities	Loss of benthnic fauna	None	Local and Temporary loss
Sanitation facilities	Sewage discharge	Effluent will be treated to Vietnamese standards	Minor
Noise	Noise during piling and steam purging operations	Restrict piling to day light hours. Notify residents of steam blows	Minor and temporary
Dust	Dust generated	Spraying of access roads and truck tyres	Minor
Construction Work	Traffic Increase	Road Improvement	Minor
Work during construction	Short term employment for over 1000 workers		Beneficial short term

TABLE 5.2

Summary of Environmental Impacts
During Operation of Plant - Aqueous Emissions of Phumy I and II

Source	Environmental Impact	Mitigation Measures	Residual impact
Water Treatment Plant Waste	Contains strong acids and alkalis	Treated in neutralisation tank to pH 6-9. Effluent will comply with waste water standards	Negligible
Oil Contaminated Surface Water	Adverse impact on marine organisms if discharged directly	All surface drains will be routed through oil interceptors. Effluent will comply with waste water standards	Minor
Sewage	High BOD and micro biological pollutants	Sewage will be treated to <20 mg/l BOD before discharge	Minor
Boiler Blowdown	Contain very low concentration of contaminants	No treatment necessary	Negligible
Boiler Acid Clean	Utilises toxic chemicals. This process arises only rarely.	These will be treated with the waste removed off site for disposal. Effluent discharged will satisfy waste water regulations	Minor
Chemical Spillage	Bulk chemicals stored on site, in particular acid and alkali	Stored bulk chemicals will be bunded so that any spillage will be contained and controlled	Negligible
Boiler Washing	If burning residual fuel oil can contain vanadium and other metals	Metals will be precipitated by chemical treatment and removed offsite to land fill	Minor

TABLE 5.3

Summary of Impacts of Atmospheric Emissions for Phumy I and II When Burning Natural Gas

Impact		Predicted	Vietnamese Regulations	IBRD
Nitrogen Oxide (NO_2) (a)				
Ambient				
1-hour maximum	$\mu g/m^3$	110	300	---
24-hour maximum	$\mu g/m^3$		---	---
Max. annual average	$\mu g/m^3$	2	80	100
Sulphur Dioxide (SO_2) (b)				
Ambient				
1-hour maximum	$\mu g/m^3$	0	300	---
24-hour maximum	$\mu g/m^3$	0	---	500
Max. annual average	$\mu g/m^3$	0	80	100
Carbon Dioxide (CO_2)				
Emission				
Tonnes/annum (total) (a)		4.7×10^6	---	---
Noise (dB (A))				
Noise Levels at Boundary fence		55		55 (b)
Residential Area		<55	55/60 (b)	55 (b)
Particulates				
24-hour maximum	$\mu g/m^3$	<1	200	500

(a) 100% load factor
(b) Varies with day / night; indoors and outdoors and other factors

Table 5.4

Summary of Impacts of Cooling Water System Operation for Phumy I and II

Source	Environmental Impact	Mitigation Measures	Residual Impact
Intake of 60 m^3/s	Loss of fish eggs and plankton	None	Small in relation to overall abundance in the area
Intake screens	Loss of fish through impingement	Optimum measures not yet selected	Minor
Discharge of heated water	Impact on sensitive organisms	Discharge designed so that temperature rise will not exceed 1^0 C	Minor
Chlorination of C.W. system	Impact of residual chlorine on ecosystem	Residual chorine levels will be kept to < 0.02ppm	Negligible
Discharge of CW	Scouring of bottom	None	Permanent but local disturbance of area

5.7 The principals under-lying the rehabilitation, resettlement and compensation for people affected by the project are:

- Loss of houses will be compensated by replacement residential land and cash compensation sufficient to replace the structure. A disturbance allowance will also be given.
- Other assets such as crops and trees will be compensated for at full market price.
- People affected by the project will have rights to argue their case and any grievances at local and district government level and, if not resolved, to district courts without incurring legal fees.
- The rehabilitation/resettlement process will be monitored by an external agency.

As a result of this RAP process the people affected by the project will improve their living standard, or at least maintain their existing one.

5.8 The impact on the townlet of Phumy should over-all be positive by the provision of jobs and the improvement of infrastructure including roads and electricity distribution. Up to 2000 people are expected to be employed on the construction for several years and several hundred permanent jobs will be created during the operating phase. It is normal practice for a proportion of these jobs to be given to local people. (Ref. 3)

5.9 The large construction force of up to 2000 workers will mostly live in serviced camps. They will be employed as drivers, excavators and construction workers. The presence of these people, who will come largely from other areas, with relatively large incomes and different life styles, may cause some social tension in this traditionally quiet area. Training programmes will be run to mitigate these potential difficulties. The camps will consist of temporary houses which will be serviced with sanitation facilities, fresh water and domestic waste removal services. A health centre will be responsible for control of infectious diseases as well as occupational health issues.

Land Use Impacts

5.10 The areas to be cleared for construction of buildings, hard surfaces, tanks, cooling water system and jetty are indicated in layout drawing 3.3. The main items of significance are the permanent loss of an area of mangrove forest of about 65m × 340m for the jetty. The number of trees lost will be about 2000. Dredging for the cooling water outlet pipes will clear an area of mangrove of about 1 ha. As these pipes will be buried the area can be replanted successfully and will return to its former state after several years. Construction of the cooling water intake will also destroy about 0.5 ha of mangrove area composing about 1000 trees.

Construction Phase - Air, Water and Noise Emissions

5.11 Dust generation is always a problem during construction activities. It will be controlled as much as possible with water spraying. The road passing through Phumy townlet passes by many residences and particular precautions will be taken to prevent dust here. Hard surfacing of this road, as is planned, will keep dust levels down.

5.12 The main sources of noise will be piling operations. Restricting this to day light hours as is customary, will prevent disturbance to neighboring residences. Restriction of speeds of trucks when passing residential areas will also help.

5.13 When the boilers are being commissioned, steam is blown through the turbines and boilers to purge them. This steam is exhausted to atmosphere causing high noise levels for several hours per day over a few days. The procedure is a once off occurrence and confined to day light hours. Silencers will be used to reduce the impact and local residents will be given prior notice of these events.

5.14 Sewage discharges will arise from the sanitation facilities provided for the construction workers. These will be treated so that the effluent satisfies Vietnamese regulations.

Dredging for Jetty and Cooling Water Outfall

5.15 The jetty is planned to take tankers up to 10,000 dw tonnage requiring water depth of 12m. Although the estuary is deep some local dredging will be required. Dredging will also be required for the cooling water outlet pipes and inlet structure.

5.16 The river bed near the plant is covered by a soft grey sediment, mixed with decayed organic matter. Dredging activities will have the following negative impacts

- Destruction of benthnic animals.
- Disturbance of fish and other animals.
- Increased pollution from suspended solid as well as organic matter and other materials present in the river sediment .
- Risk of oil spill and other waste materials from dredging operation.

These impacts are local and temporary and after ceasing dredging operations the area will revert to a similar ecological state as before.

Transmission Line and Gas Pipe Line

5.17 A 4km long 220 kV power line will be required to transmit power to the existing transmission line. A right of way of 22m will be required and this will entail the loss of 16 houses. All project affected people will be fully compensated as detailed in the project RAP report.

