C

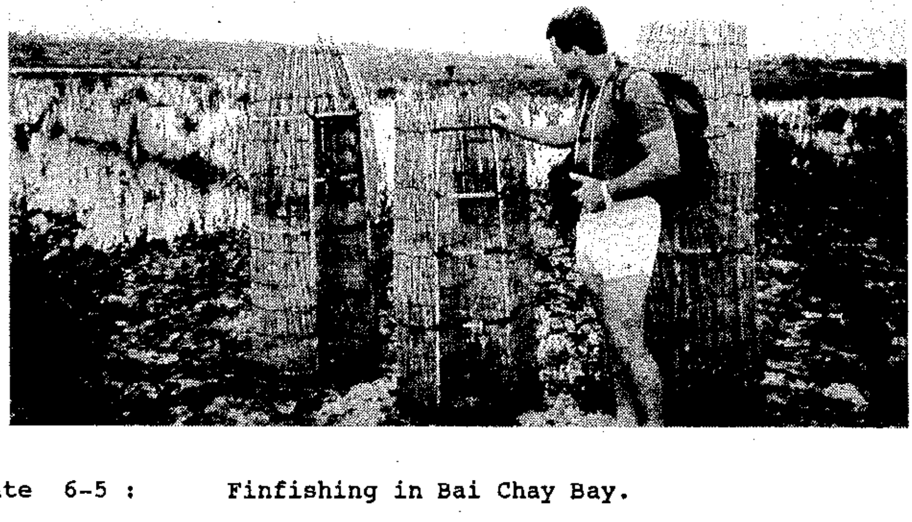


Plate 6-5 : Finfishing in Bai Chay Bay.

(A) Net casting in mangrove water-way.
(B) Small edible finfish drying.
(C) Portable fish traps awaiting placement in mangrove for a high tide harvest of finfish.

Wild terrestrial vertebrates such as lizards, snakes and bats are listed as part of the remaining vertebrate fauna associated with Bai Chay Bay (Anh, 1992).

6.6.7 Mangrove Food Chains and Trophic Dynamics

The complex nature of mangrove ecosystems is evident from the accounts given in sections 6.5 and 6.6 above. Some idea of the rather subtle networks which make up the food chains and food webs of mangrove ecosystems was given in section 6.6.1. The ecological importance of mangroves and their economic values go well beyond the obvious boundaries of these trees of the intertidal estuaries.

Even some pelagic finfish species depend on the mangrove-driven system for the resources needed to complete their life cycles. For example, many large fish species utilise the mangrove estuaries as nurseries as juveniles. In addition, they visit this environment at high tide on feeding excursions into the mangrove waterways.

Not all of the life forms which make up the complex food webs of mangrove systems have the same degree of tolerance to environmental changes. This fact is especially important in the context of Oil and Chemical Spill Management. This is a very important topic and is addressed more fully in section 6.6.8 below.

6.6.8 Mangrove Ecosystems and Environmental Vulnerability

Shallow habitats, unlike exposed high energy coastal areas, have a higher vulnerability index in relation to oil and chemical mishaps. The quiet (low energy) waterways of mangrove deltas are highly vulnerable to oil impact especially if the spills are taken into the estuarine waterways by tidal currents. In a Malaysian study of environmental vulnerability of coastal habitats in relation to oil spills, mangrove swamps had a high vulnerability index (V.I.) of 10. In contrast, open coasts with strong wave action had a V.I. of 1. Coral reefs in moderately deep water (720 feet) with a salinity of 34 ppt had a V.I. of 4-5. Mud flats, typically exposed at low tide and composed of a sandy-mud substratum are biologically rich and exposed to a variable salinity, often 20 to 30 ppt. Such habitats have a V.I. of 8-9 (Chua, 1984).

Oil spills are unlikely to occur at Cai Lan Port, which will not be shipping oil or fuel. Potential sources of oil would be limited to the ships' fuel tanks. However, it is important to emphasise that oil products in crude or fuel oil form contain a whole range of hydrocarbon compounds. Many of these can be toxic and / or lethal in the mangrove zone and in tidal estuaries. A discussion of oil spill contingency requirements is given in Chapter 8. It must be noted that the existence of the B-12 Oil Port at the entrance to Bai Chay Bay is of considerable concern from an environmental standpoint. The large quantities of oil carried by these tankers pose a much greater risk to Bai Chay Bay than the quantities of fuel likely to be carried by ships calling at Cai Lan. The high vulnerability index of mangrove areas is an extremely important environmental consideration in the context of the Cai Lan Port Project, Port and Shipping Operations in the adjoining bays and coastal areas.

6.7 Economic Considerations

6.7.1 Introduction

The remaining sections of this chapter seek to show that although the absolute biological, ecological and economic values of Bai Chay Bay are difficult to define, it is possible to assign a tentative dollar value to some components and products of the mangrove ecosystem. This is rarely attempted but has been done before, for example, in the context of Bruneian finfish values (Maxwell 1991) and with the molluscs of Ha Nam Ninh Province (Duc 1993).

Mangroves have long provided economically important products. Some of these traditional uses still apply today. They include fuel exploitation (firewood), wood and charcoal production, bark extraction and tannin products, nipa palm (*Nypa fruticans*) products such as roofing materials, rice rapping, fishing floats, plant protein and alcohol manufacture, cattle fodder, fertiliser, art and craft manufacture. Specialist products include latex, fish poisons, cork and medicines such as *Acanthus ilicifolius* leaf extracts (used as a rheumatic reducing agent) and the pounded rhizome of the mangrove fern *Acrostichum aureum* (used as an antiseptic applied to wounds and boils (Hong and San 1993)).

Not all of these products are relevant to Bai Chay Bay, however, firewood exploitation is an on-going activity studied in some detail during the field surveys. The surveys form the basis of the first of two case studies presented below. The second is regarding mangrove-dwelling shellfish.

6.7.2 Case Study 1. The economic value of *Avicennia marina* firewood in a hamlet near Le Loi Bai Chay Bay.

6.7.2.1 Basic Premises

The firewood.

Avicennia marina is a small, hardy, bonsai-like shrubby tree with yellow-white bark, olive to radiant green small leaves and small buoyant edible fruit. The sweet and sour leaves are popular and nutritious as cattle fodder. The mineral and polyphenolic content of the wood renders it mildly explosive when dry. It is an excellent and "hot" firewood, ideal for cooking.

Estimated gathering rate.

The estimated gathering rate from field observations, measurements and calculations (see Plate 6-2 A) was 50 kg per morning and afternoon session (Plate 6.2 A & B). Typically the people worked for two sessions per day. Some sessions involved walks of 3 - 6 km across sand and mud flats (Plate 6-4 B).

Charcoal equivalents.

Wood charcoal is a popular and affordable cooking fuel. Charcoal costs and quality vary. Poor quality charcoal sells for between 5,000 and 7,000 dong in the market. Local people use around 2 kg per day for cooking. Assuming 1 kg of poor quality charcoal was used in one cooking session and that two cookings took place per day we have:

(i)	cost of charcoal	= 6,000 dong /kg
(ii)	two cookings per day	= 2 kg per day
		= 14 kg per week
		= (14 x 4) 56 kg per month

The cost of cooking per month

= 6,000 dong

x 56 kg = 336,000 dong

At a conversion factor of dong to $US of 10,936, the value of firewood used by an average family per month is $US30.72.

Firewood vs. charcoal.

Assuming the gathering rate described above and that fuel is five times less efficient than charcoal, we have:

(i) 100 kg wood gathered per day

(ii) 100 kg wood / 5 = 20 charcoal kg equivalents
= 20 kg x 6,000 dong
= 120,000 dong / 10,936
= $US10.90.

So 100 kg of *Avicennia marina* firewood is estimated to be worth $US10.90.

Cooking with *Avicennia marina* firewood.

Having established that 5 kg of wood would equate with 1 kg of poor quality firewood we can calculate, as follows:

At 5 kg /cooking session and 2 cookings sessions per day:
= 10 kg used per day
= 300 kg per month.

This 30 kg wood is approximately equivalent to 56 kg of poor charcoal valued at $US30.71 as above, or $US368 per annum.

6.7.2.2 Extrapolation of the Above

The local people do not gather mangrove firewood consistently. However, the exploitation is frequent, with perhaps more activity in the winter months. Assuming a gathering season of around 5 months per year as a conservative estimate, we have:

300 kg wood per month x 5 months = 1500 kg per person .

Assuming that a village of 20 households with the average of 4 people per household (refer Chapter 3) consuming fuel at the rates described above we have:

10 kg x 20 households x 365 = 73,00 kg of wood burnt
per village per annum.

At $US10.90 per kg, this has a value of approximately $US730.

There are 2,000 ha of mangroves in the Hoanh Binh District of Quang Ninh Province. Although the exact proportion of *Avicennia marina* is not known in relation to other species, it is reasonable to assume on the basis of the field surveys and literature such as Hong and San 1993 that the species occupies some 20 - 25 % of the total mangrove area, or some 400 ha. If this

400 ha were to supply just two villages of 20 households (a conservative estimate) with their annual cookery needs this gives a dollar value of at least $US1,460.

6.7.2.3 Conclusions

This case study highlights the dollar value of one mangrove species simply in terms of its use as firewood. The known economic uses of mangrove are many and varied as already described. However, it is emphasised that the use of *Avicennia marina* or any other species as firewood may not be the most economically or scientifically sound use of the resource. Nevertheless, this study does show that mangroves are very important in the lives of people living around Bai Chay Bay. The case study described below, however, shows that the mangrove-dependent biota, including finfish, crustaceae and molluscs carry a far superior dollar value than firewood.

6.7.3 Case Study 2: The estimated economic values of the two molluscan resources in two areas of Ha Nam Ninh Province, Vietnam (after Duc 1993).

The shellfish (molluscs) for which economic values were estimated were *Meretrix meretrix* and *Mactra quadrangularis*. These occur on tidal mudflats of Kim Son and Xuan Thuy Districts in Ha Nam Ninh Province.

The methods of estimation and the parameters used are shown in Table 6-9. The estimated dollar values are shown in Table 6-10.

Table 6-9: Harvest of the two molluscs *Meretrix* and *Mactra* in the Xuan Thay and Kim Son areas of Ha Nam, Nam Ninh Province (after Duc 1993).

Species (district)	Number of People Involved in Harvest	Tonnes Harvested
Meretrix		
(a. Xuan Thay	100	60
b. Kim Son)	50	30
Mactra		
(a. Xuan Thay	200	1,200
b. Kim Son)	100	360

Note: Harvest was calculated at the rate of 10 harvest days per month over 6 months.

6.7.4 Deductions from the Data

The economic worth of mangrove-generated products is clearly considerable. Economic analyses involve many factors, projections and calculations and are complex to perform. Many more case studies invite attention, however, they are beyond the scope of this assessment. The two case studies given here nevertheless underline the combined ecological and economic value of the mangrove ecosystems in Bai Chay Bay and environs. The economic importance and need for sustainable management practices in these coastal environments is paramount. The fact that 10,000 people are directly involved in finfishing alone in Quang Ninh Province (refer section 3.2.2) emphasises this point.

Table 6-10: Estimated economic value of the *Meretrix* and *Mactra* resources in Xuan Thay and Kim Son areas of Ha Nam Ninh Province (after Duc 1993).

Points of Comparison	Meretrix		Mactra	
	Xuan Thay	Kim Son	Xuan Thay	Kim Son
Area involved (ha)	1,000	800	1,400	1,200
Shellfish density (no./m2)	0.1	0.1	40	3
Biomass (g)	140	140	20	20
Meat/mollusc ratio	1:10	1:10	1:4	1:4
Total yield of area (tonnes)	140	112	12,200	720
Yield taken (tonnes)	70	56	5,600	360
Market price (dong / kg)	400	400	60	50
Economic value (million dong)	28	22.4	336	21.6
Export value ($US)				
a. meat	18,900	15,120	7,500,000	243,000
b. shell	14,175	11,340	1,890,000	60,750
c. total	33,075	26,460	9,450,000	303,750

CHAPTER 7 EFFECTS OF CAI LAN PORT DEVELOPMENT ON THE PHYSICAL AND BIOLOGICAL CHARACTERISTICS OF BAI CHAY BAY

7.1 Introduction

In Chapter 5 the physical and biological characteristics of the Cai Lan Port area and Bai Chay Bay were described, and in Chapter 6 the ecological status and economic values of the Bai Chay Bay Mangrove Ecosystem were discussed. The effects of the Cai Lan Port construction on these components of the environment are described below. Construction of the port will have direct effects on the physical and biological environment of the port site itself, including the destruction of some small areas of mangrove in the immediate vicinity of the port. Other possible effects on mangroves elsewhere in the bay could occur if the development were to alter the water quality and sediment loadings in the bay, either during construction or operation.

Mitigation of the impacts will be required to ensure that the environment is not affected by the port construction project. Mitigation and management are the subject of Chapter 8.

Section 7.2 describes the direct effects of the port construction on the biological environment in the immediate vicinity of Cai Lan This includes both terrestrial and mangrove ecosystems. In section 7.3 the broader potential effects of the port development on the water quality of Bai Chay Bay and on the mangrove ecosystem are explored. The current status of the mangrove ecosystem and the sources of sediments and other contaminants which could potentially affect it are described. Section 7.4 summarizes this chapter.

7.2 Direct Effects of Port Construction

7.2.1 Effects on the Terrestrial Environment in the Immediate Vicinity of Cai Lan

The vegetation of the Cai Lan Port area is not of high ecological value. The entire area has been modified by clearing, burning or quarrying. The effects of port construction on the area will be minor. The habitats of fauna such as invertebrates, birds, rodents and reptiles which may live in the area will be destroyed. However, similar habitats are common in the vicinity of the port. Scrub, forest and plantation areas in the nearby hills of Bai Chay Peninsular are present for soil conservation purposes and are likely to provide good habitat if left to develop. No effects on biodiversity in the area are expected to occur as a result of port construction.

7.2.2 Effects of Construction on the Mangroves of Cai Lan Port

Reclamation will cover the band of mangroves along the shoreline east of the existing berth. Berth construction will occur across part of the mouth of the small Cai Lan Estuary. The estuary will remain open to the sea but only along the upper reaches of the shoreline. Tidal flushing is likely to be impeded by the berth construction. One way to avoid this would be to relocate the inner portion of berth 7, which is the main constraint on tidal flushing in this area (refer Fig 2-1). Unless this part of the berth is removed it is likely the estuarine area behind berths 6 and 7 will gradually silt up and the mangroves in this area will be affected in the long term.

