18.3.5 Suggested Environmental Programs and Projects

The environmental targets set in Section 18.3.4 will be achieved through an array of environmental measures. They are broadly classified into "structural measures" and "non-structural measures". The figure below schematically shows the overall organization of various environmental measures.

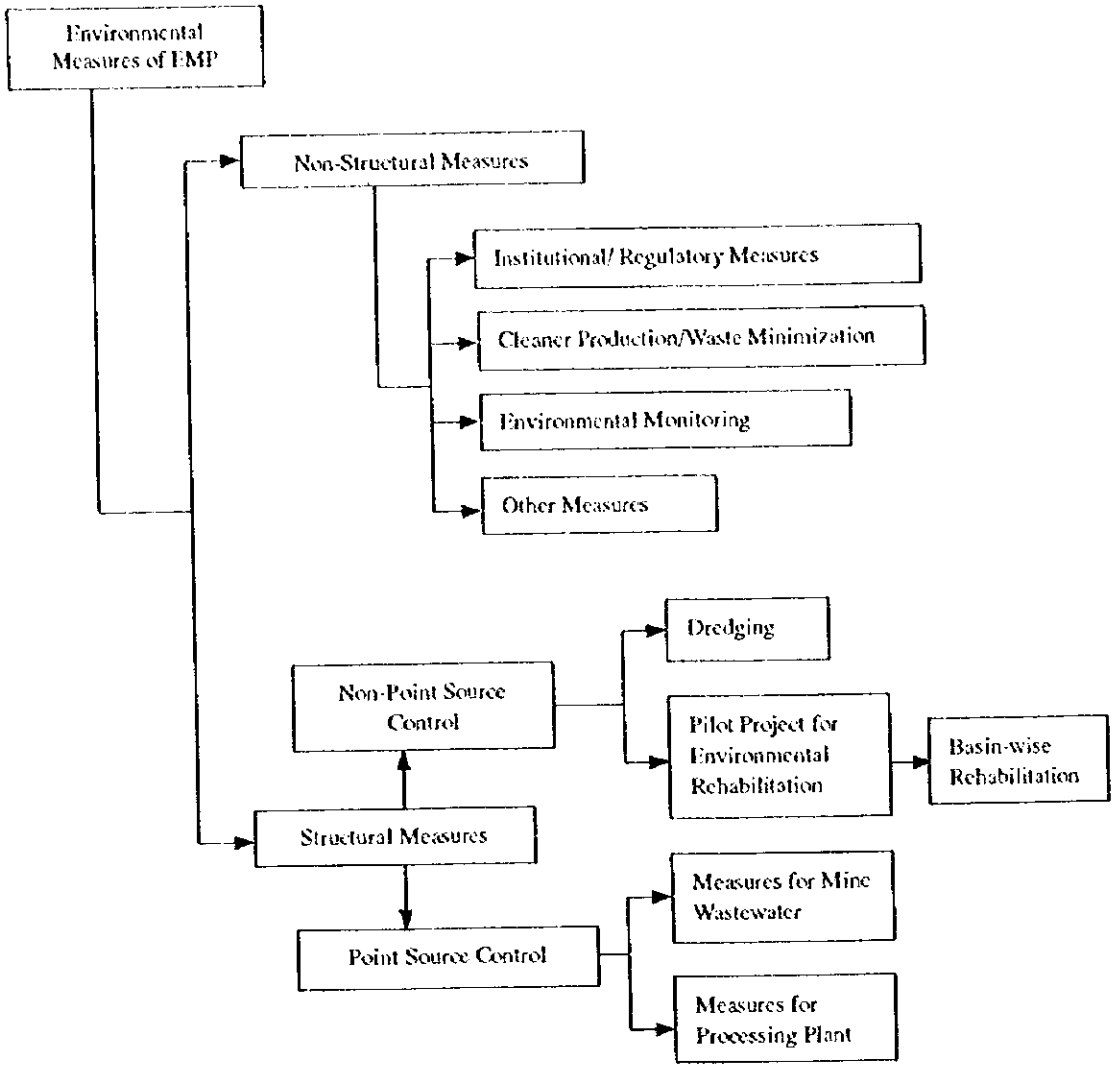


Figure 18.3.6 Organization of Proposed Environmental Measures

Non-structural measures consist of institutional, regulatory, and other soft measures. Measures such as promotion of cleaner production, wastes minimization, and wastes recycling are also classified under the non-structural measures as they are closely related to production design and planning. Another important non-

structural measure is environmental monitoring, which is discussed separately in Chapter 20.

Structural measures are physical or hard measures to control environmental problems. Because water pollution and erosion are the main environmental problems associated with the coal mining industry, the EMP focuses mainly on measures to control water pollution from point and non-specific sources. The proposed structural measures include revegetation, drainage improvement, dredging, mine wastewater treatment, and measures for coal processing plants.

Measures to control noise, vibration, impacts to groundwater regime, emission of toxic gases including coal bed gas and exhaust from mining equipment, are not included here, as they are beyond the scope of this Project. However, these measures also have to be implemented.

(1) Development of Environmental Plan

1) General description of the program

Good planning is an indispensable part of the environmental management, although developing a good environmental plan is not trivial. Hence, the EMP adopts a 2-step approach to develop environmental plans for coal industries. First, a model environmental plan is formulated for a representative mine in the EMP area. A suggested mine for this is East Coc Sau mine, where VINACOAL is currently soliciting an international business partner for the development. In such mine, introductions of advanced environmental technologies are easier. In this stage, a few international mining experts work closely with the local mining engineers, and formulate a highly site-specific environmental plan. In the following stage, all mines formulate their own environmental plans based on the model environmental plan, and VINACOAL prepares a comprehensive environmental plan for the region. The environmental plans consist of the following parts:

- production plan
- wastes management plan
- rehabilitation plan

- monitoring plan
- implementation plan
- cost estimate

Some of the important considerations include:

i) Compliance with Environmental and Mining Regulations and Standards

The environmental plans should be in compliance with any applicable laws, regulations, and standards.

ii) Wastes Management/Cleaner Production

A preliminary cost estimate indicated that it would cost roughly $1 – 2 to control 1 ton of eroded sediment. Hence, it is advantageous to minimize wastes as much as possible at the planning stage, before making significant investment on production and environmental measures. Some ideas to reduce wastes generation include:

Examples of Wastes Minimization Strategies

Location	Measures
Mine	- adoption of mining methods that produces less wastes (e.g., underground mining)- disposal of solid wastes to places less prone to erosion (e.g., pit dumping)- reuse of mine wastewater
Processing plant	- pre-screening of raw coal- sale of low grade coal- recycle of solid wastes (e.g., as construction material)- recycle of wastewater
Transportation system	- improvement of infrastructure- dust cover

iii) Rehabilitation Plan

All mines have to be rehabilitated before their closure. However, in practice, many mines and overburden dumps are left abandoned, and further exploitations are in progress without long-term rehabilitation plans. Hence, there is an urgent need to develop long-term and short-term rehabilitation plans.

iv) Enforcement

Mechanisms to ensure enforcement of proposed environmental plans should be built into the environmental plans. All individual coal enterprises are

responsible for enforcing their environmental plans. The performance shall be monitored through the environmental monitoring programs which will be carried out internally by each enterprise and externally by DOSTE (see Chapter 20 and Chapter 21 for monitoring plan and institutional set up).

2) Cost estimate and schedule

The preliminary investigation and planning will take three years in total starting in 2000. The details of the cost estimates and schedule are given in Table 18.3.7.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Design	Design	921
Total		921

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(2) Pilot Project on Environmental Rehabilitation

1) General description of project

The lack of practical experiences is one of the important factors preventing the coal industries to design and implement effective environmental measures. Therefore, a pilot project is proposed to foster working experiences in designing and implementing environmental rehabilitation.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	150	
	Revegetation	ha	100	
	Drainage System	m	11,000	
	Wastewater Treatment	facility	1	
Target	Denuded Area	ha	125	50
	SS	10^3 tons/year	3.8	1.7
	Erosion	10^3 tons/year	50	21

It was noted that UNDP Project VIE/95/003 proposed "Pilot Project on Land Reclamation" and "Pilot Project on Wastewater Treatment" which were designed to be financed through VINACOAL's environmental fund. The project proposed here is similar to these projects in spirit, although it is larger, and is designed to be financed internationally.

2) Proposed measures

Considering the trial nature of this project, the project site shall be small enough to allow controlled study, and yet large enough to verify the effectiveness of the measures to be tested. Approximately 150 ha of a mining area in Mong Duong river basin, where erosion problem is sever, is suggested for this pilot project. The project area is selected such that the following four studies can be carried out:

Proposed Rehabilitation Studies

Study	Area	Selection Criteria
Revegetation (permanent)	50 ha	Area to be permanently reforested including buffer area
Revegetation (temporary)	50 ha	Area to be temporarily revegetated with grass, e.g., buffer zone, area where permanent revegetation is difficult, etc.
Drainage improvement	11,000 m	Area where installation/rehabilitation of drainage is needed, e.g., perimeter of active mining zone, denuded steep slope, etc.
Wastewater Treatment	-	Near the discharge point of mine wastewater

In the first two years, a few international experts should work closely with the local engineers so that the Vietnamese engineer can learn international experiences from them. The third year is used mainly for the project evaluation, and the trained local engineers will engage in designing environmental measures in other mines.

Slope Control Slope length, angle, vegetation cover, drainage pattern, and soil characteristics are the important factors determining the extent of erosion problems. For a terrain where erosion is intense, measures such as contour banking, surface roughing, slope disks and other measures are recommended. Table below summarizes the suggested maximum slope length criteria.

Landform Design Criteria

Slope (%)	Vertical Height (m)	Max. Slope Length between Contour Banks (m)
20	10	50
15	20	130
10	22	220
5	26	520
3	28	900

Source: UNDP, 1998

For slopes over 18%, the use of special precautions such as terracing, rock armouring, mulching, and other measures are recommended.

Drainage System Diversion channels shall be placed upgradient of disturbed area, along long, steep slopes, along the base or toe of disturbed area, along haul roads, and around topsoil stockpiles. The channels may be lined with grass and/or riprap, especially when the velocity in the channel is high. The density/spacing of diversion depends on the local condition. Based on the slope, average mining contour level, and other factors, the assumed average density of the diversion channel is 100 m/ha, and the estimated total length of channels including both diversions and downdrains is 11,000 m. The collected runoff is directed to check dams and other sedimentation mechanisms to control sediment, and then to downdrain structures. In the main stream, one permanent erosion control dam is constructed. In addition, temporal check dams and other sediment control mechanisms are constructed.

Mine Wastewater Treatment In this pilot project, a facility for mine wastewater treatment is designed and tested. Before designing the treatment system, the design of the pumping system has to be reviewed, and the possibilities to reduce the amount of mine wastewater and pollutants shall be explored. For example, the wastewater may be pre-settled in the pit before pumping, or a finer strainer may be installed. To treat the water to the level of industrial wastewater discharge standard, TCVN5945-1995, a treatment system specifically designed for this purpose has to be constructed. For SS control, installation of sedimentation pond or filtering system may be necessary. For pH adjustment, anoxic lime stone drain, pH adjustment with base solution, and anaerobic wetland system are the potential technologies (Robinson and Robb, 1995). Tentatively anoxic limestone drain (see Figure below) is suggested as limestone is readily available in the area.

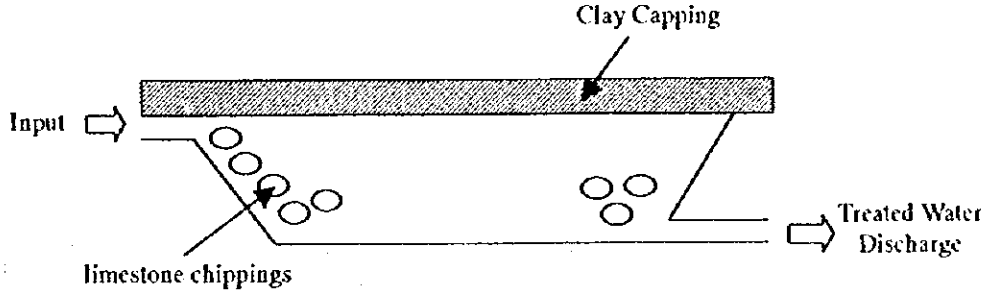


Figure 18.3.7 Schematic Diagram of Anoxic Limestone Drain

The detailed comparisons of available technologies have to be carried out in the earlier phase of the pilot study.

Revegetation In total 100 ha of the land will be selected for the revegetation studies, of which 75 ha will be used to cover denuded area, and the remaining 25 ha will be used to reinforce the degraded buffer area. Fifty ha will be used for the study of permanent revegetation with trees, and the remaining 50 ha will be used for the study of temporary revegetation with grass and/or shrub. From environmental considerations, the use of indigenous species is strongly recommended. Other promising species for permanent revegetation are Acacia, Eucalyptus, and Pine; for the temporary revegetation, Ghine Grass (Panicum maxium), and Vetiver (Vetivera sp.) may be suggested.

3) Cost estimate and schedule

Table 18.3.8 summarizes the estimated project costs and schedule. Because the results of this project will be essential in designing environmental measures in other areas, the project shall be initiated as soon as possible. The anticipated period for design/construction is 3 years, and the O&M costs after 2005 will be absorbed by the "Mong Duong River Basin Rehabilitation Project" and "Environmental Measures for Mine Wastewater".

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	1,338
	Ground Prep.	73
	Drainage	200
	Revegetation	52
O&M	O&M	166
Total		1,829

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(3) Environmental Measures for Mine Wastewater

1) General description of project

The project will install water treatment system at 50 outlets of mine wastewater to keep the level of pollutants below the discharge standard (TCVN 5945-1995).

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	-	all mines	
Target	SS in 2010	10^3 tons/year	8.88	2.82

2) Proposed measures

Design Because the general design of the wastewater treatment system is carried out as a part of the "Pilot Study on Environmental Rehabilitation", this project will mainly focus on improving the design, and implementing the system to each discharge point. The applicable industrial wastewater discharge standard, TCVN5945-1995, is given below:

Wastewater Discharge Standard

Discharge Area	Criteria	SS (mg/ℓ)	pH
Upstream of Dien Vong Water Supply Uptake	TCVN5945-1995, A	50	6.0-9.0
Other	TCVN5945-1995, B	100	5.5-9.0

The operator of the mine has to maintain the treatment facility at working condition, and regularly monitor the wastewater quality. The treated wastewater can be used to control dust, to water revegetated area, and other purposes, including, if feasible, for coal processing.

3) Cost estimate and schedule

The details of the cost and schedule are given in Table 18.3.9. The estimated total cost during 2000 and 2010 will be US$ 2,274,000.

Estimated Cost

Type	Work	Cost ($\times 10^3$ US$)
Construction	Design	58
	Treatment System	1,858
O&M	O&M	360
Total		2,218

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(4) Environmental Measures for Coal Processing Plants

1) General description of project

There are two major processing plants in the EMP area: Cua Ong Coal Processing Plant and Nam Cau Trang Coal Processing Plant. Cua Ong plant uses a

combination of wet and dry technologies, and Nam Cau Trang plant uses wet technology to process coal. Considering the environmental problems at these plants, the following measures are suggested: 1) environmentally sound disposal of solid wastes, 2) improvement of drainage system to intercept SS in runoff and floor washing wastewater, and 3) dust control.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	approx. 400 ha	
Target	Solid Wastes	-	environmentally-sound disposal	
	SS in 2010	tons/year	4,400	880

2) Proposed measures

In addition, drainage systems to capture coal particles contained in storm runoff and floor washing water has to be designed.

Solid Wastes There are a number of options to reduce the amount of solid wastes which include: 1) pre-screening at mine, 2) use of solid wastes as construction material, 3) re-screening of low grade coal, which accounts for 1/5 to 1/4 of the solid wastes for sale, and 4) improvement of transportation system. To our knowledge, Cua Ong plant recently succeeded to commercialize the low grade coal, and VINACOAL made an agreement with Taiwan to supply 200,000 tons/year of coal powder over 14 years. These measures to reduce solid wastes are particularly desirable as they often cut the overall production cost while reducing the environmental wastes. Unfortunately these measures were not thoroughly explored in this Study because essentially no information on production-side of VINACOAL's operation was available to the Study Team. However, VINACOAL is strongly urged to explore these approaches to reduce solid wastes from the production process.

Assuming that the current level of solid wastes generation continues, as much as 6.9 million m^3 from Cua Ong plant and 7.7 million m^3 from Nam Cau Trang plant will be produced by 2010. The estimated requirements for dumping sites are:

Estimated Areas for Future Dumping Sites

Plant	Area	Assumption
Cua Ong plant	173 ha	4 m high
Nam Cau Trang plant	40 ha	20 m high

Cua Ong -- East Cam Pha area has the potential to be developed as an industrial/commercial area. Hence, the solid wastes from Cua Ong plant may be used to reclaim the coastal area as shown in Figure 18.3.8 provided that: 1) full feasibility study, including material testing, and careful planning are carried out, 2) full EIA is conducted, and 3) the reclamation work is done in environmentally-sound manner. The reclaimed area may be used to house the coal industry, which is to be consolidated in Cam Pha - Cua Ong area. Solid wastes management at the Nam Cau Trang site is more problematic, mainly because there is not enough space to accommodate large dumping site. For the time being, reclamation of coast appears to be inevitable. Again, the reclamation has to be done in an environmentally sound manner.

Wastewater Although as much as 30% of the water is already recycled at these plants, the potential to further reduce the amount of water should be investigated. Examples of approaches include: 1) prescreening raw coal at mine, 2) use of mine wastewater for processing, 3) further recycle of water at the processing plant, and 4) modification of processing process. The wastewater from the process is treated by coagulation reactors, and then by sedimentation ponds. The wastewater in the sedimentation ponds is allowed to infiltrate, and the sludge left in the pond is collected as coal powder (or coal mud), and sold on the domestic market. However, the process to recover coal sludge is not efficient, and the wastewater from the process is prone to overflow and pollute Bai Tu Long bay. Hence, the improvement of the treatment process is recommended. There are plans to renovate the wastewater treatment process by introducing sludge de-watering system. This way, the coal powder can be efficiently recovered and commercialized. Furthermore, these plans also reduce pollution from the processing plant. Therefore, implementation of these plans is highly recommended.

Other important sources of pollution are the wastewater generated from washing floor and the storm runoff from the plants including the stock piles and wastes dumpsites. To control these, diversions have to be installed around the plants and dumping sites, and sedimentation ponds have to be installed at all outfall points.

Assuming that the sedimentation ponds can intercept 80% of the pollution load, the pollution loads in 2010 will be reduced from 4,400 tons/year to 880 tons/year.

Dust Control Dust at the processing plant, including the haul road to the processing plants, shall be controlled with high pressure sprayers and water trucks.

3) Cost estimate and schedule

Among the various measures suggested above, the costs for installation/improvement of drainage system, revegetation, dust control, and the related design were estimated here. The table below summarizes the overall project cost. The details of the cost and schedule are given in Table 18.3.10.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	116
	Drainage	78
	Revegetation	10
	Dust Control	20
O&M	O&M	1,464
Total		1,688

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

The cost estimates for other measures, including solid wastes disposal and improvement of wastewater treatment system, require detailed information which were not available to the study team.

(5) South Deo Nai Dumping Site Rehabilitation

1) General description of project

Due to its proximity to the residential area, steep slopes, and the massive size (225 meters high), the environmental impact of the South Deo Nai dumping site is one of the worst among the dumping sites in the EMP area. The erosion rate is the highest in the EMP area, and there is a risk of landslide. Considering the environmental impact of the dumping site, additional dumping must be prohibited immediately. Among the 739 ha of mining land in Cam Pha Central and Cam Pha East basins, the project will mainly rehabilitate 600 ha of the steep slope area. The main components of the project include: terracing the western wall, installation of diversion channels and downdrains on the slopes, and revegetation of the denuded area. The project is

expected to reduce the erosion rate to 1/6 of the present level (approximately 240,000 tons/year). Table below summarizes the project area, area to be rehabilitated, and anticipated pollution loads without and with the project.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	739	
	Revegetation	ha	600	
	Drainage	m	33,000	
Target	Denuded Area	ha	671	89
	SS	10^3 tons/year	7.3	1.5
	Erosion	10^3 tons/year	278	40

2) Proposed measures

Design The project design shall be conducted by a team of experts including geotechnical engineers, because there is a potential of landslide. Stability analysis shall be carried out to prevent slope failure.