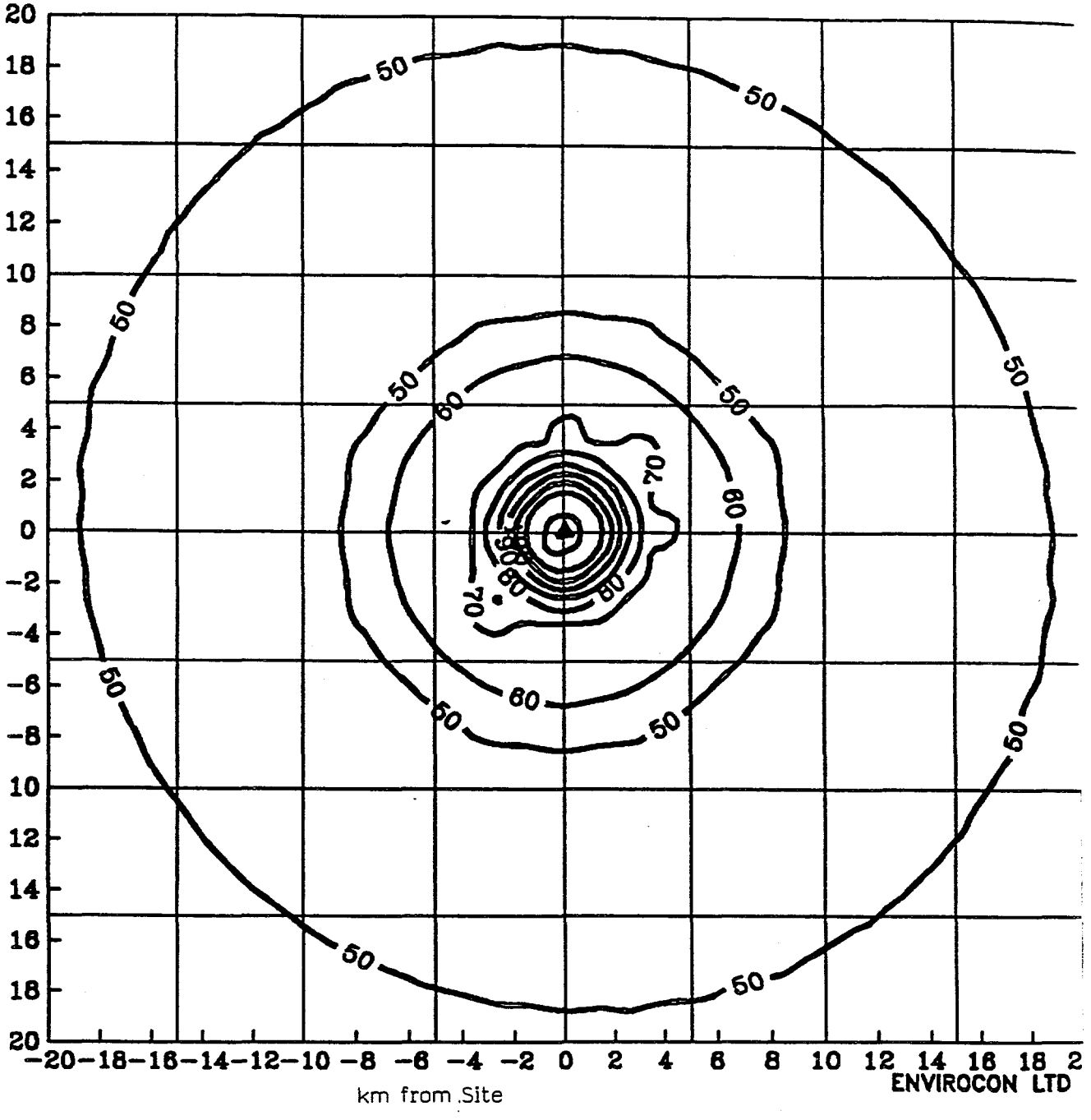
5.18 A 5km natural gas pipeline will be required to connect the site to the existing Bach-Ho - Thu Duc gas pipeline. The route will be selected to avoid disturbance to any residences and it will not cross any sensitive areas. The proposed route is shown in Figure 4.1.

Air Operation Phase Emission Impacts

5.19 Phumy I and Phumy II will burn natural gas with negligible sulphur content. The plants will be equipped with low NOx burners which will limit emission of NOx (as NO_2) to 125 ppm for Phumy I and less than 50 ppm for the combined cycle plant of Phumy II. Emission of SO_2 and particulates would be negligible.

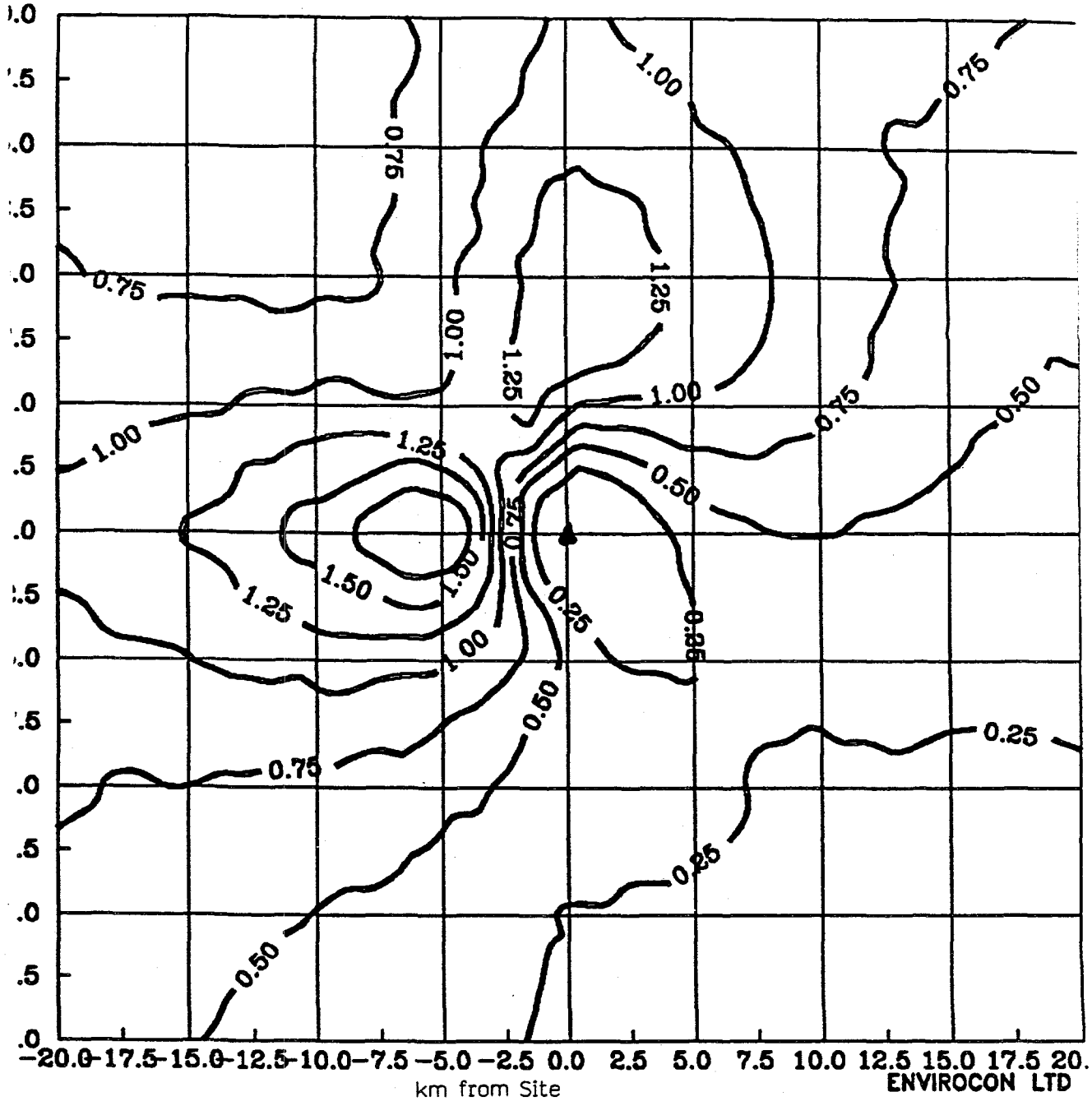
5.20 A gaussean air quality dispersion model was used to compute ground level concentrations for the case of all the plants on full load burning natural gas. The model used was the Industrial and Source Complex (ISC2) which was developed by the US EPA to predict short and long term ground level concentrations for single and multi point emission sources. Details of the study are given in Appendix X.