Section 6.5.7 presented a classification of the mangrove area of Bai Chay Bay based on ecological and economic values. The areas immediately adjacent to Cai Lan Port which would be destroyed by port construction are rated "low". The mangroves in this area are sparse and stunted and the fauna in this area has been depleted. They have a lower economic worth than the larger expanses of mangrove around the northern shoreline. Thus reclamation of the Cai Lan Mangroves will destroy only a small part of the total mangrove resource around Bai Chay Bay and is not likely to have a significant effect on the ecosystem within the bay as a whole.

The loss of this area of mangroves should be mitigated by improvements or protection of mangroves elsewhere. However, it is not recommended that a separate mitigation plan be drawn up for works to 2000. The total area of mangrove to be lost during the development of the port and the industrial areas to 2010 will be larger. A mitigation plan to cover the whole development to 2010 should be drawn up. This should incorporate mitigation of the small area to be lost in the stage to 2000. These proposals are discussed in more detail in Chapter 8.

7.2.3 Effects of Dredging on Marine In-Fauna

Dredging will remove any fauna in the sediments along the channels. No information is available as to the in-fauna likely to be present. Considering the size of Bai Chay Bay relative to the area to be dredged, this is not expected to have a significant impact on the biodiversity of the marine fauna.

7.3 Potential Effects on Water Quality and the Mangroves of Bai Chay Bay

7.3.1 Summary of Existing Status

The mangroves of Bai Chay Bay have been modified by aquaculture, firewood gathering, grazing, reclamation and dyke construction. No area of fully natural mangrove forest was observed during the field surveys associated with this EIA.

Estuarine environments by their very nature accumulate sediments and it is these soft sediments that are colonised by mangroves. Sediments are brought into Bai Chay Bay by the rivers which drain into this area. Sediment loadings in the Duong Huy River (a tributary of the Dien Vong River) and other rivers in Quang Ninh Province were described in section 5.3.6. The agricultural and other land use practices upstream have contributed to a sediment load which varies seasonally but ranges from around 7 g m^{-3} to 50 g m^{-3} in the Duong Huy River and as high as 145 g m^{-3} in the Bang Ca River. Suspended solids at sites in Bai Chay Bay were around 40 g m^{-3} near the Bay's Northern Shoreline during the water quality surveys (February and June 1994), as reported in section 5.6.2.2. The suspended solids concentrations were higher in summer, as the rainfall was much higher and greater entrainment of sediments within the catchment is likely to have occurred.

The mangrove ecosystem around the northern shoreline is considered to be healthy and is well able to cope with the levels of sediment that enter in the river waters. The additional contributions to suspended solids loads in the Bai Chay Bay waters are not expect to adversely affect water quality for the reasons outlined below.

7.3.2 Possible Sources of Sediment

Sources of sediment which could arise during port construction include sediments from dredging and reclamation activities, and sediment and other substances entrained by stormwater runoff as described below.

7.3.2.1 Dredging

Dredging will disturb the bottom sediments in the port approach channels and in the berthing and turning areas. Sediment may be entrained during this process. However, once the soft sediments which form the upper layer of the sea floor substrate have been removed, dredging of the harder clayey sediments of the deeper layers is likely to result in less sediment entrainment. The sea is calm in Bai Chay Bay for around 84 % of the time (refer section 5.3.4). Currents moving into the bay move relatively slowly on the flood tide (0.52 m s^{-1} measured at site V1 - refer section 5.3.3), and generally travel in a westerly direction. Sediments entrained during dredging at the Cai Lan Port site would need to be carried considerable distances to the west across Bai Chay Bay to the mangrove areas. The larger sediment particles are likely to settle before they reach these areas. The deposition that does occur would be of relatively short duration (the period of channel and berth construction), and dredging would then be limited to periodic channel maintenance works. Any additional deposition that may occur as a result of dredging is likely to be insignificant, both in terms of the ability of the mangroves and associated fauna to deal with any increase, and in comparison to the concentrations of suspended solids currently being brought into the Bay via the rivers. This is not expected to have a significant adverse effect on the mangrove ecosystem.

7.3.2.2 Reclamation

During reclamation the dumping of rock and fill material along the berth line will disturb the sediments. Likewise, once the reclamation wall is in place, dredged materials are likely to be pumped into the reclamation area, displacing turbid water which will drain back into the sea. The methods commonly used internationally to prevent such sediment entering the marine area surrounding the port will need to be used at Cai Lan. This will include the use of sediment curtains along the berth line and around the overflow drains from the reclamation. These will be described in more detail in Chapter 8. Provided such protective measures are stringently applied, there is not expected to be an adverse effect on water quality during the reclamation activities. It is in the interests of the port development to ensure that increases in sediment into Bai Chay Bay do not occur, this could result in a more extensive and more expensive dredging programme.

During the construction period, runoff generated on the yard areas behind the reclamation area will need to be directed into the reclamation so that sediments which may be entrained on land can also be caught by the silt curtains.

7.3.2.3 Stormwater Runoff

Sediment and other materials in the port yards could enter Bai Chay Bay in stormwater runoff. It will be necessary to install drains or bunds to ensure that dirty water cannot enter the sea. This would apply particularly to any areas which store bulk goods or in which vehicle oil and grease or fuel could be entrained by stormwater. Provided this is done and that waters containing sediments and other contaminants are appropriately treated before entering the sea, adverse effects on water quality can be minimised such that no significant effect is caused on the marine ecosystem. The measures recommended are discussed further in Chapter 8.

The yards to be constructed will be approximately 412,000 m^2 in area. Given a rainfall of approximately 1,419 - 2,892 mm (refer section 5.2.3.1) this will give a total site runoff (stormwater) of between 585,000 cubic metres and 1,191,000 cubic metres per year. Most of this would occur over the summer months. The distribution of site water runoff over the course of the year is shown in Table 7-1.

Table 7-1: Average site runoff over a twelve month period (x 1000 m^3).

Month	Jan	Feb	Mar	Apr	May	Jun
Runoff	9.3	10.5	9.8	46.4	109.9	111.2
Month	Jul	Aug	Sep	Oct	Nov	Dec
Runoff	142.6	190.1	108.2	60.0	20.1	5.8

Source: Rainfall data, Table A2-2.

Taking into account the number of rainy days (Table 5-3), the average maximum site runoff generated in one day would be around 9,000 m^3 (in August, the rainiest month). This will need to be taken into account when designing stormwater treatment facilities. Site runoff management will be discussed further in Chapter 8.

An important point in relation to site runoff is the potential for storm surges in this part of Vietnam. The maximum height predicted for this area is 2.5 m (section 5.3.6). A maximum tidal elevation of +3.71 m was recorded at Cai Lan (section 5.3.4). On top of a high tide, a maximum surge level could thus reach +6.21 m (similar to that reported by local residents in 1985). The crown height of the berth is set at +5.0 m (refer Chapter 13 of the Feasibility Study). A maximum storm surge could overtop the berth by around 1.2 m. Given the frequency of storm surges in the area (6 % of those recorded have been between 1.5 and 2 m surges), it is important to ensure that a surge could not carry goods from the port area into Bai Chay Bay. Bulk goods storage yards should be elevated at least 1.2 m above the crown height of the berths or should be bunded to that level with a bund gate which can be closed in the event of storm surge. Similarly, all stormwater treatment areas will need to be elevated to a level which will ensure they are beyond the reaches of storm surges.

7.3.3 Other Sources of Contamination

7.3.3.1 Oil and Grease

Chemical analyses of water collected in Cua Luc Strait and offshore of Bai Chay and Hon Gai indicate higher levels of oil than elsewhere. At Cua Luc the concentration of oil, in particular, is above the Vietnamese Provisional Criterion (refer Chapter 5).

Stormwater treatment systems will need to include methods for collecting and disposing of oils that could accumulate on the port yard surfaces. In the case of Cai Lan Port this is most likely to be derived from vehicles dripping oil, or from refuelling and maintenance areas. Cai Lan Port is not expected to be used for fuel or oil shipping. However, ships carry oil and oil products as fuel. In case of accidents such as fire or collisions, it is possible that such products could enter the sea. If a large quantity of oil were to enter Bai Chay Bay and reach the mangrove areas this could result in a loss of biological resources. The effects of this could be serious for local inhabitants who use these resources for food and firewood. It could also affect fish breeding patterns with possible decreases in fish stocks offshore in later years. An oil spill contingency plan will need to developed and equipment purchased to ensure that in the event of a spill it can be contained before harm is done to the Bai Chay Bay ecosystem. This is discussed further in Chapter 8.

7.3.3.2 Sewage

Sewage and other untreated waste waters should not be allowed to enter Bai Chay Bay. To maintain the health of this environment as an aquaculture and potential contact recreation area, a sewage treatment plant or plants will need to be installed. The Vietnamese Provisional Criteria set standards for faecal coliforms in Class I and Class II waters, Class I waters being those for water supply, tourism and fishing. The waters of Bai Chay Bay would be considered Class I waters. Criterion 6 sets limits for faecal coliform of 5000 cells /100ml and for BOD 80 mg l^{-1}. It may be necessary to refine the requirements for water quality standards in Bai Chay Bay which is an enclosed water body whose water exchange dynamics are not as yet fully understood. The sensitivity of the environment and the importance of maintaining the mangrove resource suggest that more conservative criteria may be required. Once defined, these limits should be used as design criteria for a treatment plant to cater for the sewage from the port facilities. The design should be sufficient to cover the expected growth in the size of the port to 2010, or should be easily able to be expanded as the volume of sewage increases.

7.3.3.3 Contaminants from Ships

Contaminants from ships could include sewage as noted above and oil contaminated waters from bilges, etc. Discharge of ballast water taken on in waters elsewhere in the world have the potential to carry new marine organisms into the Ha Long Bay while ships from other areas already enter Ha Long Bay, the increased shipping traffic is likely to increase the risk of new organisms being introduced. Vietnam is a signatory to conventions which prohibit the discharge of sewage and other waste waters in coastal water (Table 7-2). These conventions will need to be rigorously enforced. This subject is considered further in Chapter 8.

7.4 Potential Effects of Dredging and Disposal in Ha Long Bay

A large volume of sediment will be dredged in the Cua Luc - Hon Mot Channel in preparation for the arrival of large vessels. There have been no plans as to disposal sites for dredged sediments. The large quantities involved (6 million tonnes during channel excavation and 0.5 million tonnes per year for maintenance) could affect the marine environment of Ha Long Bay. Site location and disposal methods may become an important issue in the future. It will be essential to ensure that disposal sites are located such that the marine environment is not adversely impacted. The image of Ha Long Bay as a tourist destination for diving and other water-related activities is of great importance in this respect.

Table 7-2: International conventions to which Vietnam is a signatory.

The list of global conventions for the protection of the marine environment established since 1972 is as follows:
• Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Dumping Convention).
• International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).
• Protocol relating to intervention on the high seas in cases of pollution by substances other than oil, 1973.
• Protocol of 1976 to the International Convention on Civil Liability for Oil Pollution Damage, 1969.
• Protocol of 1976 to the International Convention on Establishment of an International *Standard** for Compensation for Oil Pollution Damage 1971.
• Convention on Long-Range Transboundary Air Pollution, 1979.
• United Nations Convention on the Law of the Sea, 1982.
• Protocol of 1984 to amend the International Convention on Civil Liability for Oil Pollution Damage, 1969.
• Protocol of 1984 to amend the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971.
• Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989.

Source: Institute of Ecological Economy.

Note: * = word missing in original.

7.5 Summary of Effects on the Physical and Biological Environment

Terrestrial vegetation and fauna of Cai Lan Port:

- The ecological value of the area is low and no rare species are present.
- Excavation and road development will remove small areas of habitat.`
- Similar habitats are present in the vicinity of the port.
- No effect on biodiversity or ecology of the area is expected.

Coastal vegetation and fauna of Cai Lan Port:

- Small areas of mangrove to the east of the existing berth will be covered during reclamation.
- The mangroves in this vicinity are considered to be of low ecological and economic value and the overall effect of removing these small areas is negligible in relation to the Bai Chay Bay mangrove ecosystem.

Topography and hydrology:

- The coastal faces of the small hillocks along the port backshore area will be excavated for yard development, but otherwise the overall topography will not be changed.
- Drainage over most of the flat port area is currently to ponds behind a bund along the Cai Lan Estuary. The surface hydrology of the area will not be significantly affected by the construction.

Water quality and the Bai Chay Bay Mangrove Ecosystem

- Threats to water quality from increased sediment generated during port construction can be controlled using up-to-date practices. In comparison to sediment entering Northern Bai Chay Bay from rivers, the amount of sediment that could reach the northern mangrove areas from port activities is negligible.
- Sewage discharged from the port and ships could adversely affect water quality and will need to be treated before discharge.
- Hazardous wastes (if these are present), oil and grease, fertiliser and other refuse could pose a threat to water quality if untreated.
- Bulk storage areas should be raised above the height of maximum potential storm surge or bunded above that level.

The above sections point out the possible effects that port construction and operation could have on the Bai Chay Bay area. Direct effects on the environment will be limited to the construction and reclamation near the port area. Provided internationally accepted methods to construct and control the effects of the activities are adopted, degradation of the Bai Chay Bay

environment will not occur. It is clear that mitigation and management plans are required to ensure that activities which could contribute to environmental degradation do not occur. These are the subject of the Chapter 8.

CHAPTER 8 MITIGATION, MANAGEMENT AND MONITORING

8.1 Introduction

As described in Chapters 4 and 7, the port development at Cai Lan will have some effects on the human, physical and biological environment. The effects are summarised in Sections 4.7 and 7.4. Some of these effects are unavoidable. For example, the port will increase the traffic through Cai Lan and the noise generated by vehicles will also increase.

Other factors will change as a result of changing population in the area as Ha Long City develops. While there will be changes in, for example, population and traffic that can be solely attributed to the Cai Lan Port Construction Project, similar changes will occur as the city grows and its economic status improves. Ha Long City Planners will need to develop longer-term strategies to cope with the effects of such change in the city generally. This would need to take place alongside mitigation planning by Cai Lan Port Authority.

(i) Protection of the Social Environment.

