PEOPLE'S COMMITTEE OF CA MAU PROVINCE

DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT OF CA MAU PROVINCE

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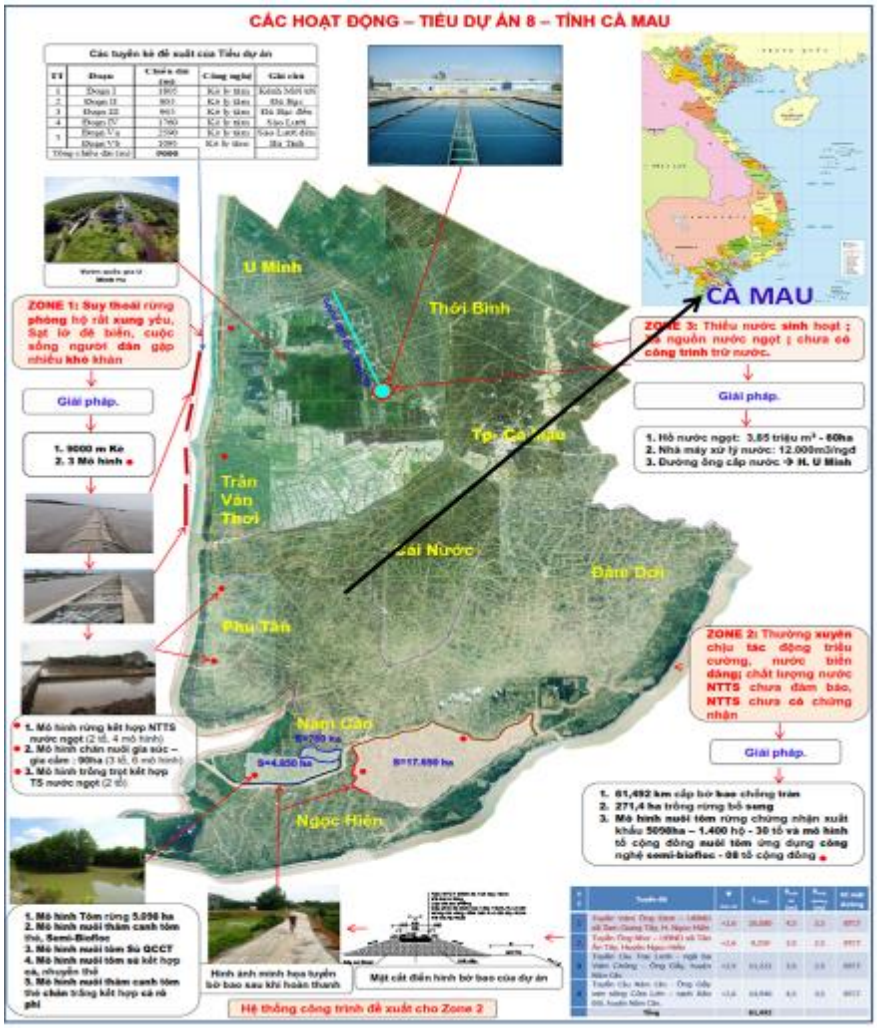
Project: Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods (MD-ICRSL)

Subproject: Infrastructure to prevent coastal erosion, supply fresh water and for production of shrimp - forest model to improve livelihoods and adapting to climate change in the coastal area of Ca Mau Province

REPORT ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

Final



Ca Mau, July- 2019

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ABBREVIATIONS AND ACRONYMS

CPMU	Central Project Management Unit of CPO
CPC	Commune People's Committee
CPO	Central Project Office (MARD)
CSC	Construction Supervision Consultant
CSEP	Contract Specific Environmental Plan
DARD	Department of Agriculture and Rural Development
DONRE	Department of Natural Resources and Environment
DPC	District People's Committee
PDWR	Provincial Division of Water Resources
ECOP	Environmental Codes of Practice
EHSO	Environment Health and Safety Officer
EMC	Environmental Management Consultant
ESMP	Environmental and Social Management Plan
ESIA	Environmental and Social Impact Assessment
ESC	Environment Safeguard Consultant
ESMF	Environment and Social Management Framework
ESU	Environment and Social Unit
GOV	Government of Vietnam
GRM	Grievance Redress Mechanism
GRS	Grievance Redress Service
HH	Household
IMC	Independent Monitoring Consultant
MARD	Ministry of Agriculture and Rural Development
MD-ICRSL	Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods
OP/BP	Operation Policy/Bank Procedures
PPC	Provincial People's Committee
PMU	Project Management Unit
PPMU	Provincial Project Management Unit
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
SIWRR	Southern Institute of Water Resources Research
SSC	Social Safeguard Coordinator
UXO	Unexploded Ordnance
WB	World Bank
NGO	Non-Governmental Organization

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INTRODUCTION

1. THE ORIGIN OF THE SUBPROJECT

Climate change has been increasing dramatically, affecting negatively to the natural resources, the environment and the social economic development of Ca Mau Province.

Ca Mau province locates on the South of Ca Mau Peninsula in southern Vietnam, with three of its borders surrounded by the ocean. With its unique geographic position: locating at one of the crucial trading regions of Vietnam and the world, natural environmental conditions; Ca Mau has many great potentials for social economic development, being considered as a very diverse, dynamic fresh-brackish water (estuary) ecosystems with very distinctive rivers catchments that are essential for both agriculture and fishing industries in Ca Mau. However, Ca Mau, as well as other coastal regions, has been facing a variety of difficulties affecting the social economic development of the province, such as:

- Lack of fresh water is an obstacle to the province's socio-economic development: although belonging to the lower section of Mekong River, due to its relatively far away location to the freshwater resources, it is almost impossible to inherit fresh water from the Mekong River. Therefore, fresh water for daily life and production in the province is mainly supplied by groundwater and rainwater. Although there is heavy rainfall (average 2.125mm/year), more than 80% of rainfall is concentrated in the rainy season; in the absence of the reserve works, this precious freshwater often flows into the sea, therefore, people don't have access to freshwater during the dry season. So, nowadays, groundwater is the main source of fresh water for socio-economic activities of the province. However, underground water is in the form of bags with limited reserves and no capacity to recover. Overexploitation of groundwater causes the groundwater source to decrease; the risk of land subsidence, salinity intrusion into the exploited underground aquifers increases…
- The coastal erosion and landslide situation has become more and more serious. Mangroves forest are losing, leading to the livelihoods of coastal people are seriously affected. In recent years, the weather condition is becoming complex and adverse. The high tides in the West Sea often rise, combining rain, thunderstorms and strong waves leading to a large area of protective forest lost. In some places, the protective forest is no longer exist, the waves directly affect the dike body, threatening to resident and the production of people inside the dike. Coastal erosion and landslide prevention, rehabilitating the protective forest on the West coast is an urgent problem that the local authorities are focused on solving immediately.
- The southern part of the province is newly cleared, especially Ngoc Hien and Nam Can districts; due to the low terrain and the direct impact of the East Sea tides, the relatively simple irrigation works are insufficient to protect the inhabitants and production activities in these districts. Whenever there is high tide, many of the embankments in Nam Can and Ngoc Hien districts have been broken, impacting considerably on the production of the local people. These are also the places that will be seriously affected by climate change and sea level rise, so in the coming time, the risk of flooding and embankment rupture's effects will increase if the embankment is not upgraded.
- Ca Mau has strength in ecological shrimp farming. However, these activities are only at the individual farmer-household level, not linked together in term of production and consumption, so products prices are often pressed or no stable output. In many places, the infrastructures do not meet the minimum requirements for these activities. Ecological shrimp farming is not consistent from farming to farming activities management, there is no process to maintain the quality of ecological shrimp so the output is not stable and does

not meet the requirements of consumption which leads to the opposite effect of difficulty in production.

Coastal erosion prevention, maintaining and developing the mangrove ecosystem; renovating and upgrading the system of embankment; providing clean water for daily life in order to stabilize livelihood are the basic works to help the lives of people in the area at present and creating infrastructures to help people adapt to climate change and sea level rise in the future. Maintaining and developing livelihoods models that are planned and managed synchronously from production to marketing to meet ecological standards as a basis for improving people's income.

Under the framework of the project "Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods (MD-ICRSL)" funded by the World Bank (WB) through ODA loans signed by the Government of Vietnam in 2016, Ca Mau province was approved for investment subproject: "*Infrastructure to prevent coastal erosion, supply fresh water and for production of shrimp - forest model to improve livelihoods and adapting to climate change in the coastal area of Ca Mau Province*" in Component 4[1]of MD-ICRSL. This is a newly constructed subproject based on the existing infrastructure. These works together with other projects have been invested will help Ca Mau province to adapt to the effects of climate change, improve the livelihoods of people in the project area in particular and in Ca Mau province in general.

Pursuant to Environmental Protection Law No.55/2014/QH13 and Decree No.18/2015/ND of the Government, it is necessary to prepare an Environmental Impact Assessment report (EIA) for the Subproject, which is managed by Ca Mau Department of Agriculture and Rural Development (DARD).

The Subproject is funded by the WB, therefore in addition to meeting the environmental requirements of the Government of Vietnam, it must satisfy the safeguard policies of the WB.

Pursuant to the WB's environmental assessment safeguard policy (OP/BP4.01), the MD-ICRSL project is rated Category A and an Environmental and Social Management Framework (ESMF) has been developed for the project to ensure that its subprojects and other activities will not cause negative impacts on the environment and local people and unavoidable negative impacts will be reduced drastically in line with the WB's safeguard policy.

Based on the guidance of the approved ESMF of the ICRSL project, the Subproject Owner has completed the eligible and technical screening to determine types of environmental assessment. The determination of the safeguard policies that will be applied to the Subproject as well as the types of issues and document relating to the safeguard policies that will be required to prepare for the Subproject has been completed.

The screening results show that:

- Regarding the eligibility screening: The Subproject is funded by the ICRSL project.

[1]Component 4 (Peninsula Coastal Protection) addresses the challenges associated with coastal erosion, groundwater management, sustainable water supply, sustainable aquaculture and livelihood improvement for communities living in the coastal areas, estuaries of Kien Giang and Ca Mau. Potential activities include: i) development/improvement of coastal protective forest belts including combination of embankments, dikes, and mangrove forests; ii) upgrading of saltwater intrusion control infrastructure along the coastline to make aquaculture activities more flexible and sustainable; iv) control of groundwater use for agriculture/aquaculture and development of fresh water sources for domestic use; v) support to farmers to help them carry out more sustainable brackish farming activities such as mangroves and shrimps and other fisheries activities, and vi) support appropriate agro-forestry suitable with climate to use water efficiently.

- WB policies are triggered for this subproject: Environmental Assessment (OP/BP 4.01)[2], Natural Habitats (OP/BP 4.04)[3], Pest Management (OP/BP 4.09);Forests (OP/BP 4.36)[4], Dam safety (OP / BP 4.10)[5], and Involuntary Resettlement (OP/BP 4.12)[6]. The subproject has also to comply with the WB's requirements on public consultation and Policy on Access to Information.
- Environmental assessment: The environmental and social screening confirmed that the proposed subproject is classified as Category B because its potential adverse environmental and social impacts are site-specific, few if any of them are irreversible, and in most cases, mitigatory measures can be designed more readily.
- The safeguard documents to be prepared for the Subproject: ESMP, RAP.

Therefore, the Subproject Owner has employed and coordinated with a Consultancy for the preparation of the Report on Environmental and Social Impact Assessment (ESIA) to submit the World Bank and the Government of Viet Nam for approval. The purpose of the ESIA report is to find out environment impacts caused by the subproject implementation to propose solutions that mitigate or minimize environmental impacts and harmonize the development and environmental protection objectives. This is also an opportunity for scientists, donors, investors, and managers to make investment decisions and to have a chance to fully discuss the Subproject's major environmental impacts to establish subproject implementation plans to minimize environmental impacts.

2. AGENCIES OR ORGANIZATIONS TO APPROVE THE FEASIBILITY STUDY OR INVESTMENT REPORT OR EQUIVALENT DOCUMENT OF THE SUBPROJECT

- Subproject approval authority: People's Committee of Ca Mau province
- Address: No. 02, Hung Vuong Street, Ward 5, Ca Mau City
- Phone: (0290) 3667.888 - Fax: (0290) 3837.951

3. THE RELATIONSHIPS OF THE SUBPROJECT AND OTHER PLANS AND PROGRAMS APPROVED BY THE STATE AGENCIES

[2]Full treatment of OP/BP 4.01 can be found at the Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543912~menuPK:1286357~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

[3] Full treatment of OP/BP 4.04 can be found at the Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543920~menuPK:1286576~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

[4] Full treatment of OP/BP 4.36 can be found at the Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543943~menuPK:1286597~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

[5]Full treatment of OP/BP 4.10 is available at the Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543990~menuPK:1286666~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

[6]Detailed description of OP/BP 4.12 is available at the Bank website:http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543978~menuPK:1286647~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

3.1. Integrated Climate Change Adaptation Project with the Coastal Management Plan of Ca Mau Province funded by the German Corporation for International Cooperation (GIZ)

This project is part of the Coastal Climate Change and Ecosystems Program (CCCEP) in the Mekong Delta (MD). The project will coordinate with CCCEP management team in Ca Mau province, mainly focus on coastal management policies (including mangrove forests rehabilitation, dikes protection), locals' livelihoods (ecological shrimp/ prawn farming, climate protection) and raise awareness in the area.

3.2. Coastal Resources for Sustainable Development (CRSD) project from the WB's loans

The project will be implemented from 2012-2017 with the objectives of improving coastal fisheries management toward sustainability; increasing institutional capacity for the fisheries sector in sustainable resources management; promoting sustainable practices in aquaculture. Application of best practices for the sustainability of the nearshore fishery.

3.3. The mangrove forest rehabilitation project through sustainable shrimp farming and emission reduction in Ca Mau funded by the Ministry of Environment, Nature Conservation and Nuclear Safety (BMU) of the Federal Republic of Germany through the Netherlands Development Organization (SNV/IUCN)

The overall objective of the project is to propose options for promoting adaptation and mitigation of the climate change impacts: economic incentives and policy consultation for forest restoration and sustainable supply capacity of mangroves forest in the coastal area of Ca Mau, Vietnam. Within the framework of the project, a number of key issues will be addressed:

- To improve livelihoods of the poor forest community, potentially threatening to deforest: Introduce sustainable shrimp farming in combination with protection and maintenance of ecosystem services in areas at risk of deforestation and high forest degradation. Encourage shrimp farming in low-quality forest areas to provide employment opportunities and increase incomes for local people; reduce pressure on mangrove ecosystems in the area.
- To establish of harmonized linkages of forest shrimp farming with international certification.
- To develop a model for mangrove forest protection management and restoration in the coastal protective zone and be replicable.
- Step by step approach to carbon financing to ensure compliance with the National REDD + Program. This objective will significantly reduce deforestation and forest degradation by improving production standards of shrimp farming and rehabilitation of shrimp's farms in degraded forests.
- To ensure replication, the project will contribute to national policy, providing a legal basis for the payment of mangrove ecosystems. The project will coordinate with the current activities of the Ministry of Agriculture and Rural Development, IUCN, and GIZ.