Slope Control Considering the steep and loose condition of the terrain, terracing or other geotechnical measure will be required to stabilize the slope. Because the east wall of the dump site has already been partially terraced, the estimated length for additional terracing work is in the order of 1.5 km. The detailed requirement for terracing shall be designed by the geotechnical engineers. Contour banking and other measure are required to control sheet flow and to create favorable condition for revegetation.

Drainage System Minimizing the risk of landslide is the first priority. Therefore, infiltration of surface runoff, which may be encouraged in other areas, shall be discouraged here. Instead, as much surface runoff needs to be collected with diversion channels constructed at the top of the terrain, at the terrace, and other places across the slope. Estimated total length of the main diversion channels is around 7.0 km, and in addition, a series of secondary channels shall be constructed along contour banks. The collected runoff is directed to downdrains, and then to the sedimentation ponds at the bottom of the slope. The outlet of the downdrains shall be protected with riprap. In addition to the surface runoff, groundwater flow may also have to be controlled by draining it to minimize the risk of landslide. To

ensure long-term effectiveness of the measure, the drainage system shall be made of concrete or other durable materials.

Revegetation It is expected that reestablishing large trees on such steep terrain is difficult. Therefore, area where establishing trees is difficult shall be temporarily covered with grass and shrub first to facilitate the development of top soil. Hydromulch method with an application rate of about 2,000 kg/ha is considered. Trees are planted along the contour using seedling method than direct seeding method. Tentatively pine and/or eucalyptus are recommended, although VINACOAL shall conduct pilot study before finally deciding the species to plant.

3) Cost estimate and schedule

The table below summarizes the project cost. The details of the cost and schedule are given in Table 18.3.11. Considering the risk of landslide, this project shall be implemented as soon as possible.

Estimated Costs

Type	Work	Cost (US$ × 10^3)
Construction	Design	144
	Ground Preparation	1,734
	Drainage	828
	Revegetation	138
	Dust Control	0
	Dyke Construction	36
O&M	O&M	496
Total		3,376

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(6) Mong Duong River Basin Rehabilitation Project

1) General description of project

Deo Nai – Coc Sau area in the southeast part of the basin is the most disturbed area (Figure 18.3.2) in the EMP area, and is a main source of erosion. In addition, the contribution from the Cao Son area is increasing recently. Unless environmental measures are taken, about 600 ha of land will be newly denuded by 2010. The main objective of the Mong Duong River Basin Rehabilitation Project is, therefore, to rehabilitate this area so that the denuded area in 2010 is reduced to 1,890 ha. Because "Pilot Study on Environmental Rehabilitation" rehabilitates a part of the basin, this project will rehabilitate the rest.

Project Size and Target*

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	3,250	
	Revegetation**	ha	900	
	Drainage	m	99,000	
Target	Denuded Area	ha	2,413	1,890
	SS	10^3 tons/year	27.7	23.6
	Erosion	10^3 tons/year	946	764

Note: * Excluding the rehabilitation with "Pilot Study on Environmental Rehabilitation"
** Including temporal rehabilitation site

2) Proposed measures

Design The project area consists of subbasins with somewhat different characteristics. Southeast subbasin area, where Deo Nai and Coc Sau mines are located, has already been disturbed significantly. In this area, rehabilitation of the denuded area through drainage system improvement and revegetation is the main goal. On the other hand, Southwest-Central subbasin area, where Cao Son, Khe Cham, Mong Duong and other mines area located, will be developed further. In this area, more emphasis shall be placed on contemporaneous rehabilitation.

Drainage System Because both active mining area and rehabilitated area need drainage systems, the following criteria are used to prioritize the target area:

- intensity of erosion (see Figure 18.3.3 for the area where the potential of erosion is high)
- vulnerability of the area to erosion (e.g., newly planted trees and grass have to be protected from erosion)
- production plan

The plan is to construct 900,000 m of diversion channels, which will be able to cover roughly 900 ha with the channel density of 100 m/ha. The actual design of the drainage system depends strongly on the local topography, discharge pattern, soil characteristics, and other factors, and steep terrain needs higher channel density. The collected runoff shall be directed to check dams and other sedimentation mechanisms to control sediment. In the main streams, 10 permanent erosion control dams are constructed. In addition, temporal check dams and other sediment control mechanisms are constructed throughout the basin.

Slope Control Surface roughing, slope disks and other measures are recommended to control runoff, and to create favorable condition for revegetation.

Revegetation The basin-specific environmental goal is the reduction of the denuded area to 1,890 ha by 2010. To achieve this, 600 ha of the denuded area has to be revegetated through this project and "Pilot Project on Environmental Rehabilitation". Assuming that the pilot study revegetates 75 ha of the denuded area, this project shall revegetate about 525 ha of the denuded area. Because the basin is already highly disturbed, even temporary revegetation with grass and shrub should be considered. In addition, vegetation in crucial areas, such as along streams and in the buffer area, has to be reinforced. The requirement for this is estimated at 350 to 400 ha.

Dust Control Water trucks are used to control dust along the haul roads. In addition, high-pressure sprayers are installed strategically.

3) Cost estimate and schedule

The details of the cost and schedule are given in Table 18.3.12. The table below summarizes the estimated costs. Mong Duong River basin is already highly disturbed. Hence, this project shall be carried out as soon as practically possible.

Estimated Costs

Type	Work	Cost (US$ × 10^3)
Construction	Design	360
	Ground Preparation	1,242
	Drainage	530
	Revegetation	323
	Dust Control	473
	Dyke Construction	41
O&M	O&M	1,423
Total		4,392

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(7) Dien Vong Basin Rehabilitation Project

1) General description of project

This area is characterized by the existence of relatively new, small mines, such as Khe Tam, Nga Hai, and Ha Rang along the southwest tributary developed in the last 10 years. In addition, there are some mines, such as Suoi Lai, Cao Thang, and

Ha Tu in the north of Ha Tu basin. Except Ha Tu mine area, mining activities are scattered, and the pollution loads per unit area are not high. However, due to the large size of the basin, and the anticipated rapid increase in denuded area in the future, this basin is going to contribute to 37% of the total SS from coal-mine related non-specific sources in 2010. Hence the project will mainly focus on establishing contemporaneous rehabilitation in the newly developed area.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	6,750	
	Revegetation*	ha	1,500	
	Drainage	m	165,000	
Target	Denuded Area	ha	2,694	1,720
	SS	10^3 tons/year	32	23
	Erosion	10^3 tons/year	769	508

Note: * Including temporal rehabilitation site

2) Proposed measures

Design Considering the future development of this area, emphasis shall be placed on minimizing the denuded area, top soil management, and contemporaneous rehabilitation. The areas where concentrated efforts are needed are the northern area of Ha Tu basin and areas upstream of the Dien Vong water supply uptake.

Drainage System The suggested total length of the drainage channels (diversions and downdrains) is 16,500 m, which can cover approximately 1,500 ha of the area where erosion is intense. In the main streams, 11 permanent erosion control dams are constructed. In addition, temporary check dams are constructed throughout the basin.

Slope Control In the past, top soil was not properly managed, which made revegetation difficult and costly. Therefore, for the newly developed sites of approximately 1,000 ha, the top soil shall be stored separately to be used later, or used for rehabilitation of denuded area.

Revegetation To meet the basin-specific environmental target, therefore, 1,500 ha will be revegetated. The prime target areas for revegetation are the Southeast tributary and the north of Ha Tu basin. About 1,000 ha is used to rehabilitate

denuded area. In addition, vegetation coverage in the upstream area of Dien Vong reservoir has to be reinforced to protect the reservoir.

Dust Control Water trucks and high-pressure sprayers are used to control dust along the haul roads. Considering the remoteness of the basin, the direct impact to residents will be small. Therefore, the allocation of resources for dust control is relatively small compared to the ones in other basins.

3) Cost estimate and schedule

The details of the cost and schedule are given in Table 18.3.13. The table below summarizes the estimated costs.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	332
	Ground Preparation	1,050
	Drainage	754
	Revegetation	571
	Dust Control	264
	Dyke Construction	22
O&M	O&M	1,146
Total		4,139

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(8) Ha Tu Basin Rehabilitation Project

1) General description of project area

Ha Tu basin is not as large as Mong Duong and Dien Vong basins. However, over 60% (790 ha) of the basin is already denuded, and the erosion rate is high. Therefore, the main objective of this project is to minimize denuded area as much as possible.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	1,275	
	Revegetation*	ha	400	
	Drainage	m	44,000	
Target	Denuded Area	ha	1,022	790
	SS	10^3 tons/year	11	9
	Erosion	10^3 tons/year	469	366

Note: * Including temporal rehabilitation site

2) Proposed measures

Design This area is highly disturbed. Hence, vegetation has to be established as soon as possible. Installation of diversions are another effective measure to control erosion from already denuded area.

Drainage System Installation of properly designed drainage channel network is probably the most effective measure to control erosion in area under use, such as mining area and dump sites. Therefore, 40,000 m of diversion channels is installed in the basin, which will be able to cover roughly 1/3 of the basin. Diversion channels shall be placed upgradient of disturbed area, along long, steep slopes, along the base or toe of disturbed area, along haul roads, and around topsoil stockpiles. The collected runoff shall be directed to check dams and other sedimentation mechanisms to control sediment, and then to downdrain structures. In the main stream, 5 permanent erosion control dams are constructed.

Slope Control Terracing of 600 m is considered to stabilize Ha Tu dump. Because the top soil in large area is already lost, it will be difficult to establish permanent vegetation right away. Hence, top soil may have to be brought in from other areas. Contour banking, surface roughing, slope disks, and other measures will also help control erosion and provide favorable condition for revegetation.

Revegetation The priority should be placed to cover as much denuded surface as possible even temporarily with grass or shrub if establishing permanent vegetation is difficult. The suggested total revegetation area is 400 ha. For the revegetation of steep area, hydromulch method may be used.

3) Cost estimate and schedule

The details of the cost and schedule are given in Table 18.3.14. The table below summarizes the estimated costs. Ha Tu basin is already highly disturbed. This project shall be carried out as soon as practically possible.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	360
	Ground Preparation	556
	Drainage	245
	Revegetation	158
	Dust Control	89
	Dyke Construction	20
O&M	O&M	392
Total		1,820

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(9) Hong Gai North Basin Rehabilitation Project

1) General description of project area

Located in the north of the inhabited area of Hong Gai, this is one of the areas where people are exposed to the direct impact of mining activities. Considering the future expansion of the urban area, the conflict between mining industry and urban development will grow further. Therefore, the project aims at isolating the environmental impacts of coal mining activities to the urban area.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	1,275	
	Revegetation*	ha	150	
	Drainage	m	16,500	
Target	Denuded	ha	333	200
	SS	10^3 tons/year	4.4	2.9
	Erosion	10^3 tons/year	111	70

Note: * Including temporal rehabilitation site

2) Proposed measures

Design The prime target areas of the project are the area around Ha Lam mine and along the haul roads to Hong Gai and Nam Cau Trang. These areas are likely to be urbanized further in the future. Therefore, the design should be consistent with the urban development plan.

Drainage System Diversion channels are constructed mainly in denuded area in Ha Lam mine. Tentatively installation of 15,000 m of diversion channels and 1,500 me of downdrains is proposed. In the main stream, a few permanent erosion control dams are constructed.

Slope Control Surface roughing, slope disks, and other measures can be applied to control erosion and to provide favorable condition for revegetation. Mulching is also recommended.

Revegetation The total areas to be revegetated will be 150 ha of which 100 ha will be revegetated permanently with trees. The area to be revegetated shall be designed strategically to protect inhabited area from mining activities including dust problem. Denuded area near residential area has the highest priority to be vegetated. In addition, area along the haul roads and rivers has to be revegetated.

3) Cost estimate and schedule

The details of the cost and schedule are given in Table 18.3.15. The table below summarizes the estimated costs.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	104
	Ground Preparation	84
	Drainage	92
	Revegetation	52
	Dust Control	45
	Dyke Construction	0
O&M	O&M	153
Total		530

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(10) Cam Pha West Basin Rehabilitation Project

1) General description of project area

This area is located north of Cam Pha town, and there is Tay Khe Sim mine in the basin. The mining activity is minor, and the environmental condition is much better than the one in the neighboring South Deo Nai dumping site. However, the south slope is steep and is prone to intense erosion once the surface vegetation is denuded. For this area, the project focuses on revegetating the denuded area and buffer area. The target is to reduce the denuded area to 40 ha by 2010.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	125	
	Revegetation*	ha	50	
	Drainage	m	5,100	
Target	Denuded Area	ha	89	40
	SS	10^3 tons/year	1.1	0.4
	Erosion	10^3 tons/year	50	23

Note: * Including temporal rehabilitation site

2) Proposed measures

Design The area is not intensively mined. However, if the area is not managed properly, the impact will directly affect the northern part of Cam Pha town. Therefore, further disturbance of surface shall be prohibited, as any disturbance on such steep slope could cause large irreversible impact, and rows of dense vegetation cover has to be established across the slope.

Drainage System Diversion channels are constructed across the slope, and collected runoff shall be transported safely down the slope with the downdrain. At the bottom of the down drain, sedimentation pond is constructed to settle the sediment.

Slope Control Major cut/fill works are not recommended on steep slopes, unless they are required to stabilize the slope. Instead, a number of small contour banks may be constructed across the slope, and diversion channels are installed along the contour banks.

Revegetation In principle, the entire terrain shall be revegetated permanently. In particular, the existing denuded area should be covered up as soon as possible to prevent the erosion problems to progress. The existing vegetation on the slope needs to be reinforced to establish densely vegetated buffer strips across the slope.

Dust Control Dust is controlled by establishing vegetation.

3) Cost estimate and schedule

The details of cost estimation and schedule are found in Table 18.3.16. The table below summarizes the estimated costs.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	20
	Ground Preparation	24
	Drainage	37
	Revegetation	26
	Dust Control	0
	Dyke Construction	0
O&M	O&M	38
Total		145

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(11) Cua Ong Basin Rehabilitation Project

1) General description of project area

This area is characterized as a haul route of coal to processing plant and coal ports. In addition, the impact of mining activities in the Mong Duong river basin is reaching this basin. Therefore, dust control, revegetation of buffer area, and erosion control of dumping sites are the main components of the project.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	550	
	Revegetation*	ha	110	
	Drainage	m	12,100	
Target	Denuded Area	ha	218	140
	SS	10^3 tons/year	2.6	1.8
	Erosion	10^3 tons/year	84	56

Note: * Including temporal rehabilitation site

2) Proposed measures

Design There are not many mines in the project area, although the impacts of mining activities, especially overburden dumping, are reaching to this basin. Hence, the reinforcement of buffer area and management of dumping area are the main components of the project.

Drainage System Diversion channels and sedimentation systems shall be placed mainly in the dumping site area and along haul roads. The proposed total length of diversions is 11,000 m. The collected runoff is directed to check dams and other sedimentation mechanisms to control sediment, and then to downdrain structures.

In the main stream, two permanent erosion control dams are constructed downstream of major dumping sites.

Slope Control Contour banking, slope disks are among the main measures for slope control. At this point, terracing of dumping site is not considered, because the bottom of the major dump site is not densely inhabited. Nevertheless, some dumping sites are large, and may require terracing in the future.

Revegetation Vegetation shall be reestablished along the haul roads to control dust. In addition, revegetation downstream of the dumping area has to be reinforced. The total revegetation area is 110 ha, and all of it will be permanently revegetated. Through the revegetation program, the size of the denuded area is reduced to below 140 ha by 2010.

3) Cost estimate and schedule

The details of cost estimation and schedule are found in Table 18.3.17. The estimated costs are summarized below.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	112
	Ground Preparation	61
	Drainage	75
	Revegetation	61
	Dust Control	45
	Dyke Construction	0
O&M	O&M	140
Total		494

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(12) Dredging Project

1) General description of project area

According to our estimate, as much as 2 million tons of sediment is eroded every year. While not all of the 2 million tons is reaching the rivers and seas, a substantial amount is filling-up rivers, reservoirs, and irrigation systems, and there are occasional problems of limited landslides in rainy season. Because denuded area is the main source of erosion, rehabilitation of denuded area, as proposed above, will significantly reduce the erosion in the long run. However, it will take time before

the proposed measures start to show the benefit. Meanwhile, the deposited sediment has to be periodically dredged out from critical water courses, such as rivers and irrigation channels.

Project Size and Target

Item	Category	Unit	Without Project	With Project
Project Size	Project Area	ha	Affected Area	
Target	Dredging	tons/year	0.6 – 0.8 million	

2) Proposed measure

Design Dredging works are to be designed every year based on the urgency of dredging works. This includes emergency dredging works in rainy season.

Dredging QNPC is urged to conduct studies to estimate the exact requirement for dredging work. The tentatively set dredging requirement is 0.80×10^6 tons/year or 0.50×10^5 m^3/year until 2005. As the effect of the proposed rehabilitation project starts to show, the requirement will gradually decrease over the years.

3) Cost estimate and schedule

Dredging cost is highly dependent on the location of the sediment, disposal site, etc. Based on the current dredging operations, the estimated overall unit cost is in the order of US$ 2/m^3 for dredging and reconstruction of river bed. The details of the cost estimates and schedule are found in Table 18.3.18.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	1,265
	Dredging	12,000
Total		13,265

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

18.3.6 Summary of Proposed Environmental Measures

The proposed environmental measures and the anticipated reduction of pollutants are summarized below.

Summary of Proposed Measures and Anticipated Reductions of Pollutants in 2010

No.	Project	Component			Reduction in 2010	
		Revege.	Drain.	Dust	Erosion	SS
		ha	m		10^3 ton/yr	10^3 ton/yr
1	Environmental Plans	-	-	-	-	-
2	Pilot Study on Rehabilitation	100	11,000	△	29	2.1
3	Measure for Mine Wastewater	-	50,000	-	-	6.1
4	Measures for Processing Plants	90	11,000	○	-	0.9
5	South Deo Nai Dumping Site	600	33,000	○	238	5.9
6	Mong Duong River Basin	900	99,000	○	205	4.1
7	Dien Vong River Basin	1,500	165,000	○	261	9.9
8	Ha Tu River Basin	400	44,000	○	103	2.2
9	Hong Gai North Basin	150	16,500	○	40	1.5
10	Cam Pha West Basin	50	5,100	△	27	0.7
11	Cua Ong Basin	110	12,100	○	28	0.7
12	Dredging	-	-	-	800	-
Total		3,900	407,700	-	1,731	34.1

Note Revege. : Area to be revegetated permanently or temporarily
Drain. : Total length of diversions and downdrains
○ : Dust control with high pressure sprayers, water truck and revegetation
△ : Dust control with revegetation

The projects are expected to reduce 1.73 million tons/year of erosion and 34×10^3 tons of SS/year in 2010 compared with the case that no environmental measures were taken.

The estimated costs are summarized below.

Summary of Estimated Project Costs (Year 2000-2010)

No.	Project	Cost (US$ × 10^6)	%
1	Environmental Plans	0.9	2.6
2	Pilot Study on Rehabilitation	1.8	5.2
3	Measure for Mine Wastewater	2.2	6.3
4	Measures for Processing Plants	1.7	4.9
5	South Deo Nai Dumping Site	3.4	9.8
6	Mong Duong River Basin	4.4	12.6
7	Dien Vong River Basin	4.2	11.9
8	Ha Tu River Basin	1.8	5.2
9	Hong Gai North Basin	0.5	1.5
10	Cam Pha West Basin	0.1	0.4
11	Cua Ong Basin	0.5	1.5
12	Dredging	13.3	38.1
Total		34.8	100

Note: Implementation: Year 2000-2010, O&M cost after 2010 not included, before adjustment of discount rate

The total cost will be about US$ 35 million during 2000 to 2010. The largest cost will be needed for the dredging project. Due to the large sizes of basins, Mong Duong River Basin Rehabilitation Project and Dien Vong River Basin

Rehabilitation Project will cost more than the measures for other basins. The measures for point sources, i.e., Environmental Measures for Mine Wastewater and Environmental Measures for Processing Plants, will cost US$ 3.9 million or 11.2% of the total cost.