- Prevention of strain on social services (such as health and education).
- Minimisation of noise from the port area.
- Minimisation of dust from the port and from the road passing through Cai Lan.
- Minimisation of effects of increased road traffic, especially the risk of accidents.
- Minimisation of the effects of increasing ship traffic, especially in Cua Luc Strait where the Bai Chay - Hon Gai ferries cross.
- Mitigation of effects on culturally important areas.
- Mitigation of changes to the landscape character.
  For the protection of the physical and biological environment, the following will need to be provided for:

(ii) Protection of water quality.

- Provision of sediment control devices during reclamation and earthworks at the port site.

- Design of a treatment plant for site stormwater runoff.

- Design of a sewage and wastewater plant to treat effluent generated at the port facilities.

- Design of a solid waste storage facility to minimise leachate and odour.

- Development of management strategies and contingency plans for minimizing the risk of oil spills or chemical spills.

Each of these is discussed below. In some cases, the effects of port development are not likely to emerge until close to 2000, or later, during Phase II of the development up to 2010. Some suggestions and recommendations about the mitigation of future developments are made as appropriate.

8.2 Proposed Mitigation Measures to Protect the Social Environment

8.2.1 Prevention of Strain on Social Services

Social services that could be affected include local education and health services. More detailed planning is required in order that local residents are not disadvantaged by the port development. This may need to form part of the wider planning for the development of Ha Long City, but in the interim, changes in the population in Cai Lan should be monitored and appropriate steps taken to increase services as they become necessary.

8.2.2 Minimisation of Noise Effects

It is not yet known whether the port will operate on a 24 hour basis or for a shorter period daily. It is expected that noise levels in Cai Lan residences by day will be below the recommended guidelines of 40 dB indoors. It may be that certain noises such as backing beepers may cause a nuisance at night. This should be investigated once the operations begin. If necessary, alternative warning methods may need to be devised. **A Noise Management Plan** should be devised to ensure that noise is minimised.

If the small hillocks along the foreshore are to be retained this would provide some topographic barrier to the noise generated at the port. If this is not possible in the design planning, it may be necessary to develop an artificial topographic barrier or bund between the port site and local residences as the port expands and the noise levels generated increase. Such a bund could be incorporated into an overall landscape plan for the area.

Because noise levels will continue to increase as the port gets bigger, a consultation strategy should be adopted to ensure residents' concerns are accounted for and noise prevention measures are effective. The residents most likely to be affected as the port grows will be those along the hillside below Route 18.

8.2.3 Minimisation of the Effects of Dust

Dust is likely to be generated both on the port site and on Route 18 during the construction and operation of Cai Lan Port. The quantities of dust generated will depend to some extent on the road and yard surfaces installed (paved or unpaved). It may be necessary to use water-trucks on Cai Lan Port site and on Route 18 to control this dust. A **Dust Management Plan** should be designed to facilitate this.

Key methods of such a management plan would include:

- Minimizing the areas disturbed.
- Revegetating disturbed or bare areas as soon as possible.
- Suppressing dust with water, including the use of sprinklers over bulk storage areas, and water trucks on roads and yards.

Some large areas of the port site and its hinterland are bare of vegetation or are only sparsely vegetated. To minimise dust generation, a full vegetation cover on areas not being utilised for port operations should be encouraged. This could include grassed areas or the development of forest plantations. As well as minimising dust, this would also assist in improving the landscape quality of the site.

Criteria for the protection of human health and avoidance of dust nuisance were described in Chapter 4. It will be important that some criteria for protection of human health off-site are adopted and that dust minimisation procedures are put in place to ensure that the criteria are met. It is recommended that standards of the type outlined in Table 4-2 be adopted.

8.2.4 Minimisation of Road Traffic Risk

The greater volume of traffic generated by the port, and the likely increase in heavy vehicles in the residential areas of Cai Lan and other residential areas on the main routes to Cai Lan Port will pose a greater risk to residents. Instigation of a low speed limit on the narrow residential street of Cai Lan would reduce the danger of accident. Provision of a clearly marked footpath and cycle track on one or both sides of the road for foot traffic and bicycles would also reduce the risk. Additionally, if traffic could be persuaded to "keep right" at all times by the use of signs, the likelihood of accidents and possible congestion would also be reduced. A **Traffic Management Plan** should be devised to provide risk control in the residential areas of Cai Lan and Gieng Day, in particular along the section of Route 18 between Gieng Day and Cai Lan Port, which until now has had very little traffic. Similarly, the stretch of road between Cai Lan Port and Bai Chay may need to be included in this plan.

8.2.5 Minimisation of Shipping Traffic Risks

As described in Chapter 4, the great increase in the number of ships passing through Cua Luc Strait will present an increased risk of shipping accidents in this narrow sea passage. At present ferries give way to the larger ships. Regulations to cover the speed and right-of-way of vessels going into and out of Cua Luc Strait will be needed. A form of traffic control from a centralised location to direct ships as to whether they are free to enter the channel should be designed. It may be necessary to limit the passage of ships to one vessel in Cua Luc Strait at any one time, in order to lessen the inconvenience to passengers when the ferries have to wait for ships to pass. If the prediction of around 7 - 8 ships per day is roughly correct, this should not be difficult to govern.

As well as the risk of collision or similar accident in Cua Luc Strait, the potential for accidents such as fire or oil spill will also be increased. A priority for Quang Ninh Port and Cai Lan Port Managers should be the design of **contingency plans** which will cover accidents such as collision, fire and oil spill. The location of Cua Luc Strait in the entrance to Bai Chay Bay means that this is a crucial area. Any substances spilled here, especially on an incoming tide would be carried throughout the bay. It may be in the interests of all ports in the area, whether private or State-owned, to contribute to the development of a contingency plan as a body. This would prevent duplication of the necessary equipment and ensure that a coordinated effort could be made in the event of an accident.

Routine refuelling and oily waste handling should also be considered in terms of the potential for oil spills. These elements would need to be taken into account in the preparation of oil spill contingency plans.

A **Cua Luc Strait Management Plan** should be devised, including regulations and plans such as those recommended above, based on updated predictions of the likely numbers of vessels and the types of cargo to be carried to Cai Lan Port, as these become available. A further consideration is the potential for contamination of Bai Chay and Ha Long Bays by the discharge of organisms in the ballast water that are new to the area. Provisions for enforcing conventions already in place should also be incorporated into this management plan.

8.2.6 Mitigation or Minimisation of Effects on Sites of Cultural Importance

The important cultural sites in the vicinity of Cai Lan are the pagodas along the foreshore in the proposed port area, and the cemetery on the hillside above the shoreline designated for later development. Buddhism is not a State-sanctioned religion but it has great significance to numerous Vietnamese people.

The design plan proposed in Chapter 12 of the Feasibility Study requires removal of one of the two pagodas, as the hillock against which the pagoda stands will need to be excavated during berth construction. If the decision is made to follow this design, it should be done in consultation with the local people.

As set out in Chapter 4, the alternatives are to remove the shoreline pagoda or to leave it in situ and redesign around it. The decision should be made in consultation with the local people and People's Committee.

Mitigation measures that could be applied, were the decision made to remove the pagoda include:

- Selection of a new pagoda site and relocation or rebuilding by the port authority.
- Landscaping and protection in perpetuity of the new pagoda site.

Mitigation measures could be extended to include the existing estuary pagoda, which is to remain unaffected by the development, including:

- Provision of a buffer zone between the port area and the pagoda.
- Landscaping.
- Provision of an improved accessway to the pagoda, upgrade of parking facilities, etc.

The cemetery on the hillside below Route 18 may be in the line of a proposed access road between berth 7 and Route 18 (after 2000). The design will need to ensure that the cemetery is not affected, and consultation with local people regarding appropriate means of protecting the area should be undertaken.

8.2.7 Mitigation of the Effects of Changes to the Landscape

The development of the port will affect the rural character of the area and present an industrial view to travellers on the section of Route 18 which passes the port. Tourism is growing in this area, and improvements to Route 18 which will occur during the development of Cai Lan Port will mean that an increase in the number of tourists exploring this area is likely. To improve the landscape quality a number of steps are possible.

The hillocks near the foreshore of Cai Lan Port will be excavated along the shore side but a natural topography will be seen from Route 18. This will provide some relief to the industrial nature of the view from the road. Also, the planting of trees as visual buffers on the flat expanse between Cai Lan Port and Cai Lan Village would be an advantage. This would have the added purpose of catching some of the dust which may be generated at the port site and would minimise dust entrainment from bare areas. Design of the port should incorporate a **Landscape Enhancement Plan** to beautify the environment and soften the visual impacts on tourists or passers by. For example, the planting of large palms trees along the dyke next to the small Cai Lan Estuary and along the road leading the port offices would give a continuity with the foreshore of Bai Chay, where palms are planted near the Petrolimex facility. These provide a special character to the area and are a major contributor to the picturesque nature of Bai Chay as seen from the ferries and from Hon Gai.

Planting of pine or eucalypt plantations on areas of ground which are not going to be used as yard space in the immediate future would also add to the "greenness" and natural qualities of the site.

8.2.8 Mitigation of Overall Effects on Residents below Route 18

Noise, dust and landscape effects may considerably diminish the quality of life experienced by residents along this foreshore. This will be an ongoing effect as developments beyond 200 are likely to increase the effects on these residents (unlike those in Cai Lan Village whose quality of life will improve once the new road along the railway line is installed). Consultation with these residents should be undertaken to determine their attitude to the developments. In the longer term, relocation may need to be considered, particularly for those residents along the foreshore where a new road may potentially be located.

8.3 Proposed Mitigation Measures to Protect the Physical and Biological Environment

8.3.1 Minimisation of Sediment in the Seawater During Reclamation

The likely sequence of reclamation at Cai Lan Port was described in Chapter 2. There are several possible methods that could be used during reclamation. These include:

- Bucket dredging along the berth line to excavate the berth foundation.

- Dumping of foundation materials (rock) for berth foundations, and possibly for the construction of a temporary bund or dyke during reclamation.

- Cutter suction dredging and pumping of mixed sediments and water into the bunded reclamation area.

- End-tipping of reclamation materials from on-land borrow sites into the bunded reclamation area.

As described in section 7.3.2.2, internationally accepted methods for minimising sediment input to Bai Chay Bay should be used to minimise the amount of sediment entering the coastal waters. Because of the sensitivity of the Bai Chay Bay environment the methods used should be those which provide the highest level of protection. A **Sediment Management Plan** should be adopted for the duration of the development activities. Methods to protect the coastal waters are outlined below, as examples of the minimisation which must be undertaken during construction.

8.3.1.1 Bucket Dredging

Silt protection curtains are commonly erected around the area where the bucket dredging is taking place. The silt protection curtains extend to just above the level at which the bucket is working, thus preventing the movement of sediments outside the immediate area of the dredging. The dredged materials are then lifted onto a barge for transportation to the target disposal site (either landfill or seabed disposal site).

8.3.1.2 Laying of Foundation Materials

Silt curtains are commonly used to ensure that as the rock and sediments settle, the sediment is retained near to the foundation area.

8.3.1.3 Cutter-Suction Dredging and Pumping to Reclamation

Once the reclamation's perimeter dyke or bund has been constructed, fill materials can be pumped to the reclamation area. Cutter suction dredging will allow sediments removed during dredging of the channel to be disposed of on land rather than at sea, as recommended in the design plan for Cai Lan Port. This has the added advantage of minimising the effects of the dumping of dredged materials on the marine environment of the dumping site. The cutter-suction method does not result in much sediment being disturbed as the sediments are removed by suction, and hence silt protection curtains are not normally used.

In the reclamation area, the pumping of the dredged material causes the displacement of much sediment-laden water. To prevent this entering the sea, an overflow unit is often installed to drain the displaced water from the reclamation. This consists of a gravity-fed chamber in which primary settlement takes place. A pipe (e.g., 600 mm diameter) is located above the level of the settled sediments to drain water back to the sea. At several locations along the pipe silt protection curtains or other mechanisms are installed to remove sediment from the water as it passes through the pipes. By the time the water reaches the outlet to the sea, almost all sediment has been removed. The sediment chamber and protection devices in the pipe must be cleared regularly to ensure the system operates effectively.

8.3.1.4 End-tipping from Land

Excavation of fill material from a borrow area on land may be end-tipped into the reclamation area. Displacement of sediment laden water will occur, similar to that described above. Similar drainage and sediment collection systems would need to be used as those described above.

8.3.2 Minimisation of Sediments from Earthworks

During construction of the port earthworks may be necessary during yard construction. In addition, excavation of materials from borrow areas destined for the reclamation may also occur. Rainfall runoff generated in the quarry or earthworks may carry considerable loads of sediment. It will be necessary to design an **Earthworks Management Plan** to ensure that these sediments are removed before the runoff drains to the sea. Such a plan could involve the excavation of interim treatment ponds to allow sediments to settle prior to discharge. Alternatively temporary channels could be excavated to direct sediment laden water into the reclamation area. From there it would pass through the same sediment removal process as that described in section 8.3.1.

8.3.3 Minimisation of Contaminants in Site Stormwater Runoff

During rainfall, the runoff from the port area may entrain any substances that have collected on the surface. This could include sediment, oil from vehicles, and materials from the bulk storage yards.

It will be necessary to prevent all such materials from draining directly into the sea. To achieve this, a site drainage system should be designed to collect all site runoff and direct it to a treatment facility. Such a facility would need to be designed to cater for peak flow conditions which might occur during typhoons or other storm events.

Because of the sensitivity of the Bai Chay Bay environment and the large scale of the port development, runoff from the whole port area should be treated. This could be achieved by the installation of a grated drainage system around the port area, including along the berth line. Alternatively, the yard area could be designed to slope slightly to landward rather than to seaward, so that water drains by gravity to the rear of the site where it can be collected and treated prior to its discharge into the sea.

The type of treatment plant required will depend on the types of cargo to be stored and shipped. Sediment could be removed by settlement and if necessary by the addition of flocculants to the stormwater plant. If fertilisers are stored on site, runoff from these areas may require additional treatment. Oil and grease should also be removed from the water, as should all flotsam and solid waste.

A Stormwater Management Plan should be developed to ensure that all runoff is appropriately treated. Sediment ponds could be located in the flat hinterland of the port in the area currently ponded behind the bund along the estuary. Sediment ponds could be a positive landscape feature and should form part of the Landscape Management Plan.

8.3.4 Treatment of Sewage and Solid Waste

Sewage and wastewater will be generated at the port site. To ensure that the water quality of Bai Chay Bay is not affected by the sewage effluent, a treatment plant should be installed. This should be designed to meet the Vietnamese Provisional Criterion for E. coli in beach water of 1000 cells / 100 ml.