3.4. Mekong Regional Water Security Project

The Mekong Regional Water Security Project covers the whole administrative boundary of the Mekong Delta (MD) with a total natural area of 40,604.7 km^2, including Can Tho city and 12 provinces of Long An, Tien Giang, Ben Tre, Dong Thap, Vinh Long, Tra Vinh, Hau Giang, An Giang, Soc Trang, Kien Giang, Bac Lieu and Ca Mau. The Project belongs to

Mekong Delta Water Supply Planning to 2030 with a vision to 2050 the Prime Minister approved in Decision No.2140/QD-TTg dated 08/11/2016.

The project's objectives:

- General objective: Ensuring water supply and social security for the provinces and city in the project area in the context of climate change and sea level rise; contributing to socio-economic development, environmental improvement; and raising the high quality of life for people.
- Specific objectives: (i) building a regional-scale water supply system to ensure stable, safe and sustainable water supply to meet the demand for drinking water, daily life and production of people in urban areas, industrial parks and adjacent urban neighborhoods in the provinces/city in the project area; (ii) limiting negative impacts caused by current groundwater extraction such as lowering water level, subsidence, etc .; (iii) developing a strong technical, organizational and institutional basis for the exploitation, management and operation of this regional water supply system.

The Mekong Regional Water Security Project is invested by the Ministry of Construction, building 03 water supply plants with the total capacity of 600,000 m^3/day-night and the water supply and conveyance pipeline. For Ca Mau province, the Project only supplies water to Ca Mau city and the districts: Nam Can, Ngoc Hien, Cai Nuoc, Phu Tan and Tran Van Thoi.

3.5. Project of West Sea improvement

The project West Sea improvement in Ca Mau province (revised) by Ca Mau DARD as the project owner consists of the following main contents:

Objectives of the project:

- To prevent and control natural disasters, high tides with the frequency of 5%, sea level rise, and storm surge level 9, protecting 26,160 coastal households and 128,972 hectares of agricultural and aquacultural land;
- To make full use of the existing sea dyke network to minimize the volume of land lost and take advantage of the consolidated dyke foundation, to combine the construction of coastal roads along the dyke surface;
- To review serious erosion sites across the dyke and provide solutions for effective remediation, protection, and development of protection forests;
- To control of salinity and drain wastewater for development purposes such as saline water supply and wastewater drainage for aquaculture; salinity intrusion prevention, freshwater storage, water drainage and alkaline flush out for agricultural production;
- To exploit and develop sustainable natural resources in the region in order to protect the ecological environment, develop production, improve people's life.

Items of the project include:

- Building 21.8 km sea dyke from Nam Canal to Cai Doi Vam
- Upgrading the existing dykes combining traffic roads on the dyke surface with the length of 72.52 km, including 4 sections: from Cai Doi Vam to My Binh, from My Binh to T25, from T25 to Khanh Hoi and from Huong Mai to Tieu Dua.
- Building 8,608m wave breakerfrom Lung Ranh to Vam Giao Bay.
- Building 4 bridges: My Binh; Huyen Doi; Quan Thep, Sao Luoi.

Implementation progress: some items have been completed, and some items are under construction.

4. NATIONAL LAWS AND REGULATIONS AND WB SAFEGUARD POLICIES

4.1. Relevant National Laws and Regulationsof Viet Nam

4.1.1. National laws and regulations are applied for the subproject environmental and social assessment and environmental management

The following national laws and regulations are applied for the subproject environmental and social assessment and environmental management during the suBproject preparation, construction, and operation:

- Law on Environmental Protection No. 55/2014/QH13 of the National Assembly ofVietnam Socialist Republic of Vietnam dated June 23, 2014. This law enacted policies and regulations on environmental safeguards, and rights and obligations of organizations, households and individuals related to environmental protection activities.
- Law on water resources No. 17/2012/QH13 of the National Assembly of Vietnam dated June 21, 2012 provides on management, protection, exploitation and use of water resources, as well as the prevention of, combat against and overcoming of harmful effects caused by water in the territory of the Socialist Republic of Vietnam.
- Law on natural disaster prevention and control No. 33/2013/QH13 dated June 19, 2013 provides natural disaster prevention and control activities; rights and obligations of agencies, organizations, households and individuals engaged in natural disaster prevention and control activities; and the state management of, and assurance of resources for, natural disaster prevention and control.
- Law on Labor No.10/2012/QH13 of the National Assembly of Vietnam Socialist Republic of Vietnam dated June 18, 2012 provides labor standards; rights, obligations and responsibilities of employees, employers, employees' representative organizations and employers' representative organizations in industrial relations and other relations directly related to industrial relations; and state management of labor.
- Law on amending and supplementing a number of articles of the law on cultural heritages No. 32/2009/QH12 of the National Assembly of Vietnam dated June 18, 2009 to amend and supplement a number of articles of the Law on Cultural Heritages.
- Law on biodiversity No. 20/2008/QH12 of the National Assembly of Vietnam dated November 13, 2008 provides for the conservation and sustainable development of biodiversity; rights and obligations of organizations, households and individuals in the conservation and sustainable development of biodiversity.
- Law on Forest Protection and Development No. 29/2004/QH11 of the National Assembly of Vietnam dated December 03, 2004 provides for the management, protection, development and use of forests; and forest owners' rights and obligations.
- Decree No. 59/2015/ND-CP of 18 June 2015 of the Government on the management of construction investment projects.

- Law on fisheries No. 17/2003/QH11 dated November 26, 2003 apply to fishery activities of Vietnamese organizations and individuals and foreign organizations and individuals on the land, islands, in the internal waters, the territorial sea, the exclusive economic zone and continental shelf of the Socialist Republic of Vietnam.
- Decree No. 39/2015/NĐ-CP of the Government dated 27 April 2015 on assistance policy applied to ethnic minority and poor women who comply with the population policy.
- Decree No. 38/2015/NĐ-CP of the Government dated 24 April 2015 on waste management including hazardous wastes, daily-life solid waste, ordinary industrial solid waste, liquid waste products, wastewater, industrial emissions and other particular wastes; environmental protection in discarded material imports.
- Decree No. 18/2015/ND-CP dated February 14, 2015 of the Government on environmental protection planning, strategic environmental assessment, environmental impact assessment, and environmental protection commitment.
- Decree No. 43/2014/ND-CP of 15 May 2014 of the Government detailing the implementation of a number of articles of the Land Law.
- Decree No. 179/2013/NĐ-CP dated 14 November 2013 of the Government prescribing administrative sanctions for environmental protection.
- Circular No. 27/2015/TT-BTNMT dated 19 May 2015 of the Ministry of Natural Resources and Environment on strategic environmental assessment, environmental impact assessment, and environmental protection plan.
- Circular No. 36/2015/TT-BTNMT of 30 June 2015 of the Ministry of Natural Resources and Environment on hazardous waste management.
- Circular No. 19/2011/TT - BYT of 06 June 2011 of the Ministry of Health guiding labor hygiene, laborers' health and occupational diseases.
- Decision No. 1956/2009/QD-TTg, dated November 17 2009, by the Prime Minister approving the Master Plan on vocational training for rural labors by 2020.
- Decision No. 52/2012/QD-TTg, dated November 16 2012, on the support policies on employment and vocational training to farmers whose agricultural land has been recovered by the State.
- Circular 146/2007/TT-BQP by Ministry of Defense dated September 11 2007 guiding UXO clearance for project construction.

The following national technical regulations and standards related to environmental quality and waste management are applied to the subproject:

- QCVN 01:2009/BYT: National technical regulation on drinking water quality
- QCVN 02:2009/BYT: National technical regulation on domestic water quality
- QCVN 03-MT:2015/BTNMT: National technical regulation on the permitted limit of heavy metal in land
- QCVN 05:2013/BTNMT: National technical regulation on ambient air quality
- QCVN 08-MT:2015/BTNMT: National technical regulation on water surface quality
- QCVN 09-MT:2015/BTNMT: National technical regulation on underground water quality
- QCVN 10-MT:2015/BTNMT: National technical regulation on water quality in coastal areas
- QCVN 14:2008/BTNMT: National technical regulation on domestic wastewater.
- QCVN 15:2008/BTNMT: National technical regulation on the pesticide residues in the soils

- QCVN 19:2009/BTNMT: National Technical Regulation on Industrial Emission of Organic Substances
- QCVN 26:2010/BTNMT: National technical regulation on noise.
- QCVN 27:2010/BTNMT: National technical regulation on vibration.
- QCVN 43:2012/BTNMT - National technical regulation on sediment quality in freshwater areas.

4.1.2. Legal documents, decisions and official letters of related authorities on the subproject

- Official Letter No. 5350 / VPCP-QHQT dated 10 July 2015 of the Government Office on the project "Integrated Rural Development to Improve Adaptation to Climate Change in the Mekong Delta", assign the Ministry of Agriculture and Rural Development to implement the project.
- Aide Memoire of the mission (project identification, technical team) of the WB during the missions: from 26/11/2014 to 15/12/2014; from 03/02/2015 to 05/02/2015; 30/03/2015 to 15/04/2015; 15-18/06/2015 and 06-17/07/2015; 21/09/2015 to 02/10/2015
- Decision No. 882 / QD-BNN-HTQT dated March 19, 2015 of the Minister of MARD on assigning to the Central Project Management Board for irrigation projects (CPO) as the project owner in the preparation phase of investment of the Integrated Rural Development to Improve Adaptability to Climate Change in the Mekong Delta project (now known as the ICRSL project).
- Official Letter No. 151/BNN-HTQT dated 29/02/2016 of the Ministry of Agriculture and Rural Development on the preparation for approval of the feasibility study report of the ICRSL project.
- Decision No. 736/QD-TTg dated 29/4/2016 of the Prime Minister approving the list of project "Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods" for WB loans.
- Decision No. 1262 / QĐ-BNN-KHCN dated 12/4/2016 of the Ministry of Agriculture and Rural Development approving the Environmental and Social Management Framework (ESMF) of the ICRSL project.
- Decision No. 1693/QĐ-BNN-HTQT dated 09/5/2016 of the Ministry of Agriculture and Rural Development on approving the Feasibility Study Report of the project "Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods (ICRSL)" funded by WB
- Official Letter No. 3831/UBND-KT dated 13/6/2016 of the People's Committee of Ca Mau province on assigning to project owner of the subproject No. 8 in component 4 under the ICRSL project funded by WB.
- Decision No. 1368/QD-SNN dated 04/7/2016 of the Department of Agriculture and Rural Development of Ca Mau province on assignment of management and operation of Subproject 8 - Component 4: "*Infrastructure to prevent coastal erosion, supply fresh water and for production of shrimp - forest model to improve livelihoods and adapting to climate change in the coastal area of Ca Mau Province*".

4.1.3. Documents and data of the subproject owner to be used in the process of environmental impact assessment

- The analysis results of the baseline environmental data in the subproject area conducted by the Southern Institute of Water Resources Research in February 2017 and May 2017.

- The field survey data carried out by the Southern Institute of Water Resources Research in November 2015
- The socioeconomic data, orientation of land-use planning, production outputs of U Minh, Tran Van Thoi, Nam Can and Ngoc Hien districts.
- The results of the public consultations on the subproject on 18-19, July 2017.
- Report on the feasibility study of subproject: *Infrastructure to prevent coastal erosion, supply fresh water and for production of shrimp - forest model to improve livelihoods and adapting to climate change in the coastal area of Ca Mau Province*

4.2. Applicable WB Safeguard Policies

The environmental and social screening has been carried out the project ESMF, and the result shows that the WB policies on Environmental Assessment (OP/BP 4.01)[7], Natural Habitats (OP/BP 4.04)[8], Forests (OP/BP 4.36)[9], Indigenous Peoples (OP/BP 4.10)[10], and Involuntary Resettlement (OP/BP 4.12)[11] are triggered for this subproject. The environmental and social screening result confirmed that the proposed subproject is classified as Category B because its potential adverse environmental and social impacts are site-specific, few if any of them are irreversible, and in most cases mitigatory measures can be designed more readily (*Table 0.1*).

Table 0.1: Application of the WB's safeguard policies

Policy	*Triggered (Yes/No)*	*Explanation/Actions*
Environmental Assessment (OP/BP 4.01)	Yes	A safeguard screening was conducted in line with the ESMF of the MD-ICRSL project. An ESIA was prepared to describe the potential negative impacts and the proposed mitigation measures to be implemented under the subproject including annexes providing information on public consultation, and ECOP to be applied during construction. The ESIA is consistent with the EIA report prepared according to the GOV's EIA regulations including consultation with the local authority and local community. The EIA report will be submitted to the agency (Ca Mau DONRE) for approval.

[7]Full treatment of OP/BP 4.01 can be found at the Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543912~menuPK:1286357~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

[8]Full treatment of OP/BP 4.04 can be found at the Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543920~menuPK:1286576~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

[9]Full treatment of OP/BP 4.36 can be found at the Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543943~menuPK:1286597~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

[10]Full treatment of OP/BP 4.10 is available at the Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543990~menuPK:1286666~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

[11]Detailed description of OP/BP 4.12 is available at the Bank website:http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543978~menuPK:1286647~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

Policy	*Triggered (Yes/No)*	*Explanation/Actions*
Natural Habitats (OP/BP 4.04)	Yes	The subproject area does not have sensitive natural habitats as the WB's guidelines but normal natural habitats that have been largely reclaimed for a long period of time. Possible impacts on water quality and ecology during the construction and operation phases will be monitored as part of the ESIA.
Forest (OP/BP 4.37)	Yes	One of the activities of the subproject is to plant mangroves in forest-shrimp ponds where may have no the potentialnegative impacts on the rights and welfare of local people and their level of dependence upon natural and plantation forests.
Pest Management(OP 4.09)	Yes	The implementation of livelihood models will likely lead to the purchase or use of pesticides or chemicals in agriculture. The MD-ICRSL has triggered a pest management policy and has been approved by the project provinces.
Indigenous Peoples (OP/BP 4.10)	No	At the subproject area, there are mostly Kinh households, only a few Khmer households, but Khmer households have been living in the area for a long time and are integrated into the Kinh community, so they are not considered as ethnic minority households.
Physical cultural resources (OP/BP 4.11)	No	All subproject's components are located in the alluvial soil newly reclaimed from 50 to 80 years ago and the population has been stable since the 1980s, so there are no valuable, cultural, archaeological, paleontology, architectural, history resources here. The subproject area does not have the potential and significant negative impacts on tangible cultural resources.
Involuntary Resettlement (OP/BP 4.12)	Yes	The subproject acquires land for construction but no household will be relocated. Avoidance of resettlement was the main reason for the selection of the subproject sites.
Dam safety (OP/BP 4.37)	Yes	The reservoir will be built on state land and would not have significant impacts of land acquisition and compensation requirements. The reservoir is far from U Minh Ha NP (about 5km). In addition, the water source to supply for the reservoir is from the outside canals (not from the Park) and the water intake is only in 15 days (in the middle rainy season). In addition, the reservoir will be constructed in an area without high earthquake risk, operating stably and being unable to become a large dam when operating. Furthermore, the subproject owner will mobilizequalified engineers in the FS and detailed design of the subproject.

