SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

OF THE

FANGCHENG PORT PROJECT

IN THE

PEOPLE’S REPUBLIC OF CHINA

June 1995
CURRENCY EQUIVALENTS

Currency Unit – Yuan (Y)

Y1.00 = $0.117
$1.00 = Y8.452

ABBREVIATIONS

EIA - Environmental Impact Assessment
EIRR - Economic Internal Rate of Return
GDP - Gross Domestic Product
IMDG Code - International Maritime Dangerous Goods Code
MARPOL - International Convention for the Prevention of Maritime Pollution
PRC - People’s Republic of China
SEIA - Summary Environmental Impact Assessment
TSP - Total Suspended Particulates

WEIGHTS AND MEASURES

°C - degree centigrade
db - decibel
ha - hectare
km - kilometer
km² - square kilometer
kph - kilometer per hour
m - meter
m² - square meter
t - ton
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PART A: PORT COMPONENT

A. Introduction

1. An environmental impact assessment (EIA) for the port component of the proposed Fangcheng Port Project in Guangxi Autonomous Region, People's Republic of China (PRC), was contracted by the Fangcheng Port Authority to the 2nd Harbor Engineering Investigation & Design Institute of the Ministry of Communication, which prepared the EIA between December 1992 and July 1994. The EIA was submitted to the National Environmental Protection Agency in August 1994 for review and approval. A map of the project-related area of the port is provided [see Map 1 page (i)].

2. The EIA scope of work included:
   (i) determination of the existing noise, water, atmospheric, and ecological pollution conditions within the proposed Project area;
   (ii) prediction of construction-induced noise, water, atmospheric, and ecological pollution levels;
   (iii) prediction of operation-induced noise, water, and atmospheric pollution levels;
   (iv) proposed mitigation measures for all potential impacts; and
   (v) proposals for an institutional monitoring program during and after construction.

3. This summary EIA presents a synopsis of baseline data and field methods used in preparing the EIA report. The EIA emphasized the effects of the Project during construction and operation on the ecology, atmosphere, and marine environments. The methodologies used in the EIA include site investigation, mathematical modeling, and analogical analysis.

4. There are no social or relocation concerns related to the port component. All land required under the port component is within the existing port boundaries and there are no social or resettlement issues.

B. Project Description

5. The proposed Project will expand the port of Fangcheng by adding one container berth and one bulk cargo berth. Fangcheng Port is the principal coastal port of the Guangxi Autonomous Region in the southwest PRC. The port also serves as a principal access to the sea for landlocked provinces to the north and west of Fangcheng including Guizhou, Sichuan, and Yunnan. Fangchonggang Port City is part of one of the principal axes of development in the region, namely the Nanning-Qinzhou-Beihai corridor, and the city is planned to grow from its present size of 45,000 to about 500,000 over the next decade. Under the Guangxi Coastal Area Development Plan, the three coastal ports (Fangcheng, Qinzhou, and Beihai) will be developed in

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1 A separate EIA was conducted for the highway component.
an integrated manner to serve different functions as defined in the development plan. Fangcheng Port will specialize in handling international trade and coastal distribution, particularly bulk cargo and containers. It is expected that the port throughput will reach about 9 million tons in the year 2000, of which nearly 0.5 million tons will be containerized cargo. Qinzhou Port will be developed for large industrial enterprises near the port and Beihai will serve mainly as a domestic passenger port, mostly for traffic to and from Hainan.

6. Project construction will commence in 1995 and will be completed at the end of 1999. Project costs are estimated at $100 million of which $52 million will be provided from the Bank’s ordinary capital resources.

C. Description of the Environment

1. Natural Environment
   a. Meteorology

7. Fangcheng Port is located in the Fangcheng River estuary west of Qinzhou Bay in the Beibu Gulf. The port and approach channel are sheltered on three sides by the mainland to the north and hilly peninsulas to the west and south. The region has a semitropical climate with a maximum average monthly temperature of 28°C and a minimum average monthly temperature of 14°C.

8. Fangcheng is affected by monsoon winds blowing from the northerly direction in the winter and from the south in the summer. The prevailing wind throughout the year is from the north-northeast with a frequency of 30 percent and a mean wind speed of 7.2 meters per second. During the southerly wet monsoon season, from June to September, the area frequently experiences typhoons accompanied by heavy rains. On average, the port is estimated to experience one typhoon a year. The annual average rainfall at Fangcheng Port is 2,363 mm.

   b. Marine Conditions

9. The port entry is characterized by an outer bar. The tides at Fangcheng Port are diurnal with a mean tidal range of 2.4 meters. Current velocities are below 0.5 meters per second. Because the port is in a sheltered location, only waves from the southerly direction will be large enough to affect the new berth. The fetch of waves from the southeast and from south-southeast is limited by Hainan Island. Waves at the new berth will also be limited by the restricted depths of water at the outer bar and in the bay. The wave height at high tide will be 2.4 meters for a 1 in 50 years return period. Soil conditions at the site consist of layers of mud and sand overlying siltstone, which is interbedded with quartzite and mudstone.