If solid waste is not removed from the site, decomposition of any organic materials may allow leachate to enter the sea. Unacceptable odours may be emitted and bird, insect and rodent nuisance may also result. This could be minimized by establishing a purpose-built solid waste facility away from the port area. If an on-site refuse area were to be used, daily covering of the active face, say to a depth FO 30 cm would minimise such nuisance problems. All loose material will need to be secured to prevent it from entering the sea. A Waste Management Plan should be devised to control the disposal of sewage and solid waste in the port site.

In section 14.4.3 of the Feasibility Study it is recommended that contractors provide their own sanitary waste system, during the construction phase. It is important that the contractors are provided with appropriate methods or locations to dispose of these wastes. In view of the fact that sewage treatment facilities are not available in Ha Long City the pond authorities will need to assist in developing appropriate disposal methods or plant. It is not sufficient to make disposal the nominal responsibility of the contractors if no reasonable means of disposal are available.

8.3.5 Mitigation Strategy for Oil and Chemical Spills

Site Management

Provided all runoff from the port area is collected and treated as outlined above, oil and chemicals stored or used on site should be prevented from entering the sea. Key factors to consider are:

- Adequate bunding (containment areas) for chemical and oil storage
- Appropriate storage containers for the materials, e.g., substances should be stored in undamaged, labelled and original containers.
- Appropriate handling procedures to minimize the risk to workers and also the environment.
- Safe compatible storage of materials, e.g., not storing reactive substances together that can catch fire.
- Protection of drains that go to natural water, e.g., installation of mechanical drain protectors, or provision of plastic covers that can be placed over drains in the event of a spill.

It should be noted that any oil, e.g., 200 L drums of oil, should be stored in a contained area, such as a concrete pad surrounded by an earth bund, so that leaks or spills cannot escape to the environment (e.g., spilled onto the earth or into drains or waterways).

It is recommended that a Port Site Contingency Plan be prepared that covers these matters.

Oil Spill Contingency

If oil were to be spilled from a ship either at the berth or on its way into or out of the port area, this could affect the ecology of Bai Chay Bay. An Oil Spill Contingency Plan should be devised to allow speedy and effective action to be taken in the event of such an emergency. As outlined in section 8.2.5 above, if an integrated oil spill contingency plan covering Cua Luc Strait, Bai Chay Bay and Inner Ha Long Bay were to form part of a Cua Luc Strait Management Plan, it would allow coordination between staff and managers at each port in the area, provide cost effectiveness and improve the outcome should this plan ever have to be implemented. Despite the fact that some of these ports may move in future (refer section 10.2) this should be carried out to protect the environment in the interim period while the facilities are still operational.

8.3.6 Mitigation of the Effects of Dredging

No studies have been undertaken regarding the effects of dredging and disposal of sediments on the Ha Long Bay environment. Investigation of existing and proposed sites should be undertaken to assess the effects of disposal on marine fauna, and if necessary design methods to minimize any potential effects.

8.4 Management Strategy

To implement the above mitigation measures and to ensure that they are effective in protecting the Bai Chay Bay environment, **an integrated environmental management system is required**. The foundations of this system would be the management plans recommended above. To recap, these include the following plans:

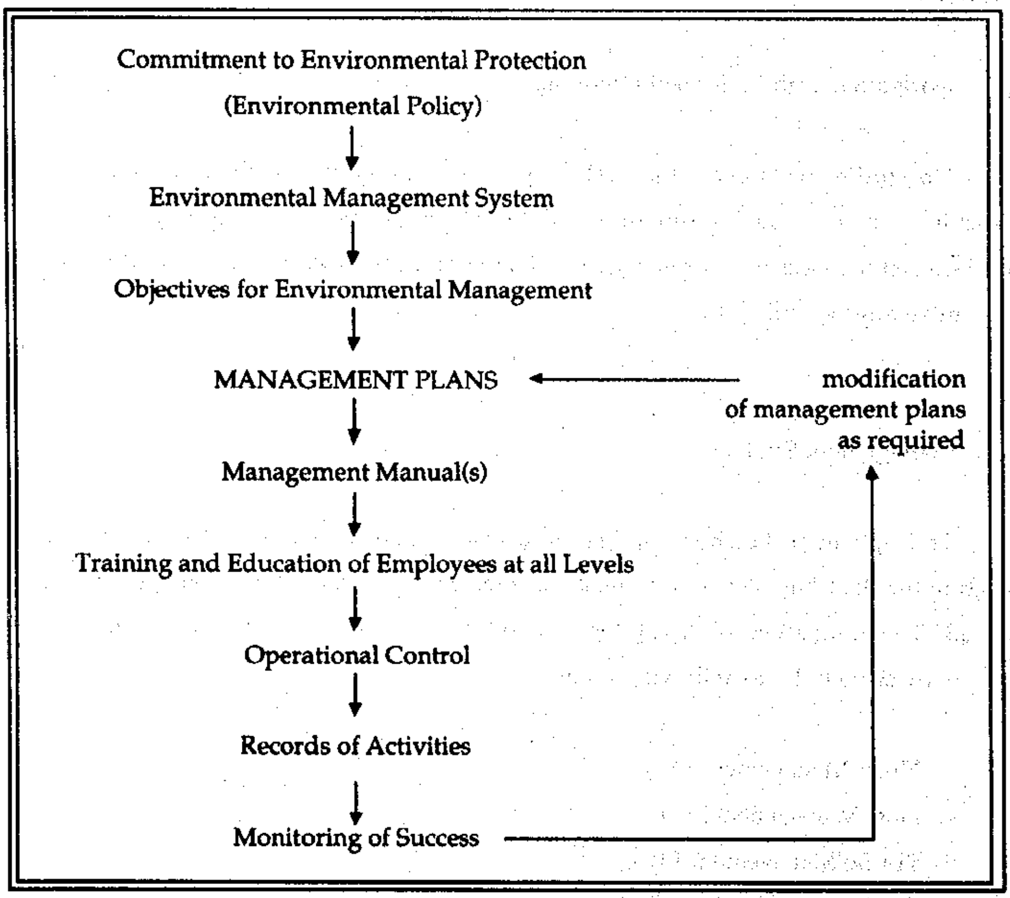
- Noise Management Plan
- Dust Management Plan
- Traffic Management Plan
- Landscape Enhancement Plan

- Sediment Management Plan
- Earthworks Management Plan
- Stormwater Management Plan
- Waste Management Plan
- Port Site Contingency Plan
- Oil Spill Contingency Plan
- Dredging Study

As well, a Cua Luc Strait Management Plan to cover all vessels within the Strait would be a very useful tool. This would not be a responsibility of Cai Lan Port Authority alone, but would need to be a cooperative plan designed with input from all of the shipping operators in the area.

The environmental management system could have the general outline shown in Table 8.1.

Table 8-1: Example of management system.



A scenario such as the example shown would enable the port management to ensure environmental management was applied at all levels within the staff system. Education of the employees is an important part of the above process. If employees understand the importance of protecting Bai Chay Bay and the reasons they must carefully undertake the operations as per the management plans, a much better outcome can be expected.

Continual checking of the effectiveness of the management plans adopted for the port site is crucial. The best designed systems can fail if all components are not functioning efficiently. For example, the silt protection mechanisms outlined in section 8.3.1 would fail to achieve their purpose, which is to allow only clean water to drain into the sea, if the silt curtains and other devices became clogged with silt, or the sediment trap areas were not cleared out regularly. Regular checking of such devices to ensure systems are operating properly would be integral to the management plan. In addition, periodic monitoring of the receiving environment by testing the water quality in Bai Chay Bay would need to be undertaken, to ensure all sediment control methods were working well.

8.5 Monitoring

Monitoring will be required in the vicinity of the port site to ensure that all air emissions and discharges into the sea meet the standards required by the Vietnamese Provisional Guidelines, or any other regulations put in place by Quang Ninh Province or Ha Long City.

Key factors to monitor will be water quality in Bai Chay Bay, dust and noise. In addition, the health of the mangrove ecosystem will also need to be monitored, this would need to include mangrove status, shellfish and fish health. The detailed design of monitoring plans should form part of each of the management plans to be prepared by Cai Lan Port Authority. The monitoring required is outlined below.

8.5.1 Noise

Noise levels in the residential areas should be monitored during construction and once the port area is operational. The aim will be to ensure that daytime and night time noise does not exceed the maximum levels suggested by the Vietnamese Provisional Guidelines, or any other levels set by Quang Ninh Province or Ha Long City. Monitoring should be carried out on a regular basis during the hours of normal operations. If "abnormal" operations are to be carried out, these should also be monitored.

8.5.2 Dust

Dust monitors should be set up near the perimeter of the port area, between the port and residences in Cai Lan. Dust monitors available internationally include deposition monitors and monitors for suspended particulate. Both may be necessary.

8.5.3 Water Quality

8.5.3.1 The Context of Water Quality Monitoring

As development in Ha Long City proceeds other industries will be establishing in the area as well the port. Many of these will also be discharging liquid wastes to Bai Chay Bay. Clearly, it would be unfair to place the burden for monitoring the effects of all industries in the area on one enterprise. Each enterprise should take responsibility for ensuring that its discharges are treated to a level that will maintain water quality in the area adjacent to the discharge point(s). However, the overall effects of all discharges combined on the receiving water of Bai Chay Bay, will need to be monitored to ensure the discharge standards and treatment are having the required effect. To achieve this, a joint programme should be set up to monitor the overall effects of all discharges on water quality in Bai Chay Bay and in Ha Long Bay.

There are various ways this could be managed. One would be for Ha Long City to commission an independent body (such as the Centre for Marine Mechanics) to undertake this programme on a regular basis, and then pass on the costs to each enterprise. The results would need to be made freely available to each participating industry. The costs would need to be proportional, to ensure that those industries which discharge the greatest volume of effluent would bear the highest cost, etc.

Through a programme such as this will it be possible to determine whether the receiving water quality is being degraded, and thus to change the requirements for treatment of effluent in each industry. This kind of broader scale monitoring will be essential if the continued good water quality of Bai Chay Bay is to be maintained.

The parameters to be included should be reviewed periodically to include, if necessary other elements that industries are discharging. Monitoring should be carried out on a six-monthly basis (summer and winter). The sites to be monitored could be similar to those selected for the water quality survey described in section 5.6.2 (Fig. 5.5). Parameters to be monitored should include those shown in Table 8.2.

Table 8-2: Suggested parameters to be monitored at sites in the broader Bai Chay Bay and Ha Long Bay areas.

Parameters	
Salinity	Phosphate
pH	Total phosphorus
Dissolved oxygen DO	Sulfur
Transparency	Total sulfur
E. coli	Total nitrogen
Redox value	Nitrate
Biochemical oxygen demand BOD	Nitrite
Chemical oxygen demand COD	Ammonium
Temperature	Lead
Oil content	Cadmium
Suspended solids	Zinc
Phosphate	Copper
Total phosphorus	Mercury
Total sulphur	Arsenic
Sulphate	

8.5.3.2 Selection of Appropriate Criteria

The receiving environment of Bai Chay Bay and the dynamics of water exchange in the estuary have not been fully described so it is not known what concentrations of various discharge parameters the system can absorb and / or flush out. It is very important that this be better defined in the future. Work should begin now on setting standards that are specific to the sensitive environment of Bai Chay Bay.

However, in the interim, industries which want to establish around Bai Chay Bay, including Cai Lan Port, need to know what standards they must meet in order that Bai Chay Bay does not become polluted. Also, industries need to know their legal obligations in this respect. Rivers entering Bai Chay Bay also carry pollutants and industries which may in future establish along these rivers should also meet these standards.

Vietnam already has some coastal water standards in place. These were derived by the Haugiang Peoples Committee. They provide a good first base for Bai Chay Bay. However, Bai Chay Bay is an estuarine environment, rather than a "normal" coastal environment. These guidelines need to be reviewed in the light of the Bai Chay Bay ecosystem and the important tourist activities in Ha Long Bay. Bai Chay Bay waters are enclosed coastal waters and may thus constitute a special case. For example, BOD of 15 - 20 mg l^{-1} may be too high for such an enclosed system. Narrative standards elsewhere suggest 3 - 5 mg l^{-1} may be more reasonable for such waters. This requires additional consideration. Meanwhile, a system to monitor water quality in Bai Chay Bay should be put in place straight away to ensure that the existing coastal water quality standards are met.

A further consideration is the effect of tidal flushing. It may be necessary to limit the discharge of effluents to the upper part of the tidal cycle, perhaps for 6 hours either side of the high tide (the tidal cycle is approximately 24 hours). This would allow for better flushing of effluent and prevent accumulation. The high tide level varies considerably over the lunar month, and this would also need to be taken into account. The Vietnamese Provisional Criteria for effluent suggest a 500 m mixing distance. This may need to be altered to reflect the tidal nature of Bai Chay Bay and the large areas of mud flat that are exposed over low tide. Selection of appropriate discharge points is also a key consideration.

Until the specific requirements of Bai Chay Bay can be determined and appropriate standards developed based on the area's chemical and biological make-up and requirements, some performance standards should be put in place based on standards operating in other countries. This would provide an initial guide to industries establishing around Bai Chay Bay. Key parameters will be:

pH	All industries.
Oil and grease	All industries.
Suspended solids and turbidity	All industries.
Colour	Ccolour generating industries such as pulp and paper.
Oxygen demand	Food processing industries.
Bacteria	Food processing industries.
E.coli in particular	Sewage effluent from all industries.
Nutrients	Fertiliser industry.
Fluoride	Fertiliser industry.
Metals	Metal handling and processing industries.

Some tentative standards can be based on standards existing in Japan and other Asian countries. These countries have set a range of standards for various industry types and for various types of receiving water. For Bai Chay Bay a conservative approach should be taken, that is, criteria for sensitive or enclosed waters should be adopted in the interim until more is known of the dynamics of this system.

It can be assumed that mixing will occur within Bai Chay Bay and therefore the discharge levels may be set somewhat higher than the coastal water quality standards allows. The performance standards will aim at ensuring that in the interim, the Vietnamese Provisional Criteria on coastal water quality standards are met. Once the specific requirements of Bai Chay Bay are known, site-specific criteria should be promulgated.