18.4 Environmental Measures for Tourism

18.4.1 Present and Future Tourism Activities

(1) Tourism Attractions

The following locations are the major tourism areas in the EMP area (see Figure 18.4.1).

1) Ha Long bay and World Heritage

Ha Long Bay is one of the most famous tourist destinations in Vietnam. For its aesthetic seascape, the area has been designated as a natural beauty spot by the Central Government (Decision No. 313-VH/QD issued in 1962), and was inscribed on the World Heritage List of UNESCO in 1994. Major tourism attractions in the bay include caves, islets with peculiar shapes, and beaches.

Caves : Islands and islets in Ha Long bay predominantly consist of limestone, and there are many stalactite caves. Famous caves in the bay include Dong Thien Cuong (Heaven Palace grotto), Dong Hoa Cuong (Marble grotto), Hang Trong (Drum cave), Dong Tam Cung (Tripple Palace grotto) and Dong Lau Dai (Castle grotto). These caves are managed by the Ha Long Bay Management Board (HLMB) for tourism activities.

Islets : Due to the steep topography, most islands and islets in the bay are not easily accessible, and do not provide large area for tourism activities. However, because of their peculiar shapes, they are attractions for sight seeing from tourism boats. Examples of famous islands include Hon Dua (Chopsticks islets), Hon Ga Troi (Fighting Cocs islets), Hon Lu Huong (Incense Burner islet) and Hon Dau Nguoi (Man's head islet).

Beaches : Because of its geological condition, there are not many beaches in the World Heritage area. Known beaches include the Ti Top beach (artificial beach), Soi Sim Beach, and Ba Trai Dao Beach.

2) Bai Chay area

Bai Chay is the tourist center of the Ha Long bay area. Most of the hotels for tourists are concentrated in this area, and there are numerous restaurants and souvenir shops. Bai Chay Beach is the most popular beach in the area, and an entertainment center is being developed along the beach.

3) Tuan Chau island

The Tuan Chau island is one of few islands that is close to the mainland, and has relatively flat topography. These conditions make this island an ideal place for tourism development. Although the infrastructure, such as electricity and water supply, is not sufficient at the moment, there is a major project to develop Tuan Chau island as a major tourism destination. As of February 1999, the causeway to the island is under construction.

4) Cua Ong temple

Although it is not as famous as the Ha Long bay or the Yen Tu relic, 125,000 people visited Cua Ong temple in Cam Pha in 1994 (QN Dept. Tourism, 1994).

5) Cat Ba island

The Cat Ba island region consists of a large island called Cat Ba (28,500 hectares) and about 400 small islands. It is located in the Cat Ba District of Hai Phong Province. The Cat Ba island region is known for its biodiversity, and was designated as a National Park in 1986. The total area of the National Park is 26,300 hectares; approximately 17,300 hectares are on the Cat Ba island, and 9,000 hectares are in the areas of smaller islands. It has been estimated that about 45,000 tourists (35,000 domestic, 10,000 international) visited the National Park in 1994 (EVS, 1996).

(2) Number of Tourists

Currently the Ha Long area receives roughly 300,000 tourists a year. The number of tourists is expected to increase significantly in the next 10 years, and will exceed 1.5 million tourist/year by 2010 (Quang Ninh Department of Tourism, 1998; See Chapter 13). The major tourism spots in the World Heritage today are limited in the northwest area of the bay (e.g., Dau Go Island). This is partly because the existing tourism boats are not powerful enough to transport tourists far away from the coast. However, the area is getting over-crowded with tourists, and the number of speed boats are increasing. To meet the tourism demand, HLMB has plans to expand tourism area to south and east all the way to Ngoc Vung island and Quan Lan island in Van Don District (see Figure 18.3.1). The table below summarizes the anticipated number of tourists at the major tourism spots.

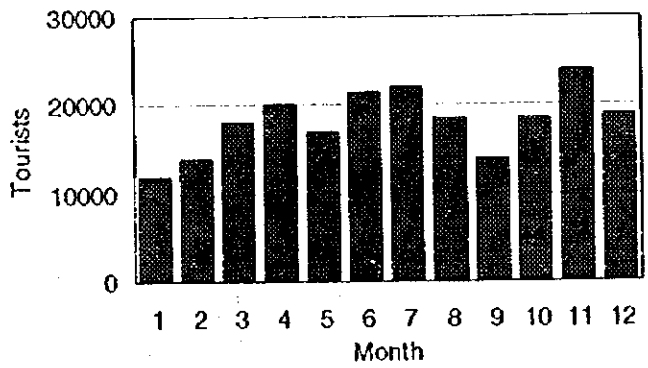
Anticipated Number of Tourists at Major Tourism Spots

(Unit: $\times 10^3$ tourists/year)

Area	1998	2000	2005	2010
Dau Go	380	500	700	900
Titop	80	150	180	200
Soi Sim	1	100	250	300
Lom Bo	50	100	300	500
Quan Lan	2	10	100	200

Source: HLMB, 1999

Figure below shows the monthly distribution of tourists in 1997. The distribution of tourists is relatively flat, with peaks in summer and late fall.



Source: QN Dept. Tourism, 1998

Monthly Distribution of Tourists to Ha Long (1997)

(3) Infrastructure

1) Transportation for tourism

The bad road condition from Hanoi and from Mong Cai (Chinese border) has been attributed to the main limiting factor of tourism development in the past. However, the road condition will be significantly improved as the project to improve Road 18A is completed in a few years (see Chapter 13). The number of tourism boat has increase significantly during 1990 (10 boats) to 1995 (120 boats). The number of boats is expected to increase further in the future.

2) Accommodation

In 1997, there were roughly 2,300 hotel rooms in the Province, of which 1,500 rooms qualified for international visitors (Dept. Tourism, 1998). Currently, the number of hotels is increasing rapidly, and by 2000, the number of hotel rooms is expected to reach 3,000. By 2010, it is anticipated that as much as 7,000 rooms will become available.

3) Utilities

Currently water in the Bai Chay area is supplied from Dong Ho intake in Hoan Bo district. The theoretical supply capacity is about 20,000 m^3/day. According to an official from the Dong Ho water supply plant, there is a plan to construct another dam in the area, and the supply capacity will be increased to 120,000 m^3/day. With this increase in supply capacity, the water demand for tourism will be met. However, the distribution network needs improvement. The extent of sewage and solid wastes disposal in Bai Chay area is limited, and is a source of major environmental problems. With the anticipated increase in tourists, the service capacities have to be increased soon, as discussed in Section 18.2.

Several major tourism spots in World Heritage, such as Dau Go Cave, and Ti Top Island, have berths and toilets. However, most of the islands do not have any tourism facilities at all. With the increase in tourists, these islands will also need basic tourism facilities in the future.

4) Major development projects

To accommodate increasing number of tourists, QNPC plans to make Bai Chay -- Hung Tang area a major tourism area. Some of the major development projects include Thanh Nien Tourism Center, Tuan Chau Island Tourism Complex, and Development of Yen Lap Lake Area (Dept. Tourism, 1998). Recently the entertainment complex in Bai Chay has opened, and the first phase of the Hung Tang area reclamation has been carried out. The construction of the causeway to Tuan Chau Island is nearly done. By 2010, the rehabilitation of Road 18A and the construction of Bai Chay Bridge will significantly improve the accessibility from Hanoi as well as from the Chinese border. The 2nd Phase reclamation of Hung Tang area will be carried out, and Tuan Chau Island will be developed as a major tourism center. The World Heritage area also expects a surge of tourism, and there are plans for improvement of tourism facilities in major caves and beaches, development of Quan Lan area, and development of Bai Tho Mountain for tourism (HLMB, 1998).

18.4.2 Present and Future Environmental Problems

The existing environmental problems associated with tourism are limited, because the number of the tourists is still relatively small. The most serious problem is the unsanitary condition of Bai Chay Beach area, which is polluted by discharge of untreated sewage from the hotel district. With the significant increase in tourism, the environmental problems will intensify in the future. The anticipated major environmental issues include:

(1) Solid Wastes

The issues of solid wastes generated from the inland sources, such as hotels and entertainment facilities, have been discussed in Section 18.2. Therefore, this section focuses on the solid wastes in the sea area. There are two major sources of solid wastes associated with tourism activities in the sea area: tourism boats and tourism islands.

Currently solid wastes generated on a tourism boat is collected by the boat operators, and is brought to a garbage bin at a wharf. However, a large amount of garbage is also discarded to the sea. The solid wastes released on tourism islands are collected by HLMB, and brought back to the land for disposal by sanitation company. HLMB also dedicates three boats to collect floating garbage on the sea.

There are no data about the amount of solid wastes generated/collected in the sea area. The estimated peak solid wastes generations on tourism boats and islands are given below, assuming that tourists spend three hours on boats and three hours on islands. Because, they spend approximately the same time on the islands and on the boats, approximately the same amounts of solid wastes are generated at these sources.

Generation of Solid Wastes on Tourism Boat & Island

	Unit	Present	2010
per capita generation	kg/tourist/site	0.11	0.14
peak number of tourists	tourist/day	750	9,500
total load (boat)	kg/day	75	1,330
total load (island)	kg/day	75	1,330

(2) Wastewater

According to the local regulation, tourism boats are supposed to have holding tanks for wastewater. However, because there is no place to discharge wastewater in environmentally-sound manner, the wastewater is dumped directly to the sea. On major tourism islands, such as Dao Go and Ti Top, HLMB already placed toilets, and wastewater is managed by HLMB. However, the number of the facilities is limited, and many islands do not have proper sanitation facilities. The estimated the peak loads of wastewater from tourism boats and islands are as follows:

Generation of Wastewater on Tourism Boat & Island

Parameter		Unit	Present	2010
peak tourists/day		tourist/day	750	9,500
boat	per capita generation	m^3/tourist	0.01	0.01
	total generation	m^3/day	7.5	95
island	per capita generation	m^3/tourist	0.025	0.025
	total generation	m^3/day	19	240

(3) Other Environmental Problems

In addition to the sanitation problems in tourism spots, the direct impacts of tourist activities to environmental resources, which is protected under the local environmental regulation, have been noted. Table 18.4.1 shows the examples of direct impacts, such as damage to coral reefs and stalactite, reported by HLMB. In reality, numerous violations appear to be taking place, and only a limited number of cases are controlled. Other environmental problems include uncontrolled development and over-development of tourism area. Because the tourism development in the area is limited, these problems are still minor. However, in the future, the tourism development needs careful control.

18.4.3 Environmental Targets for Tourism

(1) Requirements

To set specific goals for the environmental measures, the following requirements were taken into consideration.

1) Environmental laws and regulations

Tourism industries shall comply with environmental laws and regulations including the sanitation requirement, license condition for tourism boat operation, and Guidelines on the Protection of Ha Long Bay Environment (Circular No. 291 TT/KCM of MOSTE).

2) Regional environmental requirements

The EMP sets environmental areas and environmental conservation criteria (see Chapter 5). Tourism development has to be done in accordance with these requirements.

(2) Environmental Targets

Based on these considerations, the following environmental targets specific to the environmental measures for tourism were developed.

Environmental Measures for Tourism : Goals

Category	Target
Planning	Development of Tourism Management Plan
Solid Wastes	Essentially 100% collection and disposal of solid wastes from tourism boats & islands
Wastewater	Essentially 100% collection and disposal of wastewater from tourism boats & islands
Natural Resource Protection	Doubling patrolling capacity

18.4.4 Suggested Environmental Program and Projects

(1) Development of Environmental Management Plans for Tourism

1) General description

Tourism is in the early stage of development, and good planning probably is the most effective tool to achieve sustainable tourism. Environment is an important component of sustainable tourism, and environmental considerations shall be built into the comprehensive tourism management plan.

2) Proposed programs

Land Use Special attention should be paid to unauthorized reclamation of coastal area for tourism development, development without proper sanitary measures, and development of tourism spots in World Heritage area. Detailed siting plan for tourism enterprises have to be developed jointly by Department of Tourism, Department of Construction, Department of Planning and Investment, Ha Long Bay Management Board, DOSTE, and other relevant organizations.

Sanitation All newly constructed tourism facilities shall have properly constructed and maintained drainage to public sewer system. If the facility is constructed at a place far from the existing sewer system, the facility shall be connected to the local wastewater treatment system or install in-house water treatment system.

Natural Resources Education is a key approach to prevent further destruction of natural resources by tourists and tourism industries. It is recommended that a good education/public awareness program is developed and implemented as a part of the "Environmental Management Plan for Tourism".

Monitoring In tourism, environmental quality is ultimately judged by the subjective standards of the tourists, tourism operators, and local residents. Therefore, to make sure that tourists' are satisfied with the environmental condition, related organizations are urged to monitor the tourists' impression about the regional environment. Such data will help identify potential problems that prevent the development of sustainable tourism. The monitoring may be carried out as a part of the general tourism management activities. Nevertheless, environmental experts from DOSTE shall help Department of Tourism, Department of Culture and Information, HLMB, and other related organization to develop tourism monitoring plan that can capture the tourists' perception of the environmental quality. The results of the sustainable tourism monitoring will also help formulate an integrated strategy for environmental administration. The table below summarizes important indicators of sustainable development.

Examples of Core Indicators of Sustainable Development

No.	Indicator	Example
1.	Site Protection	IUCN Index
2.	Stress	Number of tourists (per annum and per peak month)
3.	Use Intensity	Intensity of use in peak period (persons/ha)
4.	Social Impact	Ratio of tourists to locals (peak and over time)
5.	Development Control	Environmental review procedure, formal controls over development of site and use densities
6.	Wastes Management	Percentage of sewage from site receiving treatment
7.	Planning Process	Existence of organized regional plan for tourists destination region
8.	Critical Ecosystem	Number of rare/endangered series
9.	Consumer Satisfaction	Level of satisfaction by visitors (questionnaire-based)
10.	Local Satisfaction	Level of satisfaction by locals (questionnaire-based)
11.	Tourism Contribution to Local Economy	Proportion of total economic activity generated by tourism only.

Source: WTO, 1995

3) Cost estimate and schedule

The details of the cost estimate and the schedule of the program are given in Table 18.4.2. The program will cost about US$ 75,000.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Design	Design	75
Total		75

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(2) Improvement of Sanitary Condition on Tourism Boats and Islands -- Phase 1

1) General description of the project

Lack of sanitation is the main environmental problem associated with tourism activities, both inland and sea area. Therefore, the sanitary conditions in the tourism areas have to be improved as soon as possible. Because the improvement of sanitation conditions in the inland area has already been discussed in Section 18.2, this section proposes measures to improve sanitation condition in the sea area, i.e., tourism boats and tourism islands. The overall goal of the project is essentially 100% collections of solid wastes and wastewater from tourism boats and islands by 2010. The estimated peak requirements in 2010 are:

Estimated Peak Loads of Solid Wastes and Wastewater in 2010

Type	Unit	Tourism Boat	Island
Solid Wastes	tons/day	1,330	1,330
Wastewater	m^3/day	95	240

The project will achieve the goal in two phases, so that the project can deal with the demand of wastes collection and disposal in flexible manner.

2) Proposed measures

Design : A series of site surveys shall be carried out to design sanitation facilities, including collection boats, and toilets on islands.

Wastewater Collection from Tourism Boats : Wastewater generated on tourism boats shall be collected at mobile and stationary service stations placed strategically at convenient places.

Mobile Service Station : By 2002, four boats equipped with pumps and holding tanks will be procured for wastewater collection services. The collection boats shall be placed at major wharves, floating gas stations, and other convenient places. The collected wastewater shall be pumped up to the domestic sewer line from the stationary service stations.

Stationary Service Station : By 2003, two wastewater collection system equipped with pump shall be installed at major wharves for stationary collection of

wastewater. The collected wastewater shall be pumped up to the domestic wastewater sewer line.

Waste Oil Collection : Containers to collect waste oil generated from tourism boats shall be placed at all mobile and stationary service stations for easy disposal of waste oil.

Wastewater Collection from Islands : Eight toilets are constructed throughout the popular tourism islands. The suggested locations include Sung Sot Cave, Soi Scam Beach, Me Cung Sea Park, Trang Luoi Liem Beach, Ngoc Vung Beach, and other areas where toilets are needed. As far as the treatment of wastewater is concerned, sequencing batch reactor is preferable. However, considering the requirements for electricity and maintenance, septic tank with filter was considered as an alternative for islands with no beaches. The septic tank has to be properly maintained and emptied regularly with a boat dedicated for this task. The effluent needs to be disinfected. If it is difficult to construct a facility, or if there is a concern for contamination of bathing beach, portable toilets may be placed instead.

Solid Wastes Collection from Tourism Boats : It is the responsibility of boat operators to collect all garbage generated on their boats. The collected wastes shall be put into a garbage collection bin strategically placed at all wharves. Garbage collection service by the Sanitation Company shall be provided everyday.

Solid Wastes Collection from Islands and Sea : HLMB has 3 boats dedicated to collect solid wastes from the World Heritage area. However, HLMB is facing the limitation of current operation of solid wastes collection due to the lack of staff and resources. The most important approach may be to educate and encourage the tourists to bring back their wastes. In addition, the solid wastes collection capability of HLMB has to be reinforced. In Phase 1, two boats with reasonable mobility shall be purchased to collect solid wastes from tourism spots in the World Heritage area (including floating solid wastes). The collected solid wastes shall be brought to a designated solid wastes disposal site (possibly a designated port or island such as Hong Doc Island) and disposed of by the Sanitation Company.

3) Responsibilities

The table below summarizes the suggested responsibilities for collection and disposal of wastewater and solid wastes.

Source, Collection and Disposal of Wastewater

Source	Collection Method	Responsibility
Tourism boat	Boat Operator, Sanitation Company	Collection : Boat operators Disposal : Sanitation Company
Islands	HLMB	Collection : HLMB Disposal : Sanitation Company

Source, Collection and Disposal of Solid Wastes

Source	Collection Method	Responsibility
Tourism boats	Collection by tourism boat operators → designated bin at wharf	Collection: Boat operators Disposal: Sanitation Company
Islands	Collection by HLMB officers →designated disposal site	Collection: HLMB Disposal: Sanitation Company
Sea (floating)	Collection by HLMB officers →designated disposal site	Collection: HLMB Disposal: Sanitation Company

4) Cost estimate and schedule

The details of the cost estimates are given in Table 18.4.3. The estimated costs are summarized below. The Phase 1 will be initiated in 2000, and terminated in 2002, followed by Phase 2 from 2003.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	29
	Collection Boat	482
O&M	O&M	1,000
Total		1,511

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

(2) Improvement of Sanitary Condition on Tourism Boats and Islands – Phase 2

1) General description of the project

The Phase 2 of the "Improvement of Sanitary Condition on Tourism Boats and Islands" is the continuation of the Phase 1 to meet the wastes collection targets set for 2010 (see Section on Phase 1 project for the targets).

2) Proposed measures

The proposed measures are essentially the same as the ones in Phase 1. Additionally, 3 mobile stations and 2 stationary stations for wastewater collection from tourism boats, 1 boat for wastewater collection from islands, 2 boats for solid wastes collection from islands, and 12 toilets will be constructed during 2004 to 2007.

3) Cost estimates and schedule

The table below summarizes the estimated costs (see Table 18.4.4 for details). The project will be initiated in 2003.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	14
	Collection Boat	657
O&M	O&M	432
Total		1,103

Note: Implementation: Year 2003-2010, before adjustment of discount rate.

(3) Reinforcement of Patrolling Capability

1) General description of project

HLMB has 3 patrol boats and staffs to control activities in the World Heritage area. With the several-fold increase in tourism numbers, however, it is likely that the existing patrol capability is overpowered by the demand in the future. Therefore, reinforcement of patrolling capability is needed.

2) Proposed measures

Reinforcement Six high-speed boats will be procured during 2000 and 2010, and a team of 5 will staff each boat. The staff will be engaged in activities to protect environmental condition of Ha Long by area, by controlling damages to environmental resources such as corals and stalactite, trashing, wastewater dumping, and unsafe activities.

Proposed Reinforcement of Patrolling Capability

Patrol Boats	6 high-speed patrolling boats by 2010
Staff	30 staff by 2010

3) Cost estimate and schedule

The table below summarizes the estimated cost. The details of the cost estimates and the schedule are given in Table 18.4.5.