10. Mariculture sites covering nearly 5,000 hectares are located opposite the port. Shellfish and finfish are captured upstream of the port for personal and commercial use. Extensive stands of mangrove occur in the Fangcheng and Anbu river estuaries. Bottom sediment quality within the immediate port area is good because of the combined flushing action of Fangcheng River and marine tides. Sediments are predominantly sands. Levels of suspended sediments appear to be relatively high adjacent to the port, because of sediments carried by rivers and ongoing dredging activity at the port. Water in the port is polluted by petroleum spills during vessel fueling and discharge of oily waste from facilities at the port. This is the most apparent existing threat to environmental quality apart from surface runoff from bulk cargo handling operations on the wharf.
c. Socioeconomic Environment

11. Guangxi Province is the least developed coastal province in the PRC and ranks twenty-third among the 29 provinces in PRC in terms of overall socioeconomic development level. The per capita gross domestic product (GDP) of Y1,776 in 1993 compares to the PRC average per capita GDP of Y2,724. The agriculture sector is the dominant source of livelihood in the port hinterland, employing more than 70 percent of the labor force. However, the scale of recent economic development in the Nanning-Fangcheng corridor is substantial, with 23 percent growth in 1993.

12. Fangcheng Port City was officially established in 1985 as one of 14 open cities approved by the State Council. The city is expected to grow rapidly in terms of population, in line with the Guangxi Development Plan. The expansion of the city will absorb a large poor population from the hinterlands by providing new employment opportunities both during and after expansion of the port and the city.

13. Environmental conditions at Fangcheng Port City are generally satisfactory because the city is small and lacks industries. Air quality is not significantly degraded by any class of pollutants; however, dust from the ongoing construction of the city and the associated noise are temporary problems. All monitored parameters are within national standards. However, the close proximity of Fangcheng City to the existing and planned port facilities and transport corridors is of concern with regard to traffic noise originating from the port.

D. Anticipated Environmental Impacts and Mitigation Measures

1. Atmospheric Pollution

a. Status of Atmospheric Quality

14. The atmospheric pollution prediction model used in the EIA is the single pollution factor index. The existing air quality parameter measured during the EIA included carbon monoxide, sulfur dioxide, and total suspended particulates (TSP).

15. Baseline data were obtained from selected monitoring stations within and outside the port at representative locations over a five-day period. In general, the tests showed that the atmospheric environment status conforms with the National Atmosphere Environmental quality standard except for the amount of TSP in the air.

b. Construction

16. Dust generated during construction is not identified as a key issue in the EIA. The main pollution source is the increased volume of suspended particulates in the air caused by land forming and construction activities. However, this atmospheric pollution is temporary and will be mitigated by regularly sprinkling water on construction vehicles and equipment. All vehicles leaving the port area will be swept and watered to minimize the impact of construction dust to the area outside the port. Cement used for the Project will be stored in a special depository.

c. Operation

17. Suspension of particulate matter from bulk cargo handling, transporting, and open air storage is likely to be the key source of atmospheric pollution from the port operations.
18. Mitigation measures for the atmospheric environment will thus focus on reducing dust production and on controlling dust diffusion. A number of measures will be adopted, including increasing the water content of coal and ores by a water spray technique. This practice will help to bind small grains to reduce dust production and is also effective at controlling the diffusion of dust. Two multifunctional watering vehicles will be procured under the Project to spray the bulk cargo storage yards 3-5 times a day. The water content of the cargo stack surfaces will be kept at 6-8 percent, resulting in substantial reduction of dust production in the storage yards. If a typhoon approaches Fangcheng Port, the water content will be increased to 10 percent through extensive water sprinkling. A chemical solution is also proposed which produces a thin surface film on the coal and ore, thus controlling the amount of dust pollution.

19. The cargo loading system at the bulk berth will be equipped with a water sprinkling facility to reduce dust production by the stacking and unloading machines and the belt conveyers. Also, 38,000 square meters will be planted with trees between the two new terminals to reduce the impact of pollution on the container terminal.

2. Water Pollution

a. Status of Water Quality

20. The regulatory standard for sea water quality adopted by the Project is GB3097-82, National Sea Water Standard. The water pollution prediction model used in the EIA is the single pollution factor index. The EIA analyzed the content of ten substances, including oil and zinc. Baseline data were obtained by collecting water samples from four selected points for two days during flood and ebb tides. Bottom mud samples were taken at low tide. The evaluation results showed that the water quality is basically satisfactory except for the oil content, which exceeded the national standards at all measuring points. This is due to oily water residues and ballast discharged by passing ships, wastewater from the engine room bilges of ships, and industrial wastewater.

b. Construction Impact

21. During the construction stage, dredging and reclamation operations will result in water pollution. The main environmental effects (during Project construction) of dredging are the sedimentation of the water column and seabed through resuspension of bottom sediments, contamination of marine waters through resuspension of toxic substances, and mortality of marine fauna caused by the compression effect of blasting during rock removal. The tests showed that the combined pollution effect of silt diffusion and underwater explosion will not result in serious pollution effects on the port area under investigation.