FIGURE 5.1



MAXIMUM HOURLY NO_2 GROUND LEVEL CONCENTRATIONS –PHUMYI AND PHUMY II(UG/M^3)

FIGURE-5.2



ANNUAL AVERAGE NO_2 GROUND LEVEL CONCENTRATIONS –PHUMY I AND PHUMY II(UG/M^3)

5.21 The maximum hourly NO_2 concentration is predicted to be about 0.100 - 0.110 mg/m^3 within 5km of the power plant and with maximum levels of about 0.050 mg/m^3 between about 5 - 20km down wind. At larger distances the predicted hourly NO_2 concentrations were less than 0.050 mg/m^3 (Figure 5.1). Given the low existing levels of NO_2 in the area there is no danger of any breach of Vietnamese (0.3 mg/m^3, hourly max.) regulations.

5.22 Annual average ground level concentrations of NO_2 were also calculated on the basis of 100% load factor. The results are shown in Figure 5.2. The maximum annual average contribution of 0.002 mg/m^3 would not break any standards or impact significantly on air quality, for comparison Vietnamese regulations limit annual mean values to 0.080 mg/m^3 (Ref. 12) while IBRD limits are 0.100 mg/m^3. (Ref. 20).

5.23 The first two gas turbines on the site will be commissioned in December 1996 and natural gas will not be available on the site until the middle of 1997. These gas turbines will therefore burn distillate for about 6 months. As there are no low NOx burners yet available for distillate, and other NOx reduction methods are not feasible for such a short period of distillate burning, NOx emissions will be relatively high at about 300 ppm during this period.

5.24 A dispersion study showed that during this period the maximum hourly ground level concentration of NO_2 would be about 0.100 mg/m^3 within 2km of the plant and with peaks of 0.050 - 0.070 mg/m^3 between 2-7km downwind. These levels will not break any Vietnamese or IBRD regulations. Details are given in Appendix X.

5.25 The conventional plant at Phumy I will burn natural gas as its primary fuel. It will however burn residual fuel oil as a backup if gas supplies fail. A dispersion analysis showed that when burning this fuel oil with a sulphur content of 2.8% the tall stack of Phumy I (200m) is sufficient to disperse the stack emissions so that hourly and daily values of SO_2 do not exceed regulations. Details are in Appendix X.

Noise

5.26 The main sources of noise from the operation of the proposed development are:-

- Gas Turbines
- Steam Turbines
- Boilers
- Ancillary equipment including Transformers, Fans, Water Treatment Plant and Cooling Water Pump.

5.27 The gas turbines will be the dominant source of noise and these will be enclosed in insulated buildings. The steam turbines and boilers will also be enclosed to allow for the easy addition of acoustic cladding and exhaust silencing. The specification

for the noise insulation will be such that noise emissions from the site, measured at the site perimeter, will satisfy Vietnamese noise regulations which, for residential areas at night, is 55 dBA.

5.28 Other measures such as tree planting and berms (mounds of earth placed with vegetation) may also be used in selected locations in order to reduce noise levels there. As a result of these measures noise emissions from the plant will not represent a significant nuisance to local residents.

Physical Impact of Cooling Water Discharge

5.29 Cooling water for Phumy I and II will be taken from the Sao River at a total maximum rate of 60 m^3/s and discharged to the Thivai River (Figure 3.2). The temperature rise across the condenser will be 7°C. The discharge will be through underground pipes, at a final depth of 13m in order to disperse the heat as quickly as possible into the Thivai estuary.

5.30 A thermal diffusion (Ref. 13) study for the site was carried out for a total cooling water discharge of 80 m^3/s at a temperature rise of 7°C. This study is given in Appendix XI. The results show relatively small thermal plumes extending from the outfall at various tidal phases. The worst case is at still water during high and low tides when the 1°C isotherm extends across the estuary. The maximum rise is calculated to be 1.5°C near the outfall. (See Figure 5.3).

5.31 The actual thermal impacts of the proposed development of Phumy I and II will be considerably less than this as the flow of cooling water will be just 60 m^3/sec. There is also likely to be a drop of 1°C in the temperature of the water as it travels 1km through open channels to the discharge points and this has not been taken into account in the calculation. The thermal impact on the Thivai estuary will therefore be minor, as expected, given the large flow (10.000m^3/s) and the depth of the estuary.

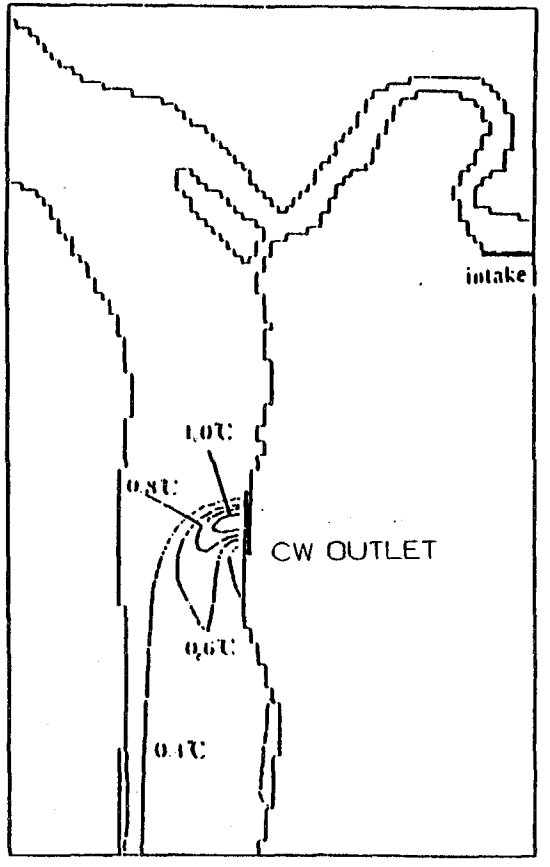
Ecological Impact of Cooling Water Discharge

5.32 The ecological impacts of the cooling water discharge are likely to be of four main types

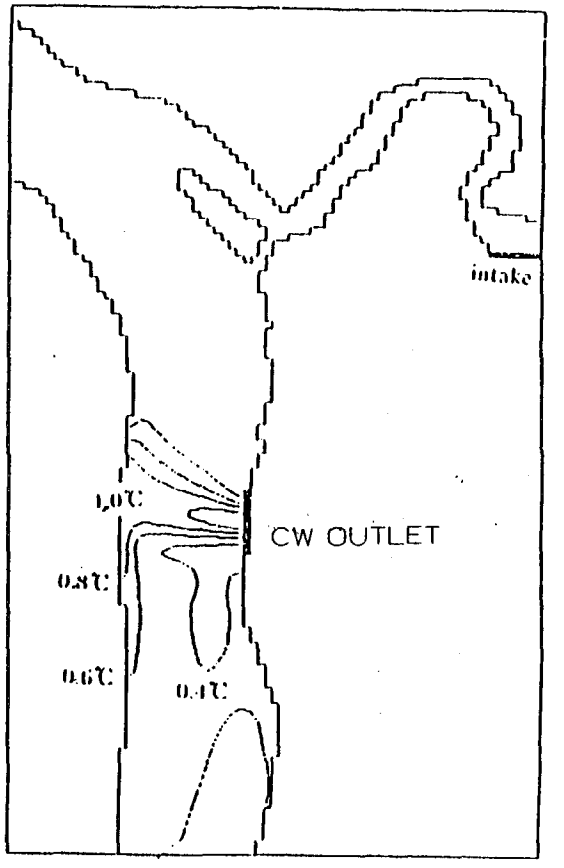
- Scouring at outfall
- Chlorine effects
- Impact of heated water
- Impacts on dissolved oxygen levels.