The subproject has also to comply with the WB's requirements on public consultation and Policy on Access to Information. The implementation of the policy OP/BP 4.12 is separately addressed in the Resettlement Action Plan (RAP) of this subproject.

World Bank Group Environmental, Health, and Safety Guidelines

World Bank-financed projects should also take into account the World Bank Group Environmental, Health, and Safety Guidelines[12] (known as the "EHS Guidelines"). The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice.

The EHS Guidelines contain the performance levels and measures that are normally acceptable to the World Bank Group[13] and are generally considered to be achievable in new facilities at reasonable costs by existing technology. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to the World Bank, become project- or site-specific requirements. This subproject should conform to the general EHS Guidelines and industry specific EHS Guidelines on Aquaculture.

5. ORGANIZATION OF ESIA

The Southern Institute for Water Resources Research (SIWRR) has been selected by the Investor of the subproject (Ca Mau Department of Agriculture and Rural Development) to prepare an EIA report for this subproject, due to its the legal status and experience.

Information about the consultant: **Southern Institute of Water Resources Research**

Represented by: Mr. Tran Ba Hoang - Position: Director

Address: 658 Vo Van Kiet, Ward 1, District 5, Ho Chi Minh City

Contact phone: (028) 39233700 - Fax: (028) 39235028

SIWRR was established in 1978 under the Decision No. 864 QD/TC dated 19 August 1978 of the Ministry of Water Resources (now the Ministry of Agriculture and Rural Development). Over 37 years of operation, development, and growth, the Institute's activities are always parallel to the cause of agriculture and rural development, management and rational use of water resources, natural disaster mitigation, and land rehabilitation, environmental protection ... in the southern provinces, especially in the Mekong Delta.

In terms of material facilities, the Institute has three specialized laboratories licensed by the Ministry of Construction including Environmental Chemistry Laboratory (LAS-1037) VIMCERTS 200, Laboratory of Foundation and Geotechnical Research (LAS-155), Building Materials and Structure Research Laboratory (LAS-143).

The Institute has been accredited with ISO 9001-2008, in addition to recognized laboratories in the accreditation system. In terms of machines and equipment: In addition to conventional machines, the Institute's units are also equipped with much-advanced research equipment such as wind meter - Distomat wind meter; Echo-sounding meter, sediment measuring equipment for different environments, gas chromatography, atomic absorption (UHCM), carbon monoxide detector, total N, UV-Vis colorimeter, DO measuring instrument, pH, EC, salinity, opacity, noise, etc.... Software support: ArcGIS, remote sensing software, MIKE, HYDROGIS, DUFLOW, KOD, SAL, VRSAP, IMSOP, SOIL, SOICHEM.

The list of people directly involved in the preparation of the ESIA report of the subproject is presented in *Table0.2*.

Table0.2: List of people directly involved in the preparation of the ESIA report

No	Full name	Specialized	Content in charge	Signature
A	**Subproject**			

[12]The EHS Guidelines can be consulted at www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines.
[13]The EHS Guidelines can be consulted at www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines.

No	Full name	Specialized	Content in charge	Signature
	owner			
1	Nguyen Van Sol	Irrigation	To manage and direct the implementation of the report	
2	Truong Quoc Trung	Irrigation	- Provide information about the subproject - Coordinate with consultants to work with local departments - Monitor the implementation of the report	
B	**Consultant**			
1	Vu Nguyen Hoang Giang	Master of Environment and Social Science	- Project Manager - General administration - Synthesize, report and defend the report in the evaluation council - Explain, edit and pass through with WB	
2	Dong Thi An Thuy	Master of Environment	- Assess the impact of the subprojects on water environment and ecosystems in the area - Develop an environmental monitoring plan	
3	Tran Thi Thanh	Doctor of Soil and Water Environment	Evaluate the impact of the subproject on land resources and propose mitigation measures	
4	Pham The Vinh	Master of Irrigation	Hydraulic modeling, water quality assessment to assess the impact of the subproject on erosion and sedimentation and proposed mitigation measures.	
5	Le Van Kiem	Master of Environmental Hydrology	- Brief description of the subproject - Assessment of site suitability of the subproject location for the regional conditions.	
6	Nguyen Minh Trung	Master of GIS, SCADA	- Develop a sampling map for assessing the status and sampling of environmental monitoring in different subproject stages - Develop a map of the affected and beneficiary area	
7	Nguyen Ngoc Quoc	Bachelor of Environmental Science	- Collect basic documents - Analyze, assess the natural, economic, social and environmental conditions of the subproject area	
8	Tran Thi Thu Huong	Bachelor of Environmental	- Developthe EIA report - Estimatebudget for the	

No	Full name	Specialized	Content in charge	Signature
		Science	environmental program	
9	Nguyen Thi Tam	Bachelor of Environmental Science	Evaluate the impact of the subproject implementation on the airenvironment and propose mitigation measures	
10	Pham Chi Trung	Master of Social Science	- In charge of socio-economic surveys of households affected by the subproject. - Assess the impact of the subproject on socio-economic development of the area	

6. METHODOLOGIES AND APPROACHES

6.1. Methods of ESIA

6.1.1. Rapid assessment method

The Rapid Assessment Method was issued by the World Health Organization (WHO) in 1993. Basis of this method is the nature of materials, technologies, and rules of natural processes as well as experiences in rating pollution load (Chapter 3).

In Vietnam, this method is introduced and applied in many ESIA reports, performing the relatively accurate calculation of the pollution load in the context of limited measurement and analysis instruments. In this report, the pollution load coefficients are taken under the EIA guidelines of the World Bank (Environmental Assessment Sourcebook, Volume II, Sectoral Guidelines, Environment, World Bank, Washington D.C 8/1991) and Handbook of Emission, Non-Industrial and Industrial source, Netherlands).

6.1.2. Impact identification method

This method is applied through the following specific steps: describe the environment system; identify the subproject components that affect the environment; and identify the full range of related waste streams, environmental issues to serve the detailed evaluation (Chapter 3).

6.1.3. Mapping method

This method is applied to assess spatial intervention of the subproject, in addition to the specific activities that cause impact and scope of influence can also use this method based on the results of the assessment of the impact of the subproject (Chapters 1 and 3). This method applies to Chapters 1 and 3 of the report to show the effects of the subproject, the location of the subproject and the location of the sampling.

6.1.4. Impact matrix method

This method is to simultaneously list the activities of the subproject with a list of environmental factors that may be affected. Combining these lists in the form of rows and columns, we obtain an environmental matrix. It then shows more clearly the causal relationship between the activities of the subproject and the environmental factors impacted simultaneously in the matrix plots. Depending on usage, the environment matrix can be

divided into the following categories: simple matrix, complex matrix, complex quantitative matrix.

In this report, the quantitative matrix method has been used, in which the inventory is listed for the activities of the subproject and the column is the list of environmental factors affected. Each matrix of the matrix evaluates the possible impact of a subproject activity on an environmental factor (Chapter 3).

6.1.5. Modeling method

To assess the impact of emissions from the operation of equipment and machinery to the t air environment, the Screen View 4.0 emission model is applied. Screen View is a Windows interface to the US Environmental Protection Agency (EPA) testing model. Screen View uses the Gaussian plume modelas a combination of related pollution sources and meteorological factors to estimate pollutant concentrations from uninterruptible sources. The Screen View model evaluates the dispersion for point sources. In the case of emissions of generators with the highest load, select the emission from the biggest source of the construction phase with the input parameters as follows:

- Lowest average monthly wind speed: 2.5 m/s.
- Vehicle emission factor: depending on the number of vehicles used.
- Diameter of chimney: 0.4m.
- Height of dispersion source: 5m.

6.1.6. Household surveys

Household (HH) survey was conducted after the completion of the review of secondary data and field observations. Prior to fieldwork, a household questionnaire was developed to guide the collection of additional data. Questionnaires developed include (i) guide questions (for focus group discussion and community consultation); (ii) household survey (for an interview with selected households).

100% directly AHs due to land acquisition, 100% CPCs and 20% HHs in the beneficiary area of the subproject were surveyed for socio-economic conditions, their interest on the land compensation policy and livelihood models proposed in the subproject from 20-23 February 2018, 4-5 April 2018, 9-12 May 2018. The results of the survey will be a basis for assessing environmental impacts and proposing mitigation measures for the subproject.

6.1.7. Focus group discussion and public consultation

In addition to the above inquiry techniques, consultation sessions were carried out by in the form of focus groups discussion, and community meetings to confirm the findings of field observation as well as household interviews. Four consultation meetings with 205 participants on the content of ESIA report and receiving comments of participants (*Table0.3*). Details of the consultation and the feedback from the consultations will be included in the ESIA report and the design of the subproject (Chapter 7).

Table0.3: Summary of public consultation meetings during ESIA preparation

No.	Time and avenue	Participants	Objectives and contents of the meeting
1	10/2/2017 at U Minh Ha National Park	U Minh Ha NP (4 participants)	Consultation on the impacts of the reservoir to the Park
2	From 20/3-20/5/2017	560 households affected by	Consultation on the scope

	(including 22 meetings, each meeting in each affected hamlet of 4 communes: Lam Hai, Vien An Dong, Tan An Tay, Tam Giang Tay)	the construction of embankments	and scale and land acquisition of the embankment
3	20/3/2017	Management Board of Ca Mau Economic Zone (9 participants)	Consultation on the content and items of investment and land acquisition of the reservoir and water supply station, location of dump sites and plan for reuse of excavated soil, impacts on socio and environment of the reservoir and water supply station
4	18-19/7/2017 (including 4 meetings at People's Committee of Tran Van Thoi district, Phu Tan district, Khanh An commune, and Tan An Tay commune)	Households affected by the subprojects (205 participants) in the district of Tran Van Thoi, Phu Tan, Nam Can, Ngoc Hien, and U Minh	Consultation on the content of the ESIA report of the subproject

6.2. Other methods

6.2.1. Method of information and data inheritance, summary and analysis

This method is to identify and assess natural conditions and socio-economic conditions of the subproject area through data and information collected from various sources such as the statistic yearbooks, regional socio-economic profile reports, and regional baseline environmental and relevant studies. At the same time, the inheritance of the available studies and reports is really essential to use up available findings and further identify limitations. In this report, data, information on the subproject information and socio-economic conditions in the subproject area are collected for relevant sources (Chapter 1-3).

6.2.2. Review of secondary data

Review of secondary data included a review of existing literature related to the subproject area and review of information available from the subproject documents. Of particular importance is the review of data/information availablefrom the Feasibility Study of the subproject (prepared by SIWRR), and other relevant information, and statistics.

6.2.1. Field survey method

Field survey is compulsory for ESIA/EIA to identify the status of the subproject area, relevant surrounding objects to select sampling positions, a survey of the status of the natural environment, hydrography, weather conditions, land use, vegetation cover, fauna and flora in the subproject area. These survey results will be used for assessment of natural conditions of the subproject area and used for Chapter 2 of the report.

6.2.2. Field observation

For the social assessment, field observation was a good source of information that helps verify the initial results obtained from the secondary data review. Field observations aimed at collecting and complementing the information already available to contribute to the design of the household survey and guide questions (for group discussion).

6.2.3. Comparison method

The method is to assess environmental quality, effluent quality, pollution load, etc. On the basis of comparison with the concerning environment norms and standards, the regulations of the Ministry of Health and Ministry of Natural Resources and Environment as well as the related researches and experiments in Chapter 3 of the report.

6.2.4. Consensus method

Based on knowledge and experiences in environmental science of ESIA, the specialists of the consultant team and other scientific research units within SIWRR will discuss and agree on the findings of the ESIA.

6.2.5. Samples taking and analyzing methods

In order to assess the environmental current status of the area, the consultant has conducted the taking and analysing: air quality (06 sites), soil (10 locations, 3 layers), sediment (6 locations), surface water and aquatic life (30 locations, at high and low tides), and groundwater (5 locations) at the proposed site. The activity was conducted in the dry season (from 10-12 March 2017) and the rainy season (from 22-24 June 2017). The results of sample analysis are used as baseline data to assess the impact of the subproject implementation on the environment and issues that the subproject owner should be aware of during the subproject implementation. The map of environmental sampling locations in the subproject area is shown in *Figure0.1*to*Figure 0.4*.

