ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
FOR DREDGING OF GANH HAO – GIA RAI CANAL

Ho Chi Minh city, February 2005
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CHAPTER ONE

POLICY LEGAL AND ADMINISTRATIVE FRAMEWORK FOR IMPLEMENTATION OF ENVIRONMENTAL IMPACT ASSESSMENT

The Vietnam Inland Waterways and Port Rehabilitation Project has set up an Environmental Impact Assessment (EIA) Report, which has been approved by the Ministry of Science, Technology and Environment (MOSTE) in March 1999.

At present, this project has been expanded an Additional Dredging Works of the Ganh Hao - Gia Rai extension canal. Following the guidelines of Vietnam and the World Band (WB), this environmental impact assessment (EIA) for the additional works is prepared.

1.1 OBJECTIVES OF THE ENVIRONMENTAL IMPACT ASSESSMENT

This EIA report is to clarify the issues as follows.

- Brief description of the additional works of the project.
- Brief description of the existing environment of the additional sites of the project and its surroundings.
- Identification, assessment and prediction of main impacts that the project may cause to the environment in the phases of pre-construction, construction and operation.
- Proposal of an Environmental Management Plan (EMP) including measures for mitigating the negative impacts, and an environmental monitoring program for the project.
- Recommendation of public consultation for the project.

1.2 LEGAL AND POLICY FRAMEWORK

1.2.1 World Bank Policy on Environmental Assessment

The Project is classified as a Category B project and therefore a detailed EIA report is not required but an Initial Environmental Examination (IEE) and EMP. The World Bank’s policy on conducting EIA is to follow Operational Policy 4.01:
Environmental Assessment (January, 1999). This describes guidance on Bank’s policies and procedures for conducting environmental assessments of proposed projects.

Additional World Bank policies that were considered through the EA process for this project include:

- **OP 4.04 Natural Habitats**
- **OP 4.11 Cultural Property**
- **BP 17.50 Public Disclosure**

1.2.2 Vietnamese Policy and Administrative Framework on Environmental Assessment

- **Vietnamese Policy Framework**

Vietnam’s most relevant environmental policies for environmental assessment are as follows:

*Law on Environmental Protection (LEP)* was enacted in January 1994

The LEP:

- Identifies the responsibilities of the state centre, provinces, organisations and individuals to prevent and remedy environmental deterioration and pollution and carry out specified environmental protection functions;

- Provides for the development of environmental standards and submission of environmental impact assessment reports on new and existing facilities;

- Provides for responsible parties to pay compensation for environmental damage;

- Establishes the right of individuals and organisations to petition for enforcement of environmental regulations;

- Calls for civil and criminal penalties for violations; and

- Encourages international environmental co-operation.

*Decree 175/CP* was promulgated in October 18, 1994 by the Government to guide implementation of the LEP and provides broad guidelines for division of responsibility among Ministries; environmental impact assessments; pollution prevention and disaster control; sources of finance; and environmental inspections and standards.

*Circular No. 490* was promulgated in April 29 1998 by the MOSTE to provide guidance on setting up and appraising environmental impact assessment reports for investment projects. The Circular identifies the legal requirements according to the
stages of implementation of a project and its category; defines the content of project subject to the EIA procedures; and specifies management of the EIA report appraisal.

Law on Forest Protection (1992), this law regulates forest management, protection, development, and exploitation, prevention of wood-cutting, and forest destruction. It also encourages individuals and organisations to protect and develop forests.

Decree 24/2000/ND-CP specifies the implementation on the Law on Foreign Investment in Vietnam (Article 82) concerning environmental protection as follows: 1) enterprises with foreign investment capital and joint ventures are obligated to observe regulations, satisfy standards in environment protection, and comply with Vietnam legislation on environment protection; 2) if investors apply international advanced environmental standards these standards should be registered with MOSTE.

Decree 52/1999/ND-CP was appended to include environmental considerations for construction management as follows: 1) for PFS, Provision 3 of Article 23 stipulates that requirements for environment study relating to the “selection of construction sites, estimation of land use area needed, in ways which comply to the principle of minimizing land use and environmental and social impacts, and resettlement to the lowest possible level”. 2) Provisions 4 and 7 of Article 24 stipulate that FS must propose “specific site options (or regions, routes) which much match with construction plans (including documents on site selection, together with proposed solutions for minimizing environmental and social impacts)”, and “architectural alternatives, construction solutions, preliminary designs suggested for selection, environment management and protection solutions”. 3) For technical design: Section B, Provision 1, Article 37 and Section A, Provision 2, Article 38, contain regulations on appraisal and approval of “techniques for the protection of environment and ecology; for prevention and combating of explosion and fire and for occupational safety and industrial sanitation.”

Decree 26/1996/CP provides regulations on the punishment of administrative violation of Environmental Protection Law. Chapter 1 describes the general provisions for punishment under the Environment Protection Law. Chapter 2, Article 6 details recommended punishments for parties who violate environmental pollution and prevention act. These punishments include financial penalties for not submitting an EIA report.

Vietnam Standards for the Environment (TCVN) are national standards published by MOSTE in 1995, 2000 and 2001 and applied to all government and non-government agencies, organisations and companies. The Vietnamese environmental standards include acceptable limits of pollutants in ambient air, air emission, surface water, ground water, waste waters, soils, etc. In general the list of physical-chemical parameters are broad enough such that most monitoring programmes can employ the standards for of evaluation. There are some exceptions - for example,
sediment, biological, and vibration standards do not yet exist. In these cases, it is common practice for ODA projects to use standards from other countries or international organisations.

- **Vietnamese Administrative Framework**

The Government of Vietnam is in the process of creating a new administrative framework for environmental management. For the Additional Works Project, the framework’s relevant institutes are as follows:

**Ministry of Natural Resources and Environment (MONRE).** MONRE was established by a Prime Ministerial Decision on November 11, 2002. This new ministry includes four vice-ministers, 16 departments, one newspaper, and one magazine. MONRE merges numerous departments from several national agencies. These are outlined in Decree 91/2002/ND-CP: *Providing for the functions, duties, powers and organisational structure of the Ministry of Natural Resources and the Environment*.

**Environmental Impact Assessment and Appraisal Department.** This Department is under MONRE. According to Decree 91/2002/ND-CP, the Department’s function includes: *To appraise environmental impact assessment reports of projects and of business and production establishments*. Environmental Impact Assessment and Appraisal Department is guided by the Vietnam’s established regulatory framework: i.e. LEP, Circular 490, CP 175, etc.

**Provincial Departments of Natural Resources and Environment (DONRE).** Each provincial DONRE houses an Environmental Management Division (EMD). The EMD is responsible for ensuring environmental protection and management of provincial matters in accordance with LEP, Decree 175, and Circular 490. Hence, it is DONRE - and in particular, its EMD - that will likely play a key regulatory role during project construction and operation.

**1.3 EIA ORGANISATION**

The Project Owner (PMU - Waterway) in collaboration with the EPC of the Vietnam Environment & Sustainable Development Institute has conducted various field surveys on the natural and socio-economic environment, sampling, analysis of environmental samples, desk studies and prepared EIA report. Various meetings with the project effected households (PAHs) and representatives of local organizations were held during the EIA study process.
1.4 CONTENTS AND METHODOLOGY OF EIA

1.4.1 Study area

- Area of water quality sampling and analysis: Ganh Hao – Gia Rai canal.

- Data on meteohydrology were collected from the Meteohydrological Stations in the Mekong Delta.

1.4.2 Content of EIA study

- Collection of the existing data on: meteohydrology, topography, soils, biological resources, socio-economy at the project area.

- Field surveys, sampling and analysis of water, soils, sediment, air quality and aquatic organisms.

- Desk study on prediction, assessment of the potential impacts and measures for impact mitigation.

- Preparation of an Environmental Management Plan (EMP) and EIA Report.

1.4.3 Methodology applied in this EIA

The following methods are applied for this environmental impact assessment.

- **Judgment**

Judging possible impacts by the project on the natural and socio-economic environment on the bases of international documents and experience.

- **Checklist**

The relationships between the influences of each activity of the project and each environmental matter are revealed on the check list, on which further studies into impacts are oriented.

- **Matrix**

Matrixes are set up for initial definition of the impact level of activities of the project on each environmental component.
• **Rapid assessment**

Methods of rapid assessment applicable to source of pollution in conjunction with air, land and water, prepared by Economopoulos, and issued by the WHO in 1993.

• **Public consultation**

Organizing public consultation for environmental impact assessment. In this process of public consultation procedure was followed the WB guideline.

1.5 **CLASSIFICATION OF IMPACTS**

In this study, the anticipated negative environmental impacts are classified into five categories: “major”, “moderate” “minor”, practically “not significant” or “no impact” and “unknown impacts”.

- A “major impact” can change an element of the environment or create a strong environment modification. Such an impact can strongly affect an environmental component and/or on a large group of the population.

- A “moderate impact” can change a part of the environmental component or creates a moderate environmental modification. Such an impact can significantly affect an environmental component or on a group of the population.

- A “minor impact” may slightly change value or use of an environmental component. Such as impact can slightly affect an environmental component or a small group of the population.

- A “not signification or no impact” may not significantly chance value or use of an environmental component. Environmental assessment will not be detailed but some commentaries may be given for this type of impacts.

- Some activities of the project may cause some impacts but the magnitude of the impacts can not be predicted. This type of impacts is identified as “unknown impact”.

In each type of impacts, there are “negative” and “positive” ones.

Beside the 5 categories, each impact may be assessed as “mitigable”, “controllable” or “uncontrollable”, “local”, “temporary”, “short-term” or “long-term”, depending on the intensity and scale of the impact.

Based on the impact classification in the Environmental Management Plan different measures will be recommended to mitigate different types of impacts.
- **No impact** or **No significant impacts**: These impacts do no need to have measures for mitigation.

- **Minor and moderate impacts**: For this type of impacts, the appropriate measures for mitigation should be developed.

- **Major impacts**: it is necessary to have more detailed information and quantification of impacts, and measures for mitigation have to be designed more carefully during project preparation and construction.

- **Unknown impacts**: it is necessary to have further study to know the nature and scale of the impact.
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OUTLINE OF THE PROJECT FOR ADDITIONAL DREDGING OF
THE WATERWAY SECTION OF GANH HAO – GIA RAI

2.1 TITLE

The project for additional dredging of the waterway section of Ganh Hao – Gia Rai is a part of the project for upgrading two southern waterways and Can Tho port.

2.2 INVESTOR

The Project Management Unit for Waterway Projects (PMU) – the Ministry of Transport, 131 Nguyen Trai, District 5, Ho Chi Minh City.
Tel.: 8365148, Fax: 8365149

2.3 NECESSITY OF INVESTMENT

The investment in dredging of the waterway section of Ganh Hao – Gia Rai will create favorable conditions for the inflow of goods to the two inland waterways, and at the same time, contribute to the socio-economic development of Ca Mau peninsula.

2.4 OUTLINE OF TECHNICAL SPECIFICATIONS

Technical specifications such as the depth, width, straightening, and curving of the canal as well as the new system of marking buoys for the two extended waterways are designed so as to meet standards on canal grade III (Vietnamese standard 5664 - 1992). The investment in dredging of the waterway section of Ganh Hao – Gia Rai will create favorable conditions for the inflow of goods to the two inland waterways.

The main contents of the project are as follows:

(i) Upgrading the canal of Ganh Hao – Gia Rai, which is 53.7km long and necessitate the dredging volume of 1,910,000 m$^3$.

(ii) Upgrading the signaling system so as to streamline the waterway.

Dredging:
- The section from Ganh Hao to Gia Rai (from the juncture of Luong The Tran canal to Gia Rai), 53.7km in length, in order to meet the technical specifications
applicable to rivers and canals of grade 3 with adjusted depth (B1 = 22m; LAD= 2,7m; clearance 7.0 m) with two sub-sections:

(i) The sub-section overlapping the Ganh Hao river: about 7 km long, from the juncture of Luong The Tran canal (Km 336 + 800 EX) to the juncture of Ganh Hao – Bac Lieu canal – Ca Mau; dredging volume: 150,000 m$^3$.

(ii) The sub-section overlapping Bac Lieu canal – Ca Mau: from the juncture with the Ganh Hao river to the juncture of Cong Cai Cung canal (Gia Rai district, Bac Lieu province): 46.7 km long; dredging volume: 1,760,000 m$^3$.

- Dredging is for deepening without expanding.

**Signaling system:**

- A complete signaling system is invested to secure the streamline and safe traffic on the waterway in both daytime and nighttime.

**Dredging method:**

The soils to be dredged are both acid sulphate and non-acid sulphate, dredging therefore includes the jobs as follows:

- The dredged soil should be discharged to spoil relocation areas (SRAs), which are designed specifically therefore and sufficiently large.

- The acid sulphate soil discharged to SRAs should be covered with and thereby maintained under a 0.5 m-thick layer of non-acid sulphate soil. This is also to prevent acid sulphates from crystallization on soil surface.

- SRAs should be embanked with protective dikes and the water therefore should be controlled. Protective dikes should be 0.5 m higher than the discharged soil.

- A ditch should be built around mud yards for collecting muddy water. It should be connected with the main irrigation ditch for driving both muddy water and rainwater back to the waterway.

**a) Spoil relocation areas**

The function thereof is to mitigate the negative impacts of mud and dredged soil on the environment. Most dredged soil is disposed in dike-protecting SRAs so as neither to neither damage crops and plants nor leak muddy water to canals. SRAs are designed with two parts, one for storing and another for settling.

SRAs are designed optionally according to the available land. Although their dimension and shape are not fixed, mud yards should have protective dikes as given
in Fig. The dike body (particularly at the points on deep pits or ponds) should be reinforced with cajuput stakes and bamboo grids.

b) Selection of position for SRAs:

Because the dredging will expand the left bank of the canal of Ganh Hao – Gia Rai (in opposite to National Road 1), SRAs should be positioned on the left bank. They should be positioned every 1,000 m from each other and at most 500 m from the bank. The area of a SRA may be 1 – 2 ha.

SRAs should be positioned at hollow regions, where agriculture is neither easy nor effective. Detailed matters in relation with positions of SRAs will be solved and the damages resulted from using the land as SRAs will be determined during implementation of the project.

2.5 WORK SCHEDULE

<table>
<thead>
<tr>
<th>Section</th>
<th>Date</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Sub-section on the Bac Lieu canal – Ca Mau</td>
<td>3/2005</td>
<td>8/2005</td>
</tr>
</tbody>
</table>

2.6 COMPENSATION AND REHABILITATION

2.6.1 Outline of the project-affected people (PAP)

There are 4 households determined as the PAP, who reside in Ward 7, Ca Mau City, Ca Mau province, in details as follows:

1. Household of Mr. Huynh Cong Dung
2. Household of Mr. Phung Ngoc Mai
3. Household of Mr. Cao Tu Hung
4. Household of Nguyen Binh Thuy

2.6.2 Main occupation

Their main occupation is petty trading alongside the canal. On average, a household has 6 people, of which 4 are in working ages.

2.6.3 Residential house – trading house

The houses – shops of the PAP have structures from house grade III to wooden houses on stilt.
List of houses of the PAP

<table>
<thead>
<tr>
<th>No.</th>
<th>(PAP code)</th>
<th>(Full name of households)</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CM-TPCM-P7-K7-01</td>
<td>Huynh Cong Dung</td>
<td>32,00</td>
</tr>
<tr>
<td>2</td>
<td>CM-TPCM-P7-K7-02</td>
<td>Phung Ngoc Mai</td>
<td>50,00</td>
</tr>
<tr>
<td>3</td>
<td>CM-TPCM-P7-K7-03</td>
<td>Cao Tu Hung</td>
<td>24,00</td>
</tr>
<tr>
<td>4</td>
<td>CM-TPCM-P7-K7-04</td>
<td>Nguyen Binh Thu</td>
<td>8,00</td>
</tr>
<tr>
<td></td>
<td>Total (4 households):</td>
<td></td>
<td>474,00</td>
</tr>
</tbody>
</table>

2.6.4 Public works
- In the project site there is no public work.
- The PAPs reside near public works in the city (no further than 1 km).

2.6.5 Residence
The PAP have resided there long time ago.

2.6.6 Family income
Of the total, two have had high income and one is wage earner with the average income of VND 1 million per month.

2.6.7 Ethnic class
There are 3 PAPs of Kinh people and 1 PAPs of Chinese people residing alongside the canal.

2.6.8. Predictions of impacts
The negative impacts by dredging and installing the signaling system are shown in the following table:

<table>
<thead>
<tr>
<th>Item</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loss of land</td>
</tr>
<tr>
<td>DREDGING</td>
<td>(none)</td>
</tr>
<tr>
<td>NAVIAD INSTALLING (Old position)</td>
<td>(none)</td>
</tr>
</tbody>
</table>

2.6.9 Estimated expenses on compensation and financial support
## CHAPTER TWO

<table>
<thead>
<tr>
<th>NO.</th>
<th>ITEM</th>
<th>ESTIMATED EXPENSE (VND)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOTAL:</td>
<td>215,616,000</td>
</tr>
<tr>
<td>1</td>
<td>COMPENSATION FOR HOUSE</td>
<td>199,380,000</td>
</tr>
<tr>
<td>2</td>
<td>FINANCIAL SUPPORT</td>
<td>13,050,000</td>
</tr>
<tr>
<td>3</td>
<td>OTHERS:</td>
<td>3,186,000</td>
</tr>
<tr>
<td></td>
<td>+ PAYMENT TO COMPENSATION COMMITTEE AND FOR PREPARATION OF COMPLEMENT PLAN (1%)</td>
<td>2,124,000</td>
</tr>
<tr>
<td></td>
<td>+ APPROVAL CHARGE (0.5%)</td>
<td>1,062,000</td>
</tr>
</tbody>
</table>
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THE EXISTING ENVIRONMENT IN THE PROJECT SITE

3.1 THE PROJECT SITE

The waterway links Bac Lieu province with Ca Mau province. The project site starts from An Trach commune in Dong Hai district let to the Ganh Hao River in Ca Mau City. The canal section to be dredged is about 25 km long and the dredging will give condition for local economic development. A diagram showing the project site is given in Fig. 3.1.