5.33 Because of the depth of the discharge, scouring will take place at the immediate outfall. This is likely to have significant impacts on benthnic animals living in the immediately vicinity.

FIGURE 5.3



Mean Outflow



Low Tide

Distribution of Surface Temperatures

in the Thermal Plume created by Discharged Water

5.34 Chlorination of the cooling water intake will be carried out in order to prevent fouling of the C.W system by mussels, slime or other organisms. Chlorine will be added at a rate that will leave a residual level of <0.02 ppm at the outfall. Because of the long outfall channel this level can be achieved with careful monitoring. At this concentration the chlorine should not have any significant impacts beyond the discharge point.

5.35 The thermal diffusion analysis shows temperature increases in the receiving water limited to 1°C except at the immediate outfall. Figure 5.1 shows the resultant thermal plumes for the cases of low tide and tidal outflow. There is no evidence from a review of the literature that such a rise has significant impact on aqueous ecology or on mangrove ecosystems. (Ref. 8, 9, 16) This compares with Vietnamese regulations which limit temperature to 40°C in the receiving water and IBRD regulations which limits temperature rise in the receiving water to 3°C. (Ref. 20).

5.36 Because of a rise in cooling water temperature, power plants can have a negative impact on dissolved oxygen (DO) content. In practice this only happens when dissolved oxygen levels, in the intake water are high. The impact of the Phumy, plant, where existing DO levels, are rather low, should be neutral or slightly positive because of turbulence created during passage through the C.W. system. (Ref. 8, 9).

Ecological Impact of Cooling Water Intake

5.37 There is no doubt that the cooling water, at a flow rate of 60 m^3/s, will entrain large numbers of organisms including zooplankton, phytoplankton, fish eggs and larvae. The base line study shows that these exist in substantial numbers in the area and they will experience significant impacts from the combined effects of chlorination, temperature increase and pressure change while passing through the CW system.

5.38 Studies from other power stations show a large variation in mortality rates for entrained plants and animals and that it is difficult to separate out the impacts of the different stress mentioned above. While it is impossible to predict exactly the impacts of Phumy cooling system on entrained organisms it must be assumed that mortality rates will be high, particularly for the sensitive fish eggs and ichtyoplankton. (Ref. 8, 9)

5.39 Although a significant loss will occur in the entrainment process there is no evidence from studies on other power stations that this leads to an overall impact on fish numbers in the area. This is likely to be particularly so in the case of Phumy where there is a large amount of similar habitat available and where the intake CW flow is a very small proportion of overall flow in the estuary. (Ref. 8, 9)

5.40 Because of the difficulties of predicting accurately the physical and ecological impacts of cooling water systems it is recommended that studies be carried out after each step wise increase in commissioning of plant involving cooling water discharge to confirm that, as predicted here, there are no significant changes in the baseline ecology. Although there are no direct mitigation measures for reducing entrainment loss, if the study shows a reduction in concentration in some fish specifies in the vicinity of the plant, then a fish hatchery could be set up to redress this loss.

Waste Water Streams

5.41 The aqueous discharges likely to arise from the proposed development are as follows:-

- Waste water arising from regeneration of ion exchange resin with acid and alkali.
- Station sewage discharged from the administration block.
- Station surface drains.
- Boiler blow down.
- Irregular discharges including water and acid boiler washes, and accidental spillages.

5.42 Fresh water for boiler make-up is required at a rate of 2000 m^3/day for the proposed development. The source of this fresh water will initially be wells on site and after the year 2000 a municipal supply. The quality of this water is given in Table 5.5 (Ref. 5).

TABLE 5.5

Ba Ria Fresh Water Parameters

Test		Result
pH		6.8
Ca	(ppm as Ca)	1.6
Mg	(ppm as my)	0.9
Fe	(ppm as Fe	0.2
S_1O_2	(ppm as S_1S_2)	19.5
C1	(ppm as Cl	7.1
SO_4	(ppm as SO_4	7.2
Bicarbonate	(ppm as $CaCo_2$)	6.1
Carbonate	(ppm as $CaCo_3$)	0

5.43 This water is purified in the water treatment plant by filtration and by demineralisation in cation, anion and mixed bed ion exchange units. The waste from the plant comes from the regeneration of the ion exchange resin with caustic (sodium hydroxide) and acid (either hydrochloric or sulphuric). The waste is collected to a neutralisation tank where it will be neutralised to a pH between 6 and 9. The effluent from this tank consists largely of a solution of sodium chloride (or sodium sulphate) as well as smaller quantities of whatever material had been removed from the fresh water supply which is mostly calcium, sodium and magnesium salts. This discharge would not breach any environmental standards or have any significant impact on the receiving waters.

5.44 The sewage discharge arising from the approximately 500 operating staff would be treated biologically to a minimum effluent quality of 20mg/l BOD and 30 mg/l suspended solids. A tertiary filtration will ensure a final effluent quality of 10/10. This will satisfy Vietnamese regulations. (Ref. 11).

5.45 The routing of all drains through oil interceptors will prevent contamination from any oil spillage. The oil interceptors will be inspected and cleaned regularly and any sludge taken off site for disposal. The drainage effluent will be tested for oil contamination to ensure the Vietnamese regulation of 10 ppm is complied with.

5.46 Blowdown of the drum in each boiler would take place for a few hours each week. The blowdown water will be discharged via a pressure reducing flash tank to the station drains. This very pure water only contains traces of ammonia and sodium triphosphate at a concentration of a few ppm and requires no treatment before disposal.

5.47 Acid cleaning of the boilers will normally occur during commissioning and at irregular intervals of about 5 years. Hydrochloric acid is usually used for this cleaning with the effluent largely containing compounds of Iron as well as smaller amounts of other metals. The effluent from this process would be neutralised with either lime or sodium hydroxide and the precipitated material would be collected and taken off site for disposal in a land fill site while the liquid portion would be safely discharged.

5.48 Water washing of the gas side of the boiler is occasionally required to remove deposits. With natural gas or distillate as the fuel, these deposits are not significant. However if residual fuel oil is used to any extent in Phumy 1 then deposits of Vanadium and other metals will occur on the boiler tubes. Washing will produce an effluent which will have to be treated separately in order to precipitate out these metals. The precipitated sludge will be taken offsite for disposal.

5.49 The danger of spillage of chemicals will be avoided by proper bunding of the containers of the main chemicals to be stored on site. - Sodium Hydroxide, Hydrochloric (or Sulphuric) Acid, Ammonia and Hydrazine. Appendix VII gives details of procedures to be employed for management and storage of these chemicals.

5.50 Overall no significant impact is predicted from the operation of the proposed development on the ecology of the Thivai River or the aquaculture and commercial fisheries carried out along the river.

Oil Spillage Risks

5.51 The spillage of residual fuel oil, distillate, lubricating or other oils represents a major risk factor to the aqueous environment. As all fuel tanks will be fully bunded the major risk will be during the fuel unloading process; however risks also will occur from oil pipeline leaks, transformer leaks, and handling of drummed and waste oils.

5.52 In order to minimise these risks strict procedures will be implemented for:

Oil delivery

Bunding and inspection of tanks

Pipeline inspection

Storage and handling of drummed oil

Oil spill clean up procedures

Emergency response plan for a major spill

These procedures are detailed in Appendix XIII.