Estimated Cost

Type	Work	Cost (US$ × 10^3)
Construction	Design	3
	Boat	193
O&M	O&M	835
Total		1,031

Note: Implementation: Year 2000-2010, before adjustment of discount rate.

18.4.5 Summary of Proposed Environmental Measures

The proposed environmental measures are summarized below. The total project cost during 2000-2010 is US$3.8 million.

Summary of Proposed Measures and Estimated Costs (Year 2000-2010)

No.	Project	Description	Cost	
			US$ × 10^6	%
1	Environmental Planning for Tourism	Development of Environmental Plans for Tourism	0.1	2.6
2	Improvement of Sanitation Condition – Phase 1	Collection of wastewater from tourism boats and islands	1.5	39.5
3	Improvement of Sanitation Condition – Phase 2	Collection of wastewater from tourism boats and islands	1.2	31.6
4	Reinforcement of Patrolling Capability	reinforcement with 6 boats and 30 staff members by 2010	1.0	26.3
Total			3.8	100

Note: Implementation: Year 2000-2010, O&M costs after 2010 not included, before adjustment of discount rate.

18.5 Environmental Measures for Environmental Resources

18.5.1 Environmental Measures for Natural Environment

(1) Target Management Items

Forests, tidal flats, mangrove swamps, seaweed beds and coral reefs are considered as the natural resources playing important roles in maintaining natural environment in the EMP area. In addition to them, fish and shellfish have economic values as fishery resources. However, the Field Survey revealed that the flora of seaweed in the EMP area was poor and large-sized species such as Sargassum that can form

seaweed bed was rare. Though the flora of seaweed was relatively diverse in the eastern area of Cat Ba island, habitat conditions of seaweed in the EMP area was poor because of relatively low transparency of 0.5 to 3.0m, causing the lack of light intensity for seaweed growth. Therefore, the following natural resources excluding seaweed beds are selected as the target items for natural environment management:

- Forests
- Tidal flats and mangrove swamps
- Coral reefs
- Fish and shellfish

(2) Strategies

In order to manage the natural environment, the following two strategies were proposed.

1) Conservation of existing resources

Conserving the existing natural resources and their habitat conditions are the primary strategies for natural environment management.

2) Rehabilitation of deteriorated resources

a) Reforestation in bare areas

The forest vegetation in Quang Ninh province is low and bare land still remains vastly at present. Therefore, the provincial office has been making efforts to raise the forest vegetation ratio by controlling deforestation and promoting reforestation. Owing to the on-going project, 5,500 to 5,800 ha of bare land have been reforested per year for the whole area of the province. However, with this rate of reforestation many years are needed to achieve vegetation ratio, and therefore the vigorous project of reforestation is needed.

b) Rehabilitation of mangrove swamps

Mangrove swamps of the EMP area has been reduced because of construction of dikes for aquacultural ponds, land reclamation for agricultural and urban development, and reclamation by solid wastes produced coal mining

excavation. Recently mangrove swamps in the areas of Cam Pha and Hung Thang has been lost by reclamation, and consequently the dense mangrove swamps are limited to the Binh Huong area, the estuary of Mong Duong river, the inlet of Quan Hanh area and the seashore area of Bai Chay bay. Therefore, it is desirable to carry out expansion of mangrove swamps by reforestation in the EMP area.

(3) Proposed Measures

1) Reinforcement of on-going management activities

In order to conserve natural resources, it is important to support and strengthen the ongoing management activities that have been carried out by each sector in charge. The following ongoing activities should be supported and strengthened continuously.

Ongoing Management Activities for Natural Environment

Target items	Ongoing management activities	Sector in charge
Forests	Conservation of the protected forests	Forest Protection Agency (FPA), Department of Agriculture and Rural Development (DARD)
Coral reefs	Prohibition of collection of coral reefs, Dynamite fishing in the area of coral reefs	Department of Fishery (DOF)
Fish and Shellfish	Regulation for fishing method, fishing gears	Department of Fishery (DOF)

2) Strengthening of environmental impact assessment and promotion of countermeasures

Tidal flats and mangrove swamps are important natural resources with significant functions of purifying water quality, preserving biodiversity, supplying organic matters and providing nursery ground for fishery resources. However, the topography of tidal flats and mangrove swamps is suitable for construction sites of regional development plans including reclamation, and until now the areas of tidal flats and mangrove swamps in the EMP area have decreased considerably due to reclamation. Therefore, careful attention should be paid for the development plans that are planned at tidal flats and mangrove swamps. It is proposed to conduct strict

environmental impact assessment (EIA) for development plans that are planned at tidal flats and mangrove swamps, and to evaluate the present function of tidal flats and mangrove swamps and predict the possible impact to the natural environment. If significant impact is predicted, the countermeasures "including mitigation measures" such as reconsideration of landform and reforestation of mangrove should be taken.

3) Reforestation in bare areas

The forest coverage in the EMP area is supposed to be higher than the average of Quang Ninh province, but there are about 800 ha of bare area at present except for denuded areas by coal mining activities. And also, in the future it is predicted that about 2,000 ha of bare area except for denuded areas by coal mining activities will be made by 2010 because of the planned development projects and related land use changes. Therefore, reforestation is the important measures for forest management including greening.

4) Rehabilitation of mangrove swamps

Mangrove swamps near Cua On, Cam Pha and Hung Thang have been lost because of land reclamation. It is recommended to make up such a large loss of mangrove swamps by reforestation.

(4) Projects and Programs

In order to manage natural environment, it is proposed to conduct the following two projects and one program.

- Reforestation in bare areas
- Rehabilitation of mangrove swamps
- Fishing activity control program

1) Reforestation in bare areas

In the EMP area, there is about 800 ha of bare areas at present, and additionally 2,000 ha of bare land will be formed by land use changes by 2010. Among the bare areas, the Troi river basin has relatively large area of bare land at present, and Man

river basin, the Dien Vong river basin and the Mong Duong basin are predicted to have large area of bare land in the future. Therefore, those areas should have priority of reforestation. It is proposed that all areas required reforestation in order to achieve the target conservation criteria for the forest coverage will be covered by trees by 2010. While denuded areas by coal mining activities are to be revegetated as measures for mining (see Chapter 21).

The Forest Protection Agency (FPA) and the Department of Agriculture and Rural Development (DARD) are in charge of forest management in bare areas except for denuded areas by coal mining activities. It is recommended that, three will be staffed additionally in FPA for management of reforestation with increase in work volume.

The estimated costs of reforestation in bare areas from 2001 to 2010 are shown in Table 18.5.1 and summarize in the next table. The costs are estimated on the basis of the plan that 2,700 ha of bare areas will be planted and revegetated. Necessary design, bed preparation, and reforestation are assumed to entrust to consultants or contractors.

Estimated Costs for Reforestation in Bare Area (Year 2001-2010)

Type	Work	Estimated Cost (US$x10^3)
Construction	Design	32
	Bed Preparation	694
	Tree Planting	655
O&M	Vegetation, Staff of FPA	86
Total		1,467

It is proposed that this project should be commenced in 2001.

2) Rehabilitation of mangrove swamps

Since the mangrove swamps in the EMP area have degraded seriously, reforestation project of mangrove has high priority in the EMP area. Reforestation project should be carried out in the area where large areas of mangroves have been lost by reclamation, such as Cua On, Cam Pha, and Hung Thang. Reforestation of mangrove swamps can also become a green buffer zone surrounding reclamation land and improve the landscape. In order to achieve the target conservation criteria for mangrove swamps rehabilitation by mangrove planting of 1,320 ha will be

carried out by 2010. For tree planting, local or native species in the EMP area are recommended, such as *Aegiceras corniulatum, Kandelia candel, Avecinnia lanata and Rhizophor stylosa.*

The proposed Tidal Flat Management Unit (TFMU) is expected to be in charge of the mangrove swamps rehabilitation (see Chapter 21). Considering expected work volume including total management of tidal flats and monitoring, five staff will be required for establishment and management of TFMU to manage tidal flat as well as mangrove swamps.

The overall estimated costs of rehabilitation of mangrove swamps are as shown in Table 18.5.2 and summarized in next table. The costs are estimated on the basis of the areas to be replanted. 1,320 ha of non-vegetated tidal flats comprised of 150 ha in Quang Hanh, 200 ha in Binh Hung estuary, 210 ha in Bai Chay coastal area, 400 ha in Bai Chay bay, 70 ha in Hong Gai coastal area and 290 ha in Cam Pha and Cua Ong coastal area, will be planted. Necessary design, bed preparation, and reforestation are assumed to be entrusted to the consultants or contractors.

Estimated Costs for Rehabilitation of Mangrove Swamps (Year 2000-2010)

Type	Work	Cost (US$x10^3)
Construction	Design/Plan	25
	Bed Preparation	319
	Tree Planting	572
O&M	Vegetation, Staff of TFMU	105
Total		1,021

It is proposed that this project should be commenced in 2000.

3) Fishing activity management program

This program is mainly to reinforce ongoing management activities by the Department of Fishery (DOF). The program consists of the following activities:

- Reinforcement of patrolling capability of fishing activities
- Promotion of environmental education to fishermen
- Collection of fishermen's data (Fishermen data survey)

It is necessary to conduct strict control for prohibited fishing methods and gears to conserve fishery resources. To implement the management of fishery resources,

fishermen's understanding for conservation of fishery resources is needed. Thus, environmental education should be provided for fishermen in subjects such as habitat conditions of fish and shellfish, necessity of the control of fishing activity and appropriate use of natural resources.

In addition, in order to manage fish and shellfish, it is necessary to understand the current condition and the changes of fishery production in the bays. However, there are no statistics of fishery production that is available to the understanding of the current conditions and the changes of fishery production in the bays. For the collection of fishery production data, a fishermen data survey is proposed. This survey is to collect the data about kinds of fishing activities, amount and seasonal changes of fishery production, location of fishing grounds and their conditions by asking fishermen to write the daily fishing records in a journal. The sample number of fishermen is about 50. This survey will be carried out through a year.

A team of three will be staffed for patrolling fishing activities. They use an additional boat for the proposed patrol. For the promotion of environmental education and fishermen data survey, two and three staff will be allocated respectively. The estimated costs of the fishing activities' management are as shown in Table 18.5.3 and summarized below.

Estimated Costs for Fishing Activity Management Program (Year 2001-2010)

Type	Work	Cost(USx10^3$)
Reinforcement patrolling capability for fishing activity	Boat	32
	O&M (Personnel)	35
Promotion of environmental education	O&M (Personnel)	11
Fishermen data survey	O&M (Personnel)	19
Total		97

It is proposed that this program will be commenced in 2001 and then be carried out continuously every year.

18.5.2 Environmental Measures for Landscape

(1) Target Management Items

In the EMP area, the landscape of the World Heritage area should be given the highest priority to be managed for absolute protection. The value of landscape of the World Heritage area depends on the following landscape elements and they should be considered as the target items of landscape management.

- Shape and surface of islands,
- Color and clearness of seawater
- View of natural resources, and
- Natural scenery

(2) Strategies

In order to conserve the landscape values of the World Heritage area, it is necessary to conserve the landscape elements.

The water color in Ha Long bay is mostly yellowish green, and it is considered to be harmony with the features of islands. The good water clearness can give clear impression for landscape, and raise the value of landscape such as diversity and beauty, if the feature of bottom of islands and sea bed are visible through clear water. Both the color and the clearness of seawater will be degraded, if eutrophication progresses and the water quality degrades. Therefore, it is needed to manage water quality so as not to degrade landscape values. And since floating garbage and oil slicks can degrade the clearness of seawater, it is necessary to monitor and regulate dumping garbage and oil leakage.

View of natural resources is important landscape elements that raise the value of landscape such as diversity and naturalness. Therefore, natural resources should be managed from the aspect of conservation of landscape value.

Major artificial landscape that may affect the natural scenery in the World Heritage area is the anchored and sailing cargo ships. The artificial landscape of the mainland is not considered to be the obstruction disturbing the landscape value of the World

Heritage area, because the landscape of the mainland is long distance landscape from the World Heritage area. Therefore, it is important to regulate the anchored area and sailing route of cargo ships so as not to disturb the natural scenery of the World Heritage area.

(3) Proposed Measures

1) Enforcement for ongoing management activities

Ha Long Bay Management Board (HLMB) has the responsibility of management of landscape resources in the World heritage area. HLMB has carried out many management activities in the World Heritage area such as patrol and collection of floating garbage and regulation of illegal activities. It is important to enforce these ongoing management activities.

As discussed in Section 18.4, these management activities have been carried out as countermeasures of tourism pollution and proposed to be reinforced in the future. As for the regulation of illegal activities such as destruction of limestone, cutting of woods on limestone islands, they can be also carried out as part of the countermeasures of tourism.

2) Landscape management guideline

The value of landscape of the World Heritage area depends on the various landscape elements such as shape of islands, water color, water clearness, condition of natural resources, condition of surface of islands and natural impression without artificial landscape. It is important to conserve these landscape elements consisting of various elements and their combination in good condition. It is necessary to coordinate measures relating to each landscape element. Therefore, a comprehensive guideline for landscape management is required.

3) Restriction of anchored area and route of cargo ships

In order to conserve the natural impression in the World Heritage area, the route and anchored area of cargo ships should be controlled by the regulation. HLMB is considered to be suitable for patrol to cargo ships mooring area.

(4) Projects and Programs

Because the patrol of floating solid wastes and illegal activities and collection of floating solids wastes are discussed as environmental measures for tourism, this section proposes measures for landscape conservation program consisting of preparation of the landscape management guideline and the patrolling shipping activities

1) Preparation of guideline for landscape

The proposed guideline for landscape is to be used by not only agencies such as HLMB but also by private sector such as shipping companies and tourism. The guideline should be in consistent with the proposed environmental plan for tourism (see Section 18.4), and also involve the results of landscape value survey which is to be implemented as part of the monitoring. Although the main target of landscape management is the World Heritage area being designated Special Conservation Zone, the proposed guideline should include that notes and directions from an aesthetic viewpoint in Active Manage Zone and Development Zone. The future development projects should follow this guideline in view of shape, coloring of buildings, and greening. The proposed EMD will be in charge of preparation of the guideline in cooperation with HLMB.

The estimated cost for preparation of the guideline for landscape is shown in Table 18.5.4 and summarized below. It is necessary to conduct pre-investigation of landscape and entrust preparation of guideline to the consultants.

Estimated Cost for Preparation of guideline for Landscape (2000-2007)

Type	Works	Cost (US$x10^3)
Guideline preparation	Pre-investigation, Preparation	75
Total		75

2) Reinforcement of patrolling capability for shipping activities

Major impact that may affect the natural impression in the World Heritage area is anchored and sailing boats. Popular tourism spots are mainly distributed in the west of the World Heritage area. This area is close to the anchored area near Hon Net

Floating Port (HNFP). HNFP is scheduled to be moved to the east area of the bays. Thus, the number of anchored ships near the popular tourism area and sailing boats deriving from the defined courses should be controlled strictly.

To control shipping activities, it is necessary to reinforce patrolling capability of HLMB. One additional high-speed boat will be required, and a team of 3 will be staffed for patrol. The estimated costs of the reinforcement of patrolling capability for shipping activities are as shown in Table 18.5.5 and summarized below.

Estimated Costs for Reinforcement of Patrolling Capability (Year 2003-2010)

Type	Works	Cost (US$x10^3)
Reinforcement of Patrolling Capability for shipping activities	Personnel	23
	Boat	32
	O&M (Boat)	15
Total		70

It is proposed that this program should be commenced in 2003 and then carried out continuously to 2010.

TABLES

Table 18.2.1 Estimated Construction Costs of Local Sewerage Systems

Conventional Sewer System				
Component	Diameter (mm)	Length (m)	Rate (US$/m)	Amount (US$)
House connections	150	4,800	20	96,000
Sewers	150	3,600	25	90,000
	200	400	30	12,000
	300	200	45	9,000
Manholes	-	132	600	79,200
House connections chambers	-	480	200	96,000
Sub Total				382,200
Add for prelims and general			30%	114,700
Total				496,900
Cost per person				104

Small Bore (Settled Sewage) Sewer Systems				
Component	Diameter (mm)	Length (m)	Rate (US$/m)	Amount (US$)
House connections	100	4,800	14	67,200
Sewers	100	3600	18	64,800
	150	300	25	7,500
	200	300	30	9,000
Manholes	-	60	600	36,000
Empty/repair septic tanks	-	480	200	96,000
Sub Total				280,500
Add for prelims and general			30%	84,200
Total				364,700
Cost per person				76

Table 18.2.2 Advantages and Disadvantages of Competitive Treatment Processes

Treatment Processes	Advantages	Disadvantages
1. Wastes Stabilization Ponds	· Low construction cost · No energy required · Simple operation with low maintenance requirement · Minimal electrical and mechanical plant · Small quantity of digested sludge produced	· Very large land requirement · Performance deteriorates at low temperature · Possible odor and mosquito problems · Algae growth can affect effluent quality of unfiltered samples
2. Oxidation Ditches	· Robust process with good resistance to shock loads · Relatively simple operation and maintenance compared to other mechanized processes · The sludge produced is stable · Nitrogen reduction is readily achievable at appropriate loading rates · No odor problems from ditches or sludge	· High energy requirement · Relatively high land requirement
3. Sequencing Batch Reactors	· Small land area required · Flexible operation allows nitrogen and phosphorus removal at appropriate loading rates · No odor problems from the reactors	· Relatively sophisticated mechanical and electrical components require maintenance · Skill needed to modify operating cycle · Sludge from higher rate (Level 1) processes requires further treatment and is a potential source of odor

Table 18.2.3 Build Up of Main Collector Rates for Domestic Wastewater

System	DWF (cu m/d)	Design Flow[1] (l/s)	Main Collector Dia[2] (mm)	Typical PS Rating[3] (kW)	Pumping Main Dia[4] (mm)	Collector Cost (US$/m)	PS Unit Cost (US$)	Pumping Main Cost (US$/m)	System Rate[5] (US$/km)
Don Dien	3,600	83	400	25	300	60	124,346	90	128,000
Dong Dang (main collectors)	10,824	251	600	61	400	100	206,815	125	208,000
Dong Dang (transfer system)	10,824	251		276	500		479,671	170	
Deo Sen	20,000	463	800	136	500	150	322,468	170	315,000
Bach Dang	7,200	125	500	37	300	80	155,580	90	160,000
Cam Pha	5,400	125	500	37	300	80	155,580	90	160,000

Notes:
1. Peak flows vary from 1.5 DWF to 2.0 DWF.
2. Collector diameters based on minimum gradient of 1 in pipe diameter in mm.
3. Collector pumping stations (PS) based on a head of 10m and 2 duty plus 1 standby pump. Transfer pumping station based on head of 45m.
4. Pumping main diameters selected to give a velocity of approx. 1.5 m/s.
5. Collection system costs per km based on 800m collector sewer, 200m pumping main plus a pumping station every 2 km.