Interim discharge criteria for industries discharging into Bay Chay Bay are suggested (Table 8-3 at the end of this chapter). These are based on regulations in place in Japan where these are available, but reference has also been made to criteria produced by other Asian countries. Several of these have specific standards relating to effluents to be discharged into inland waters and these may be more suitable to apply in the case of a tidal estuary such as Bai Chay Bay. Criteria for some elements recommended by some Asian countries reviewed are too high and would require considerable mixing in the receiving waters to reach the levels considered to be protective of aquatic life (USEPA). In these cases, the approximate mixing ratios required have been outlined. All of these tentative standards will require much greater investigation. In addition, the volume or flow rate of each discharge will need to be defined by each industry. This will affect the overall mixing requirements of the receiving water.

It is recommended that in the long term, receiving water quality should be monitored to cover the combined effect of all industries, along with discharge criteria to be applied to all industries.

8.5.3.3 Monitoring by Cai Lan Port

During construction of Cai Lan Port, numerous activities will be taking place which could affect water quality. While some of these will involve point source discharges (such as effluent discharge from the bunded reclamation area) others, such as dredging operations, would be capable of disturbing sediments over a larger area of Bai Chay Bay.

Because of this, the discharges from the port site should be monitored via testing of the receiving waters. Waters in the south-central part of Bai Chay Bay and in Cua Luc Strait should be monitored on a frequent basis and compared with the existing results for February and June 1994 (Chapter 5 of this report). Key parameters would be suspended solids, turbidity and dissolved oxygen. During construction, these should be monitored on a monthly basis.

Once the port is operational a further suite of parameters should be added, to be measured in Bai Chay Bay and Ha Long Bay. Parameters would include suspended solids, turbidity and DO as above, but also pH, oil and grease, BOD, E. coli, and nutrients such as nitrogen and phosphorus, and trace elements such as lead and cadmium. These should be monitored on a six-monthly basis and reviewed to ensure that the control measures are effective. Depending on the types of bulk cargo being handled, other parameters may be need to be analysed as well. The list of parameters sampled for this EIA would be appropriate as a starting point (refer Chapter 5).

8.6 Summary

The intention of the mitigation, management and monitoring procedures outlined above is to ensure that the quality of the Bai Chay Bay environment is not degraded by the development of a port at Cai Lan. Provided these procedures or similar are used, and regularly reviewed and updated to cover all activities and products in the port environment, Bai Chay Bay should be able to be maintained as a water body that can support the other important activities and ecosystems that occur there.

The adoption of suitable mitigation, management and monitoring will allow the Cai Lan Port Project and other development projects in the vicinity, to proceed without significantly damaging the Bai Chay Bay environment.

Table 8.3: Suggested Interim Effluent Discharge Criteria

Parameter	Interim Tentative Standard	Vietnamese Standard for Class I Water and Comparative Effluent Discharge Standards from other Asian Nations.
Suspended solids	50 mg l^{-1}	VN 50 mg l^{-1}. Sri Lanka (inland and coastal waters); Philippines, coastal water for primary contact 5.0 mg l^{-1}. Japanese standard of 200 (average 24 hour value 120.
Turbidity	50 NTU	No VN criterion. 50 NTU Iran. No Japanese criterion.
pH	5.8-8.6	VN criterion 5-8. 5.8 - 8.6 Japan. Others 6-9.
Oil and grease	1 mg l^{-1}	VN 1 mg l^{-1}. 5 mg l^{-1} Japan.
COD	5 0 mg l^{-1}	VN 160 mg l^{-1}. 5 0 mg l^{-1} Iran. Japanese standard 160 mg l^{-1} (24 hr average 120).
BOD	30-50 mg l^{-1}	VN 80 mg L^{-1}. Sri Lanka inland and coastal water. Japanese standard of 160 mg l^{-1} (24-hr average 120) may be too high.
E. coli	1000 cells/100 ml	VN 1000 cells/100 ml. Japan 300,000 MPN /100ml.

Parameter	Interim Tentative Standard	Vietnamese Standard for Class I Water and Comparative Effluent Discharge Standards from other Asian Nations
Detergent	1 mg l^{-1}	No VN criterion. Philippines, Jakarta 1 mg l^{-1} (no Japanese criterion).
Phenol	1 mg l^{-1}	VN criterion 1 mg l^{-1}. USEPA water and fish ingestion 3.5 mg l^{-1}.
Total pesticides	0.005 mg l^{-1}	VN criterion 0.005 mg l^{-1}.
<u>Nutrients</u>		
Total-N	2 mg l^{-1}	No VN criterion. 2 mg l^{-1} Sri Lanka (no Japanese criterion).
Nitrate	2 mg l^{-1}	No VN criterion. 2 mg l^{-1} Indonesia (no Japanese criterion).
Nitrite	2 mg l^{-1}	No VN criterion. 2 mg l^{-1} Jakarta (no Japanese criterion).
Phosphate	1 mg l^{-1}	No VN criterion. 1 mg l^{-1} Iran, Indonesia (no Japanese criterion).
Ammonia	2.5-5 mg l^{-1}	No VN criterion. 2.5-5 mg l^{-1} Iran, Indonesia (no Japanese criterion) (temperature and pH dependent).

Parameter	Interim Tentative Standard	Vietnamese Standard for Class I Water and Comparative Effluent Discharge Standards from other Asian Nations
<u>Metals</u>		
Iron	5 mg l^{-1}	No VN criterion. 5 mg l^{-1} Malaysia, Indonesia, Philippines. Japanese criterion of 10 mg l-1 may be too high for enclosed waters.
Cobalt	1 mg l^{-1}	No VN criterion. 1 mg l^{-1} Iran (no Japanese criterion).
Nickel	0.5-1 mg l^{-1}	No VN criterion. 0.5-1 mg l^{-1} Philippines, Iran (no Japanese criterion). Requires around 900-fold mixing to meet marine PAL criterion of 8.3 g l^{-1} (USEPA).
Copper	0.5 mg l^{-1}	0.5 mg l^{-1} VN. 1-2 mg l^{-1} Malaysia, Philippines, Thailand, Indonesia. Requires 150-fold mixing to meet PAL of 6.54 g l^{-1} (USEPA). Japanese criterion of 3 mg l-1 may be too high for enclosed waters).
Zinc	1 mg l^{-1}	VN criterion 1 mg l^{-1}. 1-2 mg l^{-1} Malaysia, Philippines, Thailand, Indonesia, Iran. Requires 17-fold mixing to meet PAL of 58.9 g l^{-1} (USEPA). Japanese criterion of 5 mg l-1 may be too high for enclosed waters).
Selenium	0.05 mg l^{-1}	No VN Criterion. India, Sri Lanka (no Japanese criterion).

Parameter	Interim Tentative Standard	Vietnamese Standard for Class I Water and Comparative Effluent Discharge Standards from other Asian Nations
Cadmium	0.02 mg l^{-1}	VN criterion 0.02 mg l^{-1}. Philippines, inland waters 0.05 mg l^{-1}. Requires 30-fold mixing to meet PAL criterion of 0.66 g l^{-1} (USEPA). Japanese criterion of 0.1 may be too high for enclosed waters.
Mercury	non-detectable	VN criterion 0.01 mg l^{-1}. Japan non detectable. USEPA marine chronic criterion 0.025 g l^{-1} .
Lead	0.1 mg l^{-1}	VN criterion 0.2 mg l^{-1}. Sri Lanka and Philippines inland waters 0.1-0.5 mg l^{-1}. Requires 75-fold mixing to meet PAL criterion of 1.32 g l^{-1} (USEPA). Japanese criterion of 1 mg l^{-1} may be too high for enclosed waters.
Boron	2 mg l^{-1}	No VN criterion. Philippines, Iran 2 mg l^{-1} (no Japanese criterion). Requires 5-fold mixing to meet PAL criterion of 10 mg l^{-1} (EPAV).
Arsenic	0.1 mg l^{-1}	VN criterion 0.1 mg l^{-1}. India, Indonesia, Iran, Philippines inland waters, Sri Lanka inland waters 0.1-0.2 mg l^{-1}. Japanese criterion of 0.5 mg l^{-1} may be too high. USEPA PAL criterion 0.19 mg l^{-1}.
Sulfur	0.5-1 mg l^{-1}	No VN criterion. Malaysia, Thailand, Iran 0.5-1 mg l^{-1} (no Japanese criterion).

Parameter	Interim Tentative Standard	Vietnamese Standard for Class I Water and Comparative Effluent Discharge Standards from other Asian Nations
Sulphide	0.5 mg l^{-1}	VN criterion mg l^{-1}(as H_2S). USEPA marine chronic criterion 0.002 mg l^{-1}.
Fluorine	2-6 mg l^{-1}	No VN criterion. Sri Lanka, Philippines. Japanese criterion of 15 mg l^{-1} may be too high in enclosed waters.
Chromium	0.5 mg l^{-1}	VN criterion 0.5 mg l^{-1}. No standards recommended in Asian guidelines. PAL of 0.011 mg l^{-1} (USEPA).
Cyanide	0.2 mg l^{-1}	VN criterion 0.2 mg l^{-1}. Sri Lanka, Philippines 0.1-0.2 mg l^{-1}. Japanese criterion of 1 mg l^{-1} may be too high in enclosed waters. USEPA marine chronic criterion 1 mg l^{-1}.

Note: PAL = Protection of marine aquatic life criterion.
USEPA = United States Environment Protection Agency.
EPAV = Environment Protection Agency of Victoria (Australia).

CHAPTER 9 SUMMARY OF ENVIRONMENTAL EFFECTS

The Cai Lan Port Construction Project should be allowed to proceed provided that measures are adopted to minimise and mitigate some of the effects and that stringent management plans are devised and implemented prior to the construction and operation phases of the project. Preparation of Management Plans should be an integral part of the detailed design phase for the port.

9.1 Introduction

A summary of the effects and mitigation required are presented in this section.

Chapters 4 and 7 presented the likely effects of Cai Lan Port Construction Project on the human and physical / biological environments. Chapter 6 dealt specifically with the mangrove ecosystem and the possible effects on it if the environment is not wisely managed. Methods for mitigating all of the effects which could be considered negative were presented in Chapter 8, along with suggested management methods for implementing such mitigation.

Table 9-2 summarises the key effects of the above, providing an evaluation of the direct impacts of the project and the net effects provided that the mitigation works are implemented effectively. Table 9.2 then shows a final impact analysis of all of the effects following mitigation.

The far right column in Table 9-1 shows the key net effects of port construction and operation to 2000 following mitigation. This shows that all of the physical and biological effects can be successfully managed.

Effects on the human environment which require further consideration are the effects of removing or relocating the shoreline pagoda (the final effect will depend on the success of negotiation with local people and on reaching agreement as to the relocation and / or protection measures). With regard to the residents living on the hillside below Route 18 and along the Cai Lan Estuary (a total of around 15 houses) the noise, dust and landscape effects of both the construction and operation of the port and road may be difficult to manage. Despite the fact that there may be no requirement for the houses to be removed, the residents may prefer to be relocated as the quality of their rural existence may be considerably diminished. However,

Table 9-1: Impact evaluation matrix of direct impacts

Project activity in port construction	Phase of project (1)	Factor affected	Degree of impact on human (H) or natural (N) environment	Duration of impact	Methods that can be used to minimize or mitigate impacts	"Success" of mitigation or minimisation of impacts	Degree of long term impact after mitigation
Reclamation	C	Water quality	high (N)	short	Sediment containment	high	low
		Landscape	high (N&H)	long	Enhancement	medium	medium
		Access to shoreline	low (H)	long	Not needed	-	low
		Ecology (mangroves)	low (N)	long	Not needed	-	low
		Noise and dust in Cai Lan	low (H)	short	Not needed	-	low
		Noise and dust at houses below Route 18	high (H)	short	Regulation & controls needed	medium	low
Excavation (on land)	C	Pagoda	high (H)	long	Relocation	high	low
		Water quality	high (N)	short	Sediment containment	high	low
		Terrestrial ecology	low (N)	short	Not needed	-	low
		Surface hydrology	low (N)	long	Not needed	-	low
		Landscape	medium (N&H)	long	Enhancement	medium	medium
		Noise and dust in Cai Lan	low (H)	short	Not needed	-	low
		Noise and dust at houses below Route 18	high (H)	short	Regulations & controls needed	medium	low
Dredging (sea)	C&O	Water quality	high (N)	short	Sediment containment	medium	low
		Sea floor fauna	low (N)	short	Not needed	-	low
		Current dynamics	low (N)	long	Not needed	-	low

Note: (1) (Phase) C = Port construction phase O = Port operation phase.

Table 9-1 (Cont.)

Project activity in port construction	Phase of project (1)	Factor affected	Degree of impact on human (H) or natural (N) environment	Duration of impact	Methods that can be used to minimize or mitigate impacts	"Success" of mitigation or minimisation of impacts	Degree of long term impact after mitigation
Cargo storage and handling	O	Water quality	high (N)	long	Site runoff containment	high	low
		Noise and dust in Cai Lan	low (H)	long	Regulation and controls	medium	low
		Noise and dust for houses below Route 18	high (H)	long	Regulation and controls; consultation re. relocation	medium	high
Manpower	C&O	Social impact on existing population	high (H)	long	Provide services; Positive impact of economic growth and employment	medium	medium
Use of road through Cai Lan until new road constructed	C&O	Dust and noise in Cai Lan	high (H)	short	Dust suppression	medium	low
	C&O	Traffic increase (increased risk of accident)	medium (H)	short	Traffic control	high	low
Construction and use of new road and railway	C&O	Dust and noise on houses below Route 18	high (H)	long	Dust suppression, noise regulation, consultation with residents re. relocation	medium	medium
	C	Water quality (rainfall runoff)	medium (N)	short	Runoff control	high	low
Shipping - use of harbour	O	Traffic and risks increase	medium (H)	long	Traffic management	high	low
	O	Water quality	high (N)	long	Regulation and controls	high	low
Shipping - discharges of ballast water, oily wastes	O	Water quality	high (N)	long	Regulation and controls	high	low
Waste management (sewage and solid waste)	C&O	Water quality	high (N)	long	Treatment of storm water, sewage and solid waste	high	low
	C&O	Odour	low (H)	long	"	low	low

Note: (1) (Phase) C = Port construction phase O = Port operation phase.