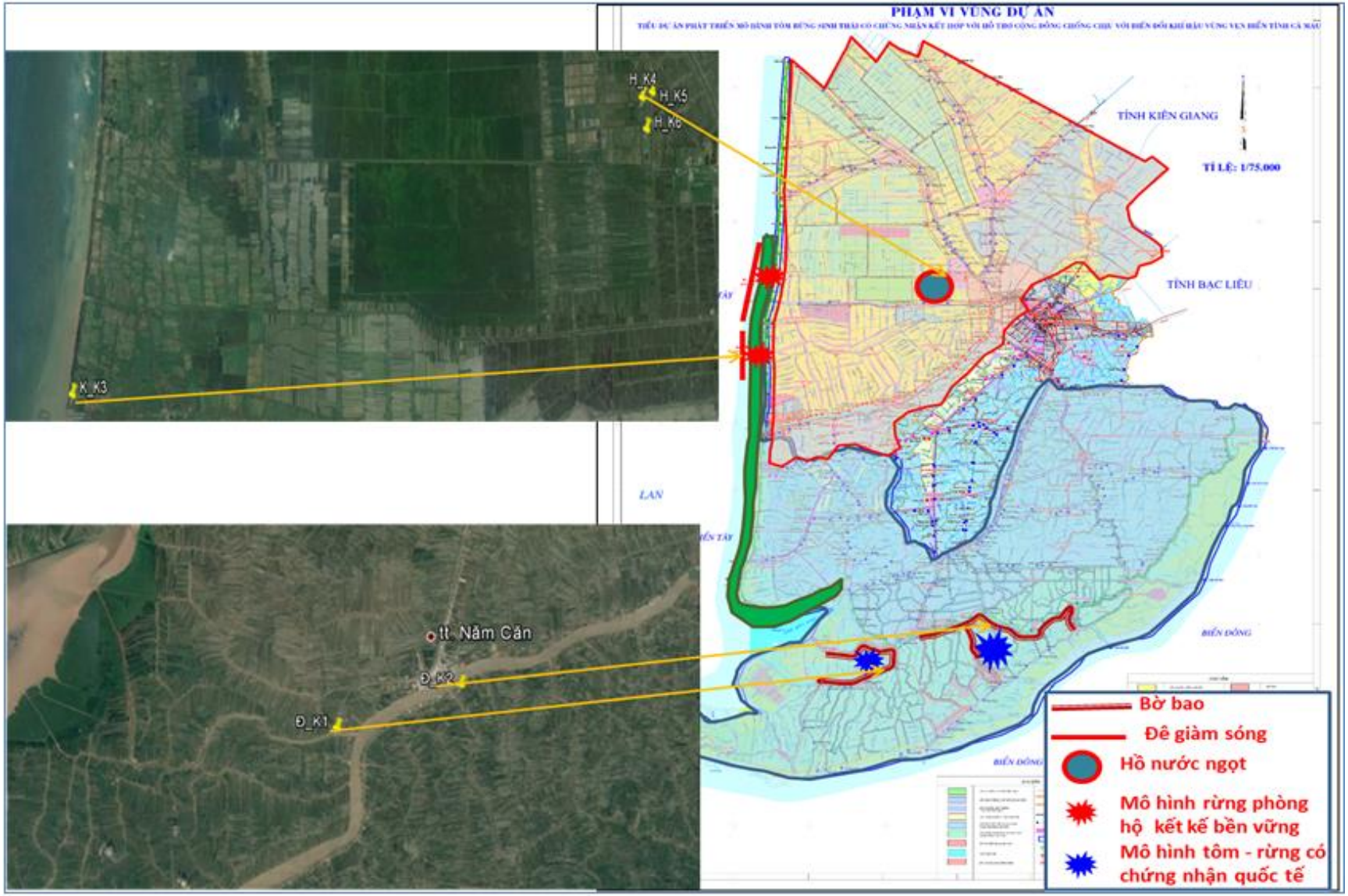


Figure0.1: Locations of air samples in the subproject area

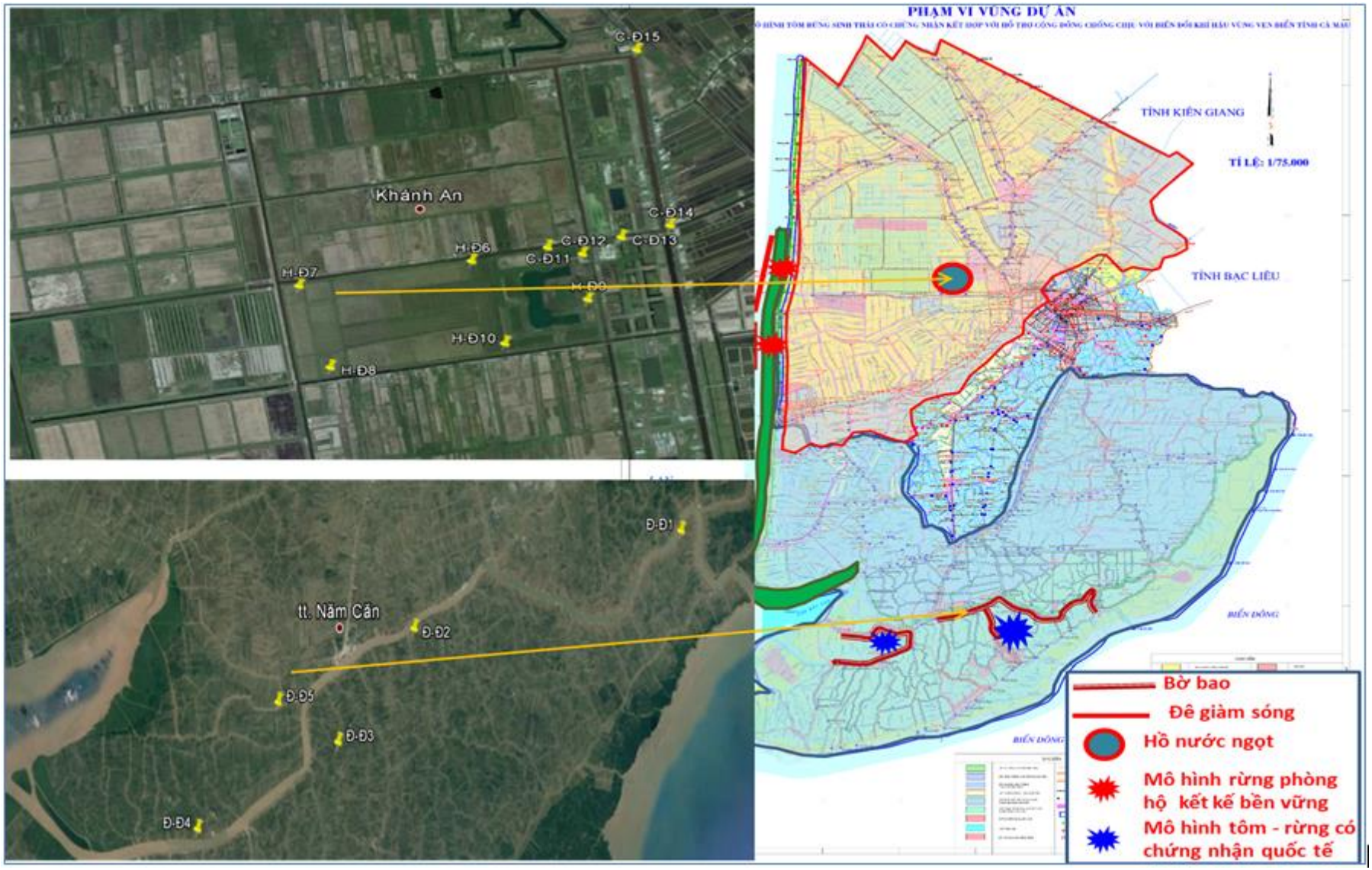


Figure0.2: Locations of soil samples in the subproject area

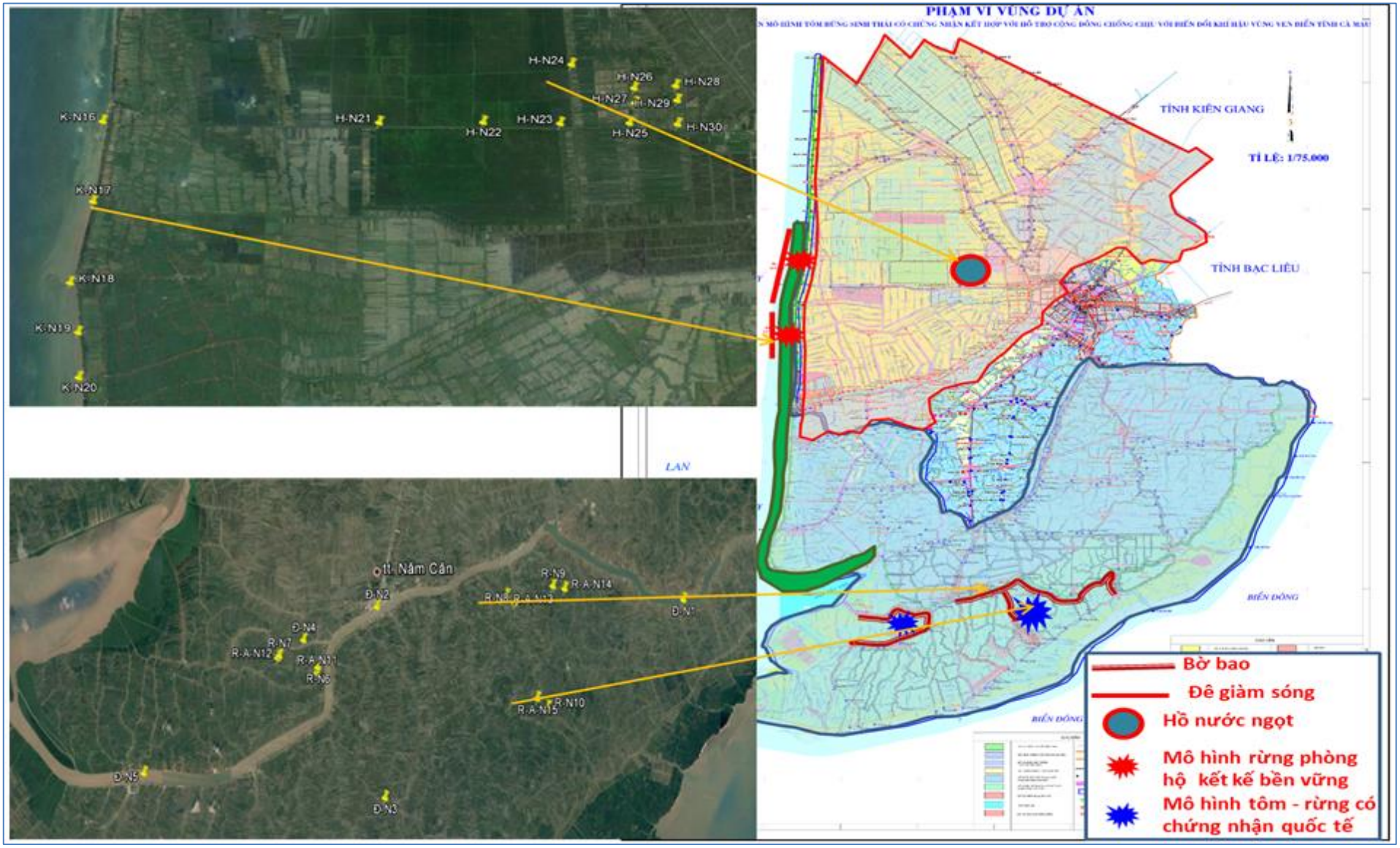


Figure0.3: Locations of surface water and aquatic life samples in the subproject area

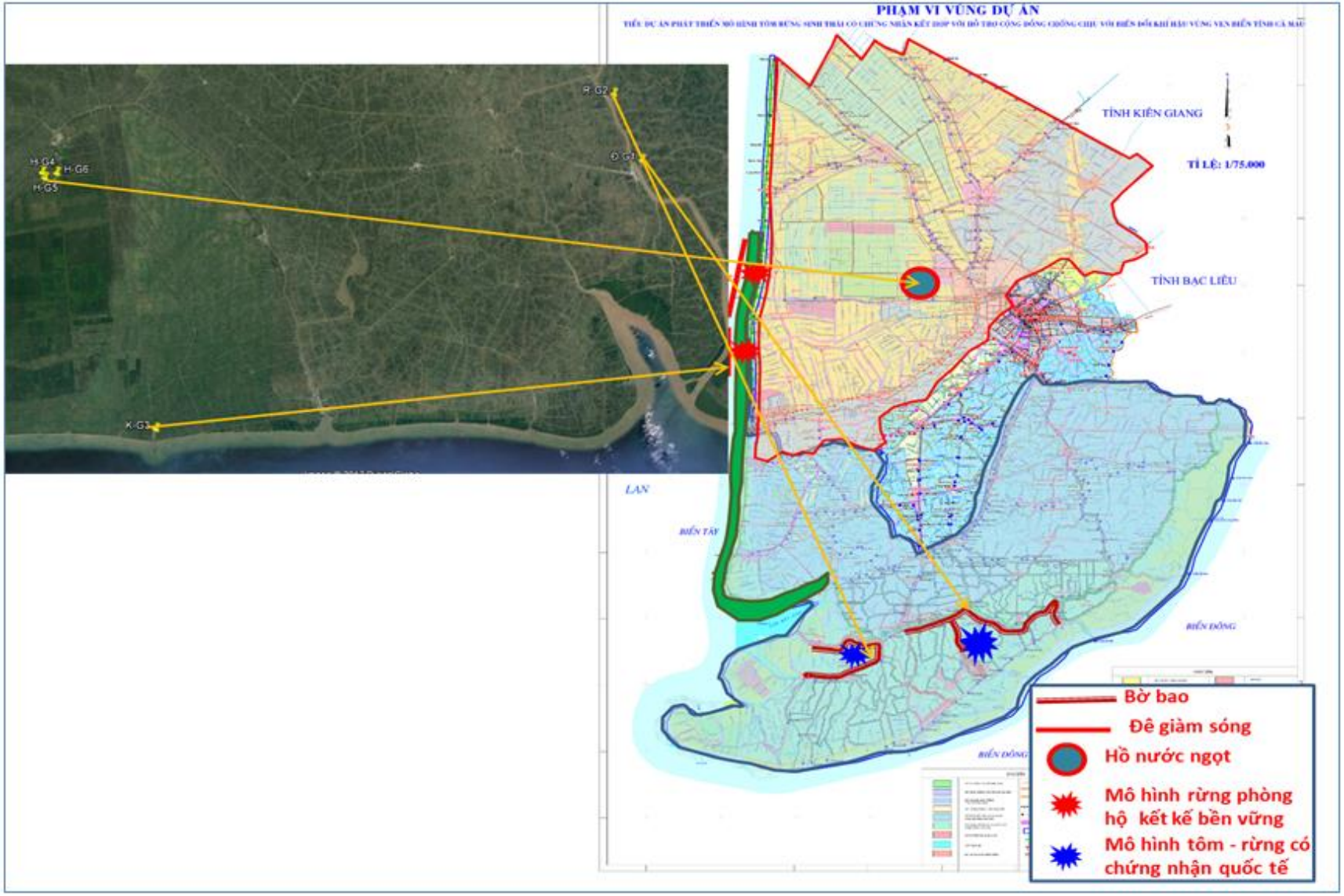


Figure 0.4: Locations of underground water samples in the subproject area

The organization of environmental sampling, field measurements, preservation and transportation of laboratory specimens and laboratory analysis complies with the measurement and quality monitoring regulated by the Ministry of Natural Resources and Environment as follows:

6.2.5.1 Air quality

Sampling method: Based on the Vietnamese standards, TCVN 5970: 1995 on the planning of ambient air quality monitoring, and TCVN 5973: 1995 on stratified sampling method to assess ambient air quality, the air specimens were taken as follows: they are taken at a depth of about 1.5m from the ground when it is sunny or after it has rained for 2 to 3 hours. Each sample is taken from 30 minutes to 2 hours.

Sample analysis methods are presented in *Table0.4*.

Table0.4: Air sample analysis method

No.	Parameters	Analysis methods
1	Dust	TCVN 5067:1995
2	SO_2	TCVN 5975: 1995
3	NO_2	TCVN 6137:2009
4	CO	Automatic measurement

6.2.5.2 Phương pháp lấy mẫu và phân tích chất lượng đất

Sampling method: the Vietnamese standard, TCVN 7538-1: 2006, gives guidance on how to program soil sampling in the project area as follows: using drillers to drill soil specimens, taking specimens at 3 floors under the ground at each location (Layer 1: 0-20cm deep; Layer 2: 50-70cm deep, and Layer: 100-120cm deep).