3.2 NATURAL CONDITIONS

3.2.1 Topography

As a wetland, Ca Mau Province has a low and comparatively plan terrain (average altitude: 0.6-1.5m) which is always suffered the influence of the sea and inundated in the rainy season. It is defined that wetland are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 meters (UNEP). Wetlands include the regions temporarily or frequently inundated such as rice field, waterlogged forest, mangrove forest or surfaces of lake, river and the like. Ca Mau has a wide wetland area (mangrove forest and acidic water logged melaleuca forest) with very specific natural ecosystems.

Over the project site (the section of Ganh Hao – Gia Rai), the topographical features include waterlogged area during the flood tide and well irrigated thank to large tidal amplitude and big rivers as discharge channels to the sea. The region incurs saline intrusion over the whole section all year round and even in the end of the rainy season, salinity of the river water is still high.

Ca Mau has a system of interlacing rivers and canals with many estuaries such as Ong Doc, Bay Hap, Ong Trang, Bo De, and Ganh Hao, etc. The rivers there have the water regime dependent on the tidal characteristics of the sea and create a well-developed system of waterway.

3.2.2 Climate

Ca Mau is located in the Mekong Delta then it suffers the influence of tropical monsoon. The air convection in the delta influenced mainly by NE and SW winds, forming two distinctive seasons, the rainy season from May to October (concurring with the W and SW), and the dry season from December to March (concurring with
the E and NE). April and November are the two transitions between the two seasons. In the rainy season there usually is a sunny of 2 to 3 weeks in August or September that is called the draught of “Ba Chang”.

- **Temperature**

The annual average of temperature in Ca Mau in 2000 is 27.3°C and relatively stable in the period from 1997 to 2000.

The temperature variation in the hottest and the coldest months is within 4°C, whereas the temperature difference between the daytime and the nighttime is large, about 8 -10°C in the dry season. The highest temperature is 38.3°C and the lowest 15.3°C.

The total temperature accumulation is approximately 8,500 -10,000°C.

- **Rainfall**

Because of geographical factors, the distribution of rain in Ca Mau varies together with not only the season but also the locations of regions from Southwest to Northeast.

The rainfall is high but its distribution in a year is uneven with the rainfall in the rainy season making up more than 90% of the total.

The rainfall in Ca Mau is usually the highest in the Mekong Delta, varying from 1,500 to 2,300 mm, being divided in 3 distinctive regions, namely the west with the highest rainfall of 1,500-2,300 mm, the center 1,500-1,800 mm and the east with the lowest, approximately 1,500 mm.

- **Average humidity and evaporation**

The annual average humidity in Ca Mau is 85.2 %, higher than other regions such as Rach Gia (82%). The annual average of evaporation in Ca Mau is approximately 992mm. The changes in climate parameters in Ca Mau over many years are shown in Table 3.1.

**Table 3.1 Data of changes in climate parameters in Ca Mau over many years**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average of temperature</td>
<td>26.9</td>
<td>27.19</td>
<td>27.9</td>
<td>27.0</td>
<td>27.3</td>
</tr>
<tr>
<td>Average of humidity</td>
<td>83.8</td>
<td>83.3</td>
<td>81.25</td>
<td>83.6</td>
<td>82.8</td>
</tr>
<tr>
<td>Sunny hours (hours)</td>
<td>1,960.5</td>
<td>2,233.3</td>
<td>2,232.5</td>
<td>1,918.5</td>
<td>2,019.6</td>
</tr>
<tr>
<td>Rainfall (mm/year)</td>
<td>2,771.5</td>
<td>2,547.9</td>
<td>2,595.7</td>
<td>3,459.7</td>
<td>2,629.7</td>
</tr>
</tbody>
</table>

CHAPTER THREE

3-3
3.2.3 Hydrology

- Hydrological characteristics of Ca Mau province

Ca Mau is under two tidal regimes. The hydrological regime is clearly different between the eastern and the Western coasts (Ca Mau has 254 km of coast, of which the Eastern makes up 107 km and the Western 147 km). The interference of the Eastern Sea with the semi-diurnal tide and the Western sea with the diurnal tide gives favorable conditions for biodiversity and advantages for regions of environmental sensitivity and high-value of biota sources. Particularly, the formation of the swamps in the West of Ngoc Hien district that moves forwards to the sea contributes to the expansion of land and development of wetland ecosystems.

The tidal regime of the Western and Eastern seas controls almost all the rivers in the province (except for Quan Lo Phung Hiep, an area newly freshened in 1997 - 1998). However, the tidal regime of the Eastern has stronger influence than that of the Western one. A study into the movement of water in rivers shows that water flows mainly from the Eastern Sea to the Gulf of Thailand because the water level in the Eastern Sea is higher.

Table 3.2 Main rivers in Ca Mau province

<table>
<thead>
<tr>
<th>No.</th>
<th>Main rivers</th>
<th>Length (km)</th>
<th>Width (m)</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ganh Hao</td>
<td>56</td>
<td>60-200</td>
<td>5-14</td>
</tr>
<tr>
<td>2</td>
<td>Cua Lon</td>
<td>58</td>
<td>600</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>Dam Doi</td>
<td>45</td>
<td>200</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Main rivers flowing into the Eastern sea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bay Hap</td>
<td>50</td>
<td>250</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Ong Doc</td>
<td>60</td>
<td>300</td>
<td>4</td>
</tr>
</tbody>
</table>

- Hydrological characteristics of the project site

The canal of Bac Lieu – Ca Mau incurs the strong influence of the tidal regime of the Eastern Sea as well as the hydrological regime of the Ganh Hao River.
3.3 LAND

3.3.1 Land use

-Agricultural land:

The area of agricultural land changed significantly in 2001 with the soaring of land for aquaculture (mainly shrimp farming) and the drop of the areas for cultivation of rice and industrial crops.

-Forestry land:

Forest land in Ca Mau includes mangrove forest and melaleuca forest, respectively 61.6% and 38.4% of the total. In details, it is distributed in districts of Ngoc Hien with 50,723 ha, U Minh 32,499 ha, Dam Doi 7,985 ha, Tran Van Thoi 8,124 ha, Thoi Binh 99 ha, and Cai Nuoc 5,386 ha. Forest over 50% at Ngoc Hien and 34.2% at U Minh districts.

-Specific land:

The area of specific land in the province in 2000 was 17,024 ha. In 2001, it was expanded by 3,000 ha to 19,500 ha, mostly by the use of land for irrigation, transportation, construction, national defense and construction of cemeteries.

-Residential land:

The area of land for settlement is on the rise because of the increasing population and urbanization. By the end of 2000, this kind of land covered 5,501 ha, accounting for 1% of the total land. It can be divided into two types:

- Urban land: mainly in Ca Mau City (636 ha) and small areas in districts,
- Rural land: 4,865 ha, in details, it consists of 930 ha in Ngoc Hien, 900 ha in Tran Van Thoi, 602 ha in U Minh, 867 ha in Thoi Binh, and 852 ha in Dam Doi. Rural land in the province is usually located along canals and roads.

-Unused land: While the residential and specializing land is expanding, the unused land is shrinking. In 2000, unused land in Ca Mau covered 40,769 ha, which was not concentrated by scattered alongside canals, interposing in agricultural land, including saline - or acid - contaminated land, warp and the like. In details, it included 3,696 ha in U Minh, 2,748 ha in Dam Doi, 1,386 ha in Thoi Binh, 5,148 ha in Cai Nuoc and 3,982 ha in Tran Van Thoi district.

The changes in land over years are shown in Table 3.3.
Table 3.3  Changes in areas of curious kinds of land over years

<table>
<thead>
<tr>
<th>Kind of land</th>
<th>2000 (ha)</th>
<th>2001 (ha)</th>
<th>Increase/decrease (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural</td>
<td>351,345</td>
<td>347,196</td>
<td>- 4,149</td>
</tr>
<tr>
<td>Forestry</td>
<td>104,816</td>
<td>109,687</td>
<td>+ 4,871</td>
</tr>
<tr>
<td>Residential</td>
<td>5,501</td>
<td>5,710</td>
<td>+ 209</td>
</tr>
<tr>
<td>Specializing</td>
<td>17,072</td>
<td>19,525</td>
<td>+ 1,307</td>
</tr>
<tr>
<td>Unused</td>
<td>40,769</td>
<td>38,535</td>
<td>- 2,234</td>
</tr>
</tbody>
</table>

Source: Data from report on land use plan in 2001, Department of land Administration.

3.3.2  Kinds of soil in Ca Mau province

From statistical data it is possible to divide land in Ca Mau province into 4 groups of soils as follows:

- **Saline soil**

Accounting for 28.84% of the total, this cover 150,278 ha, of which 82,351 ha has medium salinity, 57,987 ha has low salinity and heavy salinity is found in the remainder, which further includes the land under wetland. Wetland is distributed mainly in the coast of the Eastern Sea and the South of Ca Mau, in districts of Dam Doi, Cai Nuoc, Ngoc Hien and Tran Van Thoi.

The saline soil in the province has similar fertility. The content of organic matter is medium to low (<4.2% OM), the total nitrogen is low (<0.2% N), and in opposite, the total phosphorus is higher than other kinds of land in the region (>0.08%), the total potassium is very high in the inundated saline land (>0.15% K₂O) and low in the slightly saline land (<0.6% K₂O).

Pertaining to mechanical physical characteristics, almost all kinds of saline soil have the same size distribution with the dominance of clay (50-60%). Consequently, in the dry season land is chapped and salt (NaCl) is brought to the surface layer by capillarity.

- **Acid sulfate soil**

This covers some 334,925 ha, accounting for 64.27% of the total. This soil has a constraint for use, because of its toxic ingredients such as Al³⁺, Fe²⁺, SO₄²⁻ ... It is also saline in the dry season and influenced by the tidal inundation. According to I.P. Abrol, and CP. Moclu (1985), under tropical conditions, the accumulation of Fe and Al cat ions in this kind of soil gradually increases and the cat ions combine
with ions such as Cl, SO$_4^{2-}$ forming acidic salts Fe$_2$(SO$_4$)$_3$, Al$_2$(SO$_4$)$_3$, FeCl$_3$ … and all may cause environmental impacts.

Acid sulfate soil in Ca Mau can be further divided into two sub-groups, namely potential and actual ones, the former covers 147,039 ha, accounting for 47.409% of the province and the latter 87,886 ha and accounting for 16.866%.

This soil, however, has high potential fertility with the rich organic content of 4-12% OM equivalent, high total nitrogen (N: 0.2-0.3%), potassium (0.5-2%), and comparatively low phosphorus (0.04-0.09%). The high contents of alkaline cations, inclusive of Ca$^{2+}$, Mg$^{2+}$ mean the soil incurs the influence of saline water.

Acid sulfate soil in Ca Mau is distributed mainly in districts of U Minh (43,853 ha), Thoi Binh (66,307 ha), Tran Van Thoi (30,508 ha), Dam Doi (44,783 ha). In Ngoc Hien and Cai Nuoc, the area of acid sulfate soil is smaller.

The acid sulfate soil in U Minh, where is also a great source of peat, usually located under the peat layer, at the depth of 1-3 m, equal to the underground water level in the dry season. Therefore, exploitation of peat may release acid sulfates and cause pollution as a result of oxidation of pyrite to jarosite.

- **Peat soil**

Covering 2.03% of the province, this is considered a big mine of organic minerals. It was formed thank to natural conditions with vegetations buried and inundated anaerobically for a long time. However, this resource has decreased out quickly due to destruction of mangrove forest (U Minh forest) and up to now, its reserve is as small as 40-50 million tons (compared with 300 million tons in the past), mostly in U Minh plantations 1, 2, 3 and Tran Van Thoi plantation.

Peat in Ca Mau was formed from marsh in the form of bed and riverbed. A study with geological drills shows that:

- At the depth of 0-0.5m, it is brown, light, soft and mixed with vegetation bodies.
- From 0.5 to 1m, it is black and sometimes under which is a layer of vegetation decay.
- From 1 to 3m is a layer of sticky pasty wet bluish gray clay with vegetation decay.

Under the peat layer is usually the layer of potential sulfate acid soil with high pyrite (FeS$_2$), which, in the reaction under the sun and with oxygen in the air is oxidized easily to jarosite, acidifying the surrounding water and soil. This phenomenon is very popular in the areas where peat is exploited, exposed to the air or where fire of woods occurs.
- **Swampy soil**

This is the soil newly formed along the coast. It covers some 9.057 ha, accounting for 1.82% of the province. It concentrates mostly in districts of Ngoc Hien (7.632 ha), and Cai Nuoc (1.875 ha). Together with the formation of swamps the formation and development of the wetland vegetation populations occur, which are also favorable conditions for the reproduction and growth of brackish and saline fish species. Therefore, it is essential to protect strictly the originality of the saline swamps for the quick formation of wetland ecosystems in the coast of Ca Mau.

The velocity of encroachment of swamps on the sea over periods is as follows:

- 1930-1965: 15.3 m/year
- 1965-1985: 26.6 m/year
- 1985-1991: 38.2 m/year
- 1991-1998: 30 m/year

On average, the expansion of swamps is 136 ha per year.

### 3.4 FOREST RESOURCES

Due to various reasons, by far there remains only a limited area of natural forest in Ca Mau. The existing is mostly newly planted or secondary exhausted forest with low reserves and small areas. Furthermore, the 5th Storm (Linda storm) in 1997 destroyed at least 5,000 ha of rich forest with half a million of trees then the forests in Ca Mau remain no more than 1,495,986 m³, i.e. 15.8 m³/ha on average. Plantation and restoration of forests are frequent and active tasks of local authorities. The production and the policy on allocation of forest land to inhabitants have been new economic motives. However, the quality of forest has dropped drastically and the property of forest was fully changed. In recent years, forestation and restoration have received special attention from leaders of the province and obtained many results. The changes in forestation in Ca Mau province over years are as follows:

#### 3.4.1 Biodiversity of Ca Mau wetland

In Ca Mau, up to 98% of 5,211 km² of the wetland is inundated, seasonally or permanently, with natural ecosystems as follows:

- Wetland,
- Marsh and waterlogged forest,
- Estuary.

Each ecosystem has specific value and functions but all these ecosystems are very sensitive, any change in environmental conditions will break up their stability.
The wetland has large vegetation and wild animal diversities, stable function of coastal protection and consolidation. The mangrove forest develops on tidal marshes, forming tree walls, protecting the coastline against the erosion of waves and destruction of flood. It is also the reproduction places of fish, amphibians, reptiles, mammals and birds species.

The waterlogged forest provides for local peoples wild animals and vegetation with fresh or brackish water species all year round. It limits the acidification of soil, creating a thick vegetation carpet, preventing the oxidation of pyrite layers. With stable sufficient water, it gives places for fish to lay eggs, others to reside and local inhabitants can live on it by jobs such as breeding fish, shrimp and bee, making coal, etc. Overall, it provides for local residents with raw materials, food, entertainment and jobs.

The estuarine ecosystem is one of the most diverse and aggressive one. However, it is also easily polluted by the human activities and changes in water regimes.

3.4.2 Flora

According to data provided by the Center for Mangrove Forest Research and Application of Minh Hai, the total species of vegetation of ecosystems in Ca Mau province are 239 of 76 families, of which:

- Fern: 19 species of 09 families.
- Dicotyledonous: 139 species of 51 families, including:
  - Xylophyte: 43 species of 21 families
  - Shrub: 17 species of 10 families
  - Liana: 24 species of 10 families
  - Herbage: 55 species of 15 families
- Cotyledons: 81 species of 16 families, including:
  - Gramineous: 68 species of 15 families
  - Liana: 03 species of 2 families
  - Xylophyte: 03 species of 01 families

Those species mainly distribute on the two ecosystems, namely the mangrove forest and the melaleuca forest. There are some species that can live in both regions. In both ecosystems, species can be present over the whole forest, including the tidal water logged regions and the high impacted land, i.e. degenerated with no forest.

The reduction of area and quality of the forests is the main cause of the decrease in biodiversity and vegetation.
3.4.3 Fauna

The most diverse wild animal species in Ca Mau are aquatic ones including fish, crustacean, mollusk, amphibian and reptile and particularly birds, and water birds. The biodiversity of animals is high. The species of wild animals observed in Ca Mau province is tabulated in Table 3.4

Table 3.4: Species of wild animals in Ca Mau province

<table>
<thead>
<tr>
<th>List</th>
<th>Number of species</th>
<th>Mangrove forest</th>
<th>Melaleuca forest</th>
<th>Listed in Vietnam Red Data Book</th>
<th>Export-prohibited</th>
<th>Conditionally exported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphibian</td>
<td>11 sp., 5 families</td>
<td>06 sp., 4 families</td>
<td>11 sp., 05 families</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Reptile</td>
<td>41 sp., 15 families</td>
<td>34 sp., 14 families</td>
<td>30 sp., 14 families</td>
<td>11 sp.</td>
<td>1 sp.</td>
<td>5 sp.</td>
</tr>
<tr>
<td>Bird</td>
<td>182 sp., 38 families</td>
<td>124 sp., 35 families</td>
<td>96 sp., 32 families</td>
<td>14 sp.</td>
<td>1 sp.</td>
<td>5 sp.</td>
</tr>
<tr>
<td>Animal</td>
<td>36 sp., 17 families</td>
<td>28 sp., 13 families</td>
<td>21 sp., 12 families</td>
<td>7 sp.</td>
<td>4 sp.</td>
<td>8 sp.</td>
</tr>
</tbody>
</table>

Source: Dang Trung Tan, Overall Assessment Report on Wild Animals in Ca Mau, May 2001

Species of wild animals distribute differently in 2 ecosystems: mangrove forest and melaleuca forest.

The melaleuca forest has diverse species composition and number. According to a study of the EPC and WWF in 1998: in the Vo Doi forest there were 12 amphibian species, 32 reptile species, 100 bird species, and 18 mammal species. Besides, there were some rare and precious species such as boar, monkey, and birds. Now animals in melaleuca forests decrease significantly in quantity. No more tiger, panther, and deer are found and there are only a very small number of birds listed in the Vietnamese Red Data Book.