Table 9-2: Summary of long term effects if mitigation is successfully undertaken

	Long-term Effect on Environment after Mitigation													
Project activity	Natural environment						Human environment							
	Water quality	Terrestrial ecology	Inter tidal ecology (mangrove)	Sea floor fauna	Marine hydrology	Terrestrial hydrology	Population impacts	Landscape	Noise & dust (Cai Lan)	Noise & dust (below route 18)	Traffic risks	Loss of access to marine resources	Loss of pagoda	Odour
Construction Phase														
Reclamation	L	-	L	-	L	-	-	M	L	L	-	L	-	-
Excavation (on land)	L	L	-	-	-	L	-	M	L	L	-	-	L	-
Dredging	L	-	-	L	L	-	-	-	L	-	-	-	-	-
Use of road through Cai Lan	-	-	-	-	-	-	-	-	L	-	L	-	-	-
Construction of new road & rail	L	L	L	-	L	L	-	M	L	M	-	L	-	-
Manpower	-	-	-	-	-	-	M	-	-	-	-	-	-	-
Operation Phase														
Maintenance dredging	L	-	-	L	L	-	-	-	-	-	-	-	-	-
Use of new road & rail	-	-	-	-	-	-	-	-	L	M	-	-	-	-
Cargo storage & handling	-	-	-	-	-	-	-	-	L	H	-	-	-	-
Shipping - use of harbour	L	-	-	-	-	-	-	-	-	-	L	L	-	-
Shipping - discharge of wastes	L	-	L	L	-	-	-	-	-	-	-	-	-	-
Manpower	-	-	-	-	-	-	M	-	-	-	-	-	-	-
On-land waste management	L	-	L	L	-	-	-	-	-	-	-	-	-	L

Note: H = level of impact high M = level of impact medium L = level of impact low - = no impact expected they may consider that the benefits of living near to the port, in terms of possible economic opportunities, outweighs the negative effects. This can only be determined via consultation with the people affected.

9.2 Broader Issues

Table 9.1 focuses on the direct / immediate effects of the construction and operation phases. However there are broader issues to consider, which may be potentially affected by the port construction. The key issues are the overall potential effects of the development on water quality in Bai Chay Bay and the possible flow-on effects to the mangrove ecosystem and to tourism in Ha Long City. Clearly, water quality is of prime importance in designing management plans for the future. The effects of the port construction and these key issues are summarized below.

9.2.1 Bai Chay Bay Estuarine Environment

Cai Lan Port is located on the southern side of the estuary, next to a deep channel. It is distant from the mouths of the rivers that flow into the estuary. In the nature of estuaries, sediment-laden waters enter via rivers and streams and as the flow rate slows, sediment is deposited on the sea floor. The large expanses of mudflats around the northern shoreline of the estuary and the relatively smaller extent of mudflats on the southern shores, for example, around Cai Lan, indicate that the sedimentation rate near Cai Lan is relatively low.

Mangroves grow most readily where sediments accumulate and they are thus most widely present on the northern mudflats. But on the southern shoreline, mangroves are present only in the mouths of small streams and estuaries and as a sparse band along the rocky shoreline. The nearest large expanse of mangroves is some 1.8 km from Cai Lan.

During construction and operation of Cai Lan Port there could be a short term input of additional sediment during dredging and during port construction. However, if proper management methods are used as recommended in this EIA, it is unlikely that this will change the sediment budget of the bay sufficiently to increase the sedimentation rate in the mangrove forests along the northern shoreline. Similarly, the turbidity of the waters should be unaffected. More serious effects on the continued health of the mangroves may come from continued cutting of firewood, grazing, unplanned reclamation and other activities upstream in the Bai Chay Catchment.

The small areas of mangrove on the Cai Lan Shoreline are of relatively minor ecological value in terms of their contribution to the overall ecological status of Bai Chay Bay.

Their removal is not expected to affect the biodiversity or viability of the ecosystem.

The input of pollutants from ships and from the port area itself have also been considered in this document. It is important that careful management be employed to minimise such effluents to the greatest degree possible. It must be noted that existing sources of pollutant such as B-12 oil port may already be affecting water quality in Cua Luc Strait. Minimisation methods applied to vessels entering Bai Chay Bay on route to Cai Lan Port should also be applied to oil tankers. Sewage from residential areas is also having an effect on inshore waters.

9.2.2 Ha Long Bay Marine Environment

Dredging will be required along the Cua Luc - Hon Mot Channel and within Bai Chay Bay. No information is available as to the planned locations for disposal of dredged sediments. Experience elsewhere in the world has indicated that sediment disposal can affect water quality in the area surrounding a disposal site and this can have flow-on effects for the marine fauna. It will be important to ensure that the Ha Long Bay environment is not affected, and a long-term plan to control any such effects will be needed.

9.2.3 The Tourist Industry

Concerns about the effect of port construction on the tourist industry include the potential effects if Bai Chay Bay water quality were to become degraded, the effects of increased shipping in Ha Long Bay on tourist traffic, and a possible change in the character of the area.

As noted in section 9.2.1 above, provided management methods are implemented at the outset of port development and applied to all other industries which may establish around Bai Chay Bay in the future (refer Chapter 10) the water quality in Bai Chay Bay will remain in a state fit for aquaculture, fishing, and contact recreation.

The port itself is well removed from the main tourist area. Indeed, road traffic to Cai Lan will pass via a separate route to traffic going to the tourist area and ferry. Increases in population due to the port development may be felt in Cai Lan and also in Bay Chay. However, this is likely to provide further stimulus to the local economy. Population increases both in permanent residents and the number of tourists will mean that together they will exert pressure for better services and facilities. As facilities develop to meet these requirements, some economy of scale may be evident and this can be seen as a likely positive effect for the local people. There may be some additional positive benefits to the tourist industry if passenger ships are attracted to the area by the improved facilities.

A further possible issue raised in connection with effects of the port on tourism, relates to a change in the nature of the Bai Chay - Hon Gai area. However, Hon Gai is already a busy port and the nautical flavour of this whole area is part of its charm. Thus while the number of ships passing through Cua Luc Strait will increase as Cai Lan Port is constructed, it can hardly be said that this will change the character of the area. Tourists in Ha Long Bay focus outward to the beauty of the islands and the perception of this will be unchanged.

A further point is that many large cities world-wide maintain flourishing ports and industries as well as a thriving tourist industry. Indeed the waterfront areas of many cities are becoming an increasing focus of tourism developments as people are attracted to the life and colour of the seafront. Promenades and restaurants can link the working areas of such ports with the more conventional tourist areas.

9.3 Benefits of Planning and Management

The benefits of careful forward planning of all constituents of the Cai Lan Port Construction Project have been emphasised in this assessment. The use of Management Plans to specify mitigation methods for all aspects of construction and operation are a key to this development's proceeding with the minimum possible environmental effect. These plans should be prepared during the detailed design phase of the project, prior to work beginning at the port.

It is also important to ensure that similar planning applies to the overall development of Ha Long City in future. Chapter 10 outlines the future developments which are known to be under consideration at present, and outlines a suggested approach for planning.

CHAPTER 10 FUTURE DEVELOPMENT OF HA LONG CITY AND ITS POTENTIAL ENVIRONMENTAL EFFECTS

10.1 Outline of Future Development

Ha Long City is entering a period of rapid economic expansion. To recap on the developments expected by the year 2000, by 2010 and after 2010 (from Chapter 10 of the Feasibility Study), the following are likely to occur:

Stage 1 - by 2000

- Development of the industrial zone of Gieng Day (building material and ship building).
- Canal development next to EPZ in existing estuary.
- Construction of Cai Lan Port (Phase I).
- Completion of:
    - 1 cement factory and associated port facilities.
    - A wheat mill factory.
    - A steel billet factory.
    - A fertiliser factory.
- Up-grade of Route 18.
    - Railway extension.
    - Cam Pha Port expansion.
    - Tourism development (4 - 5 major hotels in Bai Chay).
    - Residential area development.

Stage 2 - 2000 to 2010

- Development of Cai Lan Export Processing Zone (CLEPZ), the industrial zone of Dong Dang and the high-tech industrial zone.
- Construction of Cai Lan Port (Phase II).
- Completion of:
    - 2 cement factories.
    - 1 electric power plant (thermal).
    - Further up-grade of Route 18.
    - Development of direct railway line to Hanoi.
    - Removal of B-12 Oil Port to Ha Long Bay or Cam Pha.
    - Water supply and environmental hygiene project.

- Hon Gai Port redevelopment.

Stage 3 - after 2010

- Development of Cai Lan Port (Phase III - Giap khau area).
- Completion of new residential areas.
- Completion of tourism area development.
- Minh Thanh Airport completed.
- Coal ports (Sa To and Hon Gai Ports) moved to Cam Pha.
- Coal screening factory in Hon Gai moved to Cam Pha.

10.2 Potential Environmental Issues and Mitigation Approach

Clearly, during the development of each of the industries outlined above, there will need to be an environmental assessment phase and the development of environmental management methods for each factory or industrial development. Each of these proposals will need to be examined in the light of the overall plan for Ha Long City development. The broad environmental issues that are likely to arise as development proceeds are similar to those already discussed in relation to Cai Lan Port development.

In Chapter 9 of the Feasibility Study a plan is provided which will help minimise the effects of the overall development plans. This provides for the location of industries which are most likely to affect water quality and air quality, at a distance from Bai Chay Bay and from the residential areas. Also, some of the facilities which currently have an adverse effect on water quality in Cua Luc Strait, such as the Hon Gai and Ba Sa To coal ports and the B-12 Oil Port will be removed from Ha Long City in the long term.

Key issues that are likely to arise include:

Effects on Local Residents

The scale of developments planned is large. The northern part of the Bai Chay Peninsula will effectively be semi-industrialised by 2000 and fully industrialised by 2010. Residents living in this area will face great changes in their lifestyles over this period. It is important to ensure that the living requirements of local inhabitants can continue to be met. This must be factored into detailed plans to 2000 and into further planning to 2010 and beyond.

Air Quality

- Atmospheric emissions. At present the air quality in the area is good, and dust and exhaust gases are the only emissions of any note. Factories may in future emit other gases such as sulphur dioxide and nitrogen oxides and hydrogen sulphides. These will need to be controlled.

Bai Chay Bay Water Quality and the Mangrove Ecosystem

- Water use and water discharge. Initial estimations of water discharge for the projects listed in Chapter 10 indicate a total hourly discharge from the three cement plants, steel billet and steel plate factories, aluminium smelter, wheat mill, fertiliser plant and power plant of around 6,514 m^3 per hour (or 1.8 m^3 per second). The location of the discharges, especially of the larger discharges such as the steel plate factory and aluminium smelter will need to be carefully managed. Sediment deposition patterns could be affected which could affect the mangrove ecosystem. The effects of reducing the flow rate or volume of the water source will need to be carefully assessed.

- Canal development. Depending on the design of the channel and its intended use (connection to Ha Long Bay or simply as a localised transport option) the channel could affect sediment dynamics in Bai Chay Bay. Careful study of this will be required, also, investigation of the potential effects channel development could have on existing aquaculture in the estuary.

- Effluent discharge quality and receiving water criteria. The quality of water entering Bai Chay Bay will need to be carefully controlled and monitored, as already outlined in Chapters 7 and 8. Effluent criteria will need to be developed that will allow for the protection of this semi-enclosed environment. The aim will be to preserve the quality of Bai Chay Bay waters in a state that will allow for their continued use for aquaculture, fishing and human contact recreation.

- Waste management. Area-wide solid waste and sewage treatment and disposal methods will be needed to protect water quality and the health environment. Hazardous waste storage and disposal methods will also need to be developed.

- Contingency plans. Plans for disaster or emergency such as the oil spill contingency plans outlined in Chapter 8 will also need to be prepared. This may include planning for the eventuality of storm surges and seismic events.

Loss of Mangrove Ecosystem

- Further reclamation of the shoreline for development of future port facilities and other activities. The plan for Ha Long city provides for many activities to occur along or near to the northern shoreline of Bai Chay Bay. This is likely to include aquaculture as well as reclamation for development of agriculture. Plans for Stage 3 of the port development will focus on the Giap Khau area and there will be further loss of mangroves. It will be important to ensure that large enough areas of mangrove are retained to maintain the functioning of the Bai Chay Bay ecosystem as a fishery resource. Plans need to include areas where the mangroves are reserved for economic uses of the local inhabitants, and areas where no use is allowed. Some replanting and rehabilitation may be required, or mitigation measures such as development of mangrove plantations in areas outside of Bai Chay Bay. Bird sanctuaries and reserves will add to the ecological and tourism values of the area.

Loss of the Rural Nature of the Environment

- The importance likely to be placed on economic development may overshadow the need to maintain a livable, pleasant human environment. While economic progress is clearly a key concern, the quality of life values described in Chapter 4 should not be neglected. Provision of parks and reserves or wild landscape areas should be a part of planning for the future of Ha Long City. This has particular relevance to the local tourist industry development. Although the focus of the development will be on the attractions of Ha Long Bay, as services improve and the length of time tourists stay increases, they will look further afield than the Ha Long Beachfront. It will be important to maintain an attractive environment in Ha Long City generally, and especially in Bai Chay Bay.

Effects on Tourism

- The picturesque nature of the Bai Chay and Hon Gai may be altered as the traffic increases at the ferry area. It will be important to manage such changes with a view to retaining the special nature of this environment, both in terms of charm and function.

It may be possible to make a feature of Ha Long City's plan for future development with displays in public areas, or development of eco-tourism into a well-managed Bai Chay Bay environment.

10.3 Possible Management Methods

The key aim of planning for the development of Ha Long City is to ensure that tourism, port development, commercial / industrial and residential development can all co-exist in a manner that maximises the benefits to each sector. Ha Long City could be said to comprise two distinctive elements:

- The "inner marine" area comprising an extensive mangrove forest environment, within which the port and industrial / commercial areas with associated residential areas are proposed.

- The "outer coastal" area, comprising Ha Long Bay and the coastal islands, which constitute a tourist resource of national significance.

With careful forward planning and appropriate institutional arrangements, it should be possible to enable significant port and commercial development to occur, whilst at the same time ensuring that the tourism values can be protected and a successful tourist industry established. Key tasks which would need to be carried out to achieve the appropriate level of forward planning would be:

- Confirmation of the long term planning strategy for the area, including the zoning plan.

- Development of Environmental Standards and Management Plans specific to the Ha Long Bay and Bai Chay Bay areas.

- Establishment of an effective and practical Institutional Framework for implementing the standards and plans.

Provisional Environmental Guidelines have already been promulgated on a national basis. These would need to be tailored to the precise requirements of the Bai Chay Bay and Ha Long Bay environments, in the light of the industrial developments planned and the uses required of these waters. The Environmental Performance Standards required would need to cover:

- Atmospheric emissions.
- Noise.

- Water use.
- Effluent discharge criteria.
- Receiving water criteria.
- Waste management.
- Contingency planning.