Sample analysis method is presented in*Table0.5*.

Table0.5: Soil sample analysis method

No.	Parameters	Analysis methods
1	pH	TCVN 5979-2000
2	Conductivity	TCVN 6650-2000
3	Moisture	TCVN 6648-2000
4	Total organic carbon	TCVN 6644-2000
5	Total nitrogen	TCVN 6498-1999
6	Dissolved nitrate, ammonium and total nitrogen	TCVN 6643-2000
7	Digestible nitrogen content	TCVN 5255-2009
8	Total phosphorus	Handbook of Soils and Fertilizers Research Institute
9	Digestible phosphorus	TCVN 5256-2009
10	Sulfate solubility content in water and in acid	TCVN 6656-2000
11	Carbonate content	TCVN 6655-2000
12	Total exchange base content	TCVN 4621-2009
13	Total calcium and magnesium	Handbook of Soils and

		Fertilizers Research Institute
14	Aluminum exchange	Handbook of Soils and Fertilizers Research Institute
15	Mobile iron	Handbook of Soils and Fertilizers Research Institute
16	Heavy metals (cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc)	TCVN 6496-2009

6.2.5.3 Water quality

a). Sampling method

Surface water sampling: Based on the Vietnamese standards, TCVN 6663-1:2011 on technical sampling guideline, TCVN 6663-6:2008 on technical sampling guideline in rivers and streams, TCVN 5999:1995 on wastewater sampling guideline, and TCVN 5998:1995 on seawater sampling guideline, the surface water specimens in the subproject area shall be taken as follows:

- Sample analysis of hydration components: At each time, water specimens are taken in 2-liter cans which are washed, and rinsed with water in the river. The specimens are taken in river middle water flow which is 20cm deep from the water surface.
- Sample analysis of heavy metals: water specimens are taken in 1-liter glass jars; the sampling method is similar to taking hydration specimens.
- Microbiological analysis specimens: the microbiological sampling in 100ml glass jars which are buttoned and disinfected is performed at the same time with the hydration sampling to analyze microorganism.

Groundwater sampling: Based on the Vietnamese standards, TCVN 6663-1:2011 on a technical guideline for sampling and TCVN 6663-11:2011 on a technical guideline for underground water sampling, the underground water sampling in the subproject area are collected as follows:

- Sample analysis of hydration components: At each time, water specimens are taken in 1-liter cans which are washed, and rinsed with drilled-well water and brought to the laboratory for analysis.
- Sample analysis of heavy metals: water specimens are taken in 350ml glass jars; the sampling method is similar to taking hydration specimens.
- Microbiological analysis specimens: the microbiological sampling in 100ml glass jars which are buttoned and disinfected is performed at the same time with the hydration sampling to analyze microorganism.

b). Sample preservation

Samples are preserved in refrigerated tanks at a temperature less than 4°C and are transported right in the day to the Environment Laboratory – the Southern Institute of Water Resources Science for analyzing the parameters required in TCVN 6663-3:2008 on guidance and preservation of specimens.

c). Analytical method

Sample analysis method is presented in*Table0.6*.

Table0.6: Analysis method and equipment, and accuracy of test

No.	Indicators	Analysis method	Scope of determination
1	pH	PL600 PH meter - Israel	0 – 14
2	EC (conductivity); salinity	IQ 350 EC - salinity meter - US	EC: 0.00-199.9mS Salinity: 0-80ppt
3	DO	HACH 165 ION dissolved oxygen meter	0 – 20mg/l
4	BOD_5 (biochemical oxygen demand)	Winkler improved aeration tank	0.1
5	COD (chemical oxidation demand)	Oxidation with $KMnO_4$ in alkaline medium	1-50mg/l
6	$N\text{-}NH_4^+$ (Amoni)	Colorimetry on UVis-Shimazu spectrometer	0.05-1mg/L
7	$N\text{-}NO_2^-$ (Nitrite)	Colorimetric method on UVis-Shimazu spectrometer	0.001-1 mg
8	$N\text{-}NO_3^-$ (Nitrate)	Cadmium method and colorimetry on UVis-Shimazu spectrometer	0.001-1 mg
9	Total N	Shimazu TN meter	0-3000mg/l
10	Fe_{TS}	Phenathroline and colorimetric method on UVis-Shimazu spectrometer	>0.01 mg/l
11	TSS (total suspended solid content)	Mass method (0.45µm paper filter)	>0.01mg
12	TDS (total dissolved salt content in water)	Volume, evaporative drying method to constant volume or TDS meter	>0.01mg
13	Ca^{2+}	Trilon B titrate	>0.1 mg/l
14	Mg^{2+}	Trilon B titrate	>0.1 mg/l
15	Total solid	Trilon B titrate	>0.5mg/l
16	SO_4^{2-}	Mass method (precipitation with $BaCl_2$)	>0.01mg
17	Cl^-	Titrate with $AgNO_3$	>0.01mg/l
18	PO_4^{3-}	Ascorbic acid and colorimetry method on UVIS spectrophotometers	>0.001mg/l
19	Coliform	TCVN 6191-1-1996	-
20	Fecal coliform	TCVN 6191-1-1996	-

6.2.5.4 Aquatic life

a). Sampling method

Pursuant to the Vietnamese standards, TCVN 7176: 2002 on a guideline for sampling large invertebrates by using hand-held racks and TCVN 7177: 2002 on designing and using quantitative samplers for large invertebrates on rocky ground in shallow fresh water, the aquatic species in the subproject area are collected as follows:

- **Phytoplankton**: Qualitative phytoplankton specimens are collected to determine species composition by Juday net. The net mouth diameter is 30cm. The net fabric sizes No.90 (the mesh size is 50μm). The net is netting horizontally at the water surface at the speed of 0.5 m/s within 2-3 minutes. Quantitative benthic specimens to determine the individual density (individuals/m^3) are collected by filtering 50 liters of water through net No.120 (the mesh size is 25μm). The specimens are stored in formalin 4% and taken to the laboratory of the Center for Ecological and Environmental Science and Technology for analysis.
- **Zooplankton**: Medium and large-sized zooplanktons are picked up by pyramid-net. The net mouth diameter is 50cm wide. The net mouth area is 0.2 m^2 wide. The net fabric sizes No.25 (the mesh size is 120 μm). The net is netting horizontally at the water surface at the speed of 0.5 m/s within 2-3 minutes to collect species composition as well as a number of individuals. The net mouth is fitted with a dedicated Rigosha flow-meter (Japan) to calculate the amount of water passing through the net. Small zooplanktons are collected by filtering 50 liters of water through the net No.120 (the mesh size is 25 μm). The specimens are stored in formalin 4% and taken to the laboratory of the Center for Environment Science, Technology and Ecology and for analysis.
- **Benthos**: Quantitative benthic specimens to determine individual density in a square meter is collected by Petersen sludge bucket. The bucket mouth is 0.04m^2 wide. 02 buckets are taken at each station. Qualitative benthic specimens are collected by raking net with the opening of 40cm wide to complement species composition. The specimens are soaked in 10% formol solution. Qualitative benthic specimens are weighed by 0-mg sensitivity analyzer to average the weight per square meter (g/m^2) and to count the number of individuals of each species to average their density per one square meter (unit/m^2).

b). Analytical method

The aquatic organisms are analyzed by Olympus CX41 optical microscopes and Olympus CH20 magnifying glasses, according to the comparative morphological standards of the Russian and American classification systems.

CHAPTER 1. SUBPROJECT DESCRIPTION

Chapter 1 is a brief description of the subproject including subproject name; subproject owner; subproject location; main contents of the subprojects such as non-structure items, structure item; land acquisition; construction materials, machines, construction methods,; disposal sites and transportation routes of material and excavated soil;investment cost and time schedule; auxiliary works; organizations of the subproject management and implementation

1.1. SUBPROJECT NAME

Subproject 8: **Infrastructure to prevent coastal erosion, supply fresh water and for production of shrimp - forest model to improve livelihoods and adapting to climate change in the coastal area of Ca Mau Province**.

Under the project: **Mekong delta integrated climate resilience and sustainable livelihoods (MD-ICRSL)**

1.2. SUBPROJECT OWNER

- Name of subproject owner: Ca Mau Department of Agriculture and Rural Development
- Representative of subproject owner: Ca Mau Province Management Board of ODA & NGO Projects.
- Address: 5,7,9 - Mot Thang Nam street, Ward 5, Ca Mau city, Ca Mau province
- Tel: (0290) 6596606; Fax: (0290) 6250369
- Representative: Nguyen Vinh Sang - Director

1.3. SUBPROJECT LOCATION

The subproject is located in the coastal areas of Ca Mau province in the districts of U Minh, Tran Van Thoi, Phu Tan, Ngoc Hien, and Nam Can, the location of the main items of the subproject is presented in*Table1.1* and*Figure1.1*.

Table1.1: Coordinate of the main points in the subproject

No	Items	Latitude	Longitude
I	**West sea wave breaker**		
1.1	First point location	9°14'24.57"N	104°49'12.01"E
1.2	Last point location	9° 8'17.56"N	104°48'40.91"E
II	**Embankment**		
2.1	First point of section 1.1	8°44'48.58"N	104°58'54.52"E
2.2	First point of section 1.2	8°45'17.90"N	104°59'58.85"E
2.3	First point of section 2.1	8°44'33.62"N	104°57'45.25"E
2.4	First point of section 2.2	8°44'8.43"N	104°57'53.94"E
III	**Freshwater reservoir**		
3.1	Point A	9°15'14.83"N	105° 1'42.21"E
3.2	Point B	9°15'12.05"N	105° 0'48.37"E

No	Items	Latitude	Longitude
3.3	Point C	9°14'51.63"N	105° 0'50.11"E
3.4	Point D	9°14'54.85"N	105° 1'43.91"E

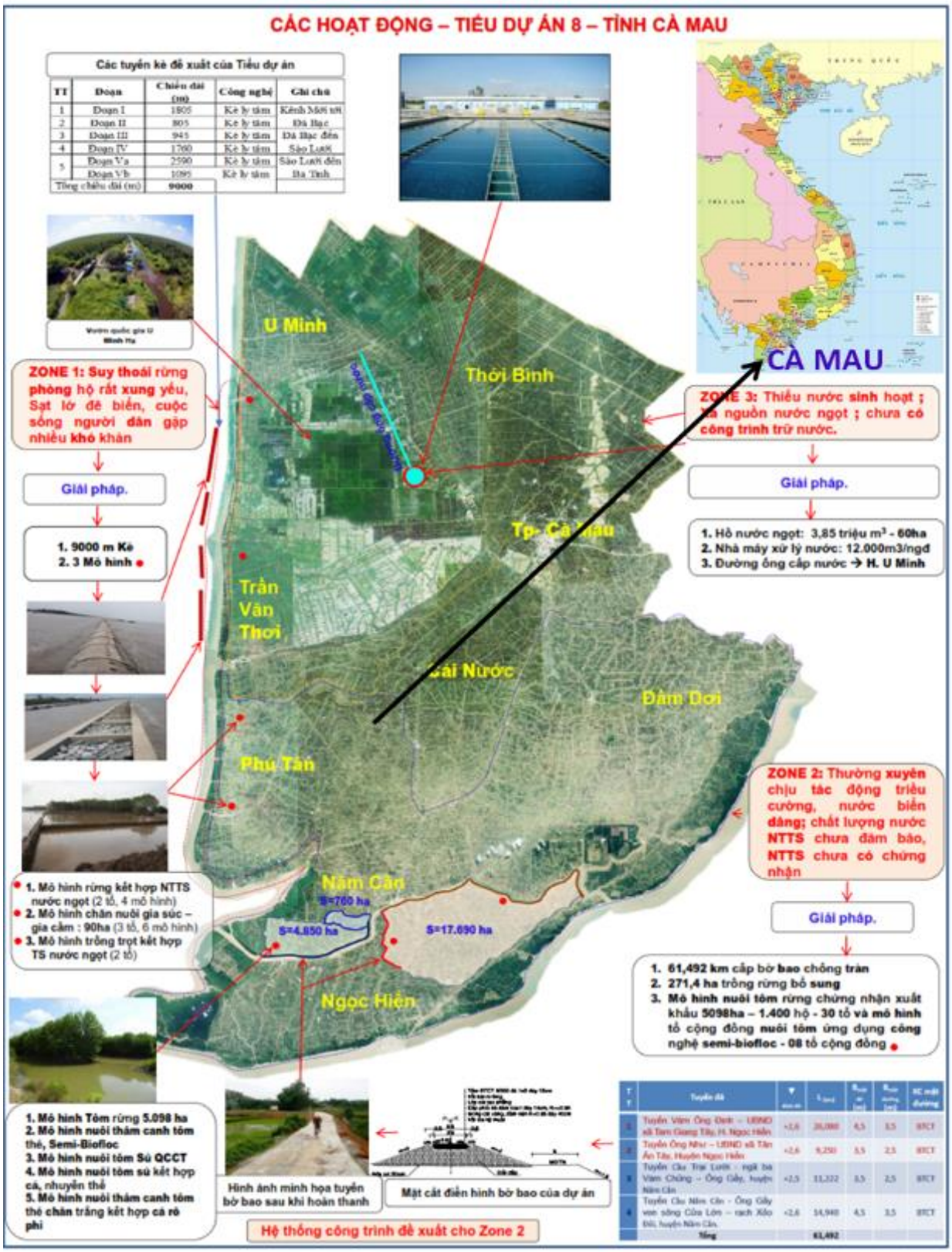


Figure1.1: Layout of the main components of the subproject

1.3.1. Location of the wave breaker

Wave breaker, that creates dams to control landslide erosion in the West Sea is expected to be built on the coastal water surface (former protective forests was infiltrated by the sea). Location is limited by (i) the Ba Tinh canal in the north; (ii) the Tu canal in the south; (iii) the West is the West Sea (formerly was a submerged protective forest); and (iv) in the east is the water surface (former protective forests was infiltrated by the sea).

Nearly all the protective forest pavilions along the sea dike have been eroded by the sea, and the loss of protective forests have threatened directly to the existing dike. The location of wave breaker of the subproject is one of the areas with strong erosion levels, mangrove forest has been washed away by the sea and become very thin, many points have eroded to the existing dike bases, which are temporarily reinforced for the protection of production and people inside. The invested locations of construction are shown in *Figure1.3*.

Figure1.2: Location of the wave breaker

1.3.2. Location of the embankment

In the area of Nam Can and Ngoc Hien districts over the past few years, when there were high tides, many dikes were broken affecting directly the living and production of people. On the basis of priority, choosing to build embankments for key areas first, four dike embankments that are expected to be reinforced and constructed including (*Figure1.3* and*Figure1.4*):

- Ngoc Hien District: From Vam Ong Dinh - Tam Giang Tay Commune People's Committee and from Ong Nhu - People's Committee of Tan An Tay Commune.
- Nam Can District: From Trai Luoi Bridge to Nga Ba Vam Chung, from Nam Can Bridge - Ong Gay Bridge - Xeo Doi canal.