5.53 The impacts of an oil spill on the Thivai river can be summarised as follows:-

- Oil film obstructs the absorption of oxygen into the water, decreasing concentration of dissolved oxygen
- Oil film adheres to vegetation and hinders respiration and photosynthesis. Mangrove trees are particularly sensitive because of their exposed root system
- Water soluble components of oil are toxic to fish and shrimps, particularly larvae and juveniles.
- Water polluted by oils may create favorable conditions for the development of certain algae species which are toxic for fish and shrimp.

5.54 The impact of an oil spill on the Thivai estuary would depend on the quantity and type of oil spill as well as the location. A spill of over 100 tonnes, which is not immediately dealt with, is likely to have major ecological consequences as well as economic losses for local fishery and aquaculture. (Ref. 4)

5.55 An analysis of the diffusion of oil spills of various quantities at the proposed Phumy jetty has been carried out and is given in Appendix XII. These studies will assist with the design of the Emergency Response Plan to control and clean up any such spills,

Dredging Activity Impacts

5.56 Because of high levels of sedimentation dredging will be required occasionally (once a year or less) in order to main depth at the jetty. This will create a local and temporary disturbance to biota in the area. The dredged material will be transported for land reclamation to an area not yet designated.

CHAPTER 6

REVIEW OF ALTERNATIVES

Introduction

6.1 The evaluation of alternatives to the proposed project at Phumy should be seen in the context of existing very low electricity usage per head of population in the south Vietnamese region (about 180 kWh/year) and a high predicted growth in demand to the year 2100 in order to allow for the expansion of the economy and the improvement in living conditions. (Ref. 17). This requires the addition of new generating plant of 150 to 100MW per year during the 1990's.

6.2 The key strategic issues relating to the development of generation capacity in this region over that period for supply of this demand are as follows:

- The potential for hydro development within the region.
- The availability of imported power from the PC1, PC3 region, utilising the new 500kV line.
- The availability of natural gas from off shore fields from the mid nineties.
- The possibility of importing coal from the north of the country.
- Limited availability of investment funds, particularly foreign currency.
- Environmental issues which are viewed on a national basis as putting some constraints on hydro and coal development but with little impact on gas-fired plant developments.

6.3 On the basis of the predicted demand forecast and the above issues the generation requirement and breakdown of type of plant used till the year 2005 has been evaluated. This will consist of a mixture of thermal and hydro plant which is required to provide a balanced mixture of peak and base load plant over the wet and dry seasons. The present proposal, which consists of 800MW of combined cycle plant, is planned as the first new thermal plant for base load operation because of its perceived low capital and operational costs, low environmental impacts and short construction schedule.

6.4 Within the above context the alternatives to the proposed project at Phumy evaluated here are:

- Alternative designs
- Alternative sites

- Hydro power as an alternative
- Importation of power via new 500kV line

Alternative Design

6.5 Where natural gas is available as in this case combined cycle plants have many advantages over all conventional thermal plant including the following:

- Lower Capital cost.
- Shorter lead times to power production.
- Smaller land requirements.
- Higher efficiencies.
- Lower air emissions for unit of electricity generated.
- Lower cooling water requirements per unit of electricity generated.

Alternative Cooling Systems

6.6 For a combined cycle plant the possibilities for design alternatives are limited but include:

- General layout, size and number of gas and steam turbines.
- Single or dual pressure system.
- Vertical or horizontal type boilers.
- Alternative cooling systems.

These project design features are not yet optimised. Environmental impacts related to the first three design options are not significant. The fourth item has significant environmental implication and is discussed below.

6.7 A direct cooling water system is usually economically favorable where, as in the case of Phumy, an adequate body of water is available which can disperse the heated cooling water without significant ecological impacts. Alternative cooling systems such as mechanical cooling towers or air cooled condensers need not therefore be considered here.

6.8 A number of possible locations for the cooling water intake and discharge points were analysed and these are discussed in Appendix XI. A deep discharge at the position chosen as shown in layout Figure 3.3 was found to be the most favorable from the point of view of heat disposal and least ecological impacts.

Alternative Sites

6.9 An initial 9 possible sites for the new combined cycle plant were short listed to 3 - Bien Hoa, Nhom Trach, Phumy (Ref. 14). Bien Hoa and Nhom Trach are about 30 km and 15 km respectively north of Phumy.

6.10 The evaluation of these sites was based on the following main issues:

- Closeness to Bach Ho - Thu Duc gas pipeline.
- Connection to electrical grid.
- Cooling water availability.
- Site area available.
- Environmental and Socioeconomic issues.
- Construction and Engineering issues.

Based on an analysis of these issues Phumy was chosen as the optimum site (Ref. 14). The other sites are likely to be selected in the future for power development projects.

Alternative Generation Source - Hydro Power

6.11 Vietnam has a theoretical hydro potential of 300 billion kWh/year with a technically exploitable hydro potential of about 91 billion kWh/year of which only 2% has been so far harnessed. In the PC2 region there are existing hydrostations at Da Nhim (160 MW) and Tri An (400 MW) while two further stations are under development at Han Thuran (470 MW) and Thac Mo (150 MW). These will come into operation in the mid to late nineties and their output has already been factored into the predicted power requirements for PC2.

6.12 Several potential hydro sites are also under consideration and preliminary feasibility work has been carried out. The levelised costs for hydro generation from some of these plants are in general higher than those costs for the conversion of gas turbine plant to combined cycle plant (Ref 17). Also the time scale for the commissioning of any new hydro schemes would be into the next century, while the requirement for power from the present project is from 1997 onwards.

While the development of hydro power will certainly play a major role in providing future generation capacity it does not represent a viable alternative to the present project at Phumy, particularly as the base load combined cycle plant, which will be required for operation in the next few years will be complementary to hydro power development.

The Importation of Power Via the 500 kV Line

6.13 This 1500 km transmission line, completed in 1994, is intended to provide for the transmission of surplus hydro power from PC1 network to PC2 and later, from the large new hydro development at Yali in PC3 to PC2. The supply is envisaged by PC2 as supplying base load at a level rising from 200 MW in 1994 to 500 MW in 1998 and eventually to 550 MW by 2001. This output has already been factored into the predicted PC2 power requirement.

CHAPTER 7

MITIGATION MEASURES

7.1 In order to reduce environmental impacts from the proposed development mitigation measures, summarised below, have already been put in hand or are planned. Apart from these, and taking into account the relatively minor residual impacts of the proposed development, no further mitigation measures are considered necessary.

Compensation for people affected by the project

7.2 About 157 families who own land, houses and other assets in the area will be affected by site acquisition and transmission line construction. Details are given in section 4.15. A Rehabilitation Action Plan (RAP) process will be completed to World Bank guidelines (Ref. 19) to ensure compensation will be awarded in a fair and timely way. This will ensure that all the people affected will, at the end of the process, be at least as well off as they were previously. Full details will be given in a separate RAP report.

Mitigation Measures for Construction Impacts

7.3 A complex of temporary houses will be provided for the construction workers for the proposed project. Clean water, sanitation facilities and a rubbish removal service will be provided. A health centre will be responsible for prevention of infectious diseases, as well as occupational health issues. Education and training will be provided in order to promote good relations with local people.

7.4 Sewage treatment facilities for the complex will be provided so that the effluent discharged will satisfy Vietnamese regulations as regards BOD and suspended solids.

7.5 Measures to limit pollution by dust during the construction phase will include:

- Water spraying at the site and of truck wheels.
- Covering construction material during its transportation.
- Hard surfacing the road to the site.

7.6 Noise control during construction will be by limiting noisy activities, such as piling, to day light hours and limiting truck speeds passing residential areas.