In Ca Mau province there were 21 bird sanctuaries, of which 1 is semi-natural, 3 abandoned (Dam Doi, Cha La, and Ho Thi Ky) and 3 uninvestigated. In general, the sanctuaries are owned by local inhabitants, who, unfortunately, have poor aware of natural resource management, and therefore no aware of protection. Besides, careless hunting and exploitation of forest for sale or making shrimp ponds did eradicate 10 bird sanctuaries. Some rare bird species which years ago existed in Ca Mau such as Pelecanus onocrotalus, Ibis leu cocephalus, Leptoptilos dubius are no longer observed.
However, some migrant bird species choose Ca Mau to live. The saline swamps which now is returned to be a natural system, will be attractive to aquatic bird species because foods at the swamps are abundant.

3.5 PRESENT ENVIRONMENTAL STATE OF THE PROJECT SITE

3.5.1 Water quality of the canal of Ganh Hao – Gia Rai

Analyzing results of water of the canal of Ganh Hao – Gia Rai in December 2004 is shown in Table 3.5.

Table 3.5 Analyzing results of quarter of the canal of Ganh Hao – Gia Rai (December, 2004)

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Unit</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>CM1</td>
</tr>
<tr>
<td>1</td>
<td>Temperature</td>
<td>°C</td>
<td>29.5</td>
</tr>
<tr>
<td>2</td>
<td>PH</td>
<td></td>
<td>7.22</td>
</tr>
<tr>
<td>3</td>
<td>NaCl</td>
<td>mg/l</td>
<td>2816.8</td>
</tr>
<tr>
<td>4</td>
<td>Turbidity</td>
<td>NTU</td>
<td>121</td>
</tr>
<tr>
<td>5</td>
<td>SS</td>
<td>mg/l</td>
<td>54</td>
</tr>
<tr>
<td>6</td>
<td>DO</td>
<td>mg/l</td>
<td>3.7</td>
</tr>
<tr>
<td>7</td>
<td>BOD₅</td>
<td>mg/l</td>
<td>11.3</td>
</tr>
<tr>
<td>8</td>
<td>COD</td>
<td>mg/l</td>
<td>19.7</td>
</tr>
<tr>
<td>9</td>
<td>NO₂</td>
<td>mg/l</td>
<td>0.009</td>
</tr>
<tr>
<td>10</td>
<td>NO₃</td>
<td>mg/l</td>
<td>0.71</td>
</tr>
<tr>
<td>11</td>
<td>NH₄</td>
<td>mg/l</td>
<td>0.29</td>
</tr>
<tr>
<td>12</td>
<td>N</td>
<td>mg/l</td>
<td>5.60</td>
</tr>
<tr>
<td>13</td>
<td>P</td>
<td>mg/l</td>
<td>2.4</td>
</tr>
<tr>
<td>14</td>
<td>Zn</td>
<td>mg/l</td>
<td>0.05</td>
</tr>
<tr>
<td>15</td>
<td>Al</td>
<td>mg/l</td>
<td>0.78</td>
</tr>
<tr>
<td>16</td>
<td>Cd</td>
<td>µg/l</td>
<td>0.16</td>
</tr>
<tr>
<td>17</td>
<td>Ni</td>
<td>mg/l</td>
<td>0.09</td>
</tr>
<tr>
<td>18</td>
<td>Hg</td>
<td>µg/l</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>19</td>
<td>T. Coli</td>
<td>MPN/100ml</td>
<td>11.000</td>
</tr>
<tr>
<td>20</td>
<td>F. Coli</td>
<td>MPN/100ml</td>
<td>900</td>
</tr>
</tbody>
</table>
Comment

Considering the aforementioned analyses, it is possible to bring out some comments on the water quality of the section of Ganh Hao – Gia Rai as follows:

- **Turbidity**

Turbidity measured along the river was 115-167 mg/l. It was high at almost all measuring points.

- **Suspended solid (SS)**

The total suspended solid measured in the river was in the range of 35 – 54 mg/l. As such, the concentration of suspended solid in the river still met the Vietnamese Standard (TCVN 5942-1995 stipulates it at 80 mg/l for Source Class B), which is shown in Annex 3.1.

- **Dissolved oxygen (DO)**

The measured concentration of dissolved oxygen met the Vietnamese standard (TCVN 5942-1995 stipulates on Source Class B at ≥2mg/l).

- **Nitrous, nitrate and ammonia concentrations**

The nitrate concentration (NO$_3^-$) varied in the range of 0.42-0.87 mg/l, which is still acceptable according to the Vietnamese Environmental Standard (TCVN 5942-1995, stipulates it at < 10mg/l).

The nitrous concentration (NO$_2^-$) varied in the range of 0.005 to 0.009 mg/l, lower than the Vietnamese Environmental Standard (TCVN 5942-1995 on Source Class B is 0.05 mg/l).

- **Organic pollution**

The COD concentration of the river met the Vietnamese Standard (TCVN 5942-1995: <35mg/l).

The BOD concentration measured in the river was lower than the Vietnamese Standard (TCVN 5942-1995: <25 mg/l).

- **Total Coliform**

All monitoring points showed high concentrations of coliforms, even higher than the Vietnamese Standard on Source Class B (TCVN 5942-1995: 10,000 MPN/100ml) at several points.
- **Pollution due to heavy metals**

Measuring data showed that the concentrations of all heavy metals in water of the river section of Ganh Hao – Gia Rai were lower than the Vietnamese Standard (TCVN 5942-1995).

### 3.5.2 Quality of sediment at the project area

Monitoring parameters for evaluation of sediment quality in the pre-construction phase include:

- Particle size
- Heavy metals in sediment

The results of analysis in sediment quality at the project area are shown in *Table 3.6* and *Table 3.7*.

**Table 3.6: Analyzing results of particle size in sediment quality**

<table>
<thead>
<tr>
<th>Sites</th>
<th>&gt; 0.1 (mm)</th>
<th>0.1 – 0.05 (mm)</th>
<th>0.05 – 0.01 (mm)</th>
<th>0.01 – 0.005 (mm)</th>
<th>&lt;0.005 – 0.001 (mm)</th>
<th>&lt; 0.001 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM1</td>
<td>0.72</td>
<td>3.67</td>
<td>35.27</td>
<td>17.41</td>
<td>28.53</td>
<td>14.40</td>
</tr>
<tr>
<td>CM2</td>
<td>0.93</td>
<td>3.63</td>
<td>32.54</td>
<td>21.56</td>
<td>28.63</td>
<td>9.98</td>
</tr>
<tr>
<td>CM4</td>
<td>0.67</td>
<td>8.21</td>
<td>29.30</td>
<td>19.64</td>
<td>22.57</td>
<td>19.61</td>
</tr>
<tr>
<td>CM5</td>
<td>0.69</td>
<td>4.78</td>
<td>34.26</td>
<td>22.34</td>
<td>31.46</td>
<td>6.47</td>
</tr>
</tbody>
</table>

**Table 3.7: Content of heavy in sediment**

<table>
<thead>
<tr>
<th>Site</th>
<th>Cr (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Cd (mg/kg)</th>
<th>Hg (μg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM1</td>
<td>56.4</td>
<td>34.7</td>
<td>21.7</td>
<td>1.06</td>
</tr>
<tr>
<td>CM2</td>
<td>32.7</td>
<td>28.9</td>
<td>16.4</td>
<td>2.15</td>
</tr>
<tr>
<td>CM4</td>
<td>64.5</td>
<td>61.5</td>
<td>17.3</td>
<td>1.86</td>
</tr>
<tr>
<td>CM5</td>
<td>39.6</td>
<td>37.3</td>
<td>12.8</td>
<td>1.63</td>
</tr>
</tbody>
</table>

*Source: Table 3.6, 3.7: EPC – VESDEC, Dec.2004*

The obtained data shows that the concentration of heavy metals such as Pb, Cr, Hg in the project area is relative lower than the Dutch Standard for Sediment (Appendix 3.2). However, to assess the impact to water environment, aquatic life and aqua farming in the operation phase, the project will monitor the contamination of heavy metals in water canal to inform timely to the local authorities.

### 3.7 ACID SULFATE SOIL
At December 2004, soil along the route of 60km of the Ganh Hao-Gia Rai canals were sampled and analyzed by the TEDI. The results are as follows:

- **Locations of soil sampling:**

1. At cross section (MC 1) LKI- 1: at the Lung Hamlet area
2. At cross section (MC 2) LKII- 2: near Noc Nang bridge
3. At cross section (MC 3) LKIII- 3: near the Cay Dua bridge
4. At cross section (MC 4) LKIV- 4: at Xang canal
5. At cross section (MC 5) LV- 5: at Hamlet 5 – Ward 6, near Ca Mau air port.
6. At cross section (MC 6) LKIV- 6: at the T-junction of Ganh Hao river and Bac Lieu – Ca Mau canal.

- **Profile descriptions:**

1. **Profile: mc1- LKI- 1:**

+ Position: Lung Hamlet area.

+ Date: 02-12-2004

+ Status: Fresh soil.

<table>
<thead>
<tr>
<th>No</th>
<th>Stratum depth (cm)</th>
<th>Stratum</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00 – 0.500</td>
<td>1a</td>
<td>Grayish black clay mud with semi-decomposed vegetation</td>
</tr>
<tr>
<td>2</td>
<td>0.500- 2.400</td>
<td>2</td>
<td>Grayish blue clay, grayish brown, with little of organic matters, in status from liquid to suspended matter.</td>
</tr>
</tbody>
</table>

Name: Medium latent acid sulfate soil - Acid sulfate stratum starting from hollow to deep places.

2. **Profile: mc2- LKII- 2:**

+ Position: Noc Nang bridge area.

+ Date: 3-12-2004
+ Status: fresh soil

<table>
<thead>
<tr>
<th>No</th>
<th>Stratum depth (cm)</th>
<th>Stratum</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00 – 0.400</td>
<td>1a</td>
<td>Grayish black clay mud with organic matters</td>
</tr>
<tr>
<td>2</td>
<td>0.400- 4.400</td>
<td>2</td>
<td>Grayish blue clay, grayish brown, with little of organic matters, in status from liquid to suspended matter.</td>
</tr>
</tbody>
</table>

Source: EPC – VESDEC, Dec.2004

Name: Medium latent acid sulfate soil - Acid sulfate stratum starting from hollow to deep places.

3. **Profile: mc3- LKIII-3:**

+ Position: Near Cay Gua bridge area
+ Date: 5-12-2004
+ Status: fresh soil

<table>
<thead>
<tr>
<th>No</th>
<th>Stratum depth (cm)</th>
<th>Stratum</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00 – 0.400</td>
<td>1a</td>
<td>Grayish black clay mud with organic matters, sand and impurities.</td>
</tr>
<tr>
<td>2</td>
<td>0.400- 4.400</td>
<td>2</td>
<td>Grayish blue clay, grayish brown, with little of organic matters, in status from liquid to suspended matter.</td>
</tr>
</tbody>
</table>

Source: EPC – VESDEC, Dec.2004

Name: Medium latent acid sulfate soil - Acid sulfate stratum starting from hollow to deep places.

4. **Profile: mc4- LKIV- 4:**

+ Position: Xang canal area.
+ Date: 7-12-2004
+ Status: fresh soil
### CHAPTER THREE

#### No Stratum depth (cm) Stratum Description

<table>
<thead>
<tr>
<th>No</th>
<th>Stratum depth (cm)</th>
<th>Stratum</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00 – 1.200</td>
<td>1a</td>
<td>Humus with organic matters, grayish black, with sand and semi-decomposed vegetation</td>
</tr>
<tr>
<td>2</td>
<td>1.200 - 4.400</td>
<td>2</td>
<td>Grayish blue clay, grayish brown, mixed organic matter, in status from liquid to suspended matter.</td>
</tr>
</tbody>
</table>

Source: EPC – VESDEC, Dec.2004

Name: Medium latent acid sulfate soil - Acid sulfate stratum starting from hollow to deep places.

#### 5. Profile: mc5-LKV-5:

- **Position:** Near Hamlet 5 – Ward 6, near Ca Mau airport.
- **Date:** 8-12-2004
- **Status:** Fresh soil

<table>
<thead>
<tr>
<th>No</th>
<th>Stratum depth (cm)</th>
<th>Stratum</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00 – 0.800</td>
<td>1a</td>
<td>Humus with organic matters, grayish brown, grayish blue, grayish black – with sand and semi-decomposed vegetation</td>
</tr>
<tr>
<td>2</td>
<td>0.800 - 4.400</td>
<td>2</td>
<td>Grayish blue clay, grayish brown, mixed organic matter, in status from liquid to suspended matter.</td>
</tr>
</tbody>
</table>

Source: EPC – VESDEC, Dec.2004

Name: Medium latent acid sulfate soil - Acid sulfate stratum starting from hollow to deep places.

#### 6. Profile mc6-LKVI-6:

- **Position:** at the T-junction of Ganh Hao river and Bac Lieu – Ca Mau canal.
- **Dated:** 10-12-2004
- **Status:** newly dug soil
### Table 3.5.3: Composition of phytoplankton

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Number of species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanophyta</td>
<td>10 sp.</td>
<td>21.7%</td>
</tr>
<tr>
<td>Bacillariophyta</td>
<td>30 sp.</td>
<td>65.2%</td>
</tr>
</tbody>
</table>
Considering the species composition, it is possible to remark as follows:

- The group of dominant saline species include *Cyclotella stylorum*, *Coscinodiscus asreromphalus*, *Coscinodiscus radiatus*, *Coscinodiscus subtilis*, *Chaetoceros compactum*, *Biddulphia obtusa*, *Triceratium favus*, *Synedra ulna*, *Nitzschia sigma*, *Nitzschia lorenziana*, *Pyrophacus horologium* …

- Cyanophyta – a phylum living in fresh water is not observed in the section of Bac Lieu – Ca Mau during this sampling.

- The species indicating a nutrient-rich environment include all *Cyanophyta* species, *Cyclotella stylorum*, *Coscinodiscus subtilis*, *Chaetoceros compactum*, *Synedra ulna*, *Nitzschia longissima*, *Nitzschia sigma* and also 5 *Euglenophyta* species.

- There are few species indicating the saline acidic land such as *Phormidium tenue*, *Arthrospira gomontiana*, *Eunotia tautonensis*.

- The species present in almost all sampling points such as *Oscillatoria sp1*, *Oscillatoria sp2*, *Phormidium tenue*, *Cyclotella stylorum*, *Coscinodiscus subtilis*, *Nitzschia longissima*, *Nitzschia sigma* are typical of a nutrient-rich environment.

- The number of phytoplankton species tends to increase along with the direction from Bac Lieu to Ca Mau, i.e. in accordance with the population density alongside the canal.

- The density of phytoplankton in the section of the section of Bac Lieu – Ganh Hao is low, approximately 600.000 – 4.050.000 cells/m$^3$, maybe due to the fact that disturbed water hinders the growth of phytoplankton. The species typical of a nutrient-rich environment are dominant, including *Desmogonium*, *Nitzschia longissima*, *Coscinodiscus radiatus*, *Oscillatoria lemermannii*, *Cyclotella sp.*
Zooplankton

In the investigation of the section of Bac Lieu – Ganh Hao in December 2004, the species composition of zooplankton was obtained as follows (Table 3.9).

Table 3.9: Composition of Zooplankton species

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Number of species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copepoda</td>
<td>5 sp.</td>
<td>55.6%</td>
</tr>
<tr>
<td>Mysidacea</td>
<td>1 sp.</td>
<td>11.1%</td>
</tr>
<tr>
<td>Larva</td>
<td>3 sp.</td>
<td>33.3%</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>9 sp.</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Source: EPC – VESDEC, December 2004

Considering the results, it is possible to remark as follows:

- The composition is simple with only copecoda species and one mysidacea species all migrate from the sea. Particularly Acartiella sinensis is a copecoda species typical of slightly brackish water.

- *Acartia clausi* and *Oithona similis* species are typical of an environment rich and polluted by organic matters.

- The density of zooplankton is high, 11,800 – 22,400 individuals/m$^3$, with the dominance of the brackish species of *Acartia clausi* typical of a nutrient-rich environment.

Zoobenthos

The number of zoobenthos species observed in the investigation of the section of Bac Lieu – Ganh Hao in December 2004 is as follows (Table 3.10)

Table 3.10: Composition of benthic animals

<table>
<thead>
<tr>
<th>Class</th>
<th>Number of species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polychaeta</td>
<td>2 sp.</td>
<td>25%</td>
</tr>
<tr>
<td>Crustacea</td>
<td>5 sp.</td>
<td>62.5%</td>
</tr>
<tr>
<td>Echinodermata</td>
<td>1 sp.</td>
<td>12.5%</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>8 sp.</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Source: EPC – VESDEC, December 2004

- The number of zoobenthos species at sampling stations 3 and 4 was more than that of the remaining stations. At station 5 there were only 2 polychaeta species. Possibly, the bottom mud polluted by the organic matters in the sanitary wastewater discharged by too many people living along the canal destructed the
system of crustacean species that have high demand for oxygen. Therefore, there remain only species indicating mesosaprobic environment. Bispira polymorpha, a settling polychaeta species, is considered as indicator of $\alpha$-mesosaprobic environment (medium polluted).

- The density of zoobenthos was $80 - 7,990$ individuals/m$^2$. It was high at stations 3, 4 and 5 ($1,220 - 7,990$ individuals/m$^2$). From station 3 to station 5, Bispira polymorpha sp. was absolutely dominant in term of quantity, accounting for $55.7 - 99.5\%$.

**Biological parameters**

**Similarity:**

The similarity of aquatic species groups is analyzed for the section of Bac Lieu – Ca Mau.

- Phytoplankton: station 3 and station 4, station 4 and station 5 have high similarity ($y = 0.56$).