The current status is largely temporary embankment for protection of aquacultures. There are households living along the existing embankment. Due to the fact that it has been cleared for aquacultures for quite a long time, the entire route of the work is no longer a natural scene but temporary embankment and aquaculture ponds.

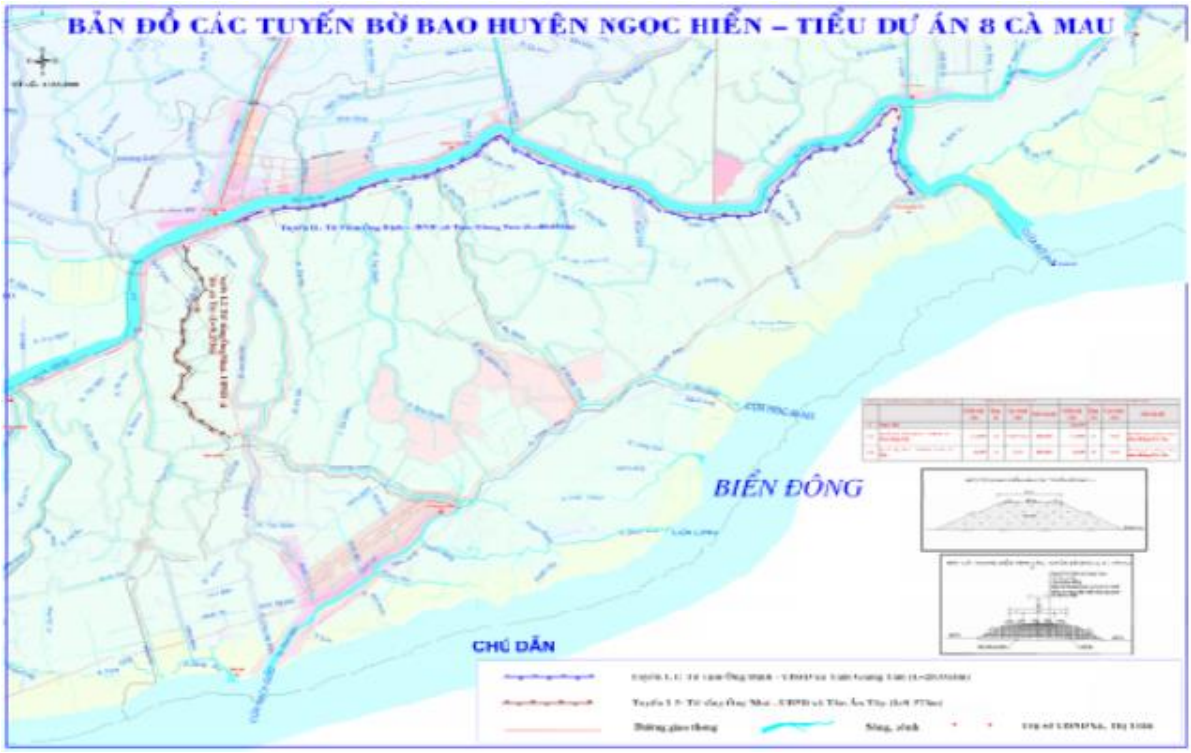


Figure1.3: Location of Ngoc Hien district embankments

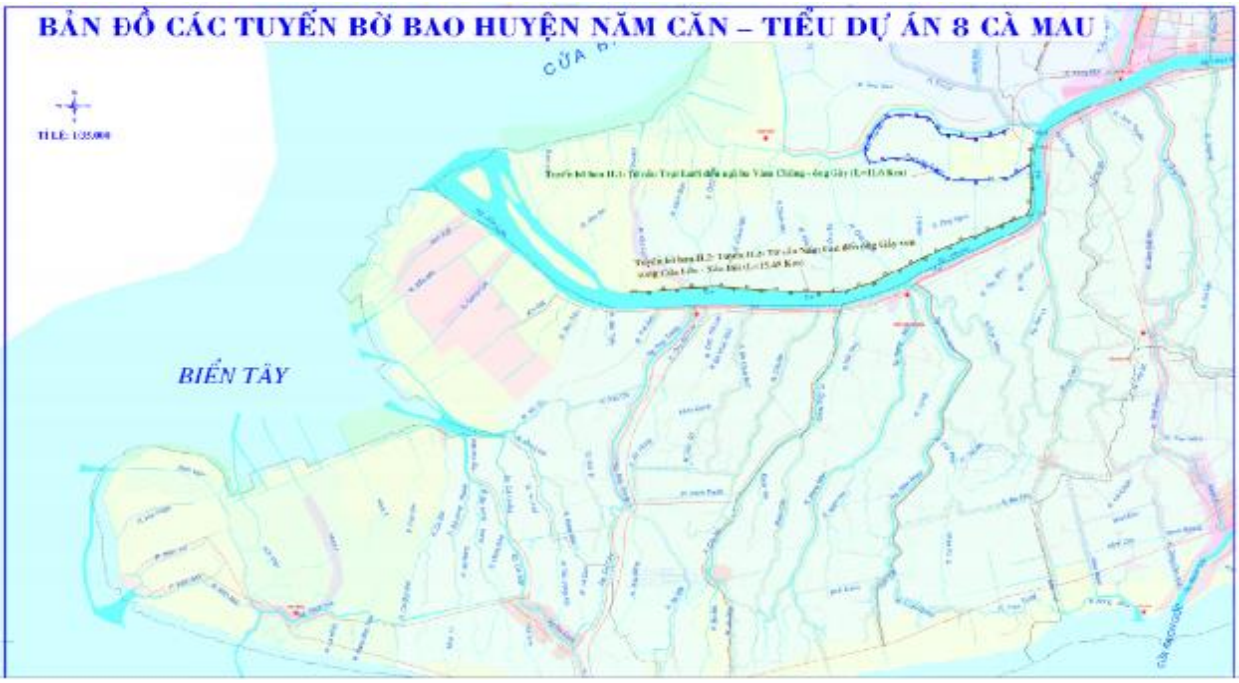


Figure1.4: Location of Nam Can district embankments

1.3.3. Location of the freshwater reservoir and water treatment system

The area of the freshwater reservoir and water treatment system construction is 102,2 ha in the resettlement area of Khanh An Commune, U Minh District. At present, this land (*Figure1.5*) is managed by the local authorities. This area is planted Melaleuca for production. At present, there are no households living and no other production activities in this area, but only two houses were built for the care of Melaleuca.

Natural and social objects in the reservoir construction area: Melaleuca is planted but not natural trees (*Figure1.6*), the reservoir is about 6 hectares, with a depth of 6-15m, formed from the excavation to get land for resettlement areas. Thus, in the area where the reservoir was built, there are no longer completely natural objects and they have been replaced by artificial objects.

The construction site is located far from U Minh Ha National Park (the nearest point is 5km away) and the reservoir is in the freshwater area which has favorable conditions to collect excess rainwater in the rain season.The results of the on-site observation and consultation with the National Park (NP), indicate that the construction of this reservoir is not expected to affect U Minh Ha NP. This result is also consistent with the findings in ESMF of MD-ICRSL project.

Figure1.5: Location of the fresh water reservoir and water supply station

Figure1.6: Planted melaleuca forests by making beds in the reservoir area

1.3.4. Location of mangrove planting

Mangroves are to be planted in the forest-shrimp ponds to meet standards of ecological shrimp farming in Ngoc Hien and Nam Can Districts (*Figure1.7*). Planting sites in Tam Giang Tay, Tan An Tay (Ngoc Hien District) and Lam Hai (Nam Can District). The natural and social objects in this area are mainly forest-shrimp ponds. The subproject only provides

technical support for the locals to increase the area of the forest to ensure the regulation of forest cover in the shrimp forest model.

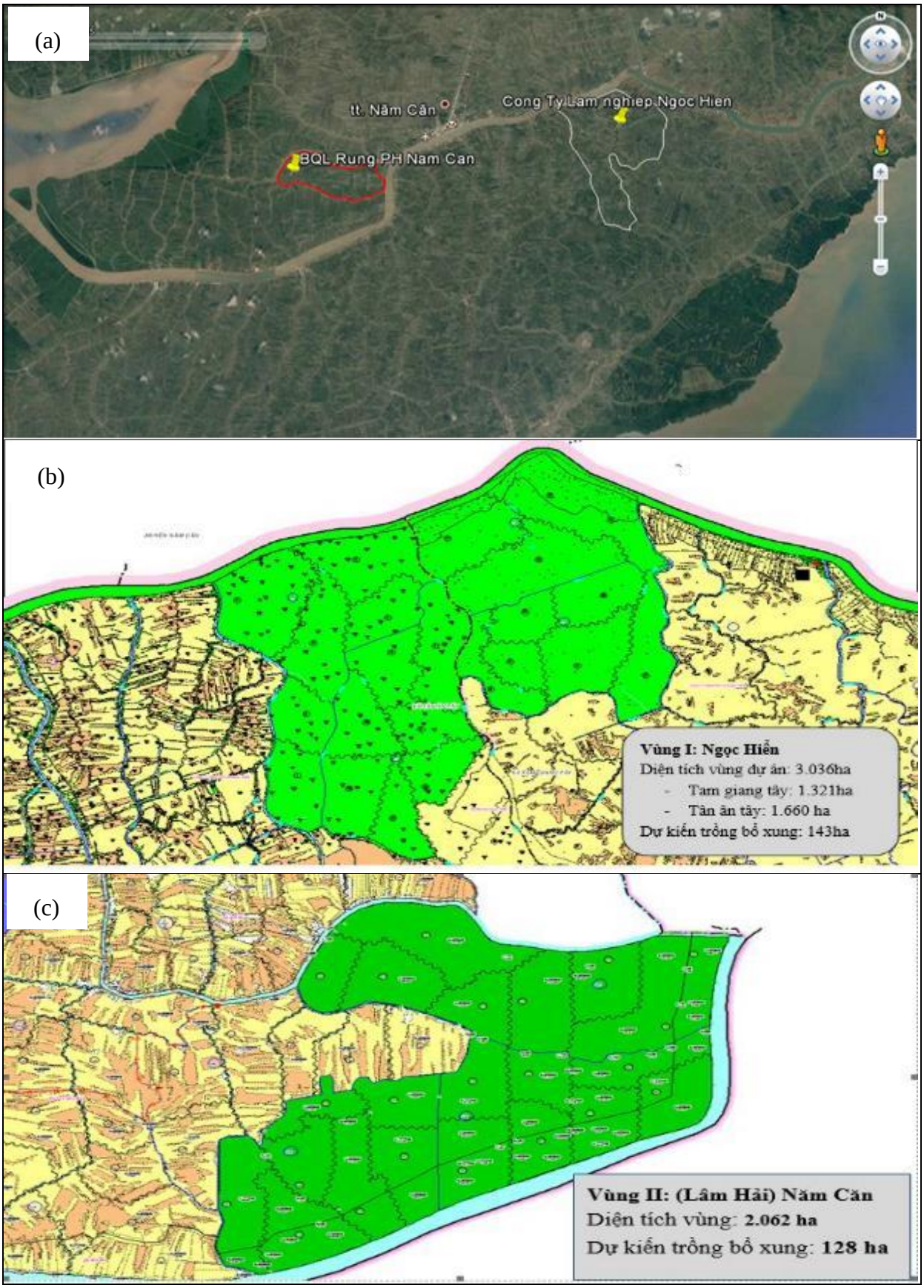


Figure1.7: Location of mangrove planting in Nam Can and Ngoc Hien (a) overall map; (b) location of forest plantation in Tam Giang Tay, Tay An, Ngoc Hien district; (c) Location of forest plantation in Lam Hai commune, Nam Can district

1.4. SCOPE OF INVESTMENT OF THE SUBPROJECT

1.4.1. Objectives and tasks of the subproject

1.4.1.1. Objectives of the subproject

- To improve livelihoods for the communities living in the coastal and under forest canopy areas in the subproject area through the sustainable livelihood models like the forest - ecological shrimp model and other aquacultural activities with the international certificates and stable markets;
- To strengthen the protection of the coastline and sea dyke of the West sea of Ca Mau province by constructing wave breakerfor beach nourishment, contributing to the restoration of the coastal protection belts which have been eroded;
- To strengthen the tidal resistance and the production and assets of the people; upgrading coastal infrastructure; contributing to the construction of the new rural areas; creating conditions for the aquaculture to be flexible, sustainable and adaptable to climate change and sea level rise; protecting the environment; contributing to the socio-economic development; and raising incomes for people in coastal areas of Ca Mau province;
- To improve the freshwater storage in rainy seasons to provide water for people in U Minh district to limit the exploitation of groundwater and to contribute to preventing land subsidence.

1.4.1.2. Tasks of the subproject

- Building embankments to prevent sea level rise due to climate change to protect the production area of 123,058 ha in Ngoc Hien and Nam Can districts of Ca Mau province;
- Improving the integrated climate resilience of the West Coast of Ca Mau province through the construction of wave breaker to prevent coastal erosion, loss of forestation and to facilitate mangrove afforestation outside the sea dyke to protect production and stabilize the livelihoods for inhabitants living inside the dyke;
- Restoring and developing the sustainable mangrove ecosystem in the coastal area of Ca Mau province combined with the effective shrimp culture under forest canopy through the model of raising a number of aquatic species of economic values but not having impacts on the forest in the coastal line of the West sea;
- Improving incomes for communities under the forest canopy in the subproject area through the model of shrimp farming with international certificates and stable markets;
- Creating and supplying clean water for about 113,780 people in U Minh district in order to stabilize the lives of local people and reduce the groundwater exploitation to avoid land subsidence (about 02 cm/year).