22. There are no sensitive natural resources in the water column or on the seabed within the potential range of sedimentation impacts. The mariculture site in Fangcheng Bay will not be affected by short-term increases in sedimentation because it lies upstream of dredging operations. No coral reefs or other important marine biota were recorded in Fangcheng or Anbu Bay.

23. To minimize sediment resuspension, a clamshell dredge will be used. The EIA recommended dredging during winter, when aquatic organisms do not grow. Test explosions are needed to determine the best method of demolishing rocks under water.

c. Operation Impact

24. Water pollution during operation will come mainly from two sources: (i) the surface
runoff from ore, coal rain and wastewater, and container washing residue; and (ii) water polluted by accidental overflow while supplying fuel oil to the ships.

25. The container washing residue will be treated to meet standard water conditions before being released into the sea. Ore and coal wastewater from runoff during rain, as well as port equipment maintenance waste, will be collected, separated, and treated before being released into the sea. For this purpose, wastewater treatment and drainage facilities are built into the engineering design of the Project. The Project will also provide a sanitary sewerage treatment station for the port worker facilities of the new berths. To contain oil dispersion following an accidental oil spillage, a multifunction oil-spill vessel will be procured and equipped with adequate on-board facilities for dealing with minor oil spills.

3. Noise Pollution

a. Status of the Noise Environment

26. The regulatory standard for noise pollution adopted by the Project is GB3096-93, Standards for Environmental Noises in Urban Districts. Baseline data were obtained by measuring noise levels at three measuring stations in the port area six times a day for two days. The evaluation results showed that the noise pollution is not of major relevance. Noise level in the port area is within acceptable levels. In the urban areas, the noise level due to the port is satisfactory during the day time but exceeds the set standard during the night. The EIA attributes this to the high level of passenger traffic.

b. Construction Phase

27. The main sources of pollution are construction and dredging equipment and related traffic noise in and outside the port area. This will be a temporary effect and will be experienced at the same time as the urban area is being developed. Consequently, few residents will be affected. Construction workers will be issued ear-muffs when exposed to excessive noise.

c. Operating Phase

28. Noise sources during operation are divided in two types: motive and fixed. Ships, automobiles, container trucks, bulldozers, and trains are motive sources, and cargo grab buckets, other cargo handling equipment, and ships at berth are fixed sources. All equipment used in the port is a source of noise and prediction of the total noise level in the port and its adjunct areas was made under the condition of all equipment working simultaneously. Because of the mobility of the port equipment, the impact of the combined calculation is the value of the maximum noise level of each machine. The analysis showed that the impact of the noise pollution is strongest at ship loading and unloading areas. The noise pollution from the port will, however, rarely affect the residential areas.

29. Procurement of equipment that satisfies stipulated industry noise control standards is the main mitigation measure for avoiding noise problems during port operations. A greenbelt between the port and the urban area will also help to reduce the noise level in the urban areas.

4. Ecological Environment

a. Status of Ecological Environment

30. The EIA analyzed the species, population, and distribution of plankton, organisms
31. Baseline ecological data were obtained from ten investigation stations in the port approaches channel and the fisheries terminal in the old port area. The investigation was carried out over a period of four days. The evaluation showed that the ecology in the area is satisfactory. The analysis showed also that the quantity of the organisms and species in the relevant areas is not very high. The main fish species in the investigated area is the lancelet, whose habitat is shallow water that will not be exposed to direct pollution from the Project. While the mangrove forest in Fangcheng Port has not been classified as a protected area, no significant adverse impact of the Project is anticipated.

b. Construction Impact

32. Environmental concerns of the dredging operations are the same as those described under paras 21-23. The EIA addressed these issues and an analysis of the ecological system of the port area showed that there are no sensitive natural resources in the water column or on the seabed within the potential range of sedimentation impacts. Thus, the marine ecology (other than mariculture) was not considered a key issue because no ecological resources of conservation significance were present.

33. The mariculture site in Fangcheng Bay would not be affected by short-term increases in sedimentation because it lies upstream of dredging operations. No coral reefs or other important marine biota were recorded in Fangcheng or Anbu Bay.

34. To minimize potential impact on the marine ecology, dredging operations will be undertaken in winter, when aquatic organisms do not grow. Also, the dredging equipment will be selected to ensure that floating silt will be minimized. Except where rock is to be removed, suction techniques will be used.

5. Solid Waste

35. Solid waste in the port comes from two sources: (i) ships at anchor or in the berth; and (ii) the port back-up area, namely cargo storage and handling areas, the container freight station, and equipment repair shops.

36. The city of Fangcheng has agreed to continue accepting the solid waste from the port. Under the Project, dustbins will be procured to carry the solid waste from the port to the city treatment plant. Fangcheng City is currently developing a medium-term plan for solid waste treatment to cater for the growing waste resulting from the city's rapid development. This medium-term waste treatment plan will also handle the treatment of solid waste from the port.