- Zoobenthos: On the basis of the similarity of zoobenthos, the environment of the section of Bac Lieu – Ca Mau can be divided into two zones:
  - Zone I covering monitoring stations 1 and 2.
  - Zone II covering stations 3, 4 and 5.

**Diversity of aquatic organisms**

- It is found that the diversity at stations 1, 2 was high, $D = 1.061 - 1.265$, at stations 3, 4, and 5 it was $0.071 - 0.454$ and it was lowest in station 5 – i.e. the curve of Ganh Hao in Ca Mau City, $D = 0.071$. As such, the closer to Ca Mau City is, the organic pollution increases.

**Conclusion**

1- The environmental background of the section of Bac Lieu – Ca Mau is typical brackish water with no fresh-water aquatic species.

2- The water in the section of Gia Rai – Tac Van (stations 1 and 2) is polluted by organic matters at the level of $\beta$-mesosaprolse – and that of the Tac Van – Ca Mau section is $\alpha$-mesosaprolse.
3.8 WATERWAY

On the basis of the study into the topography of the whole section in December 2004, the actuality of rivers therein is described as follows:

- **Bac Lieu – Ca Mau section:**

- **The Ganh Hao River:**

A natural river with a length of 51.5 Km flows from Ca Mau City to Ganh Hao estuary, discharging water to the Eastern sea. The river flows mainly in Dam Doi district and the project section starting from Luong The Tran canal to Bay Hap canal is 1.4 km long, 140m wide on average and -2.5÷ -3.5m deep (Mui Nai standard level)

3.9 LAND USE IN THE PROJECT SITE

By site study, it is possible to assess the usage of land along the canal of Ganh Hao–Gia Rai as follows:

- **Existing of house**

Ca Mau city covers an area of 24,551 ha square, in there, land is used for resettlement is about 636 ha in area, the population density of this area is 790 persons per square kilometer in 2004. Actual state of houses land along the Ganh Hao-Gia Rai canal crosses some communes such as Ba Dinh, Cai Ngang, Tan Phong, is thinly populated; the population density of this area is 300 - 350 persons per square kilometer. However, section crosses Ward 7 and Ward 6 of Ca Mau city, Ganh Hao bridge has a quite dense of houses. Therefore, the project meets with difficulties in traffic regulation and avoiding of waterway traffic accident.

- **Land use**

The land use along the Ganh Hao-Gia Rai canal is most used for houses, is distant the canal of the project about 20-30 meters of the left edge is aquacultural and agricultural land. However, this area is infected acidic sulfate and salty so agricultural product is not high, shrimp product is reduced gradually in recent years. Thus, it is appropriate to use for SRA in this area.

Besides, by surveying at the field it’s shown that the traffic of the left edge is rather difficult, so using excavated soil for upgrading the local traffic system Tac Van to Tan Phong is appropriately in economy and environment. The constructor unit should use the area – it has distance of 20 meters from the left edge of the canal – for the SRA combine to build the rural traffic.
The map of land use at the project area is shown in Fig.3.2.

**Fig 3.2** Map of exiting land use
3.8 SOCIO-ECONOMIC CONDITIONS OF THE PROJECT SITE

3.8.1 Economic development in Ca Mau province

- Population and administrative division

Ca Mau province covers 5,211 km$^2$. By 2003, it has 5 districts and one city with 84 communes, wards and towns. Its population in 2003 was 1,190,676 and the density was approximately 292 people/km$^2$. The population by districts are shown in Table 3.11.

Table 3.11: Population of Ca Mau province by districts

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Ca Mau City</th>
<th>Cai Nuoc</th>
<th>Dam Doi</th>
<th>Ngoc Hien</th>
<th>Thoi Binh</th>
<th>Tran Van Thoi</th>
<th>U Minh</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>Area - km$^2$</td>
<td>Km$^2$</td>
<td>245</td>
<td>835</td>
<td>796</td>
<td>1.249</td>
<td>628</td>
<td>700</td>
<td>758</td>
</tr>
<tr>
<td>01</td>
<td>Communes</td>
<td>Km$^2$</td>
<td>7</td>
<td>13</td>
<td>12</td>
<td>12</td>
<td>9</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>02</td>
<td>Precincts, towns</td>
<td>Km$^2$</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Households</td>
<td>Km$^2$</td>
<td>38.53</td>
<td>46.35</td>
<td>35.88</td>
<td>32.29</td>
<td>26.74</td>
<td>37.254</td>
<td>18.53</td>
</tr>
<tr>
<td>05</td>
<td>Average population in 2003</td>
<td>Inhabitant$^2$</td>
<td>193.6</td>
<td>253.3</td>
<td>179.0</td>
<td>147.1</td>
<td>137.9</td>
<td>189.369</td>
<td>90.18</td>
</tr>
<tr>
<td>06</td>
<td>Density</td>
<td>Inhabitant/km$^2$</td>
<td>790</td>
<td>303</td>
<td>225</td>
<td>118</td>
<td>220</td>
<td>271</td>
<td>119</td>
</tr>
</tbody>
</table>

Source: Socio-economic Summary Report of Ca Mau province, 2004

- GDP structure (%)

The changes in GDP structure of the province over years are resumed in Table 3.12. It is clear that in the recent year, percentages of the sectors of industry – construction and services were continuously increased and the agriculture-forestry sector was significantly reduced.

Table 3.12: Changes in GDP structure (%) of Ca Mau province

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Agro–aquaculture, forestry</td>
<td>65.95</td>
<td>63.41</td>
<td>60.47</td>
<td>59.74</td>
<td>59.96</td>
<td>58.57</td>
</tr>
<tr>
<td>Industry, construction</td>
<td>16.41</td>
<td>16.95</td>
<td>20.26</td>
<td>20.46</td>
<td>20.73</td>
<td>20.48</td>
</tr>
<tr>
<td>Service</td>
<td>17.64</td>
<td>19.64</td>
<td>19.27</td>
<td>19.8</td>
<td>19.32</td>
<td>20.95</td>
</tr>
</tbody>
</table>
Source: Statistical Yearbook 2001, Statistic Department of Ca Mau Province

- **Agriculture**

As a result of quick economic structural change from rice cultivation to shrimp farming in districts of Dam Doi, Cai Nuoc, Tran Van Thoi and Ca Mau City, the area and output of rice drop drastically. The area of cultivation in 2001 is estimated at 131,700 ha and the output of food crops 460,000 tons, i.e. half of that of 2000. Besides, the area of coconut garden reduced by at least 1,500 ha.

- **Forestry**

At present, the province has pushed forward the restoration and development of forest ecosystems (mangrove, melaleuca), diffusing forestation and plantation of riverside forests. The models of forestation in combination with shrimp farming or fish farming have given good results and been expanded.

**Table 3.13: Forest area by 2003**

<table>
<thead>
<tr>
<th>District</th>
<th>Total Area (ha)</th>
<th>Production</th>
<th>Protection</th>
<th>Specializing use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>103.563</td>
<td>81.274</td>
<td>14.395</td>
<td>7.894</td>
</tr>
<tr>
<td>Thoi Binh</td>
<td>6.746</td>
<td>6.746</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U Minh</td>
<td>23.654</td>
<td>23.143</td>
<td>511</td>
<td></td>
</tr>
<tr>
<td>Tran Van Thoi</td>
<td>11.129</td>
<td>5.853</td>
<td>1.871</td>
<td>3.405</td>
</tr>
<tr>
<td>Cai Nuoc</td>
<td>3.968</td>
<td>2.903</td>
<td>1.055</td>
<td>10</td>
</tr>
<tr>
<td>Dam Doi</td>
<td>8.006</td>
<td>6.037</td>
<td>1.903</td>
<td>66</td>
</tr>
<tr>
<td>Ngoc Hien</td>
<td>50.060</td>
<td>36.592</td>
<td>9.055</td>
<td>4.413</td>
</tr>
</tbody>
</table>

- **Aquaculture and fishery**

By the end of 2002, there were 20,200 ha of shrimp ponds in the province, increasing by at least 50,000 over the end of 2000. Of the total, shrimp farming – forest accounted for 18,000 ha, shrimp breeding– orchard 10,000 ha, shrimp breeding– rice cultivation 60,000ha, extensive shrimp farming 113,700ha and intensive (industrial and semi-industrial farming) 300ha. In addition, breeding of fish in rice fields or cajuput forests is very common. Some models of shrimp breeding combined with forestation and rice cultivation, coastal breeding of blood ark-shell, etc. have given good results and been expanded.

Shrimp farms in Ca Mau have quickly developed and by the end of 2001, there were 741 farms and at least 800 traders involving in spawn, feed, chemical and biological preparations for shrimp breeding. Concentrated in districts of Ngoc Hien,
Dam Doi, Cai Nuoc and Ca Mau City, etc. they are suppliers for coastal and transitory areas.

At present, there are 12 companies and 18 enterprises specializing in seafood processing and hundreds of sale agents (in details, 15 enterprises of shrimp processing, 1 of fish and 2 of fish powder). Furthermore, 2 enterprises are under construction (one for processing of shrimp and one for fish powder). In the province, 06 enterprises met the HACCP standards and received the codes for exporting to EU market and 2 received ISO 9002 certificates. In general, seafood companies have actively upgraded their technology so as to meet the new demand and improve their product quality.

Table 3.14: Output and area of aquaculture in the recent years.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquaculture area (ha)</td>
<td>155,062</td>
<td>154,036</td>
<td>161,598</td>
<td>141,461</td>
<td>204,381</td>
<td>-</td>
</tr>
<tr>
<td>Output (ton)</td>
<td>43,272</td>
<td>45,995</td>
<td>42,363</td>
<td>46,718</td>
<td>197,836</td>
<td>87,500</td>
</tr>
<tr>
<td>Shrimp farm area (ha)</td>
<td>104,431</td>
<td>104,371</td>
<td>106,102</td>
<td>90,511</td>
<td>153,373</td>
<td>202,000</td>
</tr>
<tr>
<td>Cultured Shrimp Output (ton)</td>
<td>18,325</td>
<td>18,932</td>
<td>16,817</td>
<td>19,720</td>
<td>49,233</td>
<td>62,000</td>
</tr>
<tr>
<td>Fishing output (ton)</td>
<td>80,655</td>
<td>85,121</td>
<td>90,155</td>
<td>124,687</td>
<td>124,649</td>
<td>125,000</td>
</tr>
<tr>
<td>Of which, shrimp (ton)</td>
<td>19,872</td>
<td>20,497</td>
<td>20,984</td>
<td>13,873</td>
<td>13,856</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Statistical Yearbook 2000, Statistic Department of Ca Mau Province

- Industry

The main industries are food and seafood processing, accounting for 94% of the total industrial production. The remainders include foodstuff, wood proceeding and mechanical production. The industrial growth over years is as follows: 110.24% in 1996, 98.59% in 1997 and 121.77% in 1998, 106.91% in 1999, 132.37% in 2000 and 112.73% in 2002.

The province has big ability of supply of raw materials and processing as well. At present, there are 18 seafood enterprises which are capable of processing 40,000 tons of seafood per year.

Some industrial parks were built in Ca Mau City. For instance, industrial parks in Precincts 1 and 8, the LPG-Electricity-Urea Combination in Ca Mau, the industrial park of Song Doc (Tran Van Thoi district); ports of Ca Mau (Ca Mau City), Nam
Can, Hon Khoai (Ngoc Hien) are going to operate; particularly, a sugar mill of 1,000 tons of sugarcane per day in Thoi Binh district has operated since 2000.

3.10.2 Social matters

The rate of the poor households in the province is still high, which is about 15.48% with 34,640 households according to the standard of the Ministry of Labor, War Invalids and Social Affairs.

The per capita income is low, which is about VND 477,000 per month in 2001, though it increased by 9.91% over the preceding year.

As for economic integration, Ca Mau with advantages of agriculture, forestry, fishery and processing of seafood for export has big potentials for integration into the regional and global economies.

The province also has the conditions for developing the human resources for its industrialization and modernization on the basis of regional cooperation as well as in combination with national and international centers for science and technology. Recently, its education and health care have been improved with special attention from the provincial authorities. Training of teachers has been standardized. Sciences and technologies have gradually been absorbed into living to solve hot issues. Health care has been enhanced and therefore it has contributed to the protection of community health.

In general, the living standards in Ca Mau are still low and so is the education level. The provincial economy is still dependent on agriculture and as a result of poor skills of exploitation and use of natural resources, its development is limited. The infrastructure is poor and the ability of saving for the development of industry and service is limited. Being dependent upon on exploitation of natural resources, it easily causes negative impacts on the nature. Furthermore, the low economic start point and the increasing population will be the challenges and difficulties of the province.
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CHAPTER FOUR

PREDICTION OF ENVIRONMENTAL IMPACTS

4.1 IMPACTS DURING DREDGING

4.1.1 Outline of impacts during dredging operation

The environmental impacts caused by dredging operation along the dredging site are identified as follows:

- Pollution of rivers and canal water due to dredger operation;
- Increases in turbidity and concentrations of heavy metals, organic chemicals due to disturbance of bottom mud;
- Water pollution due to effluent returning from the spoil relocation areas (SRAs) to canals;
- Damages to agriculture and fishery due to the farms receive polluted water from the dredging canals;
- Impacts on aquaculture and domestic water supply in case of spillage of effluent from SRAs.

4.1.2 Impacts on water quality due to dredging operation

Dredging operation may create the following impacts:

- Short-term impacts due to dredging activities;
- Short-term to medium term impact due to oxidation of acid sulphate soil;
- Water pollution due to turbidity, heavy metals pesticides in the duration of dredging operation.

**Impacts by increase in turbidity and suspended solids**

In principle, the operation of dredgers will cause an increase in turbidity and suspended solids (SS), particularly when the canals are dredged with the mud-suction technique.

The great increase in turbidity, heavy metals and pesticides from canal sediment during the dredging period can threaten the supply of water for aquaculture and domestic uses.
The monitoring programs conducted by EPC–VESDEC in various regions when the upgrading of two Southern waterways and Can Tho port from 2001 to 2003 was clearly showed turbidity of river water was locally high around the dredging sites with the interval of 400 to 600m (Table 4.1) and compared with turbidity of the river before dredging, turbidity at distance over 600m during the dredging operation was almost the same. It is therefore possible to conclude that turbidity is high locally around the dredging site only.

The monitoring results of river water quality in dredging sites from 2001 to 2003 are shown in Table 4.1.

Table 4.1: Water quality of the Cho Gao River in the dredging period

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Unit</th>
<th>VT1</th>
<th>VT2</th>
<th>VT3</th>
<th>VT4</th>
<th>VT5</th>
<th>VT6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td></td>
<td>7.28</td>
<td>7.28</td>
<td>6.99</td>
<td>7.2</td>
<td>7.02</td>
<td>7.0</td>
</tr>
<tr>
<td>2</td>
<td>Turbidity</td>
<td>mg/L</td>
<td>227</td>
<td>387</td>
<td>657</td>
<td>712</td>
<td>316</td>
<td>267</td>
</tr>
<tr>
<td>3</td>
<td>SS</td>
<td>mg/L</td>
<td>41</td>
<td>83</td>
<td>148</td>
<td>134</td>
<td>92</td>
<td>36</td>
</tr>
<tr>
<td>4</td>
<td>DO</td>
<td>mg/L</td>
<td>4.2</td>
<td>3.2</td>
<td>3.7</td>
<td>2.5</td>
<td>2.8</td>
<td>3.8</td>
</tr>
</tbody>
</table>


Notes: - Site 1: A station located about 600m downstream from the dredger.
- Site 2: A station located about 400m downstream from the dredger.
- Site 3: A station located about 200m downstream from the dredger.
- Site 4: A station located about 200m upstream from the dredger.
- Site 5: A station located about 400m upstream from the dredger.
- Site 6: A station located about 600m upstream from the dredger.

The great increase in water pollution because of suspended solid and turbidity may damage to fish and shrimp. A major part of fish species cannot live in the water that has the suspended solid concentration of over 2000 mg/L. Therefore, they must migrate out of the water of high turbidity. High turbidity and suspended solid concentration hinder oxygen from the air dissolving into water, limit the ability of fish in preying upon and thereby damage fish.

It is an international experience that dredging with dredging buckets causes lighter impacts than dredgers.
• **Disturbance of bottom sediment and increase of toxic pollutants**

The construction and dredging activities will move bottom mud to banks and move soil at two banks. They may significantly increase in suspended solid as well as pollutants from bottom mud and from acid sulfate soil at the banks.

The disturbance of bottom mud and acid sulfate soil will acidify and reduce pH of the canal water, thereby increase in concentrations of metals (iron, aluminum and heavy metals) in canal water. In some other sections, the suspended solid contains pollutants such as heavy metals, pesticides, grease and oil and bacteria accumulating in bottom sediment. Therefore, dredging operation may pollute canal water by toxic chemicals.

In principle, the polluted water may adverse affect aquatic animals. Many species may migrate from the polluted area. Furthermore, pollutants in water can be accumulated in shrimp, fish, shellfish and vegetation in the canals, causing damages to human beings through the food chains.

However, from the data of the monitoring programs in 2003 at other sections of this project, canal water contamination by toxic chemical such as heavy metals and pesticides were not evident. Therefore, this impacts is may be assessed as minor, and no significant.

• **Possible increase the heavy metal in canal water**

Although heavy metals in sediment of Ganh Hao – Gia Rai canal is much lower than the Dutch Standard for sediment disposal (Chapter Three), but dredging activities will increase their content in the canal water. Heavy metals in sediment along the canal are showed in *Table 3.11* and *Table 3.13* and Dutch Standard is at *Appendix 4.2*.