1.4.1.3. Scope of the subproject

The subproject includes 08 components as follows:

- Develop the sustainable livelihood models in southern coastal area of Ca Mau province such as the model of forest- shrimp with ecological certification of export standard (5,098 ha); the model of intensive whiteleg shrimp by Semi-Biofloc technology; the biological semi-intensive model of whiteleg shrimp; the model of whiteleg shrimp combined with

fish and mollusk; the model of intensive whiteleg shrimp combined with tilapia for treating the environment;

- Develop aquaculture livelihoods for people in the West sea forest belt: raising livestock and poultry, and cultivation combined with freshwater aquaculture. The protection of 9km coastal line of the West sea via the construction of wave breaker for beach nourishment to restore critical protection forest with an area of about 120 ha from Ba Tinh to Kenh Tu. This afforestation component is not integrated into the ICRSL project because this subproject FS has not approved yet. Thus, when the wave breaker will be completed as planned, it will be still only 2 years ahead to the project ending (31/12/2022), and at that moment the beaches will not have reached at the desired elevation for the afforestation. Approximately two years after the end of the ICRSL project, the beaches will have reached at the desired elevation for the afforestation and this will be invested by other projects like the Integrated Coastal Protection and mangrove belt rehabilitation in the Mekong Delta Project sponsored by the German Government; the Afforestation Project using non-refundable aid by the Green Climate Fund; and the afforestation projects funded by Government's annual budget... The province does not need to borrow funding for these projects.
- Building 04 embankment routes of 61.49km long to prevent tides in Nam Can and Ngoc Hien districts;
- Improving the capacity on aquaculture environment monitoring (environmental quality monitoring and disease mitigation, etc.);
- Implementing non-structural activities (training, development of operation procedures, market development, policy, establishment of farmer groups, communications, etc.);
- Building a freshwater reservoir of 3.85 million $m^3$and water treatment plant of 12,000 m^3/day-night, serving 113,780 people in U Minh district.

1.4.2. Volume of structural component of the subproject

1.4.2.1. Construction of 9-km wave breaker to protect the West sea dyke (from Vam Ba Tinh to Tu canal, Tran Van Thoi district)

Building a new wave breaker with a total length of 9,000m (see *Table1.2*) in Tran Van Thoi district has width: B = 1.8-2.5m; top elevation: +1.60. The structure consists of two centrifugal concrete piles of length L = 7m, each separated by 1.4m horizontal, the distance between the piles is 60cm. Inside the wave breaker are dropping cajuput rafts and raps with D> 30 to prevent subsidence. Top of the piles are joined together by a system of 40x30cm reinforced concrete beams, the vertical beams are linked together by a system of horizontal beams size 30x30cm with a distance of 3.0m (*Figure1.8*).

1.4.2.2. Upgrading 61,942km embankment routes in Nam Can and Ngoc Hien districts

Upgrading the embankment combined with rural roads with the length of 61.942 km in the area of Nam Can (26.162km) and Ngoc Hien (35,330km) districts, see the details in *Table1.3*. Construction solutions using borrowed soil from sites, excavating soil from the two sides to create hardness and then pour concrete on the surface of the embankments to create rural roads.

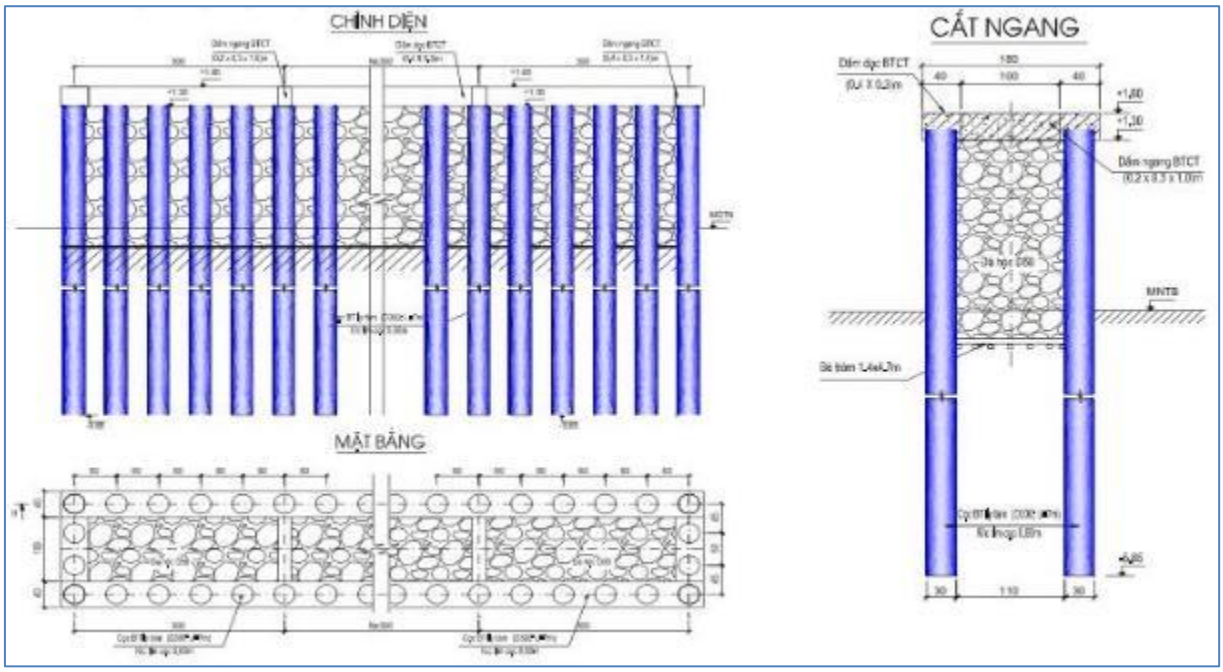


Figure1.8: Typical axial and cross sections of centrifugal pile

Table1.2: Technical parameters of the wave breaker

No	Sections	Location	Natural ground altitude (m)	Length (m)	Technology	Note
1	Section Ia	K0+00÷K1+745	-1.10	1745	Centrifugal	From Tu canal to Moi canal
2	Section Ib	K1+745÷K3+00	-1.08	1255	Centrifugal	
3	Section II	K4+728÷K5+328	-1.00	600	Centrifugal	From Moi canal to Da Bac
4	Section III	K10+438÷K11+483	-1.00	1045	Centrifugal	From Da Bac to Sao Luoi
5	Section IV	K11+783÷K13+543	-0.85	1760	Centrifugal	From Sao Luoi to Ba Tinh
6	Section Va	K13+543÷K15+043	-0.80	1500	Centrifugal	
7	Section Vb	K15+043÷K16+138	-0.60	1095	Centrifugal	
	Total			**9000**		

Table1.3: Technical parameters of embankment routes

No.	Embankment route	▼top elevation	L (km)	$B_{embankment}$ (m)	B_{road} (m)	Structure of road surface
1	Route of Vam Ong Dinh – Tam Giang Tay CPC, Ngoc Hien district	+2.6	26.080	4.5	3.5	Reinforced concrete
2	Route of Vam Ong Nhu – Tan An Tay CPC, Ngoc Hien district	+2.6	9.25	3.5	2.5	Reinforced concrete
3	Route of Trai Luoi bridge – Vam Chung T-junction – Ong Gay, Nam Can district	+2.5	11.222	3.5	2.5	Reinforced concrete
4	Route of Nam Can bridge – Ong Gay along Cai Lon river mouth – Xeo Doi creek, Nam	+2.6	14.940	4.5	3.5	Reinforced concrete

	Can district					

1.4.2.3. Construction of fresh water reservoir, water treatment plant, and pipelines

Build a reservoir, water treatment systems and pipelines to ensure clean water for daily life activities of concentrated population clusters, including: Build a reservoir of 60ha with effective capacity of W = 3.85mil.m^3; (ii) Construction of a water treatment plant of 12,000 m^3/day; (iii) Construction of pipelines to supply water for U Minh district.

- The reservoir is 60ha wide. Its capacity is 3.85 million m^3 and water elevation is +1.00m. Inside the reservoir: The upper-slope coefficient is m = 2.5; the lower-slope coefficient is m = 3.0. Outside the reservoir: the slope coefficient is m = 2; the bottom-elevation of the reservoir is - 6,0m; the crest-elevation is +2.0m. This elevation ensures not to be flooded by the water level outside the canal and ensures the water storage capacity according to the design. The reservoir inside clearance is 10.0m wide with an elevation of about 1.0m.
- The water-intake culvert shall be underground and located inside the soil bank and this is equipped with valve tower; M250 reinforced concrete sewer;sewer heads are installed with fixing and trash rack, in which: Length of culvert body L = 79,0m; culvert's aperture 2xbxh= 2x(1.5x2.5)m; Altitude of culvert threshold: -1.00m; Design intake capacity Q_{TK} = 0.218m^3/s.
- The road around the reservoir shall be reinforced concrete, length: 4,715m; altitude of pavement: +2.20 m; road pavement width: 3m; road base width: 4m.
- Construction of the water treatment plant with the capacity of 12,000m^3/day and night, including the following main works: (i) water-intake works - raw water pumping station, raw water pipeline + static mixing equipment; (ii) Composite treatment unit: receiving ditch + mechanical reaction tank + lamella sedimentation tank + quick filtration tank + filter pumping station and chemical house; (iii) clean water tank, clean water pump station in the operation house; (iv) filtered water collection tank; (v) Sludge treatment area; and (vi) technical pipeline and other auxiliary structures.The technological process of the water treatment plant is presented in*Figure1.11*. Technology demonstration: Raw water from the pond is pumped through a static mixer where the feed water is mixed with PAC, lime to ensure optimal precipitation. Static mixing unit mounted in the pipeline to the 2-stage mechanical reactor. Water through the mixing tube to the reactor where the process of cotton flocculation produces colloidal particles capable of absorbing suspended particles. Raw water from the reactor was transferred to a lamella sedimentation tank, sediment was deposited in the Lamella sedimentation tank due to low velocity flow in the sediment so that most of the sediment was deposited. After being deposited in the Lamella tank, the water is collected and deodorized to meet the requirement. Non-settable fine particles will be trapped in the filter material. Filter tanks have a water collection and distribution system for filtration using two-stage filtration for efficient filtration, high filtration efficiency, filtration, and filtration. Then the water is drained to the clean water tank in chlorinated water before being pumped grade II to the transmission network to U Minh district to connect to the existing water supply system. The filtered water is brought back to the receiving compartment. The sedimentation tank is brought to the silt treatment facility by mechanical equipment.
- Construction of water pipeline of 25km long from the plant to residential areas of U Minh district (*Figure1.12)*. Routes along the pipeline will also be constructed in the budget of rural water supply program.

The overall layout of the area of the water treatment plant is showed in the *Appendix.*