To ensure that the Standards are properly observed, the Institutional Framework would need the following:

- An overall organisational structure for monitoring development, and to ensure compliance with the plans and standards.

- A practical system to control development, i.e., procedures forpermits and for such things as air and water discharges, water use etc.

10.4 Summary

Ha Long City has only recently been gazetted, and is now embarking on some important industrial developments for the economic advantage of the region. However, another of Ha Long City's primary objectives is to ensure that its already flourishing tourist industry can continue to successfully expand. Because Ha Long City is in its infancy, now is an important time in its development. Decisions made now as to the future directions the City will take, will influence its development for years to come. It is therefore crucial that careful attention be paid to environmental planning at this outset of development, to ensure that industries that establish do so in a way that does not undermine the sustainability of the environment and its many uses for future generations. The suggestions made above would provide a means for integrating environmental management into the city's future in a practical way.

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APPENDIX A-1

Terms of Reference for Preliminary
Environmental Impact Assessment for the
Proposed Cai Lan Port Construction Project.

APPENDIX I: TERMS OF REFERENCE FOR PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED CAI LAN PORT CONSTRUCTION PROJECT

1. Introduction

1.1 Purpose of Terms of Reference (TOR)

The purpose of the TOR is to describe the requirements for the preliminary Environmental Impact Assessment (EIA) for the Feasibility Study to be prepared by the sponsoring agency, Japan International Co-operation Agency (JICA). The EIA will be used by JICA and the Transport Engineering Design Institute of Vietnam (TEDI) to review and evaluate the environmental implications of the proposed project.

This EIA is intended to provide sufficient information for these agencies to understand the effects of the project on the environment. Thus they will be able to identify any environmental constraints and incorporate appropriate measures into the detailed design phase of the project to avoid, remedy, minimise and / or mitigate any negative effects of the development.

This EIA will form one component of a Feasibility Study for the development of Cai Lan Port. The Feasibility Study will address other issues, including the requirements for port development in Vietnam, alternatives for development and economic analysis. Therefore, this EIA will not address those issues except in summary form.

1.2 Project to be Assessed

The project to be assessed is the CAI Lan Port Construction Project.

1.3 Objectives of EIA

The objective of the preliminary EIA is to provide timely environmental information which can then be incorporated into the Feasibility Study to be completed in December, 1994.

The outcome of the EIA and the recommendations developed within can then be applied at the stage of detailed port design and during implementation of the project (construction and operation of Cai Lan Port).

2. Background Information

2.1 Location of Cai Lan Port

Cai Lan Port is situated in the Bai Chay district of Quang Ninh Province in Northern Vietnam. The port is approximately 150 km east of Hanoi City and 50 km east of Hai Phong Port.

The Port is within Bai Chay Bay, an estuary which covers an area of some 33 km^2. The estuary drains via Cua Luc Strait, approximately 2 km east-south-east of the port site. The port is situated on the landward side of a peninsula separating Bai Chay Bay from the coastal waters of Ha Long Bay.

A single berth structure has already been constructed at the site. Some buildings are present in the area of the port.

The immediate vicinity of Cai Lan is sparsely populated. Main centres of population are the Bai Chay area and the town of Hong Gai, which are on either side of Cua Luc Strait, the tourist centre and associated population in the area lining Ha Long Bay, and the Gieng Day area which is approximately 3 km west of Cai Lan.

2.2 Proposed Port Development

The port development will involve activities associated with port construction and port operation.

During the construction phase, activities are likely to include:

- Reclamation along the shoreline.
- Earthworks to supply fill for the reclamation, and to prepare the cargo handling and storage areas.
- Construction of quay walls, revetments and parapets.
- Dredging of the channel adjacent to the port.
- Construction of onshore facilities including offices, warehouses and utility areas, roads and railways.

Once the port is operational, activities are likely to include:

- Transportation of personnel and cargo to and around the port site.
- Activities associated with the handling and disposal of liquid and solid wastes and any hazardous materials.
- Activities associated with shipping movement through Ha Long Bay, Cua Luc Channel and Bai Chay Bay.

2.3 Scale of Development

By the year 2000, Cai Lan Port is expected to comprise 2 - 3 berths. Between 2000 and 2010, further development is expected to increase the size of the port.

2.4 Previous Investigations

An Initial Environment Evaluation (IEE) was carried out at the inception of the project by JICA. This provided a breakdown of factors which it was considered could be affected by the development. Factors were ranked according to the level of impact expected on each, according to JICA's guideline for environmental consideration. The results of the IEE have been incorporated into the EIA study.

3. Study Area

It is important to ensure that the EIA is properly focused onto the key areas which may be affected by different components of the port development project.

Different components of port development have the potential to affect the environment at varying geographical scales. These range from the local area of Cai Lan itself, at the smallest scale, to the broader extent of Bai Chay Bay, and in the largest context, to Ha Long Bay and Ha Long City.

The key components of the development project and the focus of assessment for each of these is as follows:

1. Construction Phase
   - Effects on the local Cai Lan area.
   - Effects on Bai Chay Bay.
   - Effects on any dredging disposal areas.

2. Port Operation Phase

Land-based	-	Effects on the local Cai Lan area.
	-	Effects on Bai Chay Bay.
Shipping activities	-	Effects on the local Cai Lan area.
	-	Effects on Ha Long Bay (particularly water quality and shipping traffic effects).

4. Scope of Work

The EIA will focus on port development up until the year 2000.

The time frame for collection and analysis of data and to prepare the EIA is limited. The level of information supplied in the EIA and the methods of assessment will reflect those limitations.

The EIA will be carried out as a preliminary assessment by environmental specialists, based on information supplied by the Vietnamese counterpart organisations Institute of Ecological Economy (EcoEco) and Transport and Engineering Design Institute (TEDI). The information supplied will include the following:

- Water quality surveys to be carried out in Bai Chay Bay and Ha Long Bay as per a contract between JICA and EcoEco.

- A sediment quality survey to be carried out in Bai Chay Bay and Ha Long Bay as per the above contract.

- Information about the physical, biological and social environment collected by EcoEco, under the terms of the same contract.

Additional information will be gathered by the environmental specialists during field visits to the study area.

Another factor of importance to this project is the likelihood of further development in the Ha Long City and Bai Chay Bay areas. This may include further port development and industrial development. While the EIA will focus mainly on the effects of port development to the year 2000, a discussion of the port development in the context of likely future development will be included in the EIA document. This will form only a small component of the total EIA document.

5. Tasks to be Carried out in EIA

5.1 Description of the Proposed Project

This will describe relevant components of the port development project, incorporating maps at an appropriate scale where relevant. The following information will be included:

- Location of the proposed port and the scale of development.
- Dredging required.
- Earthworks and reclamation.
- Facilities to be built onshore.
- Water resources required and proposed sources.
- Stormwater generation and disposal.
- Products to be stored and shipped.
- Hazardous substances to be stored and shipped.
- Solid and liquid waste generation and management.
- Traffic volumes predicted, and proposed routes (land and sea).
- Implementation plan and timing of development.
- Dust suppression measures to be employed.

- Hours of operation.
- Likely employment requirements for local workforce.

As noted in Section 12.4, the EIA will focus on activities which will occur up until 2000.

5.2 Description of the Existing Environment

This will include information about the following:

1. Physical Resources

   - Seabed topography and sediments.
   - Oceanographic conditions (tides, waves, currents).
   - Seawater quality and sediment quality.
   - Meteorological conditions (temperature, wind, rainfall, fog, storm events).
   - Seismicity.

2. Natural Resources

- Marine (plankton, benthic organisms, shrimp, squid, other economic species, spawning grounds, algae of economic importance, seabirds).

- Coastal (physical features, river influx and sedimentation regimes, biota, mangrove ecosystem and resources, coastal use for fisheries and recreation, shoreline types and sediments, aquaculture).

- Terrestrial (flora and fauna, landscape values, topography).

3. Social Environment

- Socio-cultural (population size density, distribution and demography, social structure organisation, cultural and religious areas of importance).

- Socio-economic (economic activities such as fishing, industry, farming, tourism, aquaculture, other land use, living standards, transportation network).

4. Wastes

- Liquid, solid and hazardous waste handling and disposal systems.

5. Disaster and Risk

- History of natural disasters and accidents.
- Storage of hazardous materials.
- Location of fuel depots, pipelines, transmission lines.
- Oil spill history and existing contingency measures.

5.3 Legislative and Regulatory Considerations

This will describe the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species.

The national law governing environmental matters is the newly enacted "Environment Protection Law" (1994) of Vietnam.

5.4 Determination of the Potential Effects of the Proposed Port

For each component of the project, the EIA report will identify significant positive and negative impacts, and immediate and long-term impacts.

5.5 Remediation and Mitigation Measures

The EIA will outline methods which should be incorporated at the design stage of port development to avoid, remedy, minimise and / or mitigate any negative environmental impacts of the project.

Recommendations will be made for management plans which may be required to implement the mitigation and remediation measures outlined.

Recommendations for further study will be made as necessary.

5.6 Monitoring Plan

Monitoring will be required to measure the success of any mitigation measures recommended in the EIA and to assess effects of the project on the environment. A monitoring plan will be recommended within the context of the EIA. If necessary recommendations may be made to include the design of a monitoring programme in management plans to be provided at the stage of detailed design.

6. EIA Document

The EIA document will be presented under the following broad section headings. These may change somewhat as information about the project becomes available:

- Introduction.
- Development activities involved in the port project.
- Description of the physical and biological environment.
- Potential effects of development on the physical and biological environment.
- Description of the social environment.
- Potential effects of development on the social environment.
- Mitigation.
- Monitoring proposed.
- Summary.

APPENDIX A-2

Detailed Information about
the Physical Environment

APPENDIX 2: DETAILED INFORMATION REGARDING THE PHYSICAL ENVIRONMENT

TEMPERATURE

Table A2-1: Temperatures (∞C) in Bai Chay (1974 - 1982).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	16.4	16.5	19.7	23.2	26.7	28.2	28.6	27.9	26.9	24.8	20.9	17.6
Maximum	27.9	28.9	32.3	30.3	34.8	35.9	34.5	35.0	33.6	31.5	30.3	27.5
Minimum	6.0	7.0	10.7	13.7	19.0	21.9	22.2	21.8	19.4	14.2	9.0	5.4

Source: TEDI 1988

RAINFALL

Table A2-2: Rainfall (mm) in Bai Chay (1974 - 1982).

	1974	1975	1976	1977	1978	1979	1980	1981	1982
Annual Rainfall	1,885	1,598	1,417	1,429	2,327	2,270	2,892	1,923	2,275

Source: TEDI 1988

Table A2-3: Rainfall and Rainy Days in Bai Chay (1974 - 1982).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Rainfall (mm)	22.5	25.5	23.8	112.7	266.8	269.8	346.2	463.4	262.7	145.7	48.9	14.0
Rainy Days	14	16	22	19	15	19	19	21	17	15	9	8

Source: TEDI 1988

FOG

Table A2-4: Mean number of fog days per month in Bai Chay (1974 - 1982).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Dense	0	0.5	0.8	0	0	0	0	0	0	0	0	0	1.3
Medium	0	2	4	0.5	0	0	0	0	0	0	0	0.5	7.0
Thin	9.1	10.2	17	8.0	0.5	0	0	0	0.3	0.3	2	2	49.4

Source: TEDI 1988

WIND

Table A2-5: Percentage frequency of wind at Hon Gai Station (1960-1990).

A. WINTER

Wind Velocity ($m\ s^{-1}$)	Calm	Direction								
		N	NE	E	SE	S	SW	W	NW	Total %
0	14.6									14.62
1 - 5		19.5	16.9	9.5	12.0	11.0	1.42	0.18	6.80	81.86
6 - 10		4.29	1.50	0.46	0.46	0.22	0.11	0.09	0.34	7.46
11 - 15		0.48								0.48
16 - 20		0.06								0.06
21 - 25										
Total %	14.6	24.4	18.4	9.97	12.4	11.2	1.53	0.27	7.14	

B.SUMMER

10 (m/s)	Calm	Direction								
		N	NE	E	SE	S	SW	W	NW	Total %
0	10.9									10.9
1 - 5		16.8	10.6	6.7	18.3	13.3	3.1	0.6	0.7	79.8
6 - 10		3.10	1.66	0.27	1.24	1.31	0.37	0.07	0.71	8.7
11 - 15		0.27	0.06	0.02	0.03	0.02	0.07	0.02	0.05	0.60
16 - 20		0.06	0.01		0.01	0.03	0.01		0.01	0.1
21 - 25					0.01					0.01
Total %	10.9	20.2	12.2	7.00	20.3	14.6	3.55	0.70	10.5	

Source: DCQNP: General Department of Meteorology and Hydrology.

TYPHOONS

Table A2-6: Records of typhoons in Northern Vietnam (1975 - 1984).

Date	Name	Area Affected by Typhoon	Maximum Wind Speeds
June 19.1975	-	Hai Phong	NE-24 m/sec
Aug 10, 1975	-	Quang Ninh	S-24 m/sec
Aug 21,1977	Sanah	Hai Phong	NE-51 m/sec
Aug 28,1977	Etaine	Mong Cai	WNW-19 m/sec
Oct 2, 1978	Ida	Quang Ninh	NNE-32 m/sec
Aug 3, 1979	Hope	Bien Gioi Viet Trung	NE-25 m/sec
Jun 28, 1980	Herbert	Quang Ninh	WSW-24 m/sec
Jul 23, 1980	Joe	Quang Ninh / Hai Phong	S-35 m/sec
Aug 10, 1981	Roy	Hai Phong	-
Aug 20, 1981	Warren	Hai Phong	ESE-26 m/sec
Sep 16, 1982	Iwong	Quang Ninh	NE-28 m/sec
Jul 18, 1983	Vere	Hai Phong/Quang Ninh	- 40 m/sec
Apr 26, 1984	Wynne	Hai Pong/Quang Ninh	- 25 m/sec

Source: TEDI 1988

STORM SURGES

Staff from the Centre for Marine Mechanics, Institute of Mechanics, have characterised the storm surge regime along the Quang Ninh - Mon Cai Shoreline, as part of a UNDP Project (VIE/87/020) running from 1988 to 1991. The information is based on the following:

i) Statistics on typhoons and sea water levels during typhoons.

ii) Field surveys for measuring the maximum sea water levels of typhoons over the period 1985 - 1990.

iii) Hindcast of the sea water levels at stations in the marine hydrometeorological network along the shoreline for typhoons of the period 1960 to 1990.

iv) Forecast of the possible maximum typhoon surges on the basis of the above.