Air Emission and Noise Control

7.7 The proposed plant will burn natural gas with insignificant sulphur content. Low NOx burners will reduce the specified NOx emissions to 50ppm and probably much lower. This will ensure that the plant has only minor impacts from stack emissions.

7.8 Noise insulation for the gas turbine, boilers, steam turbines and ancillary plant will be specified such that noise levels at the site perimeter will meet the Vietnamese regulations for noise at night (which is the strictest time) at residential areas. This will ensure no disturbance by noise from the plant at nearest residences. Other measures such as berms (earthen mounds planted with vegetation) and tree plantations will also be employed as appropriate to improve noise ambient levels.

Oil and Chemical Spill Risk Control

7.9 An oil spill into the sensitive mangrove ecosystem could have major environmental implication. In order to minimise these risks strict procedures will be adhered to in relation to:

- Oil Delivery
- Bunding and inspection of fuel and tanks
- Pipeline inspection
- Storage and handling of drummed oil
- Oil spill clean up
- Emergency response plan for a major spill

These procedures are detailed in Appendix XIII.

7.10 The risk of chemical spillage will be avoided by implementing procedures for the management of their transport, unloading and storage. Appendix VII gives detail of these procedures.

Treatment of Aqueous Emission

7.11 Regular sources of aqueous emission will arise from the following sources:

- Water treatment plant effluent
- Sewage discharge
- Surface drain
- Boiler blowdown

These will be treated as described in sections 5.42 - 5.48, so that the effluent will satisfy Vietnamese standards and will have no significant impact on the receiving waters.

7.12 Irregular sources of aqueous emissions will include the following:

- Boiler gas side washes
- Acid washes
- Boiler storage effluent
- Chemical spill

These will be treated as described in Sections 5.45 - 5.48 so that the effluent will satisfy Vietnamese standards and will not have significant impacts on the receiving water.

Mitigating measures for Cooling Water System

7.13 Chlorine residual levels will be maintained at a low level, < 0.02ppm, in order to prevent any impacts beyond the immediate outfall.

7.14 The design of the outfall is such as to minimise thermal impacts at the cooling water discharge as described in Sections 5.29 - 5.31.

7.15 Screens will be operated at the intake of the CW system in order to prevent intake of fish and debris. Measures will be put in place in minimise impact on fish. Details are not yet decided and may include fish buckets to allow fish escape or behavioral barriers.

Control of Waste Materials

7.16 Disposal of waste materials can lead to soil contamination and ground water pollution. Many types of hazardous and non-hazardous waste materials will arise at the proposed plant including waste oils and solvents, chemicals, sludge's, electrical, mechanical, civil and office waste. These will be segregated into types, monitored by type, quantities and disposal route and removed off site to a landful site or for recycling.

CHAPTER 8

CONSULTATION WITH AFFECTED GROUPS

8.1 The groups directly affected by the project are:

- 6 families who live on the project site (Phumy I).
- 135 other families who own land and other assets on the site (88 for Phumy I, 47 for Phumy II).
- 16 families who live in houses along the proposed route of the transmission line and who will have to move (Phumy I).

8.2 These people are represented by the Peoples Committee of Phumy who also look after their interests in relation to compensation and resettlement. The company responsible for this project, Electricity of Vietnam (EVN) have had discussions with the Peoples Committee about plans for the project and compensation issues and the Peoples Committee have informed the families concerned. A representative of EVN has also spoken individually to each of the project affected families.

8.3 As already described in Chapter 4, a survey was carried out of the families affected by the project by Environmental Protection Centre (EPC), H.C.M City. This survey established details of the area of land owned by each family, the type and quantity of crops grown on each property, the annual income as well as the attitude of the families towards the project and the preferred type of compensation. No objection was voiced to the project as long as proper compensation was agreed.

8.4 On July 15th Dr. C. McMahon of the Consultancy Company, ESBI, visited the Phumy area in order to have independent discussions with the affected groups. In an open discussion with the Peoples Committee the same views as above were expressed i.e. the project is welcome because of the provision of badly needed jobs in the community as well as improvements in infrastructure such as roads and electricity supply. There was an issue about compensation for land, crops and trees. It was felt that the preliminary amount suggested was not sufficient for people to purchase equivalent land elsewhere. Apart from this the only issue raised was that of dust from trucks passing by during construction and a request to hard surface the road. This is already planned.

8.5 Discussions were also held with several individuals who live or own land on the site. These all expressed the view that they were happy with the representation of the Peoples Committee and the way they were kept informed of the project, but were worried about the amount of compensation being talked about for their land, crops and other assets. No firm offers had yet been made. Apart from this they welcomed the project, particularly as regards the likelihood of providing jobs for their children.

8.6 It should be noted that a Rehabilitation Action Plan (RAP) is being finalised by EVN and is being done to World Bank (OD 4.30) (Ref. 19) criteria and guidelines. The criteria for resettlement/compensation is that overall no affected person should suffer in terms of standard of living and must be given full rights to participate in the RAP process.

CHAPTER 9

ENVIRONMENTAL MANAGEMENT AND TRAINING

9.1 For the implementation of the present proposal the establishment of an environmental unit at Phumy is of most importance. A laboratory is already planned for the Phumy combined cycle development and the chemist / technician who would run the water quality analysis programme would be the obvious choice to run the environment unit. The most important function of this unit would be monitoring, control and optimisation of the waste water streams and other emissions. The procedures are standard and a university trained graduate chemist, for example, would be able to take on this role with little further training.

9.2 As EVN expands its thermal power plant programme the establishment of a central environmental co-ordinator with the following functions is recommended:

- Ensuring compliance with standards and laws.
- Developing environmental policy.
- Issuing in-house guidelines and standards and procedures.
- Co-ordinating information and public relations.
- Carrying out environmental studies.
- Setting up an environmental management plan.
- Carrying out environmental audits.

9.3 One other important function would be liaison with other environmental groups such as a Coastal Zone Management Group in order to co-ordinate strategies for the protection of the coastal environment. Through activities such as this EVN could positively promote the protection and sustainable development of the sensitive coastal zone. The impact of power station development on the Thivai river system will be a minor factor in its effects on this important local resource. The development of farming and aquaculture, the management of river flow and the levels of sewage and industrial pollutant are quantities which are less well documented and are likely to have a far greater impact than the proposed power plant.

9.4 The interests of all activities utilising the Thivai river system would be best served in the long term by a co-ordinated management approach. The establishment of an overall management system may require a co-ordinating authority with the necessary power to prevent uncontrolled development, monitor environmental quality and encourage the sustainable development of the delicate estuarine region. One useful joint activity would be the establishment of a oil spill emergency response plan for all bodies operating on the estuary.

9.5 The main training requirements relating to the environmental aspects of the proposed project are:

- For Station Management, training in the overall environmental significance of the station activities and the integration of environmental issues into management systems.

- For the manager of the environmental unit at Phumy, training in laboratory operation and technical monitoring and control of station emissions. A period of time spent as work experience in an environmentally well run power plant of similar type would be a good way of achieving this.

- For the environmental co-ordinator, when appointed, training will be required on the environmental aspects mentioned in 8.2 as well as the overall ecological dynamics of systems such as the Thivai river estuary.

- For all station staff, basic training should be provided in the environmental aspects of their work including storage and handling of bulk chemicals and fuel oil, handling of station waste and emissions and reporting procedures for environmental issues.

9.6 Training will be required in safety and emergency procedures in the following areas:

- Oil spill risk control procedures as outlined in Appendix III.

- Chemical spill control procedures as outlined in Appendix IV.

- Emergency response plan for oil spills into the Thivai River involving co-ordination of several responsible bodies.

- Fire safety and response plans particularly in relation to gas and oil fires.