Table18.2.4 Cost Estimates for Domestic Solid Wastes Management

Investment Costs

Component	Unit	Quantity	Rate (US$)	Amount (US$)
Collection				
Collection vehicles and equipment	ton/yr	98,000	50.0	4,900,000
Landfill				
Extension of Quang Hanh landfill	cu m	450,000	5.0	2,250,000
Hospital Wastes				
Clinical wastes incinerator	ton/day	10	75,000	750,000
Base construction cost				7,900,000
Engineering and supervision costs		10%		790,000
Institutional strengthening and pubic awareness		5%		435,000
Contingencies		10%		913,000
Total Investment Cost	-	-	-	10,038,000

Annual O&M Costs in 2010

Component	Unit	Quantity	Rate (US$)	Amount (US$)
Collection				
Collection vehicles and equipment	ton/yr	98,000	4.25	417,000
Landfill				
Extension of Quang Hanh landfill	ton/yr	98,000	3.5	343,000
Hospital Wastes				
Clinical wastes incinerator	ton/yr	1,575	25.0	39,000
Total Annual O&M Cost in 2010	-	-	-	799,000

Table18.2.5 Investment and O&M Costs for Domestic Solid Wastes Management

(Unit: US$×10^3)

Year	Investment Costs	Wastes Collected (×10^3 ton /year)	Clinical Wastes (×10^3 ton /year)	O&M Costs			Total Investment + O&M Costs
				Collection	Landfill	Clinical	
2000	0			0	0	0	0
2001	407			0	0	0	407
2002	500			0	0	0	500
2003	1,801		0.8	0	0	29	1,830
2004	2,524	64	0.9	165	135	32	2,856
2005	801	74	1.0	192	158	35	1,186
2006	801	87	1.1	224	185	38	1,248
2007	801	102	1.2	262	216	39	1,318
2008	801	119	1.3	306	252	39	1,398
2009	801	139	1.4	357	294	39	1,491
2010	801	162	1.6	417	343	39	1,600
Total	10,038			1,923	1,583	290	13,834

Table18.2.6 Build Up of Rates for Collector Systems for Industrial Wastewater

System	DWF (cu m/d)	Design Flow[1] (l/s)	Main Collector Dia[2] (mm)	Typical PS Rating[3] (kW)	Pumping Main Dia[4] (mm)	Collector Cost (US$/m)	PS Unit Cost (US$)	Pumping Main Cost (US$/m)	System Rate[5] (US$/km)
Cai Lan Industrial Park									
Collection system	23,850	414	700	102	600	125	273,612	240	285,000
Transfer system	23,850	414		406	600		595,678	240	
Hoanh Bo Industrial Park									
Collection system	27,550	478	800	117	600	150	296,566	240	316,000
Transfer system	27,550	478		586	600		733,005	240	
Lang Bang	2,560	89	500	26	300	80	128,855	90	146,000

Notes:
1. Peak flows for industrial parks are 1.5 DWF.
   Peak flows for major industries are 3 DWF.
2. Collector diameters based on minimum gradient of 1 in pipe diameter in mm.
3. Collection pumping stations based on a head of 10m and 2 duty plus 1 standby pump.
   Cai Lan transfer pumping station (PS) based on 40m head
   Hoanh Bo transfer pumping station based on 50m head
4. Pumping main diameters selected to give a velocity of approx. 1.5 m/s.
5. System costs per km for industrial parks based on 800m collector sewer, 200m pumping main plus a pumping station every 2 km.
   System costs for major industries include gravity sewers only.

Table 18.2.7(1) Sources and Characteristics of Potentially Hazardous Substances

Substances	Typical Uses and Source Industries	Principal Nature of Hazards
Inorganic acids	Steel pickling and etching; galvanizing; anodizing; electroplating. Many varied uses in the chemical industry (particularly coal carbonization and oil refining).	Corrosivity
Organic acids	Chemical industry (particularly acetates and nylon production); synthetic fibers; textiles; food industry; surface treatment of metals.	Corrosivity, toxicity
Alkalis	Glass industry; chemical industry; paper industry; soap and detergent industries; water treatment.	Corrosivity
Antimony and its compounds	Storage batteries; flame retardant paints; plastics and textiles; glass industry.	Toxicity
Arsenic compounds	Wood preservatives; glass industry.	Toxicity
Asbestos	Asbestos cement products; filler/reinforcement in felts, paper, filters, mastics and coatings; friction materials; fire resistant insulation boards; joints and packings.	Inhalation can cause asbestosis and bronchial carcinoma
Barium compounds	Glass, ceramic, paint and rubber industries. Drilling muds.	Toxicity
Beryllium and its compounds	Alloying with copper, aluminum and nickel; nuclear industry; ceramics.	Toxicity, skin lesions, eye injury
Biocides	Herbicides; pesticides; disinfectants.	Toxicity, irritation and inflammation
Boron compounds	Glass industry; washing powder and detergent manufacture; pharmaceutical, toiletry and cosmetic products; photographic chemicals.	Toxicity, irritation
Cadmium and its compounds	Electroplating; alloys; batteries; pigments for plastics, paints glass and ceramics; PVC stabilizers.	Toxicity, carcinogenic
Copper compounds	Pesticides; dye industry; anti fouling paint; electroplating; printed circuit board etching; catalysts in the chemical industry.	Toxicity, irritation
Heterocyclic organic compounds	Solvents; plasticisers; resin monomers; accelerators; dyes and dyestuffs; pharmaceuticals; disinfectants	Toxicity (extreme for some compounds)
Hexavalent chromium compounds	Chrome plating; anodizing; metal preparation and finishing; chemical industry; pigments in printing ink and paints; dyeing of textiles; tanning; wood preservative.	Corrosivity, irritation, toxicity
Hydrocarbons and their oxygen, nitrogen and sulphur compounds	Fuels; solvents; reaction media; chemical feedstocks; lubricants; antifreeze; hydraulic fluids; resins and resin manufacture; perfumery; medicinal use; food industry; plastics industry; elastomers and foams; fertilizers; gas industry; rubber industry.	Carcinogenic, inflammable, asphyxiant, irritant, toxicity
Inorganic cyanides	Metal finishing; heat treatment of steel.	Toxicity
Inorganic halogen compounds	Chemical industry; disinfectants; glass and ceramics industries; metallurgical industry; chemical industry; fluoridation of water and toothpaste; oil and gas production wells; photographic chemicals; medicines.	Toxicity, corrosivity
Inorganic sulphur compounds	Water treatment; bleaching and cleaning agents; tanning; textile industry; dyeing; oxidants; photography; chemical industry.	Toxicity, corrosivity
Laboratory Chemicals	Laboratories in hospitals, schools, higher education establishments, industry, consultancy practices, research establishments.	All hazards
Lead compounds	Storage batteries; anti-knock additives for petrol; pigments in printing ink and paints; glass industry; stabilizers for plastics.	Toxicity, carcinogenic

Table 18.2.7(2) Sources and Characteristics of Potentially Hazardous Substances

Substances	Typical Uses and Source Industries	Principal Nature of Hazards
Mercury compounds	Batteries; paints; dentistry; electrical and control equipment; catalysts; pharmaceuticals.	Toxicity
Nickel and its compounds	Manufacture of alloys and stainless steel; electroplating; catalysts; batteries; enamel, ceramics and glass industries.	Toxicity, irritation
Organic halogen compounds	Pharmaceutical industry; fine chemicals; plastics manufacture; aerosols; biocides; dyestuffs; paints; degreasing solvents; dry cleaning.	Toxicity, irritation, carcinogenic
Peroxides, chlorates, and azides	Oxidizing agents; bleaching agents for textiles, wood pulp and hair; toiletry products; epoxy manufacture; laboratory reagents; herbicides.	Explosive, irritation, toxic
Pharmaceutical and veterinary compounds	Prescription and non-prescription pharmaceutical and veterinary products.	All
Phosphorus and its compounds	Fertilizers; munitions; matches; alloys; rustproofing solutions, soft drinks; surface treatment of metals; descaling and cleaning food- making equipment; insecticides.	Burns, flammable, toxicity
Selenium and its compounds	Photoelectric cells; power rectifiers; glass production; pigments; metallurgy; vulcanizing agents; fungicide.	Toxicity
Silver compounds	Photographic use; electrical and electronic equipment; batteries.	Corrosivity, pigmentation
Tarry residues	Production of metallurgical coke and smokeless solid fuels; petroleum, chemical and allied industries.	Carcinogenic,
Tellurium and its compounds	Vulcanization of rubber; alloys; catalysts; coloring in glazes and glass; additive to selenium rectifiers.	Toxicity
Thallium and its compounds	Alloys; optical glass; photoelectric cells; batteries.	Toxicity
Vanadium compounds	Iron and steel industry; catalysts; manufacture of dyes, inks and ceramics colors; corrosion inhibitor.	Toxicity
Zinc compounds	Metal finishing; electroplating; galvanizing; battery manufacture; pigments; pesticides; pharmaceuticals.	Corrosive, toxicity

Table18.2.8 Cost Estimates for Industrial Solid Wastes Management

Investment Costs

Component	Unit	Quantity	Rate (US$)	Amount (US$)
Collection				
Collection vehicles and equipment	ton/yr	34,500	25.0	863,000
Landfill				
Extension of landfill capacity	cu m	94,000	5.0	470,000
Hazardous Wastes				
Hazardous wastes incinerator	ton/day	15	75,000	1,125,000
Base construction cost				2,458,000
Engineering and supervision costs		10%		246,000
Institutional strengthening		5%		135,000
Contingencies		10%		284,000
Total Investment Cost				3,123,000

Annual O&M Costs in 2010

Component	Unit	Quantity	Rate (US$)	Amount (US$)
Collection				
Collection vehicles and equipment	ton/yr	34,500	3.75	129,000
Landfill				
Extension of landfill capacity	ton/yr	34,500	3.5	121,000
Hazardous Wastes				
Hazardous wastes incinerator	ton/yr	3,450	50.0	173,000
Total Annual O&M Cost in 2010				423,000

Table18.2.9 Investment and O&M Costs for Industrial Solid Wastes Management

(Unit: 10^3 US$)

Year	Investment Costs	Ind. Wastes Collected ($\times 10^3$ ton /year)	Hazardous Wastes ($\times 10^3$ ton /year)	O&M Costs			Total Investment + O&M Costs
				Collection	Landfill	Hazardous	
2000	0			0	0	0	0
2001	270			0	0	0	270
2002	300			0	0	0	300
2003	646	4.8		18	17	0	681
2004	1,107	6.2		23	22	0	1,152
2005	0	8.3	1.0	31	29	51	111
2006	0	11.0	1.3	41	39	65	145
2007	400	14.7	1.7	55	52	83	590
2008	400	19.5	2.1	81	76	106	663
2009	0	26.0	2.9	120	112	146	378
2010	0	34.5	3.5	129	121	173	423
Total	3,123			498	468	624	4,713

Table 18.3.1 Anticipated Production, Overburden, and Mine Wastewater

(Unit: $\times 10^3$ tons/year)

Production

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Cam Pha	8,544	8,639	8,734	8,830	8,925	9,020	8,879	8,738	8,597	8,456	8,315	95,677
Hong Gai	2,905	3,024	3,143	3,262	3,381	3,500	3,487	3,474	3,461	3,448	3,435	36,520
Uong Bi	3,277	3,421	3,564	3,708	3,851	3,995	4,152	4,309	4,466	4,623	4,780	44,146
Total	14,726	15,084	15,442	15,799	16,157	16,515	16,518	16,521	16,524	16,527	16,530	176,343
Study Area	11,449	11,663	11,877	12,092	12,306	12,520	12,366	12,212	12,058	11,904	11,750	132,197

(Unit: $\times 10^3$ m^3/year)

Overburden

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Cam Pha	34,225	34,050	33,875	33,700	33,525	33,350	31,972	30,594	29,216	27,838	26,460	348,805
Hong Gai	9,200	9,885	10,570	11,255	11,940	12,625	11,975	11,325	10,675	10,025	9,375	118,850
Uong Bi	6,554	6,841	7,128	7,416	7,703	7,990	8,304	8,618	8,932	9,246	9,560	88,292
Total	49,979	50,776	51,573	52,371	53,168	53,965	52,251	50,537	48,823	47,109	45,395	555,947
Study Area	40,779	40,891	41,003	41,116	41,228	41,340	40,276	39,212	38,148	37,084	36,020	437,097

(Unit: $\times 10^3$ m^3/year)

Mine Wastewater

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Cam Pha	20,506	20,734	20,963	21,191	21,420	21,648	21,310	20,971	20,633	20,294	19,956	229,625
Hong Gai	6,972	7,258	7,543	7,829	8,114	8,400	8,369	8,338	8,306	8,275	8,244	87,648
Uong Bi	9,831	10,262	10,693	11,123	11,554	11,985	12,456	12,927	13,398	13,869	14,340	132,438
Total	37,309	38,253	39,198	40,143	41,088	42,033	42,134	42,236	42,337	42,439	42,540	449,711
Study Area	27,478	27,992	28,506	29,020	29,534	30,048	29,678	29,309	28,939	28,570	28,200	317,273

based on IMSAT, 1999

note: Study Area is the sum of Cam Pha and Hong Gai.
Values for 2001-2004 and 2006-2009 were linear-interporated from the estimates for 2000, 2005, and 2010.
2.0 m3 overburden/ton coal was assumed for overburden in Uong Bi.
2.4 m3 wastewater/ton coal was assumed for wastewater in Cam Pha and Hong Gai.
3.0 m3 wastewater/ton coal was assumed for wastewater in Uong Bi.

Table 18.3.2 Coal Resources under the Management of VINACOAL

(coal reserve unit: 10^3 tons)

Company/Mine	Code	Study Area*	Area km²	Estimated Reserve				Open Pit	Underground		Total
				Grade A+B	Grade C1	Grade C2	Total		Horizontal	Vertical	
Uong Bi Coal Company			64.6	81,406	398,029	185,981	665,416	29,676	174,457	461,283	665,416
Trang Bach	UB-010	0	11.6		20,130	13,173	33,303		9,924	23,379	33,303
Pham Hong Thai	UB-011	0	23.1	8,897	49,521	10,546	68,964		12,334	56,630	68,964
Yen To	UB-003	0	2.9	28,873	148,259	77,488	254,620	6,455	72,224	175,912	254,621
Than Thung	UB-004	0	2.2	14,437	74,130	38,744	127,311	3,242	36,112	87,956	127,310
Bao Dai	UB-007	0	5.0		30,687	46,030	76,717		15,247	61,470	76,717
Uong Thuong-Dong Vong	UB-006	0	13.1	7,823	48,639		56,462		28,616	27,846	56,462
Thuoc Vietnindo	UB-006	0	6.7	21,376	26,663		48,039	19,949		28,090	48,039
Mao Khe	UB-009	0	21.9		231,895	73,871	305,766	149	7,413	298,204	305,766
Vang Danh	UB-005	0	13.2		30,686	151,956	182,642	423	60,370	121,849	182,642
Hong Gai Coal Company			26.3	13,095	171,554	186,343	370,992	8,198	28,437	334,807	371,442
Ha Lam	HG-019	1	7.9	7,525	132,911	118,047	258,483	2,455		256,030	258,455
Tan Lap	HG-021	1	4.7	2,457	5,603	574	8,634	651	990	6,993	8,634
Suoi Lai	HG-017	1	5.3		17,788	55,276	73,064	5,092	13,079	55,343	73,514
Cao Thang	HG-018	1	7.4	3,111	11,672	3,456	18,269		11,884	6,385	18,269
Binh Minh 1	HG-016-1	1	1.0		3,580	8,960	12,540		2,484	10,056	12,540
Ha Tu	HG-022	1	7.0	4,763	14,458	1,414	20,635	11,552		9,083	20,635
Nui Beo	HG-020	1	6.5	15,729	9,728		25,457	25,457			25,457
Cam Pha Coal Company			15.2	153,615	244,684	74,886	473,185	61,950	11,928	399,307	473,185
Thong Nhat	CP-037	1	3.6		25,058	74,886	99,944	59,820	10,510	29,614	99,944
Mong Duong	CP-032	1	5.7	8,612	34,708		43,350	2,130		41,220	43,350
Khe Cham	CP-028	1	5.9	144,973	184,918		329,891		1,418	328,473	329,891
Deo Nai	CP-038	1	5.8	6,417	29,237	28,869	64,553	38,551		26,002	64,553
Coc Sau	CP-039	1	8.5	21,098	51,424	13,693	89,215	45,931		43,284	89,215
Cao Son	CP-029	1	10.2	18,822	44,092		62,914	62,914			62,914
Duong Huy Coal Company			11.2	80,573	157,709	6,769	245,051	3,341	41,104	200,603	245,051
Khe Tam	CP-026	1	9.6	78,166	154,952	6,769	239,887	3,183	36,101	200,603	239,887
Tay Khe Sim (II-TVIII)	CP-035	1	1.6	2,407	2,757		5,164	161	5,003		5,164
Dong Bac Coal Company			21.2	18,738	37,347	350	56,435	17,477	35,290	3,670	56,437
Tay Khe Sim (TVIII-TXII	CP-035-1	1	1.2	209	5,855	350	6,414		6,414		6,414
Nam Khe Tam	CP-027	1	4.9	3,870	4,676		8,546	1,384	7,162		8,546
Dong Khe Sim	CP-036	1	1.5	1,420	1,480		2,900	2,900			2,900
Dong Da Mai	CP-030	1	1.6	2,983	5,735		8,718	2,180	6,540		8,720
Bac Quang Loi	CP-034	1	3.6	6,977	3,743		10,720	10,720			10,720
Khe Chuoi	UB-002	0	8.4	3,279	15,858		19,137	293	15,174	3,670	19,137
Quang Ninh Coal Company			200.4	5,525	134,854	181,244	321,923	3,818	43,079	275,026	321,923
Tay Da Mai	CP-031	1	1.5	2,215	4,925		7,140	2,205	4,935		7,140
Ho Thien	UB-001	0	13.65		9,824	11,384	21,208		9,497	11,711	21,208
North Dong Vong	UB-008	0	3.5	3,610	6,514	3,740	13,864		11,425	2,439	13,864
Dong Trang Bach	UB-012	0	50.2			6,742	6,742	895	1,007	4,840	6,742
Quang La	UB-013	1	23		19,278	61,580	80,858	718	4,500	75,640	80,858
Yen Lap-Ha Moc	UB-014	1	51.8		338	3,224	3,562		95	3,467	3,562
Dong Dang-Dai Dan	UB-015	1	38.7		8,931	24,006	32,937			32,937	32,937
Binh Minh 2	HG-016-2	1	1.3		20,529	2,180	22,709		3,412	19,297	22,709
Ha Rang	HG-023	1	10.7		34,229	26,564	60,793		3,183	57,610	60,793
Tay Nga Hai-Da Bac	HG-024	1	6.1		30,286	41,824	72,110		5,025	67,085	72,110
Geology & Minerals Expl. Co.			46.3	7,686	141,472	135,893	285,051	1,115	14,138	269,798	285,051
Tan Yen	UB-011	0	2.9			300	300	240	60		300
Nga Hai	HG-025	1	11.6	7,686	99,472	30,998	138,156		8,208	129,948	138,156
Bac Mong Duong	CP-033	1	5.5			31,295	31,295	725	2,070	28,500	31,295
Ke Bao	CP-040	0	26.1		42,000	73,000	115,000	150	3,500	111,350	115,000
Binh Mine 3	HG-016-3	1	0.2			300	300		300		300
VINACOAL Total		30	458.3	427,797	1,700,169	1,041,269	3,169,235	310,555	416,216	2,442,916	3,169,687

Note: 1) Study Area*: 1 means in the Study Area, 0 means outside of the Study Area.
2) the totals do not add up in the original data.

Source: VINACOAL, 1997

Table 18.3.3 Anticipated Changes in Land Use in Mining Area

No.	Name	Permit Area	1996				2010 (Without Project)				2010 (With Project)			
			Mining Area		Other*		Mining Area		Other*		Mining Area		Other*	
		ha	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
6	Dien Vong	6,750	1709	25	5,041	75	2,694	40	4056	60	1,720	25	5030	75
7	Hong Gai North	1,275	195	15	1,080	84	333	26	942	74	200	16	1075	84
8	Hong Gai South	125	3	2	122	96	5	4	120	96	5	4	120	96
9	Ha Tu	1,275	790	62	485	37	1,022	80	253	20	790	62	485	38
10	Cam Pha West	125	65	52	60	46	89	71	36	29	40	32	85	68
11	Cam Pha Central	525	376	72	149	28	458	87	67	13	36	7	489	93
12	Cam Pha East	214	213	100	0	0	213	100	0	0	53	25	161	75
13	Cua Ong	550	138	25	412	74	218	40	332	60	140	25	410	75
14	Mong Duong	3,250	1876	58	1,374	42	2,488	77	762	23	1,890	58	1360	42
Total		14,089	5413	38	8,724	62	7,520	53	6569	47	4,874	35	9215	65

Note: * "Other" includes Forest, Shrub and Grass

Table 18.3.4 Chemical Composition of Selected Mine Wastewater

Parameters	Unit	Ha Tu Seam 16	Ha Tu Seam 10B	Coc Sau	Mong Duong
pH	-	3.6	2.11	3.7	4.8
BOD	mg/ℓ	4.58	2.7	n.a.	n.a.
COD	mg/ℓ	11.2	9.4	n.a.	n.a.
SS	mg/ℓ	99	20.2	432	173
Mineral	mg/ℓ	n.a.	n.a.	506	414
Zn	mg/ℓ	0.391	0.49	n.a.	n.a.
Cd	mg/ℓ	0.0019	0.01	n.a.	n.a.
Pb	mg/ℓ	0.0029	0.04	n.a.	n.a.
Cu	mg/ℓ	0.033	0.25	n.a.	n.a.
Mn	mg/ℓ	0.005	2.42	n.a.	n.a.
Fe	mg/ℓ	2.12	-	0.1	0.8
NO^3	mg/ℓ	3.67	0.5	n.a.	n.a.
NO^2	mg/ℓ	0	0	n.a.	n.a.
NH^{4+}	mg/ℓ	0.52	0.13	1.5	n.a.
Cl	mg/ℓ	n.a.	n.a.	6	10.8
SO^{3-}	mg/ℓ	n.a.	n.a.	419	283
Coliform	MPN/100mℓ	1,800	730	n.a.	n.a.