E. Alternatives

37. The Project port is the only seaport in Fangcheng area. Alternatives to an expansion of the port would be to: (i) divert the traffic to Guangzhou port in Guangdong Province, or (ii) use lighterage facilities in Fangcheng Port. Alternative one would incur environmental and economic costs since the cargo would need to be transported by road or rail back to the Fangcheng area and the other destinations. Alternative two would not be feasible from an
economic point of view and would moreover prevent the build up of container traffic in Fangcheng since container ships would not call at a port where waiting and service time would be prohibitively long.

F. Cost Benefit Analysis

The total cost of the port component of the Project is approximately $100 million. The estimated economic internal rate of return is about 21 percent. It is anticipated that the total cost of Project environmental provision will be 1 percent of the construction expenses. The EIA has calculated that environmental protection measures for dust treatment will result in an 80 percent reduction, equaling 2900 tons of coal loss through dust development. This underlines the effectiveness of the environmental measures adapted for reducing atmospheric and water pollution under the Project.

G. Institutional Arrangements and Environmental Monitoring Program

1. Institutional Arrangements

The port currently has an environmental monitoring unit consisting of a manager and six technical monitoring personnel. The Deputy Chief Engineer of the port is in charge of environmental protection management. The unit reports to the Environmental Protection Bureau of the Guangxi Autonomous Region.

Two additional technical staff will be deployed during construction to be responsible exclusively for the Project. For the operating phase, one management technician and one monitoring technician will be added to the staff of the unit. Additional monitoring equipment for the supervision station will be procured under the Project.

2. Environmental Monitoring

For monitoring the water quality, the port will be divided into three monitoring areas. In each section, three sampling stations will be set up and the samples will be taken twice a day to monitor floating oil and silt during construction. During operation, the water quality will be monitored monthly. The atmospheric quality will be monitored from three monitoring points set up in the areas expected to be mostly affected by the construction operations. Particular emphasis will be placed on measuring the TSP contents in the air. Data will be collected once a month at each station for a continuous period of two days during construction. During operation, monitoring will be carried out four times daily over a period of five days per month. Monitoring of the acoustic environment will also be carried out at three separated measuring points. The noise production of construction machines and vehicles will be monitored three times a month during construction and once a month during operation. Treatment of oil, sanitary, and container wastewater will be monitored every ten days.

H. Public Involvement

As a normal practice in the PRC, and as observed during the EIA, village leaders were consulted and through them the local population was informed of the Project requirements and impacts. Since the Project does not involve any relocation issues and has no impact on the income earning opportunities of the local fishermen, the interviewed public supports the Project.
I. Conclusions

43. The PRC is a signatory to the International Convention for the Prevention of Marine Pollution (MARPOL) and the International Maritime Dangerous Good (IMDG) Code. Under the MARPOL and IMDG code, the PRC has established facilities at the Project port to handle ship and port wastes and to handle hazardous cargo in an environmentally responsible manner. The Project facilities have been designed to comply with these arrangements and environmental monitoring will continue as a part of the regular activities conducted by the established Environmental Monitoring Station at the Project port. The monitoring process is being assisted by equipment procured under the Project.

44. The loss of mangrove species and forests due to the Project will not cause significant ecological impacts in the local area. Other existing mangrove and forests with the same species are better-managed/preserved and cover larger areas.

45. The current water pollution in the Port is in part contributed by oily pollutants from various small ships that lack oily water separation capabilities. The Project will include a suitably equipped oily water treatment vessel for that purpose, vessels will be constrained from discharging oily ballast water into the harbor, and oil cargo handling procedures will be improved.

46. Air quality at the Port is relatively bad, mainly because of high levels of TSP caused by uncovered piles of ore, coal, and construction materials in the port area. The Project will significantly reduce the TSP in the air and improve the air quality in the Port area by improved management to reduce the time that cargo stays in the port area and by using dust control measures. This will also improve water quality in the port because the surface runoff after rain will be cleaner.

47. There is no wastewater treatment plant in the Fangcheng area, and urban wastewater is currently contributing to the pollution of the water in the Port. A wastewater treatment plant will be installed by the Fangcheng Municipality Government. The Government has agreed to provide the Bank with a specific plan for the treatment of urban wastewater to ensure that it will not continue to pollute the Port. The Project includes a dedicated wastewater treatment plant for the Port area. Fangcheng Municipality Government has ensured that it will continue to dispose of the solid waste from the Port area, as it has done in the past.

PART B: HIGHWAY COMPONENT

A. Introduction

1. The Communications Department of the Guangxi Zhuang Autonomous Region in the People's Republic of China (PRC) signed a contract with the Second Harbor Engineering Investigation and Design Institute of the Ministry of Communications to prepare an environmental impact assessment (EIA) of the proposed highway component of the Fangcheng Port Project in the Guangxi Zhuang Autonomous Region. The Design Institute prepared the EIA from December 1993 to September 1994. The EIA was submitted to the National Environmental Protection Agency in October 1994, for review and approval.

2. The scope of work under the EIA included: (i) determining the existing noise, vibration, water, and atmospheric pollution conditions within the proposed Project area; (ii) predicting the post-construction noise, vibration, water, and atmospheric pollution levels;
(iii) determining the current social and economic development within the area; (iv) predicting the impacts on social development and quality of life including resettlement; (v) assessing the impacts on flora and fauna; (vi) assessing the impacts on cultural resources; (vii) proposing mitigation measures for all potential impacts; and (viii) proposing systems for monitoring construction and postconstruction impacts.