CHAPTER 10

ENVIRONMENTAL MONITORING RECOMMENDATIONS

10.1 In order for the proper control of the construction and operation phases of the project, as well as extending base line data the following monitoring programme is recommended.

Monitoring during Construction

10.2 Dust levels at the site and roads leading to the site should be monitored to ensure that regulated levels are not exceeded and no nuisance is created. EPC should be contracted to monitor these and other construction activities.

10.3 EPC should also be contracted to monitor occasionally for noise levels at the nearest residence and effluent from the sewage treatment plant to ensure these are within regulations. They should also carry out a visual inspection of the work for Jetty and C.W. outlet and inlet construction to ensure minimum destruction of mangrove areas and that plans in this regard are strictly adhered to.

Monitoring during Operation

10.4 The most important monitoring requirement for the proposed development is that of the various waste water streams described in Section 5. This is one area where the station has control over its discharges. This monitoring should be the responsibility of the chemical / environmental manager in charge of the laboratory. A summary of a typical monitoring programme for power station aqueous effluents is given in Table 10.1

10.5 The monitoring at the site for particular matter, SO_2 and NOx has been carried out by EPC at three locations. It is planned to extend these measurements both in time and location in order to obtain a better overall picture of ambient air quality so as to provide a baseline against which to mark any changes.

10.6 For the operation phase a number of air monitoring stations should be set up in down wind direction(s) at the plant. These should be designed to allow for the confirmation of the predicted low increases in SO_2/NOx from the plant; in practice it is difficult to pick out the contribution from power plants over natural variations. These monitoring stations could be run by EPC or station personnel.

10.7 Continuous measurements of SO_2 or NOx are not absolutely necessary in the stack exhaust gases as these concentrations are set by design factors and sulphur content of the fuel. If continuous NO_2 measurement is not being used then occasional checks for NO_2 levels should be carried out to ensure the correct operation of low NOx burners.

Table 10.1

Typical Monitoring Programme for Aqueous Effluent

	Continuous	Daily	Weekly	Monthly	Two-monthly	Infreq/ baseline
Effluent No. 1 Cooling water discharge	Temp	trc oil/gr*	cdty* pH s/s	(tests on CW inlet)	diss .02	See Note 1
Effluent No. 2 Water treatment plant effluent	pH		oil/gr* cdty pH			See Note 1
Effluent No. 3 Boiler washings and other occasional effluents						See Note 1 + 2
Effluent No. 4 Station drains		oil/gr*	cdty pH s/s	oil/gr		See Note 1
Effluent No. 5 Sewage effluent			oil/gr* pH s/s	BOD		See Note 1

oil/gr	=	oil or grease	*	visual examination
temp	=	temperature	(1)	Once off - full analysis
cdty	=	conductivity	(2)	Analysis as required for treatment and disposal
s/s	=	suspended solids	(3)	Frequency of analyses suggested above will change depending on variability of effluent characteristics
trc	=	total residual chlorine		

10.8 Noise measurements at the site perimeter should be carried out, ideally by station personnel, after commissioning of each stage of plant. This will allow the confirmation of predicted noise levels as well as the calculation of insulation requirements for future plant. It will also point out, if any anomalies are found, the need for extra measures such as tree planting or berms (mounds of earth planted with vegetation).

10.9 Many different types of waste materials will arise from station activities. These should be monitored by recording the source, type and quantity of each waste material as well as the destination, means of disposal and name and licence of the contractor who carries out the disposal. The Services Supervisor or equivalent is normally given the responsibility for this monitoring.

10.10 It is recommended that after each stage of plant requiring cooling water is commissioned a thermal plume study be carried out to confirm that the physical extent of the plume is as predicted. It is also recommended that a study of the aqueous ecosystem in the vicinity of the plant be carried out and compared to base line data already available.

Responsibility for Non-Compliance

10.11 During the construction phase all monitoring results, particularly those showing problems, should be given in a timely manner to the Site Manager who, instructed by the owner, is responsible for environmental compliance.

10.12 During the operating phase monitoring results of significance should be made known to the Station Manager who has responsibility for taking action to remedy environmental problems. An outside body such as Ministry of Science and Technology should occasionally audit the plant for environmental compliance.

APPENDIX I

LIST OF KEY PARTICIPANTS IN THIS EIA STUDY

	NAMES	*PROFESSION*
1.	Le Trinh	Eia Expert (Team Leader)
2.	Vuong Quang Viet	Environmental Chemist
3.	Pham Van Mien	Aquatic Biologist
4.	Vu Ngoc Long	Botanist
5.	Phung Chi Sy	Air Pollution Expert
6.	Nguyen Van Trong	Fishery Expert
7.	Nguyen Van Khoi	Fishery Expert
8.	Nguyen Van Nhan	Oceanographic Expert
9.	Nguyen Thi Lan	Economist
10.	Nguyen Thanh Tam	Energy Engineer
11.	Nguyen Nhu Dzung	Water Pollution Engineer
12.	Nguyen Le Ninh	Water Chemist
13.	Che Thuy Nga	Water Chemist
14.	Pham Hong Nhat	Ecotoxicologist
15.	Nguyen Tac An	Oceanographic Expert
16.	Le Thi Ngoc	Bachelor of Law
17.	D. L. Graybill	Environmental Expert
18.	H. Ogawa	System Analyst
19.	C. Mcmahon	Environmental Engineer

APPENDIX II

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APPENDIX III

SUMMARY OF WORLD BANK AND VIETNAMESE ENVIRONMENTAL CONTROLS AND STANDARDS

Water

World Bank: (IBRD) (Ref. 16)

The management of liquid effluents shall ensure that all aqueous effluents discharged will not result in any risk of toxic contamination of any water resources. All releases shall be managed in a comprehensive programme to acceptable standards, this shall include;

- sampling and analysis of effluents
- flow measurements of all waste streams
- all effluent streams shall be to acceptable quality standards
- discharges required to be treated to appropriate standards.

Spillage Containment

It is requirement of the World Bank that due consideration be given to the prevention and containment of any accidental spillages of all deleterious materials which are likely to impact on aquatic life forms in the event of them finding their way into watercourses.

Vietnam:

The discharge of aqueous effluents from power plant must comply with Vietnamese Environmental criteria 6 entitled "Maximum Limit for Wastewater Constituents Discharged to Water Sources" whose 21 characteristics and parameters are detailed in Table III.1. Different limits apply depending on the quality and use of the receiving waters. (Ref. 7).

Class 1 receiving waters includes those which are sources for water supply systems, amenity for tourism or fishing resource. All effluent discharge points should be located at least 500m from the protected area. Class 2 receiving waters are not used for any of the above.

Table III.1
Criteria 6 Wastewater Discharge Parameters

Wastewater Parameter	*Discharge Limits*	
	Class 1	*Class 2*
pH	5 - 8	4 - 9
Suspended Solids	50	100
Colour	200	500
BOD	80	100
COD	160	200
Oil & Grease	1	10
Phenol	1	5
Cyanide	0.2	1
Chromium	0.5	2
Zinc	1	5
Copper	0.5	3
Cadmium	0.02	0.1
Mercury	0.01	0.05
Arsenic	0.1	0.5
Lead	0.2	1
Manganese	2	10
Sulfide	0.5	1
Chloride	500	1000
Chlorinated Hydrocarbons	0.01	0.02
Total Pesticides	0.005	0.01
Total Coliforms	5000	10000

All values in mg/1 with the exception of pH and Total Coliforms.
Total Coliforms expressed as number/1000ml.

Air

World Bank:

(1) Dust/Suspended Particulates:

It is likely that any dust emissions will arise during the construction phase and not during subsequent plant operation. The impact of dust on human health and the environment depends on the particle size distribution, rate of deposition, and on the chemical and physical nature of the particulates. A guideline has been issued and limits contained therein should not be exceeded.