Note: n.a. means not available.
Source: UNDP, 1988

Table 18.3.5 Estimated Pollution Loads from Mining Area

No.	Name	Erosion			BOD			COD		
		Present	2010		Present	2010		Present	2010	
		-	Without	With	-	Without	With	-	Without	With
		tons/year			kg/year			kg/year		
6	Dien Vong	505,000	769,000	508,000	979	999	979	1,453	1,512	1,453
7	Hong Gai North	69,000	111,000	71,000	182	185	183	267	275	267
8	Hong Gai South	6,000	8,000	8,000	18	18	18	25	25	25
9	Ha Tu	366,000	469,000	366,000	194	199	194	302	316	302
10	Cam Pha West	37,000	50,000	23,000	19	19	18	29	30	27
11	Cam Pha Central	175,000	212,000	22,000	81	83	74	128	132	107
12	Cam Pha East	66,000	66,000	18,000	34	34	31	55	56	46
13	Cua Ong	55,000	84,000	56,000	80	81	80	118	123	118
14	Mong Duong	766,000	1,005,000	771,000	493	505	493	763	799	763
Total		2,045,000	2,774,000	1,843,000	2,080	2,123	2,070	3,140	3,269	3,110

No.	Name	SS			T-N			T-P		
		Present	2010		Present	2010		Present	2010	
		-	Without	With	-	Without	With	-	Without	With
		kg/year			kg/year			kg/year		
6	Dien Vong	61,000	89,000	62,000	1,051	1,268	1,053	304	324	304
7	Hong Gai North	8,000	12,000	8,000	170	201	172	55	58	55
8	Hong Gai South	0	0	0	13	14	14	5	5	5
9	Ha Tu	25,000	31,000	25,000	301	352	301	67	71	67
10	Cam Pha West	2,000	3,000	1,000	27	32	21	6	7	6
11	Cam Pha Central	12,000	14,000	2,000	135	153	60	29	30	22
12	Cam Pha East	6,000	6,000	2,000	68	68	33	13	13	10
13	Cua Ong	5,000	7,000	5,000	85	103	86	25	26	25
14	Mong Duong	59,000	76,000	59,000	738	872	741	168	180	168
Total		178,000	238,000	164,000	2,589	3,063	2,481	671	714	661

Note : "Without" means without EMP, "With" means with EMP.

Table 18.3.6 Selected Existing and Planned Pollution Control Programs

Category	Location	Problem	Countermeasure	Year	Cost	Source
Erosion & Water Pollution	Mong Duong River	increased risk of flooding due to excessive sedimentation	94,000 m3 sediment removed in 1997. Further dredging and construction of dyke planned	1997-1998	0.9 billion VND in 1997, 2 billion VND in 1998	1
	Cau Hai stream	excessive erosion/sedimentation problem	construction of erosion control dam (capacity 2.5 million m3)	proposed (1999-2000)	0.9 billion VND	2
	Deo Nai mine	excessive erosion/sedimentation problem	leveling of stairs at overburden dump	proposed (1998-2019)	27 billion VND	2
	Deo Nai mine	excessive erosion/sedimentation problem	construction of 3 dykes	1970's -	over 10 billion VND	2
	East Cao Son dump site	excessive erosion/sedimentation problem	construction of erosion control dyke (60,000 m3)	proposed (1998-2020)	11 billion VND	3
	Cao Son mine	excessive erosion/sedimentation problem	dredging of drainage system in mine	proposed (1998-2020)	3.4 billion VND	3
	Dien Vong Reservoir (drinking water supply)	water supply capacity decreased from 25,000 m3/day to 15,000 m3/day. Significant decrease in water quality	new reservoir in Cao Van (capacity 60,000 m3/day) proposed, rehabilitation of Dien Vong plant	ongoing	26 billion VND for water mains from Cao Van to Dien Vong and for rehabilitation of Dien Vong plant	4
	Dong Ho intake (drinking water supply)	deterioration of water quality	installation of new sedimentation tank to treat water	1997	13 billion VND	4
	BaTone, Cua Ong and Mong Duong irigation/drainage system	sedimentation problem	dredging of Ba Tone system has been proposed	proposed	2.3 billion VND (Ba Tone only)	5
	Three Lakes in Dong Trieu District	excessive sedimentation problem	7.0 million m3 to be dredged	proposed	5 billion VND	5
	Noi Hoang Lake	excessive sedimentation problem	dredging	1997-1998	3 billion VND	4
	3 Processing Plants	lack of solid waste and sludge management	installation of re-screen/refill system, sludge recovery pond	proposed	175 billion VND	7
Land Use	Cao Son mine	erosion, lack of reclamation	reforestation	proposed (1998-2020)	3.8 billion VND	3
	Quang Ninh Province	deforestation and related erosion problem	reforestation, over 3,000 ha/year during 1996-1998	1998-	unknown	5
	Quang Ninh Province	deforestation and related erosion problem	reforestation, development of forestry for use by VINACOAL (300 ha in 1997)	1997-	unknown	5
	dump sites (1,500 hectare) and buffer zones (3,400 hectare)	deforestation and related erosion problem	reforestation	proposed	40 billion VND	7
Dust	truck road in Cao Son mine	dust problem	watering	proposed (1998-2020)	2.4 billion VND	3
	truck road in Deo Nai mine	dust problem	watering	proposed (1998-2019)	35 billion VND	2
	Nam Cau Trang Coal Processing Company	dust problem	watering (trucks, spray system)	proposed (1998-)	0.6 billion VND for trucks and spray system, 0.13 billion/year for running	6
	11 underground mines, 6 open-pit mines, and 3 processing plants	dust problem	installation of ventilation system, water sprayers, dust filters, etc.	proposed	150 billion VND	7

Source: 1: VINACOAL, 1998 (hearing)
2: Deo Nai Mine EIA Report, 1997
3: Coc Sau Mine EIA Report, 1997
4: Water Supply Company, 1998 (hearing) and Carl Bro, 1995
5: QN Dept. Agr. & Rural Develop., 1998 (hearing)
6: Hong Gai Coal Processing Company EIA Report, 1997
7: EVS, 1996

Table 18.3.7 Estimated Costs & Schedule (Development of Environmental Plan for Mining)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Design	1. Design	Preliminary Investigation	person/month	240	240	480	0	0	0	0	0	0	0	0	960
		Project Design (Intn'l)	person/month	6	12	6	0	0	0	3	0	0	0	0	27
		Project Design (Local)	person/month	240	480	480	0	0	0	120	0	0	0	0	1,320

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Design	1. Design	Preliminary Investigation	100/pers./month	24,000	24,000	48,000	0	0	0	0	0	0	0	0	96,000
		Project Design (Intn'l)	20,000/pers./mo.	120,000	240,000	120,000	0	0	0	60,000	0	0	0	0	540,000
		Project Design (Local)	100/pers./month	24,000	48,000	48,000	0	0	0	12,000	0	0	0	0	132,000
		Contingency (20%)		34,000	62,000	43,000	0	0	0	14,000	0	0	0	0	153,000
		Subtotal		202,000	374,000	259,000	0	0	0	86,000	0	0	0	0	921,000
	Total			202,000	374,000	259,000	0	0	0	86,000	0	0	0	0	921,000
Grand Total				202,000	374,000	259,000	0	0	0	86,000	0	0	0	0	921,000

Note : Cost rounded to the order of 4th digit, beore adjustment of discount rate.

Table 18.3.8 Estimated Costs & Schedule (Pilot Project on Environmental Rehabilitation)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	90	60	0	0	0	0	0	0	0	0	0	150
		Project Design (Intn'l)	person/month	24	24	0	0	0	0	0	0	0	0	0	48
		Project Design (Local)	person/month	150	120	0	0	0	0	0	0	0	0	0	270
	2. Ground Preparation	Terracing	m	0	0	0	0	0	0	0	0	0	0	0	0
		Grading, Surface Roughing	ha	0	30	70	0	0	0	0	0	0	0	0	100
		Bed Preparation	ha	0	30	70	0	0	0	0	0	0	0	0	100
	3. Drainage Improv.	Diversion/Waterway	m	0	3,000	7,000	0	0	0	0	0	0	0	0	10,000
		Downdrain	m	0	300	700	0	0	0	0	0	0	0	0	1,000
		Treatment Facility	facility	0	0	1	0	0	0	0	0	0	0	0	1
		Dam & Pond (temporary)	m3	0	500	500	0	0	0	0	0	0	0	0	1,000
		Dam & Pond (permanent)	m3	0	0	300	0	0	0	0	0	0	0	0	300
	4. Revegetation	Seedlings (Trees)	each	0	25,000	100,000	0	0	0	0	0	0	0	0	125,000
		Revegetation with Grass	ha	0	20	30	0	0	0	0	0	0	0	0	50
		Tree Planting	ha	0	10	40	0	0	0	0	0	0	0	0	50
O&M	O&M	Vegetation	ha	0	0	0	20	20	30	50	0	0	0	0	120
		Drainage Sys.	ha	0	0	0	260	280	300	300	0	0	0	0	1,140
		Treatment	m3	0	0	0	975,000	975,000	975,000	975,000	0	0	0	0	3,900,000

(unit : US$)

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo.	9,000	6,000	0	0	0	0	0	0	0	0	0	15,000
		Project Design (Intn'l)	20,000/pers./mo.	480,000	480,000	0	0	0	0	0	0	0	0	0	960,000
		Project Design (Local)	200/pers./mo.	30,000	24,000	0	0	0	0	0	0	0	0	0	54,000
		Contingency (30%)		156,000	153,000	0	0	0	0	0	0	0	0	0	309,000
		Subtotal		675,000	663,000	0	0	0	0	0	0	0	0	0	1,338,000
	2. Ground Preparation	Terracing	400/m	0	0	0	0	0	0	0	0	0	0	0	0
		Grading, Surface Roughing	250/ha	0	8,000	18,000	0	0	0	0	0	0	0	0	26,000
		Bed Preparation	300/ha	0	9,000	21,000	0	0	0	0	0	0	0	0	30,000
		Contingency (30%)		0	5,000	12,000	0	0	0	0	0	0	0	0	17,000
		Subtotal		0	22,000	51,000	0	0	0	0	0	0	0	0	73,000
	3. Drainage Improv.	Diversion/Waterway	5 /m	0	15,000	35,000	0	0	0	0	0	0	0	0	50,000
		Downdrain	20 /m	0	6,000	14,000	0	0	0	0	0	0	0	0	20,000
		Treatment Sys.	50,000/system	0	0	50,000	0	0	0	0	0	0	0	0	50,000
		Dam & Pond (temporary)	3 /m3	0	2,000	2,000	0	0	0	0	0	0	0	0	4,000
		Dam & Pond (permanent)	100 /m3	0	0	30,000	0	0	0	0	0	0	0	0	30,000
		Contingency (30%)		0	7,000	39,000	0	0	0	0	0	0	0	0	46,000
		Subtotal		0	30,000	170,000	0	0	0	0	0	0	0	0	200,000
	4. Revegetation	Seedlings (Trees)	2 /each	0	5,000	20,000	0	0	0	0	0	0	0	0	25,000
		Revegetation with Grass	100/ha	0	2,000	3,000	0	0	0	0	0	0	0	0	5,000
		Tree Planting	200/ha	0	2,000	8,000	0	0	0	0	0	0	0	0	10,000
		Contingency (30%)		0	3,000	9,000	0	0	0	0	0	0	0	0	12,000
		Subtotal		0	12,000	40,000	0	0	0	0	0	0	0	0	52,000
	Total			675,000	727,000	261,000	0	0	0	0	0	0	0	0	1,663,000
O&M	O&M	Vegetation	20/ha	0	0	0	0	0	1,000	1,000	0	0	0	0	2,000
		Drainage Sys.	100/ha	0	0	0	26,000	28,000	30,000	30,000	0	0	0	0	114,000
		Treatment	003 /m3	0	0	0	3,000	3,000	3,000	3,000	0	0	0	0	12,000
		Contingency (30%)		0	0	0	9,000	9,000	10,000	10,000	0	0	0	0	38,000
		Subtotal		0	0	0	38,000	40,000	44,000	44,000	0	0	0	0	166,000
	Total			0	0	0	38,000	40,000	44,000	44,000	0	0	0	0	166,000
Grand Total				675,000	727,000	261,000	38,000	40,000	44,000	44,000	0	0	0	0	1,829,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.9 Estimated Costs & Schedule (Environmental Measures for Mine Wastewater)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	0	0	360	0	0	0	0	0	0	0	360
		Project Design	person/month	0	0	0	120	0	0	0	0	0	0	0	120
	2. Drainage Improv.	Drainage Channel	m	0	0	0	0	10,000	20,000	20,000	0	0	0	0	50,000
		Treatment Facility	facility	0	0	0	0	10	20	20	0	0	0	0	50
O&M	O&M	Treatment	m3	0	0	0	0	0	0	0	37,600,000	37,600,000	37,600,000	37,600,000	150,400,000

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo	0	0	0	36,000	0	0	0	0	0	0	0	36,000
		Project Design	100/pers./mo	0	0	0	12,000	0	0	0	0	0	0	0	12,000
		Contingency (20%)		0	0	0	10,000	0	0	0	0	0	0	0	10,000
		Subtotal		0	0	0	58,000	0	0	0	0	0	0	0	58,000
	2. Drainage Improv.	Drainage Channel	20/m	0	0	0	0	200,000	400,000	400,000	0	0	0	0	1,000,000
		Treatment Facility	10,000/facility	0	0	0	0	100,000	200,000	200,000	0	0	0	0	500,000
		Contingency (20%)		0	0	0	0	60,000	120,000	120,000	0	0	0	0	300,000
		Subtotal		0	0	0	0	360,000	720,000	720,000	0	0	0	0	1,800,000
	Total			0	0	0	58,000	360,000	720,000	720,000	0	0	0	0	1,858,000
O&M	O&M	Treatment	002 /m3	0	0	0	0	0	0	0	75,000	75,000	75,000	75,000	300,000
		Contingency (20%)		0	0	0	0	0	0	0	15,000	15,000	15,000	15,000	60,000
		Subtotal		0	0	0	0	0	0	0	90,000	90,000	90,000	90,000	360,000
	Total			0	0	0	0	0	0	0	90,000	90,000	90,000	90,000	360,000
Grand Total				0	0	0	58,000	360,000	720,000	720,000	90,000	90,000	90,000	90,000	2,218,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.10 Estimated Costs & Schedule (Environmental Measures for Coal Processing Plants)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	240	240	0	0	0	0	0	0	0	0	480
		Project Design	person/month	0	240	240	0	0	0	0	0	0	0	0	480
	2. Drainage Improv.	Drainage Channel	m	0	0	0	13,000	13,500	0	0	0	0	0	0	26,500
		Sedimentation Pond	m3	0	0	0	300	300	0	0	0	0	0	0	600
	3. Revegetation	Seedlings (Trees)	each	0	0	0	25,000	25,000	0	0	0	0	0	0	50,000
		Tree Planting	ha	0	0	0	10	10	0	0	0	0	0	0	20
	4. Dust Control	High Pressure Sprayers	each	0	0	0	4	4	0	0	0	0	0	0	8
O&M	O&M	Vegetation	ha	0	0	0	0	0	20	20	20	20	20	20	120
		Drainage Sys	m	0	0	0	0	0	18,000	19,000	20,000	20,000	20,000	20,000	117,000
		Dust Control	ha	0	0	0	0	0	4	4	4	4	4	4	24

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo.	0	24,000	24,000	0	0	0	0	0	0	0	0	48,000
		Project Design	100/pers./mo.	0	24,000	24,000	0	0	0	0	0	0	0	0	48,000
		Contingency (20%)		0	10,000	10,000	0	0	0	0	0	0	0	0	20,000
		Subtotal		0	58,000	58,000	0	0	0	0	0	0	0	0	116,000
	2. Drainage Improv.	Drinage Channel	2 /m	0	0	0	26,000	27,000	0	0	0	0	0	0	53,000
		Sedimentation Pond	20. m3	0	0	0	6,000	6,000	0	0	0	0	0	0	12,000
		Contingency (20%)		0	0	0	6,000	7,000	0	0	0	0	0	0	13,000
		Subtotal		0	0	0	38,000	40,000	0	0	0	0	0	0	78,000
	3. Revegetation	Seedlings (Trees)	.08 each	0	0	0	2,000	2,000	0	0	0	0	0	0	4,000
		Tree Planting	155/ha	0	0	0	2,000	2,000	0	0	0	0	0	0	4,000
		Contingency (20%)		0	0	0	1,000	1,000	0	0	0	0	0	0	2,000
		Subtotal		0	0	0	5,000	5,000	0	0	0	0	0	0	10,000
	4. Dust Control	High Pressure Sprayers	1,900 /unit	0	0	0	8,000	8,000	0	0	0	0	0	0	16,000
		Contingency (20%)		0	0	0	2,000	2,000	0	0	0	0	0	0	4,000
		Subtotal		0	0	0	10,000	10,000	0	0	0	0	0	0	20,000
	Total			0	58,000	58,000	53,000	55,000	0	0	0	0	0	0	224,000
O&M	O&M	Vegetation	10/ha	0	0	0	0	0	0	0	0	0	0	0	0
		Drainage Sys	10 /m	0	0	0	0	0	180,000	190,000	200,000	200,000	200,000	200,000	1,170,000
		Dust Control	2,000/ha	0	0	0	0	0	8,000	8,000	8,000	8,000	8,000	8,000	48,000
		Contingency (20%)		0	0	0	0	0	38,000	40,000	42,000	42,000	42,000	42,000	246,000
		Subtotal		0	0	0	0	0	226,000	238,000	250,000	250,000	250,000	250,000	1,464,000
	Total			0	0	0	0	0	226,000	238,000	250,000	250,000	250,000	250,000	1,464,000
Grand Total				0	58,000	58,000	53,000	55,000	226,000	238,000	250,000	250,000	250,000	250,000	1,688,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.11 Estimated Costs & Schedule (South Deo Nai Dumping Site Rehabilitation)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	480	0	0	0	0	0	0	0	0	0	480
		Project Design	person/month	0	360	0	0	0	0	0	0	0	0	0	360
	2. Ground Preparation	Terracing	m	0	0	3,000	0	0	0	0	0	0	0	0	3,000
		Contour Dike	m	0	0	60,000	0	0	0	0	0	0	0	0	60,000
		Bed Preparation	ha	0	0	250	0	0	0	0	0	0	0	0	250
	3. Drainage Improv.	Diversion/Waterway	m	0	0	30,000	0	0	0	0	0	0	0	0	30,000
		Downdrain	m	0	0	3,000	0	0	0	0	0	0	0	0	3,000
		Dam & Pond (temporary)	m3	0	0	0	0	0	0	0	0	0	0	0	0
		Dam & Pond (permanent)	m3	0	0	0	0	0	0	0	0	0	0	0	0
	4. Revegetation	Seedlings (Trees)	each	0	0	500,000	0	0	0	0	0	0	0	0	500,000
		Revegetation with Grass	ha	0	0	450	0	0	0	0	0	0	0	0	450
		Tree Planting	ha	0	0	250	0	0	0	0	0	0	0	0	250
	5. Dust Control	High Pressure Sprayers	each	0	0	0	0	0	0	0	0	0	0	0	0
		Water Trucks	vehicle	0	0	0	0	0	0	0	0	0	0	0	0
	6. Dyke	Dyke	m3	0	0	20,000	0	0	0	0	0	0	0	0	20,000
O&M	O&M	Vegetation	ha	0	0	0	450	450	450	450	450	450	450	450	3,600
		Drainage Sys	ha	0	0	0	450	450	450	450	450	450	450	450	3,600
		Dust Control	ha	0	0	0	0	0	0	0	0	0	0	0	0