3. This summary environmental impact assessment (SEIA) presents a synopsis of baseline data and field methods used in the preparation of the EIA report, and includes the results and conclusion of the EIA and the comments of the different agencies.

B. Project Description

4. The proposed Fangcheng Highway, from Natan to Fangcheng Port, will connect with the proposed Beihai to Nanning Expressway at Natan [see Map 2 page (ii)]. The Project will reduce transport bottlenecks between Fangcheng Port, one of the three main ports in the southwest part of the PRC, and the port hinterland. In particular, transport linkages will be improved between the port and Nanning, which is the largest city in the region. The existing class 4 rural road has a capacity of less than 2000 vehicles per day and is severely congested. The existing road also passes through the center of several large towns, which compounds the traffic problems in the area. This road is inadequate to meet the predicted traffic of 6,300 vehicles per day in the year 2000. The total length of the highway is 45 kilometers (km). The Bank-financed section will be the 20-km portion from Fangcheng Port to the Chonglun interchange. The highway will be a two-lane dual carriageway, 25 meters (m) wide, with a design speed of 100 kilometer per hour (kph). The alignment will require the construction of about 1,600 m of bridges, and about 180 culverts.

C. Description of the Environment

1. Natural Environment

(a) Meteorology

5. The Project area has a subtropical climate, characterized by an early spring, hot summer, and drizzly autumn and winter. The area is also subject to typhoons, with an average of one typhoon per year. The average annual temperature is about 17 degrees centigrade (C), with a high of 30 degrees, and a low of 1C. The mean average rainfall is 2350 millimeters, of which 85 percent occurs between May and September, and the average annual relative humidity is 81 percent. The wind directions are predominantly from the north in winter, the south during the summer months, and variable in spring and autumn. The annual average wind speed is about 5 m per second, and reaches a maximum of about 18 m per second.

(b) Topography and Geology

6. The highway alignment traverses an area of coastal plain and low, river-eroded hills. The highway alignment follows the river terraces and crosses several shallow river valleys. River levels are controlled by floods and a tidal difference of about 2.4 m. Quaternary alluvium up to 0.6 m thick overlies Jurassic mudstones and sandstones. Weathering of the limestones has resulted in a karst topography, and thus, had impacted on the prevailing geomorphological processes and groundwater conditions. Silurian sandstones, shales, and siltstones are also widely distributed in the area. The main faultlines lie in a north-east to south-west direction, and there is composite and locally reversed folding. There is good geological stability in the area, and buildings
and structures will be constructed with simple earthquake resistant designs.

(c) Ecology

7. A site investigation was made in January 1994 of the area within 200 m on both sides of the proposed highway alignment. The natural vegetation is tropical monsoon evergreen broadleaf forest. However, the area was almost completely denuded of forest cover during the 1950s and 1960s, and has been replanted recently with conifer forest, mainly massion pine and marsh pine. The total area investigated was 16.4 square km ($\text{km}^2$), of which 60 percent is forested and the remainder is farmland, mainly paddy rice and some fruit and vegetable cultivation.

8. The highway will also traverse coastal mangroves near the port area. Of the total 5.5 $\text{km}^2$ of mangroves in Fangcheng Harbor, less than 0.2 $\text{km}^2$ representing 3.6 percent of total mangrove area are affected by the Project. The mangroves in the Project area are mainly white soil and tung, with some autumn aubergine species. The mangrove areas affected by the Project contained the same species. There is a known, large mangrove preservation area at the Bai-lung Bay and Zheng-ju Port within the city limits of Fangcheng that will not be affected by the Project, and will continue to be preserved by the provincial government.

9. There are about 100 aquaculture ponds in the investigation area with a total area of about 2.5 $\text{km}^2$, of which only four ponds comprise 46 percent of the total aquaculture area. The main species produced annually are a total of about 114 metric tons (t) of piliform prawns, sawtooth greenish-grey crabs, and Chinese mullet. There are also 7 $\text{km}^2$ of beach aquaculture, which have a total annual yield of 2636 t of clams and oysters.

10. In the intertidal zone, about 1,000 fishermen and women are engaged in small-scale part-time net fishing for shrimps, butterfish, and eels, and in digging for sandworms and mudworms. The total annual yield of this fishery is estimated at 200 t.

11. The investigation included a sample survey of phytoplankton, zooplankton, and pollutant contents of sampled species. Of the phytoplankton, 84 common species, mainly diatoms, were observed to be widely distributed throughout the area. The zooplankton comprised 31 species, which were evenly distributed. Benthos were also sampled in the intertidal zone. Of the 47 species collected, 40 percent were *Polychaeta*, 36 percent were mollusc, 17 percent were crustaceans, and 7 percent were others. The main reason for the low variety is considered to be the result of fishing and wastewater discharge in the survey area. Benthos were also sampled in the shallow water area beyond the intertidal zone. Of the 37 species collected, 54 percent were *Polychaeta*, 19 percent were mollusc, 14 percent were crustaceans, and 13 percent were others. From the quantity composition of benthos, however, lancelet comprise 75 percent of the distribution, while *Turitella bacillum* have the highest biomass. The sampled species differ in pollutant content. Standards were exceeded, by 38 percent, only for zinc, which was detected in three of the eight samples taken. The sources of pollution are upstream in the Fangcheng River and wastewater discharged into Fangcheng Harbor.