### Table 4.2: Dutch Standard for the spoil

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameters (mg/kg dry weight)</th>
<th>Reference value</th>
<th>Testing value</th>
<th>Alarmingly value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chromium</td>
<td>100</td>
<td>480</td>
<td>1000</td>
</tr>
<tr>
<td>2</td>
<td>Nickel</td>
<td>35</td>
<td>45</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>Copper</td>
<td>36</td>
<td>90</td>
<td>400</td>
</tr>
<tr>
<td>4</td>
<td>Zinc</td>
<td>140</td>
<td>1000</td>
<td>2500</td>
</tr>
<tr>
<td>5</td>
<td>Cadmium</td>
<td>0.8</td>
<td>7.5</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Mercury</td>
<td>0.3</td>
<td>1.6</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>Lead</td>
<td>85</td>
<td>530</td>
<td>1000</td>
</tr>
<tr>
<td>8</td>
<td>Arsenic</td>
<td>29</td>
<td>85</td>
<td>150</td>
</tr>
<tr>
<td>9</td>
<td>Aldrin</td>
<td>0.01</td>
<td>0.04</td>
<td>0.5</td>
</tr>
<tr>
<td>10</td>
<td>Dieldrin</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Endrin</td>
<td>0.001</td>
<td>0.04</td>
<td>0.5</td>
</tr>
</tbody>
</table>
The high toxicity of heavy metals (mercury, lead, chromium…) and pesticides at high concentration can affect on human health and aquatic life. Drinking water standard of WHO for mercury, lead, chrome is 0.05mg/L, 0.05mg/L, 1µg/L, respectively. Water quality standard of several international organizations and Vietnam are showed at Table 4.3.

Table 4.3: Water quality standard (for heavy metals) of several international organizations and countries

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Drinking water (WHO)</th>
<th>TCVN 5942-1995 Surface water (Vietnam) Class A</th>
<th>Irrigation water (US)</th>
<th>Fish culture water (Netherlands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>mg/L</td>
<td>0.3</td>
<td>1.0</td>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>Al</td>
<td>mg/L</td>
<td>0.2</td>
<td>0.1</td>
<td>1.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Cu</td>
<td>mg/L</td>
<td>1.0</td>
<td>0.1</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Pb</td>
<td>mg/L</td>
<td>0.05</td>
<td>0.01</td>
<td>0.5</td>
<td>0.05</td>
</tr>
<tr>
<td>Cr</td>
<td>mg/L</td>
<td>0.05</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>Hg</td>
<td>mg/L</td>
<td>0.001</td>
<td>0.001</td>
<td>0.0005</td>
<td>0.005</td>
</tr>
<tr>
<td>Zn</td>
<td>mg/L</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>As</td>
<td>mg/L</td>
<td>0.05</td>
<td>0.05</td>
<td>1000</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Source: Compiled from various document

The data collected by the environmental monitoring program of EPC-VESDEC during the construction phase in 2001, 2002, and 2003 shows that the concentration of heavy metals in canal water, where dredge carried out, is much lower than Vietnamese Standard for Surface Water (TCVN 5942-1995).

Table 4.4: Concentration of heavy metals in canal water concentration

<table>
<thead>
<tr>
<th>Month</th>
<th>Monitoring site</th>
<th>Zn (mg/l)</th>
<th>Al (mg/l)</th>
<th>Cd (µg/l)</th>
<th>Ni (mg/l)</th>
<th>Hg (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>February</td>
<td>Km 212</td>
<td>0.024</td>
<td>0.034</td>
<td>0.12</td>
<td>0.044</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Km 223</td>
<td>0.041</td>
<td>&lt;0.01</td>
<td>0.24</td>
<td>0.038</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Km 229</td>
<td>&lt;0.01</td>
<td>0.021</td>
<td>0.37</td>
<td>0.056</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>March</td>
<td>Km 212</td>
<td>&lt;0.01</td>
<td>0.019</td>
<td>0.19</td>
<td>0.067</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Km 223</td>
<td>0.024</td>
<td>0.034</td>
<td>0.46</td>
<td>0.031</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Km 229</td>
<td>0.034</td>
<td>0.028</td>
<td>0.48</td>
<td>0.029</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>May</td>
<td>Km 212</td>
<td>0.028</td>
<td>&lt;0.01</td>
<td>0.51</td>
<td>0.024</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Km 223</td>
<td>0.019</td>
<td>&lt;0.01</td>
<td>0.63</td>
<td>0.036</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Km 229</td>
<td>&lt;0.01</td>
<td>0.019</td>
<td>0.15</td>
<td>0.047</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>TCVN 5942-1995</td>
<td>1</td>
<td>-</td>
<td>10</td>
<td>0.1</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>
Possible increase of pesticides in canal water

- Impacts on the biological environment

Generally, dredging activity causes negative impacts on the biological environment. It affects both terrestrial and aquatic habitats, especially to fish and shrimp species:

- Enlarging canal banks 3-5m causes damage to plants (mainly Nipa palm and aquatic weeds) grown on the banks.

- Dredging canal bottom causes direct influence on planktons and benthic animals. They are the basic components of the habitat, feeding to fish and other aquatic animals. The loss of the habitats due to changes in the existing banks will reduce the food source and the vegetation cover then fish and other aquatic animals must migrate away. The reduction in food, turbid water, reduced dissolved oxygen and increased pollutants together with the increase in acidity will force some mollusk and crustacean species, shrimp and crabs to migrate or die. At the dredging sites the concentrations of pollutants will likely do not meet the water quality standards for aquaculture.

- To restore the biological environment and species composition, it can take several years or longer after the river bed and banks become stable.

- Other aquatic species such as water hyacinth and reed and the bottom vegetation cover can also be damaged. Those species have an important role to play in the supply of oxygen, food and at the same time in stopping the waves that ship in operation cause.

The above mentioned impacts may occur at 2 canal sections. However, dredging capacity will not be high (almost 3.0 mil tons of soil and sediment), these impacts are expected as minor and temporary.

- Possible increase in water pollution during dredging operation at acid sulphate soils areas

The Ganh Hao – Gia Rai canal section crosses large areas of acid sulfate soil. When exposing to the air and water, pyrite in acid sulphate soil may create acidic materials.

The acidification of water source increases the solubility of metals (iron, aluminum) in the soil. The impact is clearly seen at the section being dredged and
furthermore, it influences the surroundings because of runoff water. The reduction of pH and increase of metal contents can cause damage to both aquatic and terrestrial eco systems as well as to quality of agricultural land.

This impact can be more severe in the beginning rainy season when rainwater runs off from the SRAs to surroundings or adjacent waterway sections.

The transport of dredged soil via pipelines of dredgers can cause extensive impacts in case of leakage or spillage of muddy water. The leakage will lead to increases in turbidity and acidity near the dredging site and the spillage can damage water and agricultural land that surround the dredging site.

From the monitoring reports of EPC-VESDEC for the other sections of this project in 2002-2003, this impact is assessed as minor and mitigable.

Increase of acidity in water, particularly at the section of Ganh Hao – Gia Rai is expected as significant but short-term.

The dredge of canals in regions of sulfate acid soils results in the exposure of pyrite (FeS$_2$) to the air, and with the presence of water, the oxidation of pyrite and formation of acid occur with the mechanism as follows:

\[
\begin{align*}
2\text{FeS}_2 + 2\text{H}_2\text{O} + 7\text{O}_2 & \rightarrow 2\text{FeSO}_4 + 2\text{H}_2\text{SO}_4 \text{ (strong acid)} \\
2\text{FeSO}_4 + \text{O}_2 + 2\text{H}_2\text{SO}_4 & \rightarrow 2\text{Fe}_2(\text{SO}_4)_3 + 2\text{H}_2\text{O} \\
\text{FeSO}_4 + 6\text{H}_2\text{SO}_4 & \rightarrow 2\text{Fe(OH)}_3 + 3\text{H}_2\text{SO}_4
\end{align*}
\]

At a lower pH pyrite can be oxidized with the presence of Fe$^{3+}$ ions:

\[
\text{FeS}_2 + 14\text{Fe}^{3+} + 8\text{H}_2\text{O} \rightarrow 15\text{Fe}^{2+} + 2\text{SO}_4^{2-} + 16\text{H}^+
\]

The conversion of ferrous sulfate to ferric sulfate is very slow at a pH lower than 4 but it very quick with micro-organic catalyst (soil-oxidizing microorganism).

The acidification of water is dependent on the following factors:

- The dredged volume of acidic bottom mud and the acidity of bottom mud;
- Dimension of SRAs where acid sulfate soil and bottom mud are disposed;
- Run off of acidic water from SRAs to surroundings.

**Assessment on environmental impacts due to high water acidity (low pH)**

Many studies show that in the Mekong Delta in the dry season, the acidic water goes up by capillarity to the soil surface. The acidic materials stagnate together with aluminum and iron sulfates on those surfaces. In the first months of the rainy season (May to July), the acids accumulated on the soil surface are washed away to
canals and fields to acidify water and soil. According to the previous observations, in the Kien Luong - Ha Tien section, in beginning of the rainy season, acidifying water from Long Xuyen Quadrangle flow down causing acidification the whole canal, result in the high water acidity.

Increase in the water acidity of canals and fields may lead to affect life of fish and shrimp. The harm of acidity (through pH) of water to shrimp and fish is outlined and shown in Table 4.5

**Table 4.5: Acute effect of acidity to fish species**

<table>
<thead>
<tr>
<th>pH</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5 – 9.0</td>
<td>No negative influence</td>
</tr>
<tr>
<td>6.0 – 6.4</td>
<td>No negative impact unless when concentration of CO₂ is very high (&gt; 1000 mg/l)</td>
</tr>
<tr>
<td>5.0 – 5.9</td>
<td>No negative impact unless when concentration of CO₂ is high (&gt; 20 mg/l) or Fe^{2+} is present</td>
</tr>
<tr>
<td>4.5 – 4.9</td>
<td>Damages to spawn. Some fish species are influenced when the concentrations of Ca^{2+}, Na^{+} and Cl⁻ are low</td>
</tr>
<tr>
<td>4.0 – 4.4</td>
<td>Damages to many fish species</td>
</tr>
<tr>
<td>3.5 – 3.9</td>
<td>Fatal damages to some fish species but some species of black fish (anabas, catfish, etc.) are survived.</td>
</tr>
<tr>
<td>3.0 – 3.4</td>
<td>Almost all fish die after several hours</td>
</tr>
</tbody>
</table>


From above mentioned information it may indicate that: the acidification and transfer of acidic water that is generated by dredging and digging canals crossing acid sulfate soil area will cause negative impacts on water quality, aquatic biota, aquaculture, water supply and irrigation inside and around the dredging zone. However, this Ganh Hao-Gia Rai canal, where is affected by salt water with pH of over 7.5, the increased acidity by dredge may be neutralized. Therefore, this impact is expected as negative, but minor and short-term.

### 4.1.3 Impacts due to effluent from spoil relocation areas

- **Acidic water from the SRAs**

Acids in disposed sediment might not transfer immediately to the environment but retain in the dredged mud for many years. Pyrite in the mud is gradually oxidized over many years because of oxygen penetration. In the oxidation of pyrite, the diffusion of its end products to surfaces occurs also at a low speed. In heavy clay, the transfer of oxidation products (H⁺, Fe^{2+}, Al^{3+} and SO₄^{2-}) takes place mainly by capillarity. On reaching the surface, those substances accumulate in acidic salt form...
that may be washed by water to rivers, canals, fields or ponds and thereby they acidify water.

- **Impacts by effluents from the SRAs**

The effluent from the SRAs, if not passing settling compartments prior to returning to canals, has high suspended solid concentration and very high turbidity. The monitoring programs on the Rehabilitation of Southern waterways and Can Tho Port Project in 2000-2004 conducted by EPC of VESDEC have indicated contents of the pollutants in effluent from some SRAs (*Table 4.6, Table 4.7*).

**Table 4.6  Water from SRSs in Tac Cay Tram canal**

<table>
<thead>
<tr>
<th>Month</th>
<th>Station</th>
<th>Temp. (°C)</th>
<th>pH</th>
<th>DO (mg/l)</th>
<th>SS (mg/l)</th>
<th>F.Coli MPN/100ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Km 257</td>
<td>30.2</td>
<td>3.12</td>
<td>1.1</td>
<td>1452</td>
<td>210</td>
</tr>
<tr>
<td>September</td>
<td>Km 257</td>
<td>30.4</td>
<td>2.98</td>
<td>1.4</td>
<td>1224</td>
<td>110</td>
</tr>
<tr>
<td>October</td>
<td>Km 257</td>
<td>30.1</td>
<td>3.03</td>
<td>1.9</td>
<td>869</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>TCVN 5945-1995</td>
<td>-</td>
<td>5.5-9</td>
<td>-</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>TCVN 6773-2000</td>
<td>-</td>
<td>5.5-8.5</td>
<td>-</td>
<td>-</td>
<td>200</td>
</tr>
</tbody>
</table>

*Sources: EPC, 2003*
Table 4.7  Water from SRAs in Rach Soi – Hau Giang canal

<table>
<thead>
<tr>
<th>Station</th>
<th>Temp. (°C)</th>
<th>pH</th>
<th>DO (mg/l)</th>
<th>SS (mg/l)</th>
<th>F.Coli MPN/100 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Km 198</td>
<td>29.3</td>
<td>6.24</td>
<td>2.4</td>
<td>2014</td>
<td>350</td>
</tr>
<tr>
<td>Km 204</td>
<td>29.7</td>
<td>6.12</td>
<td>2.2</td>
<td>2415</td>
<td>210</td>
</tr>
<tr>
<td>Km 208</td>
<td>29.4</td>
<td>6.10</td>
<td>2.1</td>
<td>1896</td>
<td>240</td>
</tr>
<tr>
<td>Km 212</td>
<td>29.1</td>
<td>6.31</td>
<td>1.9</td>
<td>1647</td>
<td>210</td>
</tr>
<tr>
<td>Km 222</td>
<td>29.4</td>
<td>6.28</td>
<td>2.0</td>
<td>2341</td>
<td>110</td>
</tr>
<tr>
<td>Km 233</td>
<td>29.3</td>
<td>6.17</td>
<td>2.3</td>
<td>1698</td>
<td>90</td>
</tr>
<tr>
<td>Km 245</td>
<td>29.1</td>
<td>6.09</td>
<td>1.6</td>
<td>2412</td>
<td>70</td>
</tr>
<tr>
<td>TCVN 5945-1995</td>
<td>-</td>
<td>5,5-9</td>
<td>-</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>TCVN 6773-2000</td>
<td>-</td>
<td>5,5-8,5</td>
<td>-</td>
<td>-</td>
<td>200</td>
</tr>
</tbody>
</table>

Sources: EPC, 2003

From the monitoring data it is clear that, effluent from SRAs has high concentration of suspended solid, which many times exceed the Vietnamese environmental standard for industrial effluent (TCVN 5945-1995). pH values of the effluent is low, not meeting the standard. Therefore, discharge of effluent from SRAs may damage to the aquatic environment of the canals.

- **Environmental incident such as breakage of protecting edges and leakage of waste matters**

During dredging operation, any incident such as breakage of protecting edge of the SRAs and leakage of effluent to the environment will cause adverse impacts on agriculture aquaculture of SRAs and water supply for irrigation and domestic uses. The impacts resulted from breakage of protecting edges include:

- Effluent overflowing from the SRAs may shrimp and fish when it reaches to aquacultural ponds;

- Effluent overflowing from the SRAs may acidify cultivated soil when it reaches to rice fields;

- Effluent overflowing from the SRAs may damage people’s living conditions when it reaches their houses;
- Effluent overflowing from the SRAs may cause sedimentation in canal bottom to shallowing the canals.

The expected incidents have been occurred in the regions such as canals of Xa No, Trac Cay Tram, the Cho Gao River, the canal of Rach Gia – Ha Tien, etc. during the dredging operation at the two Southern waterways and Can Tho port. However, the level of damage was low and the constructors did solve the incidents timely. As such, environmental incidents in relation with SRAs are likely to occur but they may be controlled by managerial measures.

4.1.4 Pollution due to acidified soil from the SRAs

In the acid sulphate soil areas soil from the project normally has low pH. Data on the monitoring of pH of soil from the SRAs in the Rehabilitation of two Southern Waterways and Can Tho Port project in 2003 are shown in Table 4.8

Table 4.8: pH value of soil at the SRAs along the Trem-Canh Den River in Vinh Thuan District

<table>
<thead>
<tr>
<th>Section</th>
<th>Note</th>
<th>Km</th>
<th>PH value inside</th>
<th>PH value spill way</th>
<th>PH value outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-VT 1</td>
<td></td>
<td>Km 290+250</td>
<td>3.41</td>
<td>3.21</td>
<td>3.76</td>
</tr>
<tr>
<td>ST-VT 2</td>
<td></td>
<td>Km 290+000</td>
<td>3.73</td>
<td>3.26</td>
<td>3.49</td>
</tr>
<tr>
<td>ST-VT 3</td>
<td></td>
<td>Km 288+900</td>
<td>3.44</td>
<td>3.76</td>
<td>4.03</td>
</tr>
<tr>
<td>ST-VT 4</td>
<td></td>
<td>Km 288+500</td>
<td>3.39</td>
<td>3.33</td>
<td>3.38</td>
</tr>
<tr>
<td>ST-VT 5</td>
<td></td>
<td>Km 287+800</td>
<td>2.77</td>
<td>2.83</td>
<td>3.26</td>
</tr>
<tr>
<td>ST-VT 6</td>
<td></td>
<td>Km 287+800</td>
<td>3.20</td>
<td>2.68</td>
<td>3.30</td>
</tr>
<tr>
<td>ST-VT 7</td>
<td></td>
<td>Km 287+000</td>
<td>2.39</td>
<td>2.88</td>
<td>3.41</td>
</tr>
<tr>
<td>ST-VT 8</td>
<td></td>
<td>Km 286+800</td>
<td>3.50</td>
<td>4.20</td>
<td>4.28</td>
</tr>
<tr>
<td>ST-VT 9</td>
<td></td>
<td>Km 286+000</td>
<td>3.42</td>
<td>3.32</td>
<td>3.94</td>
</tr>
<tr>
<td>ST-VT 11</td>
<td></td>
<td>Km 285+500</td>
<td>3.28</td>
<td>3.63</td>
<td>3.63</td>
</tr>
</tbody>
</table>

Source: EPC – VESDEC, 2003

According to the Ministry of Agriculture and Rural Development (MARD) to evaluate soil acidity the following classification is used: pH range.