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers /mo	0	48,000	0	0	0	0	0	0	0	0	0	48,000
		Project Design	200/pers /mo	0	72,000	0	0	0	0	0	0	0	0	0	72,000
		Contingency (20%)		0	24,000	0	0	0	0	0	0	0	0	0	24,000
		Subtotal		0	144,000	0	0	0	0	0	0	0	0	0	144,000
	2. Ground Preparation	Terracing	400 /m	0	0	1,200,000	0	0	0	0	0	0	0	0	1,200,000
		Contour Dike	2 /m	0	0	120,000	0	0	0	0	0	0	0	0	120,000
		Bed Preparation	500/ha	0	0	125,000	0	0	0	0	0	0	0	0	125,000
		Contingency (20%)		0	0	289,000	0	0	0	0	0	0	0	0	289,000
		Subtotal		0	0	1,734,000	0	0	0	0	0	0	0	0	1,734,000
	3. Drainage Improv.	Diversion/Waterway	20 /m	0	0	600,000	0	0	0	0	0	0	0	0	600,000
		Downdrain	30 /m	0	0	90,000	0	0	0	0	0	0	0	0	90,000
		Dam & Pond (temporary)	3 /m3	0	0	0	0	0	0	0	0	0	0	0	0
		Dam & Pond (permanent)	100 /m3	0	0	0	0	0	0	0	0	0	0	0	0
		Contingency (20%)		0	0	138,000	0	0	0	0	0	0	0	0	138,000
		Subtotal		0	0	828,000	0	0	0	0	0	0	0	0	828,000
	4. Revegetation	Seedlings (Trees)	08 each	0	0	40,000	0	0	0	0	0	0	0	0	40,000
		Revegetation with Grass	80/ha	0	0	36,000	0	0	0	0	0	0	0	0	36,000
		Tree Planting	155/ha	0	0	39,000	0	0	0	0	0	0	0	0	39,000
		Contingency (20%)		0	0	23,000	0	0	0	0	0	0	0	0	23,000
		Subtotal		0	0	138,000	0	0	0	0	0	0	0	0	138,000
	5. Dust Control	High Pressure Sprayers	1,900 /unit	0	0	0	0	0	0	0	0	0	0	0	0
		Water Trucks	16,000 /vehicle	0	0	0	0	0	0	0	0	0	0	0	0
		Contingency (20%)		0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal		0	0	0	0	0	0	0	0	0	0	0	0
	6. Dredging & Dyke	Dyke	2 /m3	0	0	30,000	0	0	0	0	0	0	0	0	30,000
		Contingency (20%)		0	0	6,000	0	0	0	0	0	0	0	0	6,000
		Subtotal		0	0	36,000	0	0	0	0	0	0	0	0	36,000
	Total			0	144,000	2,736,000	0	0	0	0	0	0	0	0	2,880,000
O&M	O&M	Vegetation	15/ha	0	0	0	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	56,000
		Drainage Sys	100/ha	0	0	0	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	360,000
		Dust Control	2,000/ha	0	0	0	0	0	0	0	0	0	0	0	0
		Contingency (20%)		0	0	0	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	80,000
		Subtotal		0	0	0	62,000	62,000	62,000	62,000	62,000	62,000	62,000	62,000	496,000
	Total			0	0	0	62,000	62,000	62,000	62,000	62,000	62,000	62,000	62,000	496,000
Grand Total				0	144,000	2,736,000	62,000	62,000	62,000	62,000	62,000	62,000	62,000	62,000	3,376,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.12 Estimated Costs & Schedule (Mong Duong River Basin Rehabilitation Project)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	300	300	300	300	0	0	0	0	0	0	1,500
		Project Design	person/month	0	360	360	360	360	0	0	0	0	0	0	1,440
	2. Ground Preparation	Terracing	m	0	0	0	150	150	150	150	150	200	200	200	1,350
		Grading, Surface Roughing	ha	0	0	0	100	200	100	100	100	100	100	100	900
		Bed Preparation	ha	0	0	0	100	200	100	100	100	100	100	100	900
	3. Drainage Improv.	Diversion/Waterway	m	0	0	0	10,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000	90,000
		Downdrain	m	0	0	0	1,000	2,000	1,000	1,000	1,000	1,000	1,000	1,000	9,000
		Dam & Pond (temporary)	m3	0	0	0	1,000	1,000	1,000	1,000	1,000	500	500	500	6,500
		Dam & Pond (permanent)	m3	0	0	0	200	200	0	200	0	200	500	200	1,500
	4. Revegetation	Seedlings (Trees)	each	0	0	0	250,000	250,000	250,000	125,000	125,000	125,000	125,000	125,000	1,375,000
		Revegetation with Grass	ha	0	0	0	100	200	100	100	100	100	100	100	900
		Tree Planting	ha	0	0	0	100	100	100	50	50	50	50	50	550
			ha	0	0	0	5	5	5	5	0	5	0	5	30
	5. Dust Control	High Pressure Sprayers	each	0	0	0	11	2	2	2	1	1	1	1	21
		Water Trucks	vehicle	0	0	0	4,000	4,000	4,000	2,000	2,000	2,000	2,000	2,000	22,000
	6. Dyke	Dyke	m3	0	0	0	50	150	300	400	450	500	550	575	2,975
O&M	O&M	Vegetation	ha	0	0	0	200	300	600	700	800	900	950	1,000	5,450
		Drainage Sys	ha	0	0	0	30	32	34	36	38	40	45	50	305
		Dust Control	ha	0	0	0									

(unit : US$)

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo.	0	30,000	30,000	30,000	30,000	0	0	0	0	0	0	150,000
		Project Design	100/pers./mo.	0	36,000	36,000	36,000	36,000	0	0	0	0	0	0	144,000
		Contingency (20%)		0	15,000	15,000	15,000	15,000	0	0	0	0	0	0	60,000
		Subtotal		0	90,000	90,000	90,000	90,000	0	0	0	0	0	0	360,000
	2. Ground Preparation	Terracing	400 /m	0	0	0	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	540,000
		Grading, Surface Roughing	250/ha	0	0	0	25,000	50,000	25,000	25,000	25,000	25,000	25,000	25,000	225,000
		Bed Preparation	300/ha	0	0	0	30,000	60,000	30,000	30,000	30,000	30,000	30,000	30,000	270,000
		Contingency (20%)		0	0	0	23,000	34,000	23,000	23,000	23,000	27,000	27,000	27,000	202,000
		Subtotal		0	0	0	138,000	204,000	138,000	138,000	138,000	162,000	162,000	162,000	1,242,000
	3. Drainage Improv.	Diversion/Waterway	2 /m	0	0	0	20,000	40,000	20,000	20,000	20,000	20,000	20,000	20,000	180,000
		Downdrain	10 /m	0	0	0	10,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000	90,000
		Dam & Pond (temporary)	3 m3	0	0	0	3,000	3,000	3,000	3,000	3,000	2,000	2,000	2,000	21,000
		Dam & Pond (permanent)	100 m3	0	0	0	20,000	20,000	0	20,000	0	20,000	50,000	20,000	150,000
		Contingency (20%)		0	0	0	11,000	17,000	7,000	11,000	7,000	10,000	16,000	10,000	89,000
		Subtotal		0	0	0	64,000	100,000	40,000	64,000	40,000	62,000	98,000	62,000	530,000
	4. Revegetation	Seedlings (Trees)	08 each	0	0	0	20,000	20,000	20,000	10,000	10,000	10,000	10,000	10,000	110,000
		Revegetation with Grass	80/ha	0	0	0	8,000	16,000	8,000	8,000	8,000	8,000	8,000	8,000	72,000
		Tree Planting	155/ha	0	0	0	16,000	16,000	16,000	8,000	8,000	8,000	8,000	8,000	88,000
		Contingency (20%)		0	0	0	9,000	10,000	9,000	15,000	5,000	5,000	5,000	5,000	33,000
		Subtotal		0	0	0	53,000	62,000	53,000	31,000	31,000	31,000	31,000	31,000	323,000
	5. Dust Control	High Pressure Sprayers	1,900 /unit	0	0	0	10,000	10,000	10,000	10,000	0	10,000	0	10,000	60,000
		Water Trucks	16,000 /vehicle	0	0	0	176,000	32,000	32,000	32,000	16,000	16,000	16,000	16,000	336,000
		Contingency (20%)		0	0	0	37,000	8,000	8,000	8,000	3,000	5,000	3,000	5,000	77,000
		Subtotal		0	0	0	223,000	50,000	50,000	50,000	19,000	31,000	19,000	31,000	473,000
	6. Dredging & Dyke	Dyke	2 m3	0	0	0	6,000	6,000	6,000	3,000	3,000	3,000	3,000	3,000	33,000
		Contingency (20%)		0	0	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	8,000
		Subtotal		0	0	0	2,000	7,000	7,000	4,000	4,000	4,000	4,000	4,000	41,000
		Total		0	90,000	90,000	575,000	513,000	288,000	287,000	232,000	290,000	314,000	290,000	2,969,000
O&M	O&M	Vegetation	10/ha	0	0	0	1,000	2,000	3,000	4,000	5,000	5,000	6,000	6,000	32,000
		Drainage Sys.	100/ha	0	0	0	20,000	30,000	60,000	70,000	80,000	90,000	95,000	100,000	545,000
		Dust Control	2,000/ha	0	0	0	60,000	84,000	68,000	72,000	76,000	80,000	90,000	100,000	610,000
		Contingency (20%)		0	0	0	16,000	19,000	26,000	29,000	32,000	35,000	38,000	41,000	236,000
		Subtotal		0	0	0	97,000	115,000	157,000	175,000	193,000	210,000	229,000	247,000	1,423,000
		Total		0	0	0	97,000	115,000	157,000	175,000	193,000	210,000	229,000	247,000	1,423,000
	Grand Total			0	90,000	90,000	672,000	628,000	445,000	462,000	425,000	500,000	543,000	537,000	4,392,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.13 Estimated Costs & Schedule (Dien Vong River Basin Rehabilitation Project)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	330	330	330	330	0	0	0	0	0	0	1,320
		Project Design	person/month	0	360	360	360	360	0	0	0	0	0	0	1,440
	2. Ground Preparation	Terracing	m	0	0	0	0	0	200	0	100	0	200	0	500
		Grading, Surface Roughing	ha	0	0	0	100	200	200	200	200	200	200	200	1,500
		Bed Preparation	ha	0	0	0	100	200	200	200	200	200	200	200	1,500
	3. Drainage Improv.	Diversion/Waterway	m	0	0	0	10,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	150,000
		Downdrain	m	0	0	0	1,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	15,000
		Dam & Pond (temporary)	m3	0	0	0	750	750	750	750	750	750	750	750	6,000
		Dam & Pond (permanent)	m3	0	0	0	200	200	200	200	200	200	200	250	1,650
	4. Revegetation	Seedlings (Trees)	each	0	0	0	250,000	250,000	250,000	250,000	250,000	250,000	500,000	500,000	2,500,000
		Revegetation with Grass	ha	0	0	0	100	200	200	200	200	200	200	200	1,500
		Tree Planting	ha	0	0	0	100	100	100	100	100	100	200	200	1,000
	5. Dust Control	High Pressure Sprayers	each	0	0	0	2	2	2	2	2	4	4	4	22
		Water Trucks	vehicle	0	0	0	1	1	1	1	1	2	2	2	11
	6. Dyke	Dyke	m3	0	0	0	1,000	1,000	1,000	1,000	1,000	2,000	2,000	2,000	11,000
O&M	O&M	Vegetation	ha	0	0	0	200	300	400	500	600	700	800	1,000	4,500
		Drainage Sys	ha	0	0	0	100	200	400	600	800	1,000	1,200	1,500	5,800
		Dust Control	ha	0	0	0	9	12	15	18	21	24	30	36	165

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo	0	33,000	33,000	33,000	33,000	0	0	0	0	0	0	132,000
		Project Design	100/pers./mo	0	36,000	36,000	36,000	36,000	0	0	0	0	0	0	144,000
		Contingency (20%)		0	14,000	14,000	14,000	14,000	0	0	0	0	0	0	56,000
		Subtotal		0	83,000	83,000	83,000	83,000	0	0	0	0	0	0	332,000
	2. Ground Preparation	Terracing	400 /m	0	0	0	0	0	80,000	0	40,000	0	80,000	0	200,000
		Couteur Dike	250/ha	0	0	0	25,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	375,000
		Bed Preparation	200/ha	0	0	0	20,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	300,000
		Contingency (20%)		0	0	0	9,000	18,000	34,000	18,000	26,000	18,000	34,000	18,000	175,000
		Subtotal		0	0	0	54,000	108,000	204,000	108,000	156,000	108,000	204,000	108,000	1,050,000
	3. Drainage Improv.	Diversion/Waterway	2 /m	0	0	0	20,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	300,000
		Downdrain	10 /m	0	0	0	10,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	150,000
		Dam & Pond (temporary)	3 m3	0	0	0	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	16,000
		Dam & Pond (permanent)	100 m3	0	0	0	20,000	20,000	20,000	20,000	20,000	20,000	20,000	25,000	165,000
		Contingency (20%)		0	0	0	10,000	16,000	16,000	16,000	16,000	16,000	16,000	17,000	123,000
		Subtotal		0	0	0	62,000	98,000	98,000	98,000	98,000	98,000	98,000	104,000	754,000
	4. Revegetation	Seedlings (Trees)	08 each	0	0	0	20,000	20,000	20,000	20,000	20,000	20,000	40,000	40,000	200,000
		Revegetation with Grass	80/ha	0	0	0	8,000	16,000	16,000	16,000	16,000	16,000	16,000	16,000	120,000
		Tree Planting	155/ha	0	0	0	16,000	16,000	16,000	16,000	16,000	16,000	31,000	31,000	158,000
		Contingency (20%)		0	0	0	9,000	10,000	10,000	10,000	10,000	10,000	17,000	17,000	93,000
		Subtotal		0	0	0	53,000	62,000	62,000	62,000	62,000	62,000	104,000	104,000	571,000
	5. Dust Control	High Pressure Sprayers	1,000 /unit	0	0	0	4,000	4,000	4,000	4,000	4,000	8,000	8,000	8,000	44,000
		Water Trucks	16,000 /vehicle	0	0	0	16,000	16,000	16,000	16,000	16,000	32,000	32,000	32,000	176,000
		Contingency (20%)		0	0	0	4,000	4,000	4,000	4,000	4,000	8,000	8,000	8,000	44,000
		Subtotal		0	0	0	24,000	24,000	24,000	24,000	24,000	48,000	48,000	48,000	264,000
	6. Dredging & Dyke	Dyke	2 m3	0	0	0	2,000	2,000	2,000	2,000	2,000	3,000	3,000	3,000	19,000
		Contingency (20%)		0	0	0	0	0	0	0	0	1,000	1,000	1,000	3,000
		Subtotal		0	0	0	2,000	2,000	2,000	2,000	2,000	4,000	4,000	4,000	22,000
	Total			0	83,000	83,000	278,000	377,000	390,000	294,000	342,000	320,000	458,000	368,000	2,993,000
O&M	O&M	Vegetation	10/ha	0	0	0	2,000	3,000	4,000	5,000	6,000	7,000	8,000	10,000	45,000
		Drainage Sys	100/ha	0	0	0	10,000	20,000	40,000	60,000	80,000	100,000	120,000	150,000	580,000
		Dust Control	2,000/ha	0	0	0	18,000	24,000	30,000	36,000	42,000	48,000	60,000	72,000	330,000
		Contingency (20%)		0	0	0	6,000	9,000	15,000	20,000	26,000	31,000	38,000	46,000	191,000
		Subtotal		0	0	0	36,000	56,000	89,000	121,000	154,000	186,000	226,000	278,000	1,146,000
	Total			0	0	0	36,000	56,000	89,000	121,000	154,000	186,000	226,000	278,000	1,146,000
Grand Total				0	83,000	83,000	314,000	433,000	479,000	415,000	496,000	506,000	684,000	646,000	4,139,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.14 Estimated Costs & Schedule (Ha Tu River Basin Rehabilitation Project)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	0	0	300	300	300	300	0	0	0	0	1,500
		Project Design	person/month	0	0	0	360	360	360	360	0	0	0	0	1,440
	2. Ground Preparation	Terracing	m	0	0	0	0	0	100	100	100	100	100	100	600
		Grading, Surface Roughing	ha	0	0	0	0	0	50	50	50	50	100	100	400
		Bed Preparation	ha	0	0	0	0	0	50	50	50	50	100	100	400
	3. Drainage Improvemer	Diversion/Waterway	m	0	0	0	0	0	5,000	5,000	5,000	5,000	10,000	10,000	40,000
		Downdrain	m	0	0	0	0	0	500	500	500	500	1,000	1,000	4,000
		Dam & Pond (temporary)	m3	0	0	0	0	0	300	300	300	500	500	500	2,400
		Dam & Pond (permanent)	m3	0	0	0	0	0	50	100	150	150	150	150	750
	4. Revegetation	Seedlings (Trees)	each	0	0	0	0	0	25,000	125,000	125,000	125,000	125,000	125,000	700,000
		Revegetation with Grass	ha	0	0	0	0	0	50	50	50	50	100	100	400
		Tree Planting	ha	0	0	0	0	0	30	50	50	50	50	50	280
	5. Dust Control	High Pressure Sprayers	each	0	0	0	0	0	1	1	1	1	1	0	5
		Water Trucks	vehicle	0	0	0	0	0	0	0	1	1	1	1	4
	6. Dyke	Dyke	m3	0	0	0	0	0	1,000	1,000	2,000	2,000	2,000	2,000	10,000
O&M	O&M	Vegetation	ha	0	0	0	0	0	240	240	240	240	240	240	1,440
		Drainage Sys	ha	0	0	0	0	0	240	290	340	390	440	550	2,250
		Dust Control	ha	0	0	0	0	0	4	5	6	8	10	12	45