2. Socioeconomic Setting

12. Guangxi Autonomous Region had a total population of about 45 million in 1994, most of whom are of Han ethnic background. The remaining 36 percent comprise minority groups, of whom 86 percent (or 33 percent of the total population) are of Zhuang ethnic background. In the Project area, about 60 percent of the affected people are Zhuang. Guangxi is the least economically developed coastal province in the PRC, and ranks twenty-third among the 30
provinces in the PRC in terms of overall socioeconomic development. The per capita gross domestic product (GDP) was Y1,776 in 1993 compared with the average per capita GDP in the PRC of Y2,724. In the 17,000 km$^2$ area covered by the Project, the population is about 3.62 million, with an average density of 214 persons per km$^2$.

13. The Project area has fertile soil and a warm, humid climate, suitable for agricultural development. Agricultural production is currently based on grain: rice, wheat, and corn. The commercial crops include edible oil plants, tobacco, fibre crops, and fruit. Agriculture accounts for about 70 percent of employment in the area. The secondary and tertiary sectors are still relatively weak. As in other coastal provinces, open economic zones have been established, including the Nanning-Fangcheng-Beihai corridor. The annual growth rate of the provincial GDP has accelerated from 7 percent in 1990 to 23 percent in 1993. It is estimated that this rapid rate of increase, especially in the Project area, will continue into the next century. At present, there is excess labor in the rural areas, with the result that every year large numbers of residents migrate to find work in the new industrial production centers, such as the Nanning-Fangcheng corridor. Fangcheng City is also expanding rapidly, and a new urban center is under development in the port area, about 20 km from the existing city center. The population of Fangcheng City is expected to increase from about 60,000 at present to about 500,000 by the year 2005. Most of the growth in population is expected to be the result of migration by the rural poor who will be absorbed into the manufacturing industries being established in the Fangcheng area.

D. Anticipated Environmental Impacts and Mitigation Measures

1. Direct Socioeconomic Impacts

14. The construction of the 45 km highway will involve the acquisition of about 345 hectares (ha) of land and resettlement of 2096 affected families, or 10,000 people. About 35 percent of the required land is presently under cultivation. Farmers will be resettled whose farms are within 0.3-1.0 km of existing road. Compensation funds will be distributed through the 58 production brigades in the area to the individual farmers. The local government will ensure that the compensation is administered and determined based on the Land Administration Laws of the PRC. The compensation will ensure that the previous living standards of the affected families are at least maintained.

15. Compensation for land acquisition is divided into three parts: compensation for output loss, resettlement subsidies, and resettlement procedure. The land acquisition fee includes a compensation fee for output loss, in addition to a resettlement subsidy. The land acquisition fees will total Y6.2 million. This amount is calculated by taking five times the value of the average output over the three years prior to acquisition. The resettlement subsidy per person is three times the value of the average output of the cultivated land over the three years prior to acquisition and will total Y 5.7 million. At present, the average income of farmers in the affected area is between Y861 and Y1,000 per annum. As a result of agricultural land lost to the construction of the highway, about 1,740 surplus agricultural workers will be provided with employment during the first half of 1995 in cement plants, port operations, aquaculture, plantations, construction, and service industries in the Fangcheng area. The average income of workers in these enterprises will be Y3,500 to Y7,000, which is much higher than they obtained from their present agricultural activities. Compensation for the buildings to be demolished for the Project will be in the form of newly-built houses and other facilities. The local government authorities have given an assurance that the people will be resettled first and then the houses and building will be demolished. The average compensation will be 120 yuan/m$^2$, a figure based on town planning and land standards used by local governments for local residents. Other
compensation standards include:

(i) compensation for cultivated land, 5,000 yuan/ha;
(ii) compensation for non-cultivated land, 45,000 yuan/ha;
(iii) demolished buildings: 60 to 150 yuan/m$^2$;
(iv) water wells: 40 yuan each;
(v) tombs: 80 yuan each;
(vi) gas digesters (methane-generating pits) 30 yuan/m$^2$;
(vii) brick kilns: 600 yuan each;
(viii) grain drying apparatus: 10 yuan/m$^2$; and
(ix) dirt roads: 80 yuan/m$^2$

2. **Physical Environment Impacts**

16. There will be some impacts on forests and mangroves related to the highway construction. Of the 2.94 km$^2$ that will be damaged by the construction of the highway, highway interchanges, approaches, and cutting the slopes, 1.47 km$^2$ (50 percent) is secondary forest cover. Farmland accounts for 1.09 km$^2$ (37 percent), and the remaining 0.38 km$^2$ (13 percent) is coastal area which also includes 0.0075 km$^2$ of mangrove forest. These losses will not pose significant impacts to the local ecological system. This is noted especially for the mangrove and forests which are the same species as in the wider survey area. There are no rare plants or ecological species in the affected area.