<table>
<thead>
<tr>
<th>pH</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,5</td>
<td>Very acidic</td>
</tr>
<tr>
<td>5,0</td>
<td>Moderate</td>
</tr>
<tr>
<td>5,5</td>
<td>Light</td>
</tr>
<tr>
<td>6,0</td>
<td>Near</td>
</tr>
<tr>
<td>8,0</td>
<td>Alkaline</td>
</tr>
</tbody>
</table>

The data given in Table 4.8 show that in the middle and near the discharge gates of the SRAs, pH was < 5 and soil therein was slightly or medium aciditic.
Soil in the project site is a kind of actual acid sulfate soil (AASS). Therefore, at the beginning, it has low acidity but after dredging, it is oxidized, turning to be acidic and polluting the soil environment, possibly damaging to agricultural production.

4.1.5 Possibility of increase in salinity intrusion

The canal of Ganh Hao – Gia Rai will be deeply dredged for improving the waterway. However, the dredging volume is limited. Furthermore, because water in the project site is saline for all year round, the impacts caused by dredge on salinity intrusion in the region is not expected.

4.1.6 Impact on aquaculture

The construction phase will last some months at each section. This may cause negative effects on local aquaculture, due to the following reasons:

- Water in taken for shrimp culture may be contaminated by turbidity and acidity. Particularly, soil along section of Kien Luong – Ha Tien is heavy acidified, therefore, the dredging activities may increase the water acidity, possibly caused damage for aquaculture in the surrounding area.

- Effluent leak from the SRAs may cause death of shrimp in the surrounding shrimp ponds.

- The overflow of effluent and embankment breakdown may kill shrimp and fish in canals and ponds.

- Wastewater from construction sites and dredgers containing organic compounds, grease and oil, discharged into the canal may damage water quality that effect on aquacultural ponds where intake canal water.

It is able to evaluate that the dredging activities of the two additional waterways may cause significant effect on aquaculture at Ha Tien and Nam Can areas. This negative impact is assessed as moderate, but controllable. Therefore, Project Management Unit will co-operate with the consultants (SMEC) and the constructors to choose the right area for SRAs and implement a proper monitoring program to prevent the predicted impact.

4.1.7 Waste oil from dredgers

During the dredging operation, effluent and oily waste from the dredgers may be a problem. That may pollute rivers and canals, damaging the aquatic organisms and the mangrove trees grown along the canals.
The standard on water quality for aquaculture permits the oil concentration of < 0.005 mg/L. According to the previous monitoring program of this project, oil contents in the dredging canals were only sometimes a little higher than that limit. Therefore this impact is assessed as negative but slight, local, temporary and controllable.

4.1.8 Impacts of workers’ activities in dredgers

In the dredging phase, some 30 to 40 workers may aggregate in some dredgers. Their activities may cause environmental and social problems, which is mainly due to sanitary waste and relation to the local peoples.

**Water pollution**

The averages of wastes from 40 workers are estimated as follows:

- Daily sanitary wastewater: 4-5 m$^3$

- Daily solid waste: 20-30 kg, containing organic matters (60 – 70%), other components such as paper, plastic, glass, metals etc. (30 - 40%).

- This amount of wastes, if not properly collected and treated, may damage to water environment

**Conflict with local people**

In some nations the conflict between construction workers from other regions with local residents are likely to occur with the causes as follows:

- Difference of habits and living style;
- Difference of income;
- Encroachment of construction workers to local cultural or traditional values.
- Environmental problems created by the constructors.

It is, however, experienced in many projects in Vietnam that conflicts will not occur if construction workers are well educated and disciplined. Furthermore, in Vietnam the good relation between workers and farmers is traditional and at the same time, people residing along the site understands the project activities. For this reason, the conflict between workers and local people has no ground to exist.

4.1.9 Impacts on trading activities on the river
Along the canal section to be dredged, particularly in the region of Ganh Hao bridge in Ca Mau City, a large number of boats transporting passengers and trading goods. Therefore, the dredging operation will make constraint for those activities. Nevertheless, because the dredging duration in that sub-section will be short (about 10 to 15 days) so this impact is expected as minor and short-term.

4.1.10 Traffic hindrance

A site study into the canal section of Ganh Hao – Gia Rai shows that the traffic density on the canal is relatively high and the canal also crosses over Ca Mau City. Therefore, the dredging operation may hinder the movement of boats, transporting passengers and goods, particularly at the area near the Ganh Hao bridge.

However, as mentioned in section 4.1.9 the area occupied by the dredgers is small and the dredging duration is short, this impact is assessed as minor and temporary. Measures for mitigation of traffic hindrance will be implemented by the constructors.

4.2 IMPACTS DURING THE OPERATION PHASE OF THE TWO EXTENSION WATERWAYS

Currently, increase in number and traveling speed of boats significantly results in erosion of the banks of rivers, canals and increased water pollution as well. Particularly, oil spill from engines boats will make pollution of water and may damage to aquatic biological resources, aquaculture and water supply at the areas along the waterway.

Scales of those impacts are not easy to predict precisely but the impacts can be expected as follows. For mitigation of the impacts various appropriate managerial and technical measures will be applied.

4.2.1 Pollution due to boat protection materials

The increase of river fleets can lead to water pollution by wooden hull-protecting materials. The common materials for this purpose in Vietnam include bitumen, charcoal, and paints. The aromatic hydrocarbons from those materials can be dissolved partially in water. Nevertheless, this impact is not significant because of the amount of boat protection materials is small, the materials are hardly dissolved in water and the discharge of the river is large.

4.2.2 Bank erosion

The increase in number and velocity of boats may cause erosion to banks of rivers and canals. This impact has occurred in many places in the Mekong Delta, where
river banks are not strong. This impact will be significant, long-term but mitigable. Measures for mitigation are recommended in Chapter Five.

4.2.3 Oil spill

The upgrading of two extension waterways, Ca Mau - Nam Can and Kien Luong - Ha Tien, will to a significantly increase the waterway traffic. Therefore, the risk of water pollution due to grease and other oily wastes may occur. Traffic accident as a result of heavy traffic density is easier to occur and cause oil spill. In such a case, the damages to aquatic, terrestrial ecosystem, agriculture, aquaculture and water supply will be significant. In Vietnam, there were various cases of oil spill (mainly in the Dongnai-Saigon river) damage aquatic ecosystems and aquaculture. They are lessons for management of this waterway.

Fuel spills to watercourses cause negative impact on the water environment and aquatic ecosystem.

When oil or petroleum products fall into water, the mechanic, physical and chemical processes occur and turn its state in a very complicated manner. Oil spillage increases the hydrocarbons in sediments. The ecological toxicity of petroleum products are assessed as shown in Tables 4.9 and 4.10. In some cases of oil spill in Vietnam concentrations of crude oil and FO were 1-10mg/L, which may cause death for some aquatic animals.

Table 4.9: Ecological toxicity of petroleum products

<table>
<thead>
<tr>
<th>Products</th>
<th>EC50 (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>10/100</td>
</tr>
<tr>
<td>Lubricant</td>
<td>1,000</td>
</tr>
<tr>
<td>Coal-derivative oil</td>
<td>1/10</td>
</tr>
<tr>
<td>Diesel oil</td>
<td>10/100</td>
</tr>
<tr>
<td>Petrol No. 1&amp;2</td>
<td>10/100</td>
</tr>
<tr>
<td>Petrol No. 3 &amp;5</td>
<td>100/1000</td>
</tr>
<tr>
<td>Petrol No. 6</td>
<td>1000</td>
</tr>
</tbody>
</table>
| Crude oil               | 10/100
Table 4.10: Eco-toxicity of crude oil ($LC_{50}$ at 96h) and dissolved hydrocarbons

<table>
<thead>
<tr>
<th>Species</th>
<th>Testing material</th>
<th>$LC_{50}$(mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>Fresh crude</td>
<td>88±18,000</td>
</tr>
<tr>
<td>Spawn, larva</td>
<td>Fresh crude</td>
<td>0.1±100</td>
</tr>
<tr>
<td>Hairy crab</td>
<td>Fresh crude</td>
<td>100±40,000</td>
</tr>
<tr>
<td>Benthic crab</td>
<td>Fresh crude</td>
<td>56</td>
</tr>
<tr>
<td>Shell</td>
<td>Fresh crude</td>
<td>1,000±100,000</td>
</tr>
<tr>
<td>Fin-fish</td>
<td>Soluble hydrocarbon</td>
<td>5±50</td>
</tr>
<tr>
<td>Spawn</td>
<td>Soluble hydrocarbon</td>
<td>0.1±1</td>
</tr>
<tr>
<td>Hairy crab</td>
<td>Soluble hydrocarbon</td>
<td>1±10</td>
</tr>
<tr>
<td>Mollusk</td>
<td>Soluble hydrocarbon</td>
<td>1±100</td>
</tr>
<tr>
<td>Shell</td>
<td>Soluble hydrocarbon</td>
<td>5±50</td>
</tr>
<tr>
<td>Benthic crab</td>
<td>Soluble hydrocarbon</td>
<td>1±10</td>
</tr>
<tr>
<td>Other invertebrate sp.</td>
<td>Soluble hydrocarbon</td>
<td>1±10</td>
</tr>
</tbody>
</table>

Source: Cradock, 1977; Moor&Dwyer, 1974.

Oil spill prevention and response at the waterways are recommended in Chapter Five.

4.2.4 Environmental risks due to transport of materials on the river

Environmental risks may occur in the following cases.

- Overloaded transport
- Boat operation not abiding navigation regulations
- Failure of built-in lighting and signal system of boat in nighttime
- Navigation in bad weather
- Colliding with underwater obstacles such as a sunken boat.

In case of oil spill or breakage of ships, boats transported agricultural chemicals (pesticides, fertilizers) caused by the incidents the impacts on the environment and local economy is expected as moderate, due to population, aquacultural farms along the canals have high density.

### 4.3 GENERAL ASSESSMENT OF THE PROJECT IMPACT ON THE LOCAL ENVIRONMENT AND SOCIO-ECONOMY

During the construction and operation phases of the additional waterway sections, bridge and LSs the following direct negative impacts may be happen at different scales:

- Air, noise and vibration pollution. This impact is minor and mitigable.

- Water pollution: this impact is minor; the water quality will be recovered after the completion construction activity. Only at the section Kien Luong – Ha Tien water pollution by acidity may be at moderate scale but it is temporary and controllable.

- Possible damage on aquaculture at Ha Tien and Nam Can: this impact in the construction phase is moderate but controllable if the project has an appropriative measure of environmental management.

- Riverside land: Plants along the canal will be cut, caused increase of erosion and landslide. This impact is expected as minor but long-term.

- Change in aquatic ecosystem: the bottom aquatic ecosystem structure may be changed but it will be recovered in several years after completion of canal dredged.

- Local living conditions: impact on living conditions of households settle closed to the spoil disposal site during the dredging period. This impact is minor if the constructors will have good management plan for SRAs, but it is major if the spoil disposal management will be failure.

- Environmental risks: during the operation phase, oil spill may be a major environmental risks, caused by ship, boat accidents. This type of impacts may be moderate or minor depending on the scale of accidents but it is controllable.

In order to prevent and mitigate the predicted impacts an Environmental Management Plan (EMP), including measures for impact mitigation, project monitoring and strengthening management capacity is suggested in Chapter Five and Chapter Six.
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CHAPTER FIVE

ENVIRONMENTAL MANAGEMENT PLAN

5.1 MEASURES TO MITIGATE THE ENVIRONMENTAL IMPACTS DURING CONSTRUCTION OF TWO EXTENSION WATERWAYS

5.1.1 Outlines of mitigation measures in the construction phase

- Limiting the increase in turbidity during dredging operation by using suitable dredging equipment.

- Treating acidic water in the SRAs before returning effluent to the canals.

- Selecting construction times appropriate to the production conditions of each section.

- Conducting geological and hydrological investigation before dredging in order to limit banks erosion.

- Making full use of the dredged soil, for instance, using it for leveling for construction of residential areas and rural roads.

- Discharge of engine oil and oily waste from dredgers and construction machines to the canals should be strictly forbidden they must be properly collected and treated.

- Proper organization and inspection of waterway transport to avoid boat incidents.

- Frequently organizing meetings with local people for public consultation for adequate information to the project affected peoples (PAPs), so that they could prevent and control the passable adverse impacts on their living and production conditions.

- Frequently conducting environmental monitoring programs to evaluate the possible changes in environmental quality and provide for the WB, MOT, PMU – W and the contractors, sufficient information on the environmental impacts, so that the proposed measures could be applied timely to mitigate the impacts created during the construction and operation phases of the project.
5.1.2 Design of spoil disposal sites (SRAs)

In order to limit the negative impacts of mud (produced by dredging) on the environment as well as the water quality of the canals, the dredged sediment should be transported to the SRAs.

The bottom mud (dredged sediment) is pumped a containing area of the SRAs, then it overflow to a settlement pond, where turbidity and total suspended solids are settled. After some, effluent is returned to the canals. (*Figure 5.1*)

As for the regions of acid sulfate soil (Kien Luong – Ha Tien section), SRAs’ dikes should be covered with PVC sheets so as to prevent the leakage of acidic water to the surrounding canals and fields.

*Figure 5.1 Layout of Spoil Disposal Site (SRAs)*

A dike around each SRA is designed as follows:

- Height: 2m
- Footing width: 5 m
- Surface width: 1m

A typical design of a SRA is shown in *Figure 5.2*
Fig. 5.2 Typical design of a SRA
5.1.3 Limiting the disturbance of watercourse

Improvement of this waterway includes dredging and enlarging the canals. The following measures should be taken so as to minimize the disturbance of the watercourse and to prevent polluted water transferring to surroundings.

In the zones where the concentrations of heavy metals and pesticides in sediments are higher than the Standard, a monitoring program for heavy metals and pesticide contamination in water and in fish tissue should be done.

On laying dredging machines on a barge, constructors can use a proper mud-stopping net for enclosing the dredging site and keeping back mud on land, not to let it goes back to the canal. However, a major part of the dredged sediment is clay with high adhesion then mud-stopping net is not compulsory. At the sections where the canal expansion is more than 2 m, the dredged spoil should be kept dry on the bank so as not to leak turbid water in the canal.

On installing dredging machines on ferries for expanding the canal banks, contractors should limit the flow of mud returning back to the canal. At the sections where the canal is expanded by more than 2 m, the dredged soil should be kept dry on banks and prevented from falling back to the canal.

After the bank part is dredged, a suction dredger should be used to transfer all the mud and soil in water to the SRA, which is located within 2 km from the bank. The length of dredging sections should be limited less than 1 km and the dredging should be done one by one.

The dredging direction should be arranged such that aquatic animals can move to better places; meaning that fresh water fish can move to field while estuarine fish can move out to the sea.

As for the sections where sulfate acid soil is determined like the project site, the dredging should be carried out in the rainy season for having more fresh water for diluting acidic water.

5.1.4 Mitigating impacts due to widening of the canal

In order to reduce the volume of site clearance, compensation and rehabilitation, the widening of the canal should be carried out on the one bank where the density of houses and population is low, where neither agriculture nor the natural ecosystem is important. And after the canal is expanded, its bank should be covered by proper trees as soon as possible.
Plankton communities can recover together with the return to normal state of turbidity and suspended solid in water (meaning that water will get back the transparency for light penetration) then zoo benthos will recover after several months.

### 5.1.5 Protection of riverside mangrove trees

In order to limit the impacts on the riverside salt-marsh vegetation species during the dredging operation, the project will implement the following measures:

- Designing of sideward dredged so as to minimize site clearance and destruction of the riverside vegetation cover.

- Selecting abandoned land to locate SRAs, not building SRAs inside mangrove forests

- Building and laying pipelines such that no riverside tree is damaged.

### 5.1.6 Public consultation

On preparing for dredging operation in sensitive regions, the Project Management Unit should cooperate with contractors in communal information, which is targeted at bringing out the matters as follows:

- Objectives and meanings of the investment in the project.

- Potential impacts due to dredging operation on the water environment, agriculture shrimp farming, water use such that people could apply countermeasures to minimize damages, if any.

- Measures of mitigating the negative impacts on local aquaculture.

- Improvement of community’s participation in environmental protection. Addresses and telephone numbers of responsible units should be provided then people can inform any environmental incident in due time.

- Obtaining feedback from local people and the project affected households on the environmental issues of the project

Guidelines and requirement in public participation are detail indicated in *Chapter Seven*.
5.1.7 Selection of Spoil Relocation Areas (SRAs)

The right selection of location of the SRAs will mitigate impacts of the project on the environment and livings and productions. A selected SRA should meet the conditions as follows:

- **Land use**

  Public land, land for construction of rural roads, public works, private land, etc. may be used, with an agreement with the project affected households. It should also meet local plans for land use.

- **Size**

  A selected SRA should be large enough or larger than the designed size which has been approved.

- **Location**

  A selected SRA should be located at least 1 km from any Bird Sanctuary or protected sites, at least 200 m from public works (schools, administrative offices, markets), temples and churches, and at least 200 m from aquacultural farms. It should not be located in mangrove forests.

5.1.8 Improvement of environmental monitoring and management

The environment should be monitored in the pre-construction, construction and operation phases. PMU-W will consolidate the relationship with the Provincial Departments of Natural Resources and Environment (DONRE) and local authorities in relation with the project for information disclosure, particularly to PAPs, and assist the contractors to find out suitable SRAs and inspect the implementation of mitigation measures during the construction.

Budget for environmental monitoring during the construction phase and 3 first year of the operation phase is taken from the project’s budget (see Section 6.5).

Budget for environmental monitoring after 3 years from the beginning of the operation phase will be provided by the PMU-W if this monitoring will be necessary.

5.1.9 Measures against accidents

In a bid to prevent traffic accidents during construction, the project has prepared a plan for regulating the traffic specifically for each region so as to meet the demand for transport of every locality.
Because of heavy traffic on the waterway, the regulation is made by dividing it into many short sections that are suitable for dredging machines arranged along the canal. The Waterway Administration Division 14 is in charge of traffic regulation during the dredging. The plan for traffic regulation in every region is as follows:

- **Contents**

Informing vehicle holders in the construction site by mean of mass media.