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo.	0	0	0	30,000	30,000	30,000	30,000	0	0	0	0	150,000
		Project Design	100/pers./mo.	0	0	0	36,000	36,000	36,000	36,000	0	0	0	0	144,000
		Contingency (20%)		0	0	0	15,000	15,000	15,000	15,000	0	0	0	0	60,000
		Subtotal		0	0	0	90,000	90,000	90,000	90,000	0	0	0	0	360,000
	2. Ground Preparation	Terracing	400 /m	0	0	0	0	0	40,000	40,000	40,000	40,000	40,000	40,000	240,000
		Contour Dike	2500/ha	0	0	0	0	0	13,000	13,000	13,000	13,000	25,000	25,000	102,000
		Bed Preparation	3000/ha	0	0	0	0	0	15,000	15,000	15,000	15,000	30,000	30,000	120,000
		Contingency (20%)		0	0	0	0	0	14,000	14,000	14,000	14,000	19,000	19,000	94,000
		Subtotal		0	0	0	0	0	82,000	82,000	82,000	82,000	114,000	114,000	556,000
	3. Drainage Improvemer	Diversion/Waterway	2 /m	0	0	0	0	0	10,000	10,000	10,000	10,000	20,000	20,000	80,000
		Downdrain	10 /m	0	0	0	0	0	5,000	5,000	5,000	5,000	10,000	10,000	40,000
		Dam & Pond (temporary)	3. m3	0	0	0	0	0	1,000	2,000	2,000	2,000	2,000	2,000	11,000
		Dam & Pond (permanent)	100. m3	0	0	0	0	0	5,000	10,000	15,000	15,000	15,000	15,000	75,000
		Contingency (20%)		0	0	0	0	0	4,000	5,000	6,000	6,000	9,000	9,000	39,000
		Subtotal		0	0	0	0	0	25,000	32,000	38,000	38,000	56,000	56,000	245,000
	4. Revegetation	Seedlings (Trees)	08 each	0	0	0	0	0	6,000	10,000	10,000	10,000	10,000	10,000	56,000
		Revegetation with Grass	80/ha	0	0	0	0	0	4,000	4,000	4,000	4,000	8,000	8,000	32,000
		Tree Planting	155/ha	0	0	0	0	0	5,000	8,000	8,000	8,000	8,000	8,000	45,000
		Contingency (20%)		0	0	0	0	0	3,000	4,000	4,000	4,000	5,000	5,000	25,000
		Subtotal		0	0	0	0	0	18,000	26,000	26,000	26,000	31,000	31,000	158,000
	5. Dust Control	High Pressure Sprayers	1,900 /unit	0	0	0	0	0	2,000	2,000	2,000	2,000	2,000	0	10,000
		Water Trucks	16,000 /vehicle	0	0	0	0	0	0	0	16,000	16,000	16,000	16,000	64,000
		Contingency (20%)		0	0	0	0	0	0	0	4,000	4,000	4,000	3,000	15,000
		Subtotal		0	0	0	0	0	2,000	2,000	22,000	22,000	22,000	19,000	89,000
	6. Dredging & Dyke	Dyke	2 m3	0	0	0	0	0	2,000	2,000	3,000	3,000	3,000	3,000	16,000
		Contingency (20%)		0	0	0	0	0	0	0	1,000	1,000	1,000	1,000	4,000
		Subtotal		0	0	0	0	0	2,000	2,000	4,000	4,000	4,000	4,000	20,000
	Total			0	0	0	90,000	90,000	219,000	234,000	172,000	172,000	227,000	224,000	1,428,000
O&M	O&M	Vegetation	10/ha	0	0	0	0	0	2,000	2,000	2,000	2,000	2,000	2,000	12,000
		Drainage Sys	100/ha	0	0	0	0	0	24,000	29,000	34,000	39,000	44,000	55,000	225,000
		Dust Control	2,000/ha	0	0	0	0	0	8,000	10,000	12,000	16,000	20,000	24,000	90,000
		Contingency (20%)		0	0	0	0	0	7,000	8,000	10,000	11,000	13,000	16,000	65,000
		Subtotal		0	0	0	0	0	41,000	49,000	58,000	68,000	79,000	97,000	392,000
	Total			0	0	0	0	0	41,000	49,000	58,000	68,000	79,000	97,000	392,000
Grand Total				0	0	0	90,000	90,000	260,000	283,000	230,000	240,000	306,000	321,000	1,820,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.15 Estimated Costs & Schedule (Hong Gai North Basin Rehabilitation Project)

Scheudle

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	0	0	90	90	90	90	0	0	0	0	360
		Project Design	person/month	0	0	0	126	126	126	126	0	0	0	0	504
	2. Ground Preparation	Terracing	m	0	0	0	0	0	0	0	0	0	0	0	0
		Grading, Surface Roughing	ha	0	0	0	0	0	15	15	30	30	30	30	150
		Bed Preparation	ha	0	0	0	0	0	15	15	30	30	30	30	150
	3. Drainage Improv.	Diversion/Waterway	m	0	0	0	0	0	1,500	1,500	3,000	3,000	3,000	3,000	15,000
		Downdrain	m	0	0	0	0	0	150	150	300	300	300	300	1,500
		Dam & Pond (temporary)	m3	0	0	0	0	0	50	100	100	100	100	100	550
		Dam & Pond (permanent)	m3	0	0	0	0	0	0	150	150	0	0	0	300
	4. Revegetation	Seedlings (Trees)	each	0	0	0	0	0	25,000	25,000	50,000	50,000	50,000	50,000	250,000
		Revegetation with Grass	ha	0	0	0	0	0	10	10	10	10	10	10	60
		Tree Planting	ha	0	0	0	0	0	10	10	20	20	20	20	100
	5. Dust Control	High Pressure Sprayers	each	0	0	0	0	0	0	1	0	0	1	1	3
		Water Trucks	veluele	0	0	0	0	0	1	1	0	0	0	0	2
	6. Dyke	Dyke	m3	0	0	0	0	0	0	0	0	0	0	0	0
O&M	O&M	Vegetation	ha	0	0	0	0	0	45	55	65	85	105	130	485
		Drainage Sys	ha	0	0	0	0	0	60	75	90	120	150	180	675
		Dust Control	ha	0	0	0	0	0	2	3	5	5	5	7	27

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo.	0	0	0	9,000	9,000	9,000	9,000	0	0	0	0	36,000
		Project Design	100/pers./mo.	0	0	0	13,000	13,000	13,000	13,000	0	0	0	0	52,000
		Contingency (20%)		0	0	0	4,000	4,000	4,000	4,000	0	0	0	0	16,000
		Subtotal		0	0	0	26,000	26,000	26,000	26,000	0	0	0	0	104,000
	2. Ground Preparation	Terracing	400 /m	0	0	0	0	0	0	0	0	0	0	0	0
		Contour Dike	250/ha	0	0	0	0	0	4,000	4,000	8,000	8,000	8,000	8,000	40,000
		Bed Preparation	200/ha	0	0	0	0	0	3,000	3,000	6,000	6,000	6,000	6,000	30,000
		Contingency (20%)		0	0	0	0	0	1,000	1,000	3,000	3,000	3,000	3,000	16,000
		Subtotal		0	0	0	0	0	8,000	8,000	17,000	17,000	17,000	17,000	86,000
	3. Drainage Improv.	Diversion/Waterway	2 /m	0	0	0	0	0	3,000	3,000	6,000	6,000	6,000	6,000	30,000
		Downdrain	10 /m	0	0	0	0	0	2,000	2,000	3,000	3,000	3,000	3,000	16,000
		Dam & Pond (temporary)	3 m3	0	0	0	0	0	0	0	0	0	0	0	0
		Dam & Pond (permanent)	100 m3	0	0	0	0	0	0	15,000	15,000	0	0	0	30,000
		Contingency (20%)		0	0	0	0	0	1,000	4,000	5,000	2,000	2,000	2,000	16,000
		Subtotal		0	0	0	0	0	6,000	24,000	29,000	11,000	11,000	11,000	92,000
	4. Revegetation	Seedlings (Trees)	0K each	0	0	0	0	0	2,000	2,000	4,000	4,000	4,000	4,000	20,000
		Revegetation with Grass	k0/ha	0	0	0	0	0	1,000	1,000	1,000	1,000	1,000	1,000	6,000
		Tree Planting	155/ha	0	0	0	0	0	2,000	2,000	3,000	3,000	3,000	3,000	16,000
		Contingency (20%)		0	0	0	0	0	1,000	1,000	2,000	2,000	2,000	2,000	10,000
		Subtotal		0	0	0	0	0	6,000	6,000	10,000	10,000	10,000	10,000	52,000
	5. Dust Control	High Pressure Sprayers	1,900 /unit	0	0	0	0	0	0	2,000	0	0	2,000	2,000	6,000
		Water Trucks	16,000 /vehicle	0	0	0	0	0	16,000	16,000	0	0	0	0	32,000
		Contingency (20%)		0	0	0	0	0	3,000	4,000	0	0	0	0	7,000
		Subtotal		0	0	0	0	0	19,000	22,000	0	0	2,000	2,000	45,000
	6. Dyke	Dyke	2 m3	0	0	0	0	0	0	0	0	0	0	0	0
		Contingency (20%)		0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal		0	0	0	0	0	0	0	0	0	0	0	0
	Total			0	0	0	26,000	26,000	65,000	86,000	56,000	38,000	40,000	40,000	377,000
O&M	O&M	Vegetation	10/ha	0	0	0	0	0	0	1,000	1,000	1,000	1,000	1,000	5,000
		Drainage Sys	100/ha	0	0	0	0	0	6,000	8,000	9,000	12,000	15,000	18,000	68,000
		Dust Control	2,000/ha	0	0	0	0	0	4,000	6,000	10,000	10,000	10,000	14,000	54,000
		Contingency (20%)		0	0	0	0	0	2,000	3,000	4,000	5,000	5,000	7,000	26,000
		Subtotal		0	0	0	0	0	12,000	18,000	24,000	28,000	31,000	40,000	153,000
	Total			0	0	0	0	0	12,000	18,000	24,000	28,000	31,000	40,000	153,000
Total				0	0	0	26,000	26,000	77,000	104,000	80,000	66,000	71,000	80,000	530,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.16 Estimated Costs & Schedule (Cam Pha West Basin Rehabilitation Project)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	0	0	0	0	0	0	42	42	0	0	84
		Project Design	person/month	0	0	0	0	0	0	0	36	36	0	0	72
	2. Ground Preparation	Terracing	m	0	0	0	0	0	0	0	0	0	0	0	0
		Grading, Surface Roughing	ha	0	0	0	0	0	0	0	0	15	15	15	45
		Bed Preparation	ha	0	0	0	0	0	0	0	0	15	15	15	45
	3. Drainage Improv.	Diversion/Waterway	m	0	0	0	0	0	0	0	0	1,500	1,500	1,500	4,500
		Downdrain	m	0	0	0	0	0	0	0	0	150	150	300	600
		Dam & Pond (temporary)	m3	0	0	0	0	0	0	0	0	0	50	50	100
		Dam & Pond (permanent)	m3	0	0	0	0	0	0	0	0	0	150	0	150
	4. Revegetation	Seedlings (Trees)	each	0	0	0	0	0	0	0	0	25,000	50,000	50,000	125,000
		Revegetation with Grass	ha	0	0	0	0	0	0	0	0	15	15	15	45
		Tree Planting	ha	0	0	0	0	0	0	0	0	10	20	20	50
	5. Dust Control	High Pressure Sprayers	each	0	0	0	0	0	0	0	0	0	0	0	0
		Water Trucks	vehicle	0	0	0	0	0	0	0	0	0	0	0	0
	6. Dyke	Dyke	m3	0	0	0	0	0	0	0	0	0	0	0	0
O&M	O&M	Vegetation	ha	0	0	0	0	0	0	0	0	85	95	115	295
		Drainage Sys	ha	0	0	0	0	0	0	0	0	85	95	115	295
		Dust Control	ha	0	0	0	0	0	0	0	0	0	0	0	0

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers /mo	0	0	0	0	0	0	0	4,000	4,000	0	0	8,000
		Project Design	100/pers /mo	0	0	0	0	0	0	0	4,000	4,000	0	0	8,000
		Contingency (20%)		0	0	0	0	0	0	0	2,000	2,000	0	0	4,000
		Subtotal		0	0	0	0	0	0	0	10,000	10,000	0	0	20,000
	2. Ground Preparation	Terracing	400 /m	0	0	0	0	0	0	0	0	0	0	0	0
		Contour Dike	250/ha	0	0	0	0	0	0	0	0	4,000	4,000	4,000	12,000
		Bed Preparation	200/ha	0	0	0	0	0	0	0	0	3,000	3,000	3,000	9,000
		Contingency (20%)		0	0	0	0	0	0	0	0	1,000	1,000	1,000	3,000
		Subtotal		0	0	0	0	0	0	0	0	8,000	8,000	8,000	24,000
	3. Drainage Improv.	Diversion/Waterway	2 /m	0	0	0	0	0	0	0	0	3,000	3,000	3,000	9,000
		Downdrain	10 /m	0	0	0	0	0	0	0	0	2,000	2,000	3,000	7,000
		Dam & Pond (temporary)	3 /m3	0	0	0	0	0	0	0	0	0	0	0	0
		Dam & Pond (permanent)	100 /m3	0	0	0	0	0	0	0	0	0	15,000	0	15,000
		Contingency (20%)		0	0	0	0	0	0	0	0	1,000	4,000	1,000	6,000
		Subtotal		0	0	0	0	0	0	0	0	6,000	24,000	7,000	37,000
	4. Revegetation	Seedlings (Trees)	08 each	0	0	0	0	0	0	0	0	2,000	4,000	4,000	10,000
		Revegetation with Grass	80/ha	0	0	0	0	0	0	0	0	1,000	1,000	1,000	3,000
		Tree Planting	155/ha	0	0	0	0	0	0	0	0	2,000	3,000	3,000	8,000
		Contingency (20%)		0	0	0	0	0	0	0	0	1,000	2,000	2,000	5,000
		Subtotal		0	0	0	0	0	0	0	0	6,000	10,000	10,000	26,000
	5. Dust Control	High Pressure Sprayers	1,900 /unit	0	0	0	0	0	0	0	0	0	0	0	0
		Water Trucks	16,000 /vehicle	0	0	0	0	0	0	0	0	0	0	0	0
		Contingency (20%)		0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal		0	0	0	0	0	0	0	0	0	0	0	0
	6. Dyke	Dyke	2 /m3	0	0	0	0	0	0	0	0	0	0	0	0
		Contingency (20%)		0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal		0	0	0	0	0	0	0	0	0	0	0	0
	Total			0	0	0	0	0	0	0	10,000	30,000	42,000	25,000	107,000
O&M	O&M	Vegetation	10/ha	0	0	0	0	0	0	0	0	1,000	1,000	1,000	3,000
		Drainage Sys	100/ha	0	0	0	0	0	0	0	0	8,000	10,000	11,000	29,000
		Dust Control	2,000/ha	0	0	0	0	0	0	0	0	0	0	0	0
		Contingency (20%)		0	0	0	0	0	0	0	0	2,000	2,000	2,000	6,000
		Subtotal		0	0	0	0	0	0	0	0	11,000	13,000	14,000	38,000
	Total			0	0	0	0	0	0	0	0	11,000	13,000	14,000	38,000
Grand Total				0	0	0	0	0	0	0	10,000	41,000	55,000	39,000	145,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.17 Estimated Costs & Schedule (Cua Ong Basin Rehabilitation Project)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	0	0	0	132	132	132	132	0	0	0	0	528
		Project Design	person/month	0	0	0	99	99	99	99	0	0	0	0	396
	2. Ground Preparation	Terracing	m	0	0	0	0	0	0	0	0	0	0	0	0
		Grading, Surface Roughing	ha	0	0	0	0	0	10	20	20	20	20	20	110
		Bed Preparation	ha	0	0	0	0	0	10	20	20	20	20	20	110
	3. Drainage Improv.	Diversion/Waterway	m	0	0	0	0	0	1,000	2,000	2,000	2,000	2,000	2,000	11,000
		Downdrain	m	0	0	0	0	0	100	200	200	200	200	200	1,100
		Dam & Pond (temporary)	m3	0	0	0	0	0	50	100	100	100	100	100	550
		Dam & Pond (permanent)	m3	0	0	0	0	0	0	0	150	0	150	0	300
	4. Revegetation	Seedlings (Trees)	each	0	0	0	0	0	25,000	50,000	50,000	50,000	50,000	50,000	275,000
		Revegetation with Grass	ha	0	0	0	0	0	10	20	20	20	20	20	110
		Tree Planting	ha	0	0	0	0	0	10	20	20	20	20	20	110
	5. Dust Control	High Pressure Sprayers	each	0	0	0	0	0	1	0	1	0	1	0	3
		Water Trucks	vehicle	0	0	0	0	0	1	0	0	1	0	0	2
	6. Dyke	Dyke	m3	0	0	0	0	0	100	100	200	200	200	200	1,000
O&M	O&M	Vegetation	ha	0	0	0	0	0	50	60	80	100	120	140	550
		Drainage Sys	ha	0	0	0	0	0	50	60	80	100	120	140	550
		Dust Control	ha	0	0	0	0	0	2	4	4	5	6	7	28

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo.	0	0	0	13,000	13,000	13,000	13,000	0	0	0	0	52,000
		Project Design	100/pers./mo.	0	0	0	10,000	10,000	10,000	10,000	0	0	0	0	40,000
		Contingency (20%)		0	0	0	5,000	5,000	5,000	5,000	0	0	0	0	20,000
		Subtotal		0	0	0	28,000	28,000	28,000	28,000	0	0	0	0	112,000
	2. Ground Preparation	Terracing	400 /m	0	0	0	0	0	0	0	0	0	0	0	0
		Contour Dike	250/ha	0	0	0	0	0	3,000	5,000	5,000	5,000	5,000	5,000	28,000
		Bed Preparation	200/ha	0	0	0	0	0	2,000	4,000	4,000	4,000	4,000	4,000	22,000
		Contingency (20%)		0	0	0	0	0	1,000	2,000	2,000	2,000	2,000	2,000	11,000
		Subtotal		0	0	0	0	0	6,000	11,000	11,000	11,000	11,000	11,000	61,000
	3. Drainage Improv.	Diversion/Waterway	2 /m	0	0	0	0	0	2,000	4,000	4,000	4,000	4,000	4,000	22,000
		Downdrain	10 /m	0	0	0	0	0	1,000	2,000	2,000	2,000	2,000	2,000	11,000
		Dam & Pond (temporary)	5 m3	0	0	0	0	0	0	0	0	0	0	0	0
		Dam & Pond (permanent)	100 m3	0	0	0	0	0	0	0	15,000	0	15,000	0	30,000
		Contingency (20%)		0	0	0	0	0	1,000	1,000	4,000	1,000	4,000	1,000	12,000
		Subtotal		0	0	0	0	0	4,000	7,000	25,000	7,000	25,000	7,000	75,000
	4. Revegetation	Seedlings (Trees)	0.8 each	0	0	0	0	0	2,000	4,000	4,000	4,000	4,000	4,000	22,000
		Revegetation with Grass	80/ha	0	0	0	0	0	1,000	2,000	2,000	2,000	2,000	2,000	11,000
		Tree Planting	155/ha	0	0	0	0	0	2,000	3,000	3,000	3,000	3,000	3,000	17,000
		Contingency (20%)		0	0	0	0	0	1,000	2,000	2,000	2,000	2,000	2,000	11,000
		Subtotal		0	0	0	0	0	6,000	11,000	11,000	11,000	11,000	11,000	61,000
	5. Dust Control	High Pressure Sprayers	1,000 /unit	0	0	0	0	0	2,000	0	2,000	0	2,000	0	6,000
		Water Trucks	16,000 /vehicle	0	0	0	0	0	16,000	0	0	16,000	0	0	32,000
		Contingency (20%)		0	0	0	0	0	4,000	0	0	3,000	0	0	7,000
		Subtotal		0	0	0	0	0	22,000	0	2,000	19,000	2,000	0	45,000
	6. Dyke	Dyke	2 m3	0	0	0	0	0	0	0	0	0	0	0	0
		Contingency (20%)		0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal		0	0	0	0	0	0	0	0	0	0	0	0
	Total			0	0	0	28,000	28,000	99,000	57,000	49,000	48,000	49,000	29,000	354,000
O&M	O&M	Vegetation	10/ha	0	0	0	0	0	1,000	1,000	1,000	1,000	1,000	1,000	6,000
		Drainage Sys	100/ha	0	0	0	0	0	5,000	6,000	8,000	10,000	12,000	14,000	55,000
		Dust Control	2,000/ha	0	0	0	0	0	4,000	8,000	8,000	10,000	12,000	14,000	56,000
		Contingency (20%)		0	0	0	0	0	2,000	3,000	3,000	4,000	5,000	6,000	23,000
		Subtotal		0	0	0	0	0	12,000	18,000	20,000	25,000	30,000	35,000	140,000
	Total			0	0	0	0	0	12,000	18,000	20,000	25,000	30,000	35,000	140,000
Grand Total				0	0	0	28,000	28,000	78,000	75,000	69,000	73,000	79,000	64,000	494,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.3.18 Estimated Costs & Schedule (Dredging)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	person/month	480	480	480	480	480	480	480	480	480	480	480	5,280
		Project Design	person/month	480	480	480	480	480	480	480	480	480	480	480	5,280
	2. Dredging	Dredging	m3	500,000	500,000	500,000	500,000	500,000	500,000	400,000	400,000	400,000	400,000	400,000	5,000,000

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Preliminary Investigation	100/pers./mo.	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	528,000
		Project Design	100/pers./mo.	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	528,000
		Contingency (20%)		19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	209,000
		Subtotal		115,000	115,000	115,000	115,000	115,000	115,000	115,000	115,000	115,000	115,000	115,000	1,265,000
	2. Dreding	Dredging	2 /m3	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	800,000	800,000	800,000	800,000	800,000	10,000,000
		Contingency (20%)		200,000	200,000	200,000	200,000	200,000	200,000	160,000	160,000	160,000	160,000	160,000	2,000,000
		Subtotal		1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	960,000	960,000	960,000	960,000	960,000	12,000,000
Grand Total				1,315,000	1,315,000	1,315,000	1,315,000	1,315,000	1,315,000	1,075,000	1,075,000	1,075,000	1,075,000	1,075,000	13,265,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.