Items iii) and iv) above have been estimated based on the numerical solution of shallow water 2-D non-linear equation system for the description of sea water level changes (as well as the current velocity fields) under the typhoon wind stress at the sea surface. The analytical model of typhoons used in the project includes an asymmetrical component and appears to be the most robust when compared with other international published models. The results obtained for the Quang Ninh - Mong Cai area are as follows.

Occurrence of Typhoons and Tropical Depressions

Of 144 typhoons and tropical depressions which affected the shoreline of the Bay of Tonkin during the period 1960-1990, 37 landed on the Quang Ninh Mong Cai Shoreline. They occurred between June and October, with the maximum number recorded in August (Table 5-9).

Table A2-7 Monthly percentage frequency of typhoons and tropical depressions over the period 1960 - 1990.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Frequency (%)	0	0	0	0	0	13.5	21.6	32.5	21.6	10.8	0	0

Source: Centre of Marine Mechanics

Surge Characteristics

Among the 100 storm surges which landed on the Gulf of Tonkin Shoreline between 1960 to 1990, 50 % were lower than 0.5 m; 38 % were between 0.5 m and 1 m; 5 % were from 1 m to 1.5 m; 6 % from 1.5 m to 2.0 m; and 2% were between 2 m and 2.5 m. Based on the available information the maximum storm surge height is predicted to be 2.5 m.

The duration of a storm surge ranges from around 12 to 30 hours, although most last for less than 24 hours. The average duration is 7 hours. The duration of the top of the surge, where the surge is greater than or equal to 90 % of the maximum, is approximately 2 hours. The surges tend to diminish at a rate 1.5 times longer than the rate of increase.

Maximum Storm Surges Recorded

The maximum measured storm surge recorded between Hon Gai and Mon Cai was 1.2 m during typhoon Carmen-63 at Mui Chua Station, approximately 35 km up the coast from Hon Gai. At Hon Gai the maximum recorded was 0.9 m during typhoon Kim-70. It must be noted that the Stations do not record on a continuous basis and some typhoon events may not be recorded.

Older records from the Bai Chay Weather Station (TEDI 1988) indicate that the highest previous level at Hong Gai Port recorded prior to 1960 was in 1942 (maximum 0.8 m). The local people report that high water level reached between +6.00m and +6.60m when a typhoon approached Hong Gai in 1985 (interview between Environmental Specialist and local people). This may be somewhat exaggerated as this level is 3 m above mean high water level and 0.5 m above the level predicted to be the maximum.

The height of storm surges within Bai Chay Bay have not been recorded. Although Cua Luc Strait is some 500 m across, the mouth of Bai Chay Bay may well act to dampen the magnitude of storm surges within the bay. However, the clear conclusion to be drawn from this information is that Cai Lan Port is located in an area substantially influenced by water surges caused by typhoons.

Table A2-8: Relationship Between Wind and Waves at Bai Chay (1965 - 1968).

Date	Wave Direction-Wave Height	Wind Direction-Wind Speed
1962	W - 1.5m	W - 12 m/sec
1963	SW - 2.5m	SW - 24 m/sec
1964	W - 2.5m	SW - 28 m/sec
1965	SE - 0.75m	SW - 12 m/sec
1966	SE - 0.75m	S - 7 m/sec
1967	NE - 1.0m	N - 14 m/sec
1968	SW - 0.75m	-
1969	SSE - 0.75m	WNW - 12 m/sec
1970	NE - 0.75m	NNE - 8 m/sec
1971	SE - 0.75m	SE - 8 m/sec

Source: TEDI 1988.

Table A2-9: Annual average percentage frequency of waves at Hon Gai Station.

Wave Height ($m\ s^{-1}$)	Direction								Calm	Total
	N	NE	E	SE	S	SW	W	NW		
0.25 - 0.50	2.84	1.79	0.24	2.04	1.58	0.49	0.04	0.47		9.49
0.51 - 0.75	1.42	0.35	0.15	0.78	1.26	0.29	0.12	0.10		4.46
0.76 - 1.00	0.21	0.10	0.02	0.05	0.09	0.07		0.01		0.46
1.01 - 1.50	0.04	0.01		0.01	0.04	0.06				0.12
1.51 - 2.00					0.01					
Total %	4.50	2.25	0.41	2.88	2.98	0.86	0.16	0.58	85.40	100

Source: DCQNP: General Department of Meteorology and Hydrology; Institute of Water Resources and Environment.

SEDIMENTS

Table A2-10: Monthly suspended solids and sediment flow in three rivers in Quang Ninh Province.

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Bình Liêu													
SS (g m^{-3})	27.6	30.0	30.1	54.5	102	74.4	82.8	72.9	60.5	31.4	23.0	23.6	70.5
R (kg s^{-1})	0.145	0.13	0.13	0.68	1.89	3.12	5.44	4.75	2.61	1.02	2.30	1.43	2.134
Duong Huy													
SS (g m^{-3})	9.3	7.4	9.7	14.5	36.9	37.9	30.8	49.4	34.8	23.7	13.5	8.7	46.6
R (kg s^{-1})	0.005	0.003	0.002	0.021	0.09	0.32	0.30	0.54	0.45	0.08	0.02	0.004	0.150
Bàng cả													
SS (g m^{-3})	27.9	18.5	17.5	32.0	145.7	77.6	43.6	78.1	41.4	24.4	11.3	11.8	93.6
R (kg s^{-1})	0.015	0.009	0.01	0.037	0.705	0.58	0.25	0.92	0.22	0.15	0.01	0.008	0.218

Source: DCQNP: Institute of Water Resources and Environment.

Notes : SS = Suspended solids; R = Sediment flow.

Table A2-11: Average sediment discharge in three rivers in Quang Ninh Province.

Catchment-basin of rivers	Area of catchment (km^2)	Discharge (kg s^{-1})	Total (tonnes) x 10^3	Coefficient of erosion
Bình Lieu	505	2.134	67.30	133 tonnes/km^2
Duong Huy	52	0.150	4.73	91 tonnes/km^2
Bàng Cả	85	0.218	6.875	81 tonnes/km^2

Source: DCQNP: Institute of Water Resources and Environment

APPENDIX A-3

Equipment and Methods used in
Water and Sediment Surveys,
February and June 1994.
Institute of Marine Mechanics
Hanoi.

APPENDIX 3: EQUIPMENT AND METHODS USED IN WATER AND SEDIMENT SURVEYS, FEBRUARY (WINTER) AND JUNE (SUMMER) (FROM REPORT BY INSTITUTE OF MARINE MECHANICS, HANOI, 1994).

1. List of Equipment and Instruments Used

No	Items	Producer	Quantity
1	Bathometer	Russian	4
2	Reversing thermometer	--	8
3	Water pump	Germany	1
4	Hydrographic winch	Russian	2
5	Thermometer	UK	2
6	Secchi disk	Russian	2
7	Bottom sampler	China	2
8	Insolate sample carrier	Germany	2
9	Water quality checker-20A	Japan	1
10	Marine sextant	Germany	2

2. Methodology

2.1 Site Location

Location of the sampling site has been made by the navigation method using morphological feature of the surveyed and two marine sextants.

2.2 The Standards Used

All of the procedures are sampling, storing, transporting and analyzing have been followed by:

1. The Vietnamese Standards TCVN 4556-88-4583 for examination of water and waste water. Hanoi. VN 1986 and 1983.

2. APHA (American Public Health Association).
   Standard methods for the examinations of water and waste water. Sixteenth edition 1985. Prepared and published jointly by APHA, AWWA, APCF.

2.3 Sampling and Storage

Plastic bottles of 300 ml capacity were cleaned with HCl solution 10 % rinsed thoroughly with distilled water. Before collecting samples, rinsed twice the bottles with sampled water.

1. The samples for determination of PO_4^{-3} and total phosphor were stored by addition of $CHCl_3$ (1 ml of $CHCL_3$ to 1000 ml of sample).

2. The samples for determination of Petroleum, SO_4^{-2}, total Sulfur were kept by acidifying with concentrated cloric acid (HCl) to pH = 2 (1 ml of HCl to 1 liter of sample).

3. The samples for determination of H_2S were kept by adding 0.1 ml Cadmium acetate 0.01 N to 100 ml of samples.

4. For determination of E. coli, BOD and COD use the glass bottle of 100-125 ml capacity with ground stoppers.

   The bottles were cleaned with a detergent and rinsed throughly and dried at 105℃ for 2 hours.

   The stoppers have been opened just before use. For E.coli Samples after filling the water to bottles the bottles and stoppers were burned. Stoppers were fixed by paraffine. All of the bottles were stored in a refrigerator in order to keep the temperature below 4℃.

5. Bottom sediment samples were kept in clean polyethylene bags. All of the samples both water and sediment ones have been labeled.

2.4 The Methods for Determination of Chemical Attributes and E.coli of the Sea Water

1. Determination of BOD:

   Measure DO before adding sample in to bottle. Keep a sample in the air incubator at 20℃ + 1℃ for 5 days, excluding all light.

Measure DO after incubation.

The BOD is computed from the difference between initial and final DO.

2. Determination of COD:

Determine COD by the bichromate method using Ag_2SO_4 as the Catalyses and $HgSO_4$ for eliminating influence of the Ion C1-. Boil the reactive mixture by the Kendan apparatus for 24 hours till residual amount of $K_2Cr_2O_2$ by the Mor Salt Solution of 0.1N.

3. Determination of the Petroleum Amount:

Extract petroleum by tetrachloride Carbon (CCl_4). Dry organic faze.

Measure absovbence with the apparatus IR-470 (SHIMADZU-Japan) at = 2600 - 3200 cm^{-1}.

4. Determination of Suspended Solid:

Shake thoroughly water sample. Take 1000 ml of sample. Filter sample through the blue tape paper filter (before used the paper filter is weighted to constant weight by an analytical balance with 0.0001 g accuracy). Dry the filter with the remains at 105°C until constant from the difference between the initial and the final weights.

5. Determination of SO_4^{-2}:

Determine amount of SO_4^{-2} by the gravimetric method. Precipitate SO_4^{-2} in to the form of $BaSO_4$ by the Solution of $BaCl_2$ in the HCl medium. Filter $BaSO_4$ through the paper filter without ashes. Clean thoroughly with distilled water. Transfer to a muffle furnace and keep temperature at 600°C for 2 hours. Weigh the finding and analytical balance with accuracy of 0.0002 g.

6. Determination of Total Sulfur:

Oxidise all of Sulfur forms in to SO_4^{-2} form by H_2S_2. Determine the SO_4^{-2} form by the gravimeter method as the determination of SO_4^{-2}.

7. Determination of Ions $PO^4{}_{-3}$:

Transfer $PO^4{}_{-3}$ into the yellow complex with $(NH_4)_6\ MO_7O_{24}$ in the H_2SO_4 medium. Product the yellow complex to the green complex by ascorbic acid and catalysis $[K(SbO)\ (C_4H_4O_6)]$. Measured absovbance at = 882 nm.

8. Determination of Total Phosphor:

Evaporate 200 ml of sample till 20 ml. Transfer all of the organic form of phosphor into inorganic form PO_4^{-3}. Determine PO_4^{-3} from by the colormetric method as the determination of ion PO_4^{-3}.

9. Determination of H_2S:

Determination amount of H_2S by the colormetric method. Transfer ion HS- into the color complex with reagent sodium Nitro Prusiate in the medium with pH: 8-9.5. Measure absovbence at = 620 nm. Check by the voltammetric method.

Precipitate S^{-2} into CdS by accurate amount of the Cd $(CH_3COO)_2$ solution.

Determine amount of free ion Cd^{+2} by the voltammetric method. Compute amount of Cd in the CdS form and receive H_2S.

10. The Method for Determination of E.Coli Bacterial:

+ Inoculate 25 tubes of lactose broth medium with various volumes of test water and incubate at 37°C for 24 - 48h.

+ Transfer all caltures that show acid reaction or acid and gas reaction to brilliant green lactose bile broth for 24h incubation at 42-0.5°C.

+ Transfer all positive tubes into 2 following medium
  - Pepton broth.
  - Endo agar.

+ Record the number of indole positive tubes and endo positive dishes and compute it in term of MPN (most possible number).

2.5 The Method for Determination of Chemical Attributes of Bottom Sediment

1. Determination of the Loss on Ignition:

   Weigh 10 g of sediment sample after drying in an analytical balance with 0.0002 g accuracy. Transfer into muffle furnace and heat the sample at 750°C to a white ash. Cool to room temperature in an axicater. Weigh again the ash by an analytical balance with 0.0002 g accuracy. Compute the difference between the initial and the final weights.

2. Determination of the Loss on Drying:

   Separate completely water from the sample by a centrifugal machine. Weigh 100 g of sample by a balance with accuracy of 0.001 g. Dry at temperature 105°C until constant weight. Cool the sample to the room temperature in an exicater. Weigh it by an analytical balance with 0.0002 g accuracy.

3. Determination of the Heavy Metal Amounts:

   Digest the sample by nitric acid and sulfuric acid mixture. Determine As, Hg by Adsorptive Stripping Voltammetry. Transfer a part of the obtained solution into HC1 medium and determine Cd, Pb by atomic Absorption Spectrophotometry.

4. Determination of COD:

   Determine COD by the bichromate method, using Ag_2SO_4 as the catalysis and $HgSO_4$ for elimination the influence of ion Cl-.

5. Determination of Total Sulfur:

   Using Na_20_2 for transferring the oxidation of all of the sulfur forms into SO_4^{-2} form. Determine SO_4^{-2} by the gravimetric method.

6. Determination of Total Phosphor:

   Digest sample by the HF + HNO_3 mixture in the platinum cup.

Transfer ion PO_4^{-3} into the yellow complex with $(NH_4)_6MO_7O_{27}$ in the H_2SO_4 medium. Using Sb (III) and ascorbic acid for the reduction of the yellow complex into the green complex measure absovbence at = 882 nm.

7. Determination of Poly-Aromatic Hydrocarbon P.A.H.:

Apparatus: Fluoresence Detector-Shimadzu RF530.

Method: High performance liquid chromatography analytical.

Conditions:

+ Column 4.6 mm x 25 cm lichromsorb (si60).
+ Mobile phase: n hexane + i propanol (98120).
+ Flow rate: 1.0 ml / min.
+ Temperature: 25°C.