When the passage is closed, directions to the construction site are warned. Small and light vehicles can continue their usual travel, whereas heavy ones are detained and arranged out of the site.

When the passage is opened, vehicles are guided for passing the site, not to jostle or surpass in the site; one way or two way traffic over the site is allowed periodically.

Subcontractors are coordinated with functional bodies in arrangement of schedules of daily works so as to ensure traffic over the site and at most 16 hours of construction per day.

- **During the construction**

The passage is closed until the construction is complete. The administrative division will set up warning positions to control the traffic to the site. Those include two 33-Hp boats as two upstream and downstream positions.

- **After complement of the construction**

Dredgers should recollect pipes and anchoring cables, get close to one side of the passage and leave the remaining for traffic over the site.

**5.1.10 Protection of canal banks and limitation of soil erosion**

After the waterway of Ganh Hao – Gia Rai is dredged and upgraded, the flow of traffic therein will certainly increase. That however causes noticeable impacts on the environment and the flow of canal. Waves in the canal may be risen when increase of number of boats and boat speed. This may create erosion of the banks. Therefore, in order to ensure the safety of people’s houses and assets as well as the good traffic of the waterway, we building bank-protective works at critical positions, which have been eroded is recommended. The selection of the stone should be made, considering some main criteria as follows:
The bank section has been eroded or is likely to be eroded when the waterway is launched into operation;

The section with important works of the state or populated areas.

The section, where construction of stone jetty is the most reasonable because other measures are ineffective or expensive.

The structure of stone embankment is shown in Fig. 5.3

**STONE EMBANKMENT FOR SOIL EROSION PREVENTION**

![Stone embankment diagram](image)

Fig. 5.3 Stone embankment at sections of strong erosion

**5.1.11 Green protective belt**

In order to protect the bank of the waterway, the project will take the following measures:

- Planting species capable of preventing strong erosion.
- Guiding people who reside on the riverside to plant species such as Nipa and grass for protection of the canals banks.

**5.2 SUMMARY OF MEASURES SUGGESTED FOR ENVIRONMENTAL PROTECTION**

Clay colored livid. The measures suggested for the EMP of the project are summarized in Table 5.1.
### Table 5.1 Summary of impacts and mitigation measures for dredging two extension waterways

<table>
<thead>
<tr>
<th>Potential impacts</th>
<th>Mitigation measures</th>
<th>Responsible body</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONSTRUCTION PHASE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water Pollution</strong></td>
<td>- SRAs include a settlement area; muddy water is pumped to a storing partition, overflowed to the settle area then discharge to the canal.</td>
<td>- SMEC is responsible for designing of SRAs.</td>
</tr>
<tr>
<td>Dredging leads to environmental pollution due to suctioning and disturbing of the bottom mud and expanding the canal. During construction, water near the dredging site has high turbidity and suspended solids. Besides, effluent from SRAs has high turbidity and low pH, contributing to pollution of water sources in the region.</td>
<td>- In the region of acid sulfate soil such as Ha Tien, contractors should build SRAs. with PVC sheets to prevent the leakage of acidic effluent.</td>
<td>- Contractors are responsible for building SRAs as designed as well as sufficiently implementing environmental protection measures.</td>
</tr>
<tr>
<td><strong>Impact on agriculture, aquaculture</strong></td>
<td>Building SRAs as designed, using PVC sheets in regions of acid sulfate soil, so as to prevent leakage and break of dikes. Contractors shall compensate damages in case of incident.</td>
<td>In the contract, PMU-W requires contractors to apply sufficiently environmental protection measures and compensate any damages in case of incident.</td>
</tr>
<tr>
<td>Dredging operation can damage agriculture and aquaculture. The impacts are possibly due to leakage of effluent from the SRAs or break of SRAs dikes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disturbance of living conditions</strong></td>
<td>In order to mitigate impacts and deterioration of living environment, canals shall be expanded on one side, and edaphologically suitable trees should be planted on the new bank.</td>
<td>PMU-W, constructors and local authorities will initiate a campaign for planting trees along the canal with suitable species such as Nipalm.</td>
</tr>
<tr>
<td>Dredge for expanding the canal can destroy the living conditions of aquatic animal’s biota and flora on the banks as well.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Acidification control</strong></td>
<td>- Setting up a water quality monitoring plan for assessing the change in pH and concentrations of metals; - Dredging acid sulfate soil</td>
<td>PMU-W will contract with the EPC-VESDEC in monitoring the water quality and relevant impacts during the implementation of the</td>
</tr>
</tbody>
</table>
environment during construction and from SRAs, causing impacts on the livings of terrestrial and aquatic biota.

in the rainy season to dilute the acid released to the environment;
- Building SRAs for storing dredged sediment.
- Applying lime at SRAs where is high in acidity.

Mitigating impacts by pesticides and other toxic chemicals

Contents of some heavy metals and pesticides may increase in the environment due to dredge and from SRAs having low pH.

- Monitoring before dredge, sediment samples are taken to determine the concentration of any toxic chemicals found in the canal bottom.
- Implementing mitigable monitoring programs to monitor the change in water quality by toxic chemicals
- Monitoring the contamination of fish species by toxic chemicals for timely notification to people.

Mitigating loss of agricultural and residential land

A large area of agricultural and residential land will be used for building SRAs.

Using abandoned land, public land and land for building rural roads for building SRAs.
PMU-W shall properly compensate damages to crops and houses encroached by the project private land.

PMU-W will contract with EPC-VESEC in sampling and analyzing samples of sediment before dredging operation.

PMU-W will contract with EPC-VESDEC to conduct monitoring programs on water, soil quality and fish quality in the construction phase.

PMU and local authorities will determine the location of SRAs. The contractors will agree with local authorities on compensation program (Resettlement Action Plan).
### Mitigating impacts on fish resources

Dredging operation influences on fish resources and fishery.

| No specific measures | PMU-W and contractors. |

### Control of solid and liquid waste during construction

Oil and oily waste from dredgers, if directly discharged to the canals will pollute water.

| - Not discharging oil and grease oily wastes to the canals  
- Garbage from ships shall be collected then transported to the disposal sites of the districts. | Constructors are responsible for management of wastes created by dredgers. |

### OPERATION PHASE

#### Mitigating increase in erosion of banks

Considering the increase in waterway density as a result of the improvement of the canal and the increase in the flow after expansion and dredging, it is possible to predict an increase in waves caused by ships and furthermore, the current will be stronger. Consequently, erosion and sedimentation will be stronger.

| Local authorities shall lease the public land along the canal, which needs plantation of trees, to the private sectors for 30 – 50 years. All benefits shall be of the land leases holders.  
In the regions where the bank less stable, the speed of ships and boats shall be controlled so as to reduce waves. In some regions that need protection, wave fences should be built. | The technical details will define the regions under protection against erosion as well as necessary countermeasures and standards for design. In order to improve the living of aquatic fauna and protect the bank, inundated protective foothill should be built in canal sections of abrupt slopes. |
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CHAPTER SIX

ENVIRONMENTAL MONITORING

To timely assess the impact of environmental project in the construction and operation phase, to assess the effect of reducing pollution methods, monitoring and management program of project is below – mention. This monitoring environment will be implemented by Vietnam Inland Waterways and Port Rehabilitation Project combine with Environmental Project Center (VESDEC).

6.1 LEGAL AND MONITORING ORGANIZATION IN THE MONITORING PROGRAM

6.1.1 Legal documents

Environmental monitoring for project implementation is required by the Government of Vietnam as well as the World Bank (WB). The major legal documents related to the requirement in environmental monitoring are indicated as follows:

- Law on Environmental Protection of Vietnam, issued on 10th January 1994 by the Order of the State President.

- Decree N175/CP on 18th October 1994 issued by the Government, guiding implementation of the Law on Environmental Protection.

- Circular N276-TT/Mtg on 6th March 1997 issued by the Ministry Science, Technology and Environment (MOSTE) guiding implementation of pollution control and environmental monitoring after approval of EIA report.


6.1.2 Environmental monitoring organization

- In Vietnam, the former Ministry Science, Technology and Environment (MOSTE) before and at present the Ministry of Natural Resources and Environment (MONRE) are responsible for Nation – wide environmental management included environmental monitoring. The Environmental Monitoring System is established by MOSTE since 1994.
According to the guidelines of Vietnam, the project should conduct programs of internal monitoring in the dredging and operation phases. To check all environmental problems created by the project. In addition, the state environmental monitoring government agency or independent bodies are responsible for (external monitoring programs) followed requirement of MONRE or provincial Department of Natural Resources and Environment (DONRE).

In this project the Independent environmental monitoring agency is EPC belonging to the Environment and Sustainable Development Institute. It is responsible for environmental monitoring in the pre-construction, construction, and operation phases of the extension canal sections.

6.2 ENVIRONMENTAL MONITORING IN THE PRE-CONSTRUCTION PHASE

6.2.1 Canal water quality monitoring

- **Monitoring parameters**

The monitoring parameters required by the WB for this project in the pre-construction phase included: temperature, pH, EC, salinity, turbidity, TDS, SS, DO, BOD, COD, NO$_2^-$, NO$_3^-$, NH$_4^+$, Zn, Al, heavy metals (Cd, Ni, Hg), T. coli and fecal coliform.

- **Monitoring sites**

The monitoring sites for the pre-construction phase are shown in *Fig 6.1*.

6.2.2 Monitoring of bottom sediment

- **Monitoring parameters**

The parameters to be monitored for bottom sediment of the canal include:

- Particle size
- Heavy metals (Hg, Cd, Pb, Cr)
- Pesticides (DDT, DDE, DDD, Lindane, Aldrin, Dieldrin, BHC (alpha, beta, gamma)).

- **Monitoring sites**
Three monitoring sites along the canal were selected, distance between the site to site is 9 km. The sites for monitoring bottom mud in the pre-construction phase are shown in Fig 6.1.

6.2.3 Monitoring acid sulphate soil

- Monitoring method

Using drilling equipment to collect soil samples which represent the layer of 5m depth. Immediately, Treatment collected soil at the site to identify water content and pH. One part of soil sample is treated with strong hydro peroxide (H$_2$O$_2$), a strong oxidizer, to change sulfite and the remains is analyzed in the laboratory.

- Monitoring sites

Monitoring sites of acid sulfate soil are presented in Figure 6.1

6.3 ENVIRONMENTAL MONITORING PROGRAM DURING THE CONSTRUCTION PHASE

6.3.1 Water quality monitoring

One of the important impacts during the construction phase is the disturbance of bottom mud that releases pollutants to water and transfers of acidic materials.

In order to determine the quality of water in the natural condition prior to dredging, PMU had conducted water quality monitoring at 2 sections.

- Monitoring parameters

Temperature, pH, EC, salinity, turbidity, TDS, SS, DO, BOD, COD, NO$_2^-$, NO$_3^-$, NH$_4^+$, Zn, Al, heavy metals (Cd, Ni, Hg), grease and oils, T.coliform, fecal coliform.

For each construction sector, the water quality is measured 3 times a week at 2 transects: one upstream and one downstream, about 1.5 km from the dredging site.

The sampling sites for water quality monitoring during the construction phase are shown in Table 6.1.

- Monitoring frequency

Water quality monitoring is conducted with a frequency of 4 times a year (2 times in the dry season and 2 times in the rainy season).
### Table 6.1 Monitoring sites and number of sampling in the construction phase

<table>
<thead>
<tr>
<th>Section/Construction site</th>
<th>Monitoring points</th>
<th>Canal water quality</th>
<th>Water quality for domestic supplying</th>
<th>Water quality for irrigation</th>
<th>Leatchate of disposal landfill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca Mau–Nam Can</td>
<td>Km 0+000</td>
<td>2 x 3</td>
<td>1 x 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Km 4+000</td>
<td>2 x 3</td>
<td>1 x 3</td>
<td>1 x 1</td>
<td>1 x 3</td>
</tr>
<tr>
<td></td>
<td>Km 8+000</td>
<td>2 x 3</td>
<td>1 x 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Km 12+000</td>
<td>2 x 3</td>
<td>1 x 3</td>
<td>1 x 1</td>
<td>1 x 3</td>
</tr>
<tr>
<td></td>
<td>Km 16+000</td>
<td>2 x 3</td>
<td>1 x 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Km 20+000</td>
<td>2 x 3</td>
<td>1 x 3</td>
<td>1 x 1</td>
<td>1 x 3</td>
</tr>
<tr>
<td></td>
<td>Km 24+000</td>
<td>2 x 3</td>
<td>1 x 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>7</td>
<td>42</td>
<td>21</td>
<td>3</td>
</tr>
</tbody>
</table>

#### 6.3.2 Monitoring the drainage of water from the spoil disposal site (SDSs)

As for the SDSs, all drainage water will be driven to the drains thereof for discharging back to the canal. All the SDSs should be designed such that the deposit volume of dredged materials there is maximal.

As the dredged is in the state of mud, soil particles are suspended for 24 to 48 hours. In the time of drainage and discharge, pH and the content of suspended solids should be measured 3 times a week at the discharge point.

- **Monitoring parameters**

  For leakage water from the SDSs: pH, DO, TSS, temperature, fecal coliform.

- **Monitoring sites**

  4 times a year (2 times in the dry season, 2 times in the rainy season) and the monitoring times will be the same with the times for water quality monitoring.

- **Monitoring method**

  Water quality is evaluated at the field based on 5 basic parameters, e.g. pH, DO, SS, T, Coliform and temperature. The remaining parameters are examined in laboratory. The measured results are compared with the data collected at the same sites in the pre-construction phase.
6.3.3 Monitoring of the intake sites for domestic water supply

To assure water quality for domestic use in the construction phase PMU will conduct canal water quality monitoring at 5 intake sites. The 5 basic parameters to be examined are pH, DO, SS, temperature, total coliform and the 5 selected metals (Pb, Hg, Cd, Al, Zn) water quality monitoring will be conducted at 4 times a year, each time 3 days a week. The measured data will be compared with the Vietnamese Surface Water Quality Standard (TCVN 5942-1995) to assess whether canal water quality could be used for domestic purpose.

6.3.4 Monitoring the intake sites for aquaculture

Water of the canals somewhere is taken for aqua farming. In order to assure water quality for aquaculture, the PMU will conduct monitoring program at the start, the middle and the end of the canal section. The monitoring parameters are pH, DO, SS, temperature, total coliform. The monitoring frequency is a time a week during the dredging duration.

The monitoring results will also be compared with the Vietnamese or/and FAO Standards on water quality for aquaculture.

The monitoring parameters, frequency and methods along the waterways during the dredging are shown in Table 6.2

Table 6.2 Outline of the monitoring plan for the construction phase

<table>
<thead>
<tr>
<th>Water quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring parameters</td>
</tr>
<tr>
<td>Analyzing method</td>
</tr>
<tr>
<td>Sampling positions</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Monitoring time and frequency</td>
</tr>
</tbody>
</table>

CHAPTER SIX
6.4 MONITORING DURING THE OPERATION PHASE

6.4.1 Canal water quality monitoring

In the first year after dredging on a waterway section finished, the PMU-W will implement a monitoring program for evaluating water quality in the operation phase.

- **Monitoring sites**

Monitoring sites after construction will be determined at the transects along the canal where samples were taken into checkup before construction which are presented in Figure 6.1.

- **Monitoring frequency**

Water sample will be taken at each transect one day in March and September.

- **Monitoring parameters**

Samples will be analyzed with 17 parameters: pH, dissolved oxygen, salinity, BOD, COD, nitrate, nitrite, suspended solid, dissolved solid, ammonia, temperature, cadmium, lead, aluminum, zinc, mercury and E. coli form. Some parameters will be measured at site and samples will be examined in laboratory. The data to be used for comparison is of water quality of the surroundings prior to construction and the national environmental standard on quality of surface water (TCVN 5942-1995).

6.4.2 Monitoring effluent from SDSs

In the first year after the construction phase. The SDSs almost are used for foundation of house, rural road area or improved to fruit gardens or cultivated

<table>
<thead>
<tr>
<th>Implementing agencies</th>
<th>The PMU will sign a contract with the Environmental Protection Center (EPC) for implementation of the monitoring programs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>times a week</td>
<td>- Drain from yard to canal: 5 parameters, 3 times a week when water is drained</td>
</tr>
<tr>
<td></td>
<td>- Intake of water for living: 5 parameters and contents of metals, 3 times per week during the dredging.</td>
</tr>
<tr>
<td></td>
<td>- Intake of water for aquaculture: 5 parameters and once a week at the places where water is taken in</td>
</tr>
</tbody>
</table>
farms. Acid sulfate soil was treated with powdered lime by farmers so acidic pollution of soil was reduced. Therefore, monitoring effluent from SDSs will not be necessary.

6.4.3 Monitoring used for domestic purpose water

- Monitoring parameter

In the first year after the accomplishment of dredging, all water intake sites for domestic uses, where were monitored in the construction phase, will be monitored. 5 basic parameters (pH, DO, SS, Fe, and turbidity) and the concentrations of 5 toxic metals (Pb, Hg, Cd, Zn, Al) will be examined.

- Monitoring frequency

Monitoring program will be implemented one time in the rainy season (September) and one time in the dry season (March).