3. **Construction Impacts**

17. Soil erosion will occur during the construction period, from 1996 to 1998, especially during the rainy season, which is from May to September. The estimated volume of earthworks for the Project is 5.0 million m$^3$. It is assumed the cut and fill requirements will balance. However, because the cut and fill requirements are not evenly distributed and there are restrictions on the amount of spoil to be used as filler material, there will be about 120,000 m$^3$ of excess spoil. This is a small amount and can be disposed of on waste land or retained and planted to minimize the effects of soil erosion. Careful attention will be given to the selection of borrow and disposal sites, especially the sites near rivers. No disposal of spoils will be permitted in rivers or other water courses. Attention will also be paid to subgrade slope protection and to adopt reinforcement measures such as mortar masonry, dry stone masonry, and turf. The most severe cases of induced soil erosion will be found at locations with high embankments and deep cuts. Soil erosion will be minimized by replanting exposed areas, paying attention to slope angle to avoid instability, and protecting the slopes with retaining walls and drains.

4. **Operation Impacts**

(a) **Noise and Vibration**

18. The main sources of noise and vibration will be equipment during construction and vehicle operations after construction is completed. The peak noise during construction may reach 110 decibels (db), but it will reach no more than 90 db beyond 120 m of the source. This will be a temporary and intermittent problem. Site workers will be provided with earmuffs. Noise produced by vehicles will be within acceptable limits. In planning the route, the most sensitive areas such as
schools and hospitals will be at least 500 m away from the highway. Noise sensitive structures such as residential houses are forbidden within 30 m of both sides of the highway and noise barriers will be placed at strategic points. According to the EIA, there are currently no points especially sensitive to vibration along the highway. However, the impingement of wheels on the road and the engines of the vehicles can have an impact on instruments and equipment that are sensitive to vibration and close to the road. These will not be installed within 100 m on either side of the highway alignment.

(b) Water Pollution

19. There are two kinds of wastewater associated with the highway. The first contains oil and grease and constitutes the wastewater of construction and highway maintenance depots. The second is from domestic sewage. Provision has also been made for sewage treatment at all depots along the highway. After treatment, the wastewater will meet Guangxi Zhuang Autonomous Region Standards (Class II) standard requirements for discharging sewage. The current water pollution in the Fangcheng Port area is in part contributed by the oily pollutants from small ships, which do not have oily water separation capabilities. The port component of the Project will include an oily-water treatment vessel to deal with the minor oilspills. There is no wastewater treatment plant in the Fangcheng area, and the urban wastewater is currently contributing to the pollution of the water body at the port. A wastewater treatment plant is being planned by the Fangcheng municipal government. The municipal government will prepare a specific plan for the treatment of urban wastewater to ensure that it will not continue to pollute the water body of the port. The Project will also include a dedicated wastewater treatment plant in the port area. Runoff wastes from the highway will be intercepted at cofferdams built into the highway drainage system. The runoff water will subsequently be channelled into the irrigation channels.

(c) Air Pollution

20. The main pollutants during operation of the highway will be carbon monoxide, nitrogen oxide, suspended particulate matter and lead from vehicle exhausts, and from soil and cement dust during construction and to a lesser extent during operation of the highway. The air pollution risks associated with the Project are consistent with the prevailing wind strength and directions. From the prediction analysis based on five selected sites along the highway alignment, and using forecasted traffic to the year 2020, the PRC's Standard II will be exceeded for nitrogen oxide after the year 2010 within 60 m of the highway. The PRC's standards for carbon monoxide will not be exceeded within the forecast period to the year 2000. By improving the road to permit greater speeds than under the present conditions, the effects of pollution will be less than without the Project. Also, spot checking of exhaust emissions will be carried out at the Chonglun interchange, and vehicles exceeding the standard emission levels will be prohibited, and drivers will be fined. Mitigation measures for suspended dust and gas pollutants will include planting trees along the highway margins. Watering will also help to reduce the dust pollution and careful attention will be given to the siting of cement mixing stations to avoid affecting villages downwind.

(d) Solid Wastes

21. There are several sources of solid waste along the highway alignment: domestic refuse from passengers and workers and sludge from sewage treatment during construction. Rubbish disposal from vehicles will be prohibited. Rubbish disposal will be centralized at specific site. To the extent possible, the waste will be recovered and recycled. Sewage will be collected from temporary latrines during construction, and will be used as agricultural fertilizer. The Fangcheng Municipality Government gave an assurance that it will continue to dispose of solid waste from the port area, as it has done in the past.
E. Alternatives

22. The construction of the highway in the general area of the Project is necessary because of the existing severe congestion of the existing road, which passes through the center of several medium-size towns, and the expected continued rapid growth in traffic in the future. The feasibility study examined two alternative alignments for the highway, both close to each other. The alternative was selected based on minor cost saving considerations. The environmental consequences of either alternative was not significant. An option, which was common to both of the main alternatives, is that the final 7 km of the highway leading into the port will be routed along the coast rather than through the Fangcheng Port City area. The coastal route was adopted because it avoids traffic congestion and vehicular emissions reduce pollution in the city area. The main disadvantage is that the selected alignment for the last 7 km results in the destruction of 0.0075 km$^2$ of mangroves and encloses an area of about 2 km$^2$ of intertidal and shallow waterbays. However, the ecological consequences are minor. Because the Government had already begun to reclaim the enclosed area before reaching a decision on the road alignment caused by the pressing need for urban construction sites, the selected option is rational and will ensure that soil erosion from the reclaimed urban area is suitably contained by the embankment works for the highway. Without the highway protection works, the degradation of the marine environment would have been more significant.