Dust Guideline Values	*Limit*
Stack Emissions: areas affected by high dust levels)	100 mg/m^3
Ambient Air Quality:	
Annual Geometric Mean	100 µg/m^3
24 hour Maximum Concentration	100 µg/m^3

Vegetation affected by dust deposits in areas meeting the above ambient air quality limits will require that the limits be revised downwards.

(2) ***Sulphur Dioxide:*** World Bank guidelines on the control of SO_2 are achieved through two steps;

- Ambient Air Standards: set air quality limits which must not be exceeded within an industrial area or community.

- Emission Levels: these specify permitted limits for the control of SO_2 emitted from a pollution source, depending on air quality within its immediate area.

All World Bank projects are required to meet the SO_2 ambient air quality standards detailed in Table III.2

Table III.2

World Bank Ambient SO_2 Air Quality Limits

Location	*Annual Arithmetic Mean*	*Max. 24-hr Peak*
Inside Plant Site	100	1000
Outside Plant Site	100	500

(all values in micrograms/cu.m)

World Bank procedure on the control of SO_2 emissions is based on 2 criteria. Each criteria specifies an upper concentration limit for SO_2 which must not be exceeded. Where the actual concentrations resulting from the development exceeds either of these limits the largest excess will determine a sulphur removal requirement (SRR). The criteria are based on different inputs and may both yield different SRR values. The largest of the SRR is the one which must be applied.

Areas are classed as unpolluted to highly polluted depending on the measured ambient conditions. For each of these classes a limit is imposed under Criteria I and II. The definitions of each criteria are as follows:-

Criteria I: defines the maximum permitted uncontrolled SO_2 emission and is dependent on the fuel sulphur content.

Criteria II: this fixes the permitted increase in ambient ground level SO_2 concentrations. A dispersion model will be required to determine these values.

Table III.3 details the ambient air quality limits for each of the four area classifications. Alongside are the respective limits which must be complied with as required by Criteria I and II. These limits define the sulphur removal rates when exceeded.

Table III.3
SO_2 Emission Controls

Ambient Air Quality	*Annual Average*	*Max. 24-hr Interval*	*Criteria I*	*Criteria II*
Unpolluted Area	<50	<200	500	50
Low Pollution	50	200	500	50
High Pollution	100	400	100	10
Highly Polluted	>100	>400	100	10

(all values in micrograms/cu.m)

Emissions of SO_2 from the natural gas fired combined cycle plant at Phumy will not result in any significant increase in ambient SO_2 concentrations in the vicinity of the plant. This is by the nature of the fuel itself which has an extremely low sulphur content. For this reason there will not be a requirement to control SO_2 emissions.

(3) ***Nitrogen Oxides:*** Standards for the control of NOx emissions are similar to those that exist for SO_2, in so far as both standards for ambient air quality and emission levels are specified. All Word Bank projects must meet an ambient air quality of $100\mu g/m^3$ as an annual arithmetic mean. Guidance values for emission levels include 85ng/J of heat input for steam generators fired on gaseous fossil fuels. This is equivalent to about 143 ppm of NO_2 depending on conditions. For liquid fuels the equivalent value is 130 ng/J of heat or 217 ppm.

Vietnam:

(1) ***Dust/Suspended Particulates:*** Indirect control by Vietnamese Environmental Criteria 18 entitled "Sanitary Protective Distance Requirement for Thermoelectric Power Plants and Boilers", sets out the distance to be maintained between dwellings and power stations. Distances are calculated on the basis of hourly fuel consumption and fuel percentage ash content. Plants burning gas have a predetermined distance of 16m irrespective of size. Oil fired plants must respect limits applicable to fuels of less than 10% ash according to Table III.4

Table III.4

Sanitary Protective Distances (m)

Fuel Ash	*Levels of maximum fuel combustion, tonne/hour*				
%	*<3*	*3 - 5*	*5 - 10*	*10 - 15*	*15 - 20*
<10	25	30	40	50	60
10 - 15	35	40	50	60	80

There is no national requirement to control the quality of emissions or the level of efficiency of installed pollution abatement equipment. However the nearby province of Dongnai has a local limit of 250 mg/NM^3 for new sources.

(2) ***Sulphur Dioxide:*** No national standard exists to control the emissions of SO_2 from industrial stacks. However a control does exist to minimise ground level concentrations. Vietnamese Environmental Criteria 16 entitled" Requirement of the Chimney Height for Places of Fuel Combustion" details necessary chimney heights for installations on the basis of their fuel sulphur content and rate of consumption. Values listed in Table III.5 are for plant operating without flue gas desulphurisation. Different values apply to installations operating flue gas desulphurisation plant (FGD).

Table III.5

Required Chimney Heights When Burning Sulphur Rich Fuels

Fuel Consumption tonne/hour	*Required Chimney Height*		
	Sulphur 5%	*Sulphur 3%*	*Sulphur 1%*
0.5	45	35	20
0.5 - 1.0	63	50	30
1.0 - 1.5	77	60	35
1.5 - 2.0	90	70	40
2.0 - 5.0	140	110	63
5.0 - 10.0	200	154	90
10.0 - 15.0	244	190	110
15.0 - 20.0	280	220	125

(3) ***Oxides of Nitrogen:*** There are no national standards for control of emissions of NOx from industrial stacks.

(4) ***Ambient Air Quality:*** Vietnamese Environmental Criteria for Maximum Permissible Concentration for Toxic Chemicals in Ambient Air are contained in Table III.6.

Table III.6

Ambient Air Quality Standards (mg/Nm^3)

Administrative Unit Promulgating Ambient Standards	*10 min*	*30 min*	*1 hour*	*1 day*	*1 year*
MOSTE					
SO_2			0.3		0.08
NOx			0.3		0.08
Particulates			0.5	0.2	0.06
Baria Vungtau Province					
SO_2			0.3		0.08
NOx			0.3		0.08
Particulates			0.5	0.2	0.06

Noise

World Bank:

The environmental impact of noise can adversely affect the quality of life of people living close to a source of obtrusive sound. This is of particular concern during the night-time hours when noise levels may interrupt the sleeping patterns of the local population. In evaluating the possible impact a project may have in terms of noise, it is necessary to quantify any increases in noise levels during the construction and operational phases of the project.

In the World Bank guideline on noise pollution figures are quoted from the US EPA on levels to ensure adequate protection of public health and welfare (Table III.7). Noise pollution values for the area classification "Residential with Outside Space and Farm Residences" shall not exceed 55 dBA as a day/night average. The night time levels have a 10dBA weighting.

Table III.7

EPA Permitted Sound Pressure Levels (dBA)

Area Class	*Indoor*	*Outdoor*
Residential	45	55
Industrial	70	70
Farmland	--	70

Residential limits are average day/night values (Ldn) others are 24 hour equivalents (Leq)

Vietnam:

Vietnamese Environmental Criteria 13 entitled "Allowable Noise Levels in Populated Areas" gives noise limits which must be observed. Relevant values are contained in Table III.8.

Table III.8
Vietnamese Sound Pressure Limits (dBA)

Time (24 hour)	*Permitted Sound Pressure Levels*	
	Public Areas	*Indoor Areas*
7 - 23	60	40
23 - 7	55	30

All values in dBA

Extensions to these values may be permitted where the duration is controlled. A maximum additional 15 dBA is allowed where the noise duration does not exceed 6% of (time interval).

Secondary Environmental Effects

World Bank:

The influx of population to a previously rural area can cause a severe deterioration in the environment due to an insufficient sanitary infrastructure. This is of particular importance in relation to sewage collection and disposal. In such instances it is important to estimate the total influx of population.