6.5 ESTIMATED COST OF ENVIRONMENTAL MONITORING PROGRAM

In order to implement the environmental monitoring program, Project should have a fund as shown in Table 6.3

Table 6.3 Estimated cost of environmental monitoring program

<table>
<thead>
<tr>
<th>No</th>
<th>Items</th>
<th>Cost (VND)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total:</td>
<td>214,740,000</td>
</tr>
<tr>
<td>A</td>
<td>Studying on EIA</td>
<td>91,990,000</td>
</tr>
<tr>
<td>1</td>
<td>Survey, monitoring at the project area</td>
<td>23,690,000</td>
</tr>
<tr>
<td>2</td>
<td>Public consultation program</td>
<td>26,200,000</td>
</tr>
<tr>
<td>3</td>
<td>Documentation</td>
<td>28,500,000</td>
</tr>
<tr>
<td>4</td>
<td>Approval fee</td>
<td>13,600,000</td>
</tr>
<tr>
<td>B</td>
<td>Environmental monitoring:</td>
<td>122,750,000</td>
</tr>
<tr>
<td>I</td>
<td>Environmental monitoring during construction phase</td>
<td>69,450,000</td>
</tr>
<tr>
<td>1</td>
<td>Samples analysis</td>
<td>10,650,000</td>
</tr>
<tr>
<td>2</td>
<td>Transportation</td>
<td>34,800,000</td>
</tr>
<tr>
<td>3</td>
<td>Others</td>
<td>24,000,000</td>
</tr>
<tr>
<td>II</td>
<td>Environmental monitoring during operation phase</td>
<td>53,300,000</td>
</tr>
<tr>
<td>1</td>
<td>Samples analysis</td>
<td>6,300,000</td>
</tr>
</tbody>
</table>
Table 6.7: Source of environmental monitoring fund

<table>
<thead>
<tr>
<th>No</th>
<th>Items</th>
<th>Total</th>
<th>Pre-construction phase</th>
<th>Construction phase</th>
<th>Operation phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Year 2005</td>
<td>161,440,000</td>
<td>91,990,000</td>
<td>69,450,000</td>
<td>53,300,000</td>
</tr>
<tr>
<td></td>
<td>- Corresponding capital</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>- WB Fund</td>
<td>161,440,000</td>
<td>91,990,000</td>
<td>69,450,000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Year 2006</td>
<td>53,300,000</td>
<td>-</td>
<td>-</td>
<td>53,300,000</td>
</tr>
<tr>
<td></td>
<td>- Corresponding capital</td>
<td>53,300,000</td>
<td>-</td>
<td>-</td>
<td>53,300,000</td>
</tr>
<tr>
<td></td>
<td>- WB Fund</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

6.5 ENVIRONMENTAL MONITORING PLAN

- Task of environmental monitoring in the pre-construction phase should be carried out at last quarter of 2004 and end at the first quarter of 2005.

- Task of environmental monitoring in the construction phase should be carried out in 2005 and end before September of 2005.

- Task of environmental monitoring in the operation phase should be carried out in 2006.

Source of the environmental monitoring in the operation phase of Ganh Hao – Gia Rai section is used corresponding capital.
CHAPTER SEVEN

PUBLIC CONSULTATION IN EIA OF ADDITIONAL DREDGING WORKS OF THE GANH HAO-GIA RAI EXTENSION CANAL

7.1 POLICIES OF THE WORLD BANK AND GOVERNMENT OF VIETNAM ON PUBLIC CONSULTATION IN EIA

7.1.1. World Bank Policy

World Bank (the Bank) policy regarding community involvement is provided in detail in the WB Environmental Assessment Source Book, Vol. 1 (1991). It is summarized as follows.

Bank policy directs the borrower to publicly solicit, hear and consider the concerns of the local community, other affected groups and local NGOs (non-governmental organizations) and to fully incorporate into the design and implementation of the project and the Environmental Assessment (EA). The rationale for consideration and incorporation of the concerns of the affected parties is to assure community acceptance and enhance the viability of the project. The Bank has found that where such views have been successfully incorporated into the design and plan of implementation, the projects are more likely to be successful. The Bank has not found community participation to be an impediment to project execution. On the contrary, projects in which affected parties views have been excluded are more likely to suffer from delay and quality issues resulting from community resistance.

The Environmental Assessment Operational Directive (EAOD) clarifies Bank policy, which for more than a decade has encouraged community participation in Bank-supported projects. Sociological considerations were added to the Bank’s operational manual statement on project design and appraisal in 1995, specifying that effective project implementation requires the full commitment of all beneficiaries and associated stakeholders and that to be effective a project appraisal should verify that affected parties were fully informed and involved in project identification and preparation.

The operational directive on collaboration with non-governmental organizations (NGOs) also urges Bank staff “as a matter of Bank policy” to develop contacts and operational collaboration with NGOs (OD 10.70). The directive defines NGOs as “private organization that pursues activities to relieve suffering, promote the interests of the poor, protect the environment, or undertake community development”.

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CHAPTER SEVEN

7-1
At identification of an EA category “A” project, or as soon as the project is classified as a category “A” project, any borrower who does not consult with local NGOs, or does not seek and consider the informed views of the affected parties through the release and public comment on the relevant EA, are considered to be out of compliance with this policy. It is therefore unlikely, in such cases, that the Bank would continue to support that project. EA requirements should be reviewed well in advance of the implementation of any project to ensure compliance with the principles outlined in the EA OD.

The EA OD’s provision for public consultation reflects a larger social trend. Forces are converging to convince both government and development agencies to be more responsive to public concerns and participation because popular support is a key factor in project viability. In some countries, this trend has helped to motivate a popular shift towards democracy. Experience with “people-centred” development is growing and gaining acceptance and attention.

7.1.2 Policy of the Vietnamese Government (GOV)

Vietnam is a socialist country. The State is determined by the fundamental principle “of people, from people and for people”. The democratic approach to the social management of GOV is expressed in the basic principle of “people know, people discuss and people control” all activities of the Government.

At present, based on these basic principles, all policies, programs or projects of the Government, private and/or foreign investors should be disclosed and discussed with the people in the affected areas so that the reasonable comments and concerns of project affected people (PAHs) are fully considered and incorporated.

In the recent years, the rapid pace of industrialization and urbanization has impacted environmental quality, causing adverse impacts on public health, the general ecology and associated economy in various regions in Vietnam. As a result, inclusion of relevant environmental considerations in the socio-economic development decision process have became an important issue, and compliance is of concern by not only to the Government (MOSTE, DOSTE, MPI, Ministry of Industry, MOT) but also affected parties associated with the project.

To avoid negative impacts of the project, Governmental Decree No. 175/CP issued on 18th October, 1994 requires that all projects in the development of industry, energy, transport, water resource, agriculture, etc. should conduct a compliant EIA study meeting the requirements of the environmental management authorities and that the contents of EIA reports include predicted impacts and mitigation measures must be discussed with the PAHs.
The PAP should submit their comments and concerns to the project proponents through their authorized representatives, e.g. Governmental agencies (the People’s Committee, People’s Council) and/or socio-political organizations (Front Fatherland Committee, Farmers Association, Women Union etc.) or non-government organizations (e.g. Vietnam Association for the Conservation of the Nature and Environment, Biological Association, Economic Association, Foresters Association etc.). These organizations should collect all comments from the local people and send them to the environmental management authorities (DONRE at provincial level or MONRE at central level) or even to Provincial People’s Council or National Assembly. During the environmental review process, all comments and requirements of the PAP should be discussed and conclusions reported to the project proponents, so that the project can develop proper alternatives and implement measures for mitigation of the negative impacts. The project will receive an investment license only after appropriate modification of location, design, capacity and/or technology of the project to meet the requirement of environmental protection and resettlement.

Relating to compensation for the PAHs who lost land, dwellings and/or income as a result of the projects, the GOV issued Decree No. 22/1998/ND-CP (24/4/1998).

This Decree is the legal base for preparation, implementation of proper resettlement action plan (RAP) which supports the PAHs in finding new jobs and new settlement sites, maintain living standard and avoid adverse impacts of the project on the local socio-economy.

7.2 THE PUBLIC CONSULTATION PROCESS

7.2.1 Guideline

The following items comprise the full public consultation process required by WB.

- Levels of public consultation

  - Informed public participation in the environmental review process encompasses consultation with those parties both directly and indirectly affected. In the first case are the groups that would be directly impacted by a proposed project, for example fishers’ folk downstream from a dam. It is important to remember that the most critical effects may occur some distance from the project itself, that the informed views of all potentially affected communities should be taken into account in the pre-design stages of the project, and that these communities should be involved in the EA.
- The second group to be involved in public consultation consists of those who, because of their particular concern or expertise, have relevant information and specific input regarding the nature or scope of potential environmental impact. Obvious examples are societies of consulting engineers, experts on cultural property, environmental NGOs, or grassroots organizations concerned with environmental quality. Less obvious, but frequently important because of their perspective, are educators or human rights, anti-poverty or religious groups.

- The distinction between these groups cut across two criterions: one is the degree to which a group will be affected by the proposed project; the other is the kind of knowledge the group can bring to the EA. Local and external groups at various points along each axis should be consulted during the EA process. By far the most important point is that such consultations must start very early in the process if they are to be meaningful and influence decisions made during the development process, which will affect their lives. The views and concerns of the potentially affected people and the local NGOs should be solicited no later than the process beginning.

It is advisable during the identification phase, to have preliminary contacts with affected parties. Public participation in the EA should start when the preparation of the feasibility study begins. The EA is an integral component of the feasibility study. Public participation is usually fostered by the social scientist members of the EA team, although the full co-operation of the EA physical and biological disciplines is needed. Where social impacts have significant scale or severity or where they are particularly complex, a social science team of local residents may be required at several intervals during the process of project feasibility and preparation studies. Where few people are affected, a single social scientist can often reside in the area for a few months total time spread over a year, so that the studies will encompass the entire annual cycle.

Although the bulk of the work is during preparation, there is still a great deal of social input needed during construction, less during operation and thereafter. The affected people and local NGOs and the public at large should participate in monitoring during operation and assist in post hoc evaluation.

- Consultation at the Community Level

Communities may be large or small; they are easily defined by recognized geographical boundaries in either urban or rural areas, and may encompass a number of villages over a large area. The people of an affected area may be homogeneous and speak the same language, be at roughly the same economic level, share the same customs and values and make their living in similar ways. Conversely, they may be highly differentiated in language, culture, occupation and income levels. If the
community is diverse and the people heterogeneous, the consultative process will be particularly demanding.

Public consultation is accepted as an essential part of the EA process in industrial countries, but EA performed in industrial countries provide little guidance for the inclusion of local communities in developing countries. The premise of public consultation in most industrial countries is: (a) if the citizens are informed about a project and the opportunity to discuss its environmental implications, those citizens most interested will respond; (b) most citizens have access to newspapers, radio and television and can read and understand notices; and (c) citizens who participate are accustomed to the frank dialogue associated with democratic discussions, and are not exposed to any personal or political risk in questioning proposed governmental action.

In many developing countries, an EA team cannot operate on this premise and often cannot function in the responsive stance suitable to industrial countries, but must take a proactive, initiatory approach to encourage and to promote citizen participation. This means sharing whatever information is available about the project so that informed views can be obtained.

A primary objective of consultation with a community is to encourage opening discussion of all issues and concerns. To this end, the challenge is to provide means that are congruent with local cultures and customs and that provide a safe and comfortable setting to voice the issues as they see them. If the sociologists or anthropologists attached to a multi-disciplinary team are expatriates, the team will need members from the country who are familiar with the people, culture and language of the affected area. In many cultures, women specifically will be needed to talk with the women involved.

Selecting team members in this way, who speak the language and are culturally acceptable to the communities is crucial to the project’s success. Advice on recruitment can be sought from local staff of development agencies or from NGOs with specific experience in the area. The recruits may be researchers from colleges and universities, staff of local NGOs, or social workers or extension workers with ties both to government ministries and to the community.

Exploration at the community level should not be rushed. The team members should be involved at various stages, including the early stage when the official and informal leadership of the communities – all the key figures in the authority structure – are briefed on the project and invited to participate and express their views. The sociological members of the EA team should reside in the area while gathering information. Often, this is the only way to achieve reliable consultation.
Large meetings are sometimes inappropriate forums for public consultation at the community level. Small meetings and individual interviews are often more useful. All communities have social groups through which they normally organize activities, such as work groups, savings societies, schools or cooperatives, or small enterprise groups. Groups that primarily involve women should be sought out. Religious groups also provide useful forums. The structure of the small meetings will vary according to country and culture; but in general, new organizational forms with which people are unfamiliar (e.g., committees) should be avoided in preference for existing social groups within people feel comfortable.

A major difficulty in consulting with people who may be affected is the inability of many either to understand how their world can be different from what it is, or to realistically understand what their real needs might be when the project materializes. Where feasible, graphic illustrations should be used to clarify the issues; scale models of the area showing villages and the project are generally better understood than speeches alone. Videotape can be useful in presenting this sort of information. Posters, illustrated pamphlets and cartoons have proved effective in literate communities; they can be displayed at schools, religious buildings, shops, clinics, co-operatives and other centres of community activity.

Involving affected people, especially the poor, often requires additional expenditures. The costs include travel and subsistence for attendance at meetings, translation and expert advice that the community needs to help to formulate a response to the proposal, etc. Such costs should be systematically budgeted. The EA team must ensure that issues raised in affected communities are communicated to the other participants in the EA process, including various public agencies and NGOs that may be involved in the larger process of public consultation.

As the EA proceeds, the people in the affected area should be kept informed routinely and systematically. Written material must be translated into local languages. Where many are unable to read, oral discussion and visual presentations sessions (often, by the resident social promoters or facilitators) should be used. Throughout the EA process, the project agency should continue seeking views from and providing feedback to the affected community.

7.2.2 Organization of communal consultancy for the project:

By far there is no concrete guidance for communal consultancy in Vietnam. In combination of the Vietnamese government’s policies and the World Bank’s Directive, on implementation of the project, the following activities have been and will be organized.

- Official meetings:
- The PMU bearing the responsibility of organizing meetings for obtaining opinions from the community.

- The PMU contacting with local authorities such as the Service of Resources and Environment and the People’s Committee of Ca Mau province for organizing meetings.

- The PMU collaborating with the EIA consulting agent (EPC) in preparing booklets (outline of the environmental impact assessment study and the feasibility study), which are handed over to local authorities and the PAP. In the meetings, the PMU and EPC are responsible for presenting contents as well as explaining relevant matters.

- An official meeting organized in Ca Mau province with the participation of representatives for the PAP, local authorities and local social organizations, the Service of Resources and Environment, consultants and subcontractors.

- Meetings organized on implementing the EIA study with a view of introducing the project towards constructive dialogues, collecting of questions and understanding the participants’ issues.

- Meetings with the PAP during the course of environmental study. Those unofficial meeting are recommended in site study for EIA. The EIA team of the EPC has many times met with families in the affected region. This EIA study also used some opinions and viewpoints of the interviewed people.

Communal consultancy meetings which have been organized include.

- At communal level: January 2005 together with finding of spoil relocated areas for start-up of dredging in March 2004.

**Contents of the meetings for obtaining people’s opinions:**

- The PMU and EPC disseminated information of the main technical specifications, and environmental matters and mitigating methods thereof.

- During the meetings, all questions raised by the PAP were answered and all issues and recommendations by the PAP and the People’s Committee were acknowledged.

- Lists of participants were established with acknowledgement of participation by participant’s signatures.
Camera and tapes were used in meetings.

Means of presentation in meetings:

The PMU made their presentation by the following means:

- Booklets with outlines of the feasibility study and EIA study
- Map of the project site
- Figures, graphs, photos and drawings showing activities of the project.

Feedback from the PMU:

- The PMU and the consulting agent fully answered the questions and recommendations raised in the meetings.
- All questions and recommendations were studied and added in the EIA report.
CONCLUSION

The project for rehabilitation of two Southern waterways and Can Tho port plays an important role in the socio-economic development of the whole Mekong Delta and Hochiminh city. The project contributes in improvement of life of people and poverty alleviation in the Mekong Delta region. Therefore, it selected as one of the 6 priority projects in the development plan for the Mekong Delta.

The EIA report on the project was approved by the Ministry of Science, Technology and Environment (now the Ministry of Natural Resources and Environment) according to Decision 1021/QD-BKHCNMT dated 3 June 1999.

In 2004, the Dredging Works of Ganh Hao-Gia Rai extension canal is additionally researched. That, Environmental Impact Assessment (EIA) Report for this additional project is implemented by the Project Management Unit (PMU-W).

The construction and operation of the Additional Dredging Works of Ganh Hao-Gia Rai extension canal will cause the environmental impacts as follows.

- Water pollution due to dredging canal sections and building landing stages and bridges. This impact is assessed as negative but minor and mitigable, canal water quality will be recovered shortly after completion of construction activities.

- Impact on aquafaming at the areas along the Ganh Hao – Gia Rai canal. This impact is assessed as negative, moderate but not serious if the project will have adequate measures for environmental management and pollution control.

- Loss of riverside vegetation cover and consequent increase in erosion of banks. This impact is minor and local.

- Impacts on the structure of the aquatic habitat in the project site. This will be minor. The structure of the canal section will be recovered in a duration of one to some years after the project completion.

- Impact on fish sources and fishery during the dredging of the extension waterway. This impact is expected as minor and temporary.

- Impact of the production and living conditions of people at the SDSs during dredging. This impact is assessed as moderate but controllable.

In order to mitigate the negative impacts, the Project Management Unit has proposed various feasible managerial and technical measures. Those include:
- Measures to managing and treating effluent having high turbidity and suspended solid.

- Measures to protecting local agriculture and aquaculture in the construction phase;

- Measures to minimizing the impacts on sensitive zones such as shrimp farms and bird sanctuary.

- Measures to reduce the transfer of acidic water and water pollution during construction and dredging.

- A detailed program for environmental monitoring in the pre-construction, construction, and operation phases which has been approved by the WB.

The above indicated environmental impacts and mitigation measures were informed by the PMU-W to the local authorities and people. They were accepted by the stakeholders.

The Project Management Unit will be fully responsible for any environmental problems, including pollution and risks, in the construction and operation of the additional works.

On the bases of the conclusions as mentioned above, the Project Management Unit (PMU-W) requests the Ministry of Natural Resources and Environment to approve the EIA report on the Additional Dredging Works of Ganh Hao-Gia Rai extension canal of the Vietnam Inland Waterways and Port Rehabilitation Project.
REHABILITATION OF REFERENCE


2. MOSTE. Circular 490/1988/TT-KHCNMT, 29-4-1998


7. Le Trinh, Environmental Profile of the Mekong Delta, prepared NEDECO, 1992


9. VESDEC. Results of Environmental Study for the project, December 2003 and March 2004