F. Cost Benefit Analysis

23. The costs of the environmental protection and mitigation measures are summarized in Table 1 and total Y41.0 million ($4.8 million equivalent). These costs amount to 9 percent of the total cost of the highway component cost of the Project, which are estimated to be $54.0 million.

<table>
<thead>
<tr>
<th>Items</th>
<th>Y million</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Soil Erosion Protection</td>
<td>34.00</td>
</tr>
<tr>
<td>2. Afforestation</td>
<td>0.88</td>
</tr>
<tr>
<td>3. Noise Prevention</td>
<td>0.50</td>
</tr>
<tr>
<td>4. Water Pollution Abatement</td>
<td>1.10</td>
</tr>
<tr>
<td>5. Contingency</td>
<td>4.52</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>41.00</strong></td>
</tr>
</tbody>
</table>

24. The economic internal rate of return (EIRR) for the highway component of the Project is about 21 percent. The benefits of the mitigation measures are difficult to quantify, however, they include: (i) maintenance of water quality standards for all receiving surface waters; and (ii) maintenance of air quality within accepted national and provincial standards.

G. Institutional Arrangements and Environmental Mitigation and Monitoring Program

1. Institutional Arrangements

25. Within the Communications Department of the Guangxi Zhuang Autonomous Region are professional environmentalists and technical specialists who will assist in the environmental protection along the highway alignment. To mitigate the environmental impacts
from construction as much as possible, environmentalists will be assigned to the construction units to implement environmental protection measures. Each local environmental protection agency and water and soil conservation agency will manage and supervise environmental protection and soil erosion prevention.

2. Monitoring

26. All the monitoring of environmental impacts will follow national standards at the minimum. The monitoring of the human (socioeconomic) impact will include resettlement, land acquisition, compensation, employment, and housing. Periodic monitoring is typically carried out by the monitoring stations of the railway administrations and subadministrations. The monitoring of the natural environment will include wastewater quality, air emissions, and noise levels for each administration's geographic area of responsibility. The Fangcheng Municipality Government has set up a lead team to handle migration and resettlement. The team will investigate, consult, and supervise the removal, resettlement, compensation, and employment of the populations affected. Branches of this group will be set up in the main townships along the road and will consist of administrators, technicians, workers, and residents.

27. The Fangcheng Municipal Government was only officially chartered in October 1993, thus, many of its environmental institutions are still being developed. Nevertheless, the municipal government has a plan for detailed environmental monitoring of the Project. It will recruit competent professional staff to implement the plan. The municipal government has monitoring records for 1992-1994, which demonstrates its existing monitoring capability.

H. Public Involvement

28. As normal practice in the PRC, and as observed in the field, the leaders of townships, villages, and districts were consulted and the local people were informed about the requirements and impact of the Project. While public involvement at the grassroots level is institutionalized within the political system, public forums on the highway have been held. In January 1994, an environmental protection assessment unit sought opinions about the alignment alternatives. Generally, the public supported the Project in such forums. Discussions with individuals also confirmed they support the Project. Minority groups will be affected by the Project, but these groups have been settled in the area for many years. The economic prospects, along with those of the population at large in the area will be improved by the Project through opportunities for employment in industry and opportunities to market agricultural produce on a competitive basis.

I. Conclusions

29. The proposed Fangcheng Highway component of the Fangcheng Port Project, which covers a 45 km long new alignment from Natan to Fangcheng Port will provide significant benefits to the regional economy because it will significantly reduce serious transport bottlenecks by improving the access between Fangcheng Port and its rapidly developing hinterland in the southwest part of the PRC. The highway will also provide a necessary improvement in access to the rapidly industrializing Nanning-Beihai-Fangcheng corridor, and will complement the proposed expansion of Fangcheng Port as well as contribute to employment prospects for the rapidly increasing population in the area covered by the Project.

30. The major environmental threats will arise in the area of ecology, notably soil
erosion and loss of mangroves because of the construction activities; the potential noise pollution; the relocation and compensation of populations forced to resettle because of highway construction; and the impact of induced development. The mitigation of these impacts will be achieved through the design of disposal sites for the excess soil excavated, the reforestation, and rehabilitation of mangrove forests after construction, and the careful planning of resettlement and compensation. A rigorous monitoring program will also be implemented during and after construction of the Project. In summary, the negative environmental impacts can be mitigated and offset by the benefits of the Project.