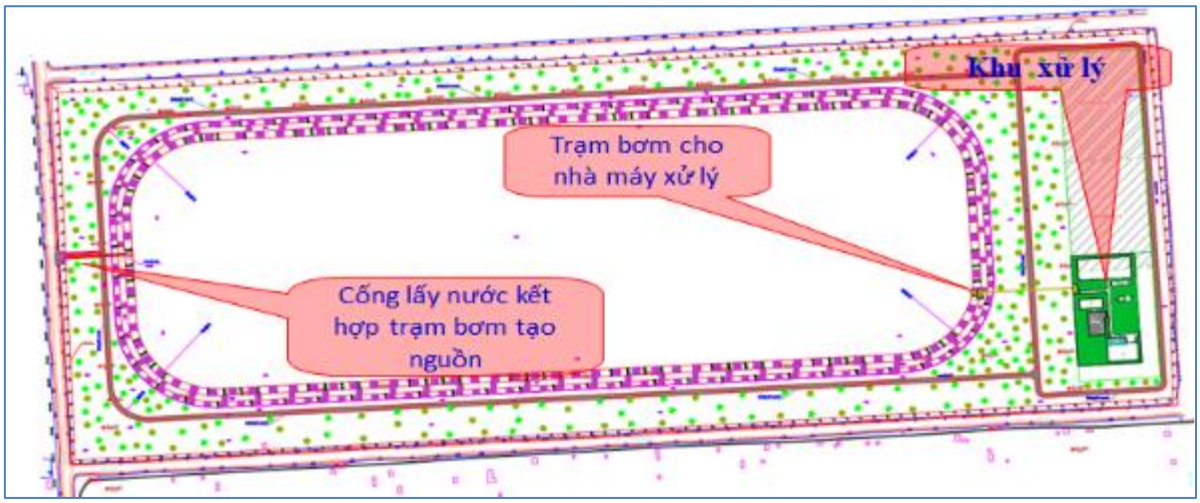


Figure1.9: Overall layout of the reservoir

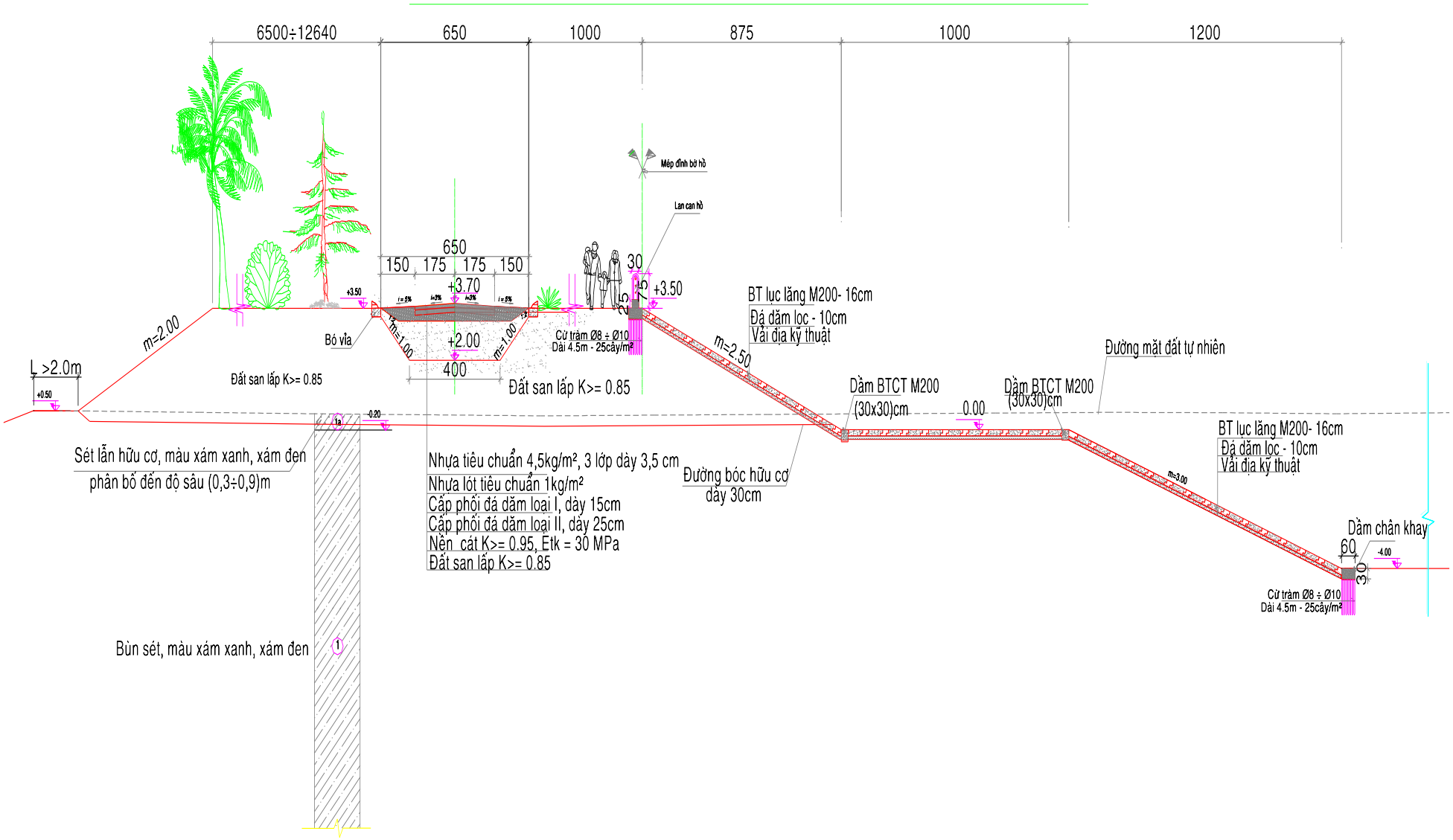


Figure1.10: Typical cross-section of the reservoir's banks

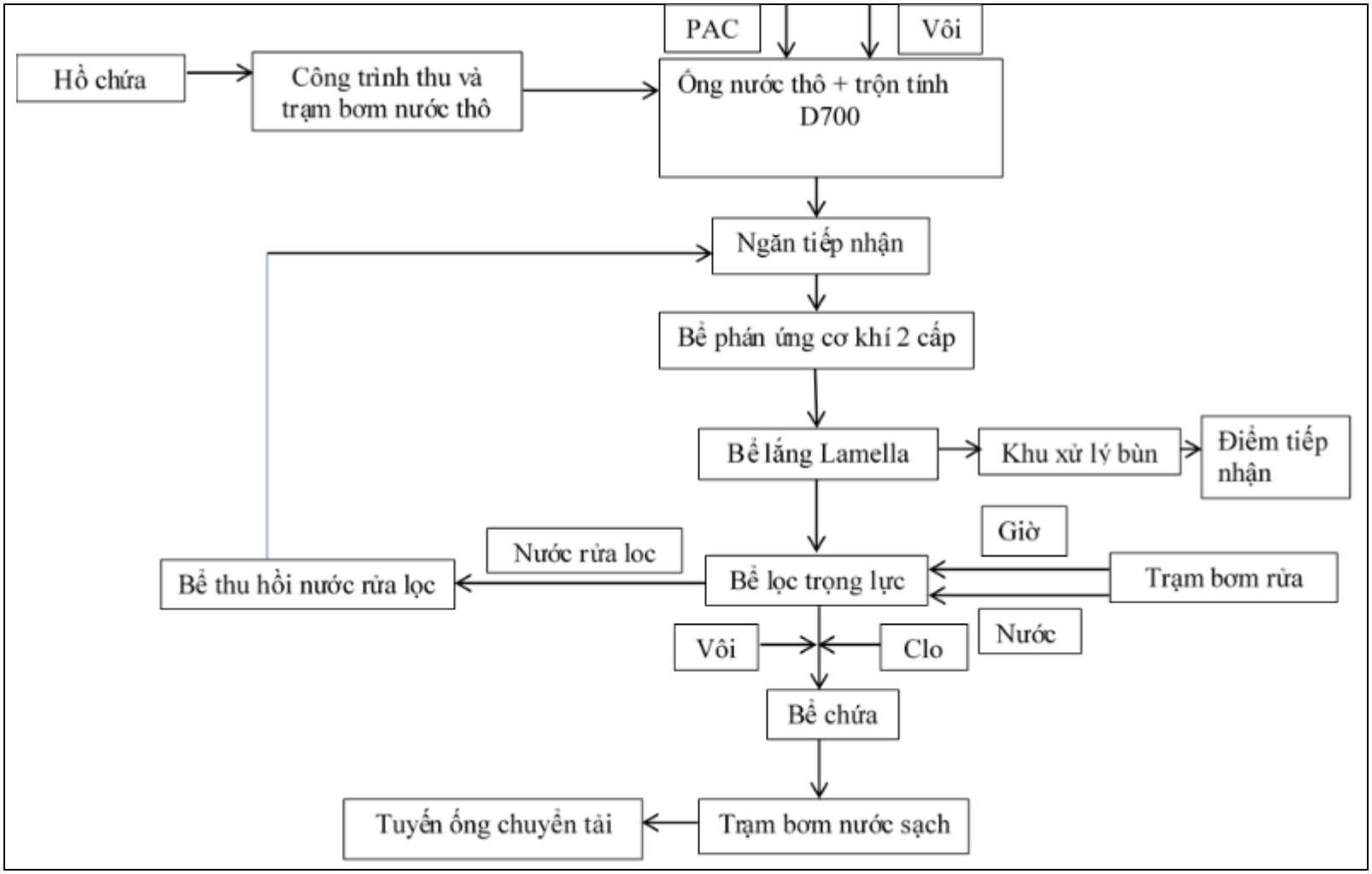


Figure1.11: Flowchart processing technology of the water treatment plant

Figure1.12:Pipeline from the treatment plant to center of U Minh district

1.4.2.4. Mangrove plantation

a) Planting mangroves in the shrimp-forest ponds

Additional planting of 271 ha of mangroves for the total area of 5,098 ha, of which 143 ha in Zone I (Ngoc Hien) and 128 ha in zone II (Nam Can) to meet the forest requirement area as minimum as 60% for 5,098ha of ecological shrimp farming (in which: Ngoc Hien 3,036ha, Nam Can 2,062ha). Details are in *Table1.4*.

Table1.4: Estimation of additional mangrove planting area in shrimp ponds

No	Subproject region		Area of forest + water surface for aquaculture (ha)	Forest coverage (%)	Area in need of additional afforestation to ensure 60% coverage (ha)
I	**Region I (Ngoc Hien)**				**143.1**
	Sub-area	**Plot**			
1	157	1,2,3,4,5,6	450.3	49.2	35.61
2	158	7,8,9,10,11,12,13	463.6	48.3	43.57
3	159	17,18,19,21	188.8	47.8	18.37
4	160	22,23,24,25,26,27	392.8	46.9	45.56
II	**Region II (Nam Can)**				**128.3**
	Sub-area	**Plot**			
1	147	74,75,76,77,78	311.01	44.3	46.08
2	151	63,64,65,66,67,68,69	367.86	46.9	44.61
3	152	79,80,81,82,83,84,85	270.19	45.0	37.57
	Total				**271.4**

b) Planting mangroves along the sea dyke (inside the wave breaker)

The protection of 9km coastal line of the West sea via the construction of wave breaker for beach nourishment to restore critical protection forest with an area of about 120 ha from Ba Tinh to Kenh Tu.

The afforestation will be implemented after completing the beach nourishment. However, this activity is not integrated into the ICRSL project because this subproject FS has not approved yet. Thus, when the wave breaker will be completed as planned, it will be still only 2 years ahead to the project ending (31/12/2022), and at that moment the beaches will not have reached at the desired elevation for the afforestation. Approximately two years after the end of the ICRSL project, the beaches will have reached at the desired elevation for the afforestation and this will be invested by other projects like the Integrated Coastal Protection and mangrove belt rehabilitation in the Mekong Delta Project sponsored by the German Government; the Afforestation Project using non-refundable aid by the Green Climate Fund; and the afforestation projects funded by Government's annual budget... The province does not need to borrow funding for these projects.

1.4.3. Volume and scale of non-structural component of the subproject

1.4.3.1. Livelihoods model for people living inside the West Sea protection forest belt

- Developing aquaculture models for the community living along the protective forest belt. The model scale is piloted in 30 ha, raising whiteleg shrimp combined with sea snails (*Cerithidea obtusa*), Mud clam(*Geloina coaxans*), blood cockle (*Tegillarca granosa*), etc. in Tan Hai and Phu Tan communes of Phu Tan district, then is expanded to the remaining 30ha in the subproject area. The number of benefited households includes about 60.
- Developing the livestock and poultry models for the households whose lands for feeding livestock and poultry do not affect shrimp ponds (an average distance from a livestock and poultry breeding facility to a shrimp pond and water resources is at least 10 m). The scale will be 90 ha, divided into 3 production areas, 30 ha of each. The total of 150 households will participate in the models. 03 models will be developed in Tan Hai, Khanh Binh, Tay Bac and Khanh Binh Tay communes with the size of 03 ha/model. The number of households participating in these models will be from 10-15 households/group.
- Developing the model of combining between cultivation and freshwater aquaculture. The scale is 60 ha. It is demonstrated in the two-rice crop area inside the sea dyke. The households are selected to the model demonstration of raising giant freshwater shrimps (Macrobrachium rosenbergii) and freshwater fish in rice fields. The technical officers will be supported to monitor and manage the model. It is expected that 40-50 households will participate in the model. The replication of the model will be implemented in the areas with suitable conditions in the province after the end of the subproject.

1.4.3.1.Livelihood models in the coastal zone of South Ca Mau province

- The forest-shrimp model with international certification: The total scale is 5,098ha, including 2,062 ha of Nam Can protection forest area in Lam Hai commune; 1,536 ha in Tam Giang Tay commune; and 1,500 ha in Tan An Tay commune, Ngoc Hien district. The production area is divided into with 30 farmer groups (12 groups in Lam Hai commune and Nam Can Protection Forest Management Board, and 18 groups in Ngoc Hien Forestry Company in Tam Giang Tay and Tan An Tay communes). The total participants in the model include 1,400 households.
- The model of white-leg shrimp intensive by Semi-Biofloc technology. The scale is 200 ha with 150 households participating. The subproject will set up 10 community groups/farmer groups in the province's key aquaculture districts (each group will include 15 to 20 people). The subproject will support the application of Semi- Biofloc technology for the super-intensive shrimp culture through training, coaching, learning experience and cooperating the model demonstration points, to be the basis for the summarization and replication.

- The biological extensive model of tiger prawn.The scale is 400 ha, with about 400 participating households. The subproject will pilot 20 community groups in five key aquaculture districts of the province (each group will include 15 to 20 people). The subproject will support the training and coaching of the biosecurity shrimp raising techniques; organize learning experiences inside and outside the province; support and cooperate with the people in the farmer groups in the model demonstration points, to be the basis for the summarization and replication.
- The model of giant tiger shrimp, fish, and mollusk raising. The scale is 400 ha, with about 400 participating households. The subproject will pilot 20 farmer groups in five key aquaculture districts of the province (each will include 20 to 25 people). The project will support the shrimping technical training combined with some types of economic value raising; organize learning experiences in and outside the province; and support and cooperate with the people in the cooperative groups in the model demonstration points, to be the basis for the summarization and replication.
- The intensive model white-leg shrimp and tilapia for environmental treatment. The scale is 180 ha, with about 200 participating households. The subproject will form 10 community groups/farmer groups in the province's key aquaculture districts (each initial group will include 15 to 20 people). The subproject will support improving technical and management levels of the farmer groups through field training and coaching courses, learning experiences and coordination of demonstration model at the site, to be the basis for the summarization and replication.
- Activities that support the livelihood models include disease surveillance, environmental monitoring, vocational training for rural workers and other propaganda activities.

Other non-structural solutions:

- Developing operational procedures to clean the environment to ensure efficient production;
- Building the brand of ecological shrimp in Nam Can, Ngoc Hien districts;
- Organizing training courses on aquaculture, shrimp-forest, forest-shrimp technology for farmers in the subproject area;
- Vocational training for affected and vulnerability people due to site clearance, resettlement and production conversion during the subproject implementation;
- Establishing an environmental warning system;
- Raising awareness on climate change and supporting the establishment of CC response teams;
- Preparing and implementing commune action plans;
- Developing farmer associations and market linkages.

1.4.4. Acquired land for the subproject

Only the components of upgrading embankment and reservoirs require land acquisition. The wave breaker is located on the area of coastal water surface and the mangrove plantation is conducted at shrimp-forest ponds area managed by the State (*Table1.5*).

Table1.5: Summary of land loss due to the construction of the subproject

No	Item	Land use (ha)		Note
		Permanently	Temporary	
1	Embankments	60,75	87,39	
2	Reservoir	102,2	70,0	Underground water pipeline buried along Ca Mau - U Minh route
3	Embankment	0	0	Offshore construction, therefore, there will be no land loss
4	Afforestation	0	0	Planted on the seaboard and in shrimp ponds (to ensure ecological certification)
	Total	**162,95**	**157,39**	

Table1.6: Summary of permanent land loss due to the construction of embankment

No	Land type	Total land area available (m^2)	Area of loss (m^2)	The remaining area (m^2)	Land loss ratio (%)
1	**ONT+RST Land**	**1,754,685**	**112,539**	**1,642,146**	**6.4**
1.1	T1 Nam Can	641,244	54,850	586,394	8.6
1.2	T2 Nam Can	279,242	14,518	264,724	5.2
1.3	T1 Ngoc Hien	171,589	12,849	158,739	7.5
1.4	T2 Ngoc Hien	662,610	30,322	632,288	4.6
2	**TSL+RST Land**	**22,012,990**	**495,005**	**21,517,985**	**2.2**
2.1	T1 Nam Can	4,166,616	43,014	4,123,602	1.0
2.2	T2 Nam Can	4,708,878	128,163	4,580,714	2.7
2.3	T1 Ngoc Hien	3,744,152	64,055	3,680,097	1.7
2.4	T2 Ngoc Hien	9,393,344	259,772	9,133,572	2.8
	Total	**23,767,675**	**607,544**	**23,160,131**	**2.6**

Source: Report on the resettlement action plan of the subproject

1.5. CONSTRUCTION ORGANIZATION MEASURES, CONSTRUCTION TECHNOLOGY OF THE SUBPROJECT ITEMS

1.5.1. Construction methods of the wave breaker

- Centrifugal concrete piles are purchased at the factories and transported to the construction site by barges, the pile size of 300m in diameter and 7m in length. The piling work is done with a hammer of 1.8 tons, and with the excavator v = 0.7m^3 standing on the support bar with the pile driving position, the pile will be dropped down to the designed elevation.
- After piling, proceed to construct reinforced concrete beams (elevation +1.50).
- Drop diameter D30 gabion to fill in the wave breaker body mechanically and manually.

1.5.2. Construction methods of the embankment

1.5.2.1. Filling segments

All four embankment sections are located on soft land with subsidence of 25 to 46cm, so fast construction will not be able to avoid subsidence, so the construction will depend on the current status of the subproject, the height of the landfilling which must be segmented as follows:

- Section from Ong Dinh ute to Tam Giang Tay CPC (Ngoc Hien district):
  - This route is based on the current status divided into two sections as follows: (i) segment 1: From Vam Ong Dinh to Bao Vi canal 18,053m long is new ones with a height of 2.5 to 3.2m; and (ii) Section 2: From the Bao Vi canal to Tam Giang Tay CPC, this section is 10,000m long and this section has existing embankment and cement concrete road but it has been damaged. This section only needs to be upgraded and repaired, thus, filling height is small so construction only needs to be carried out once.
  - The section from Vam Ong Dinh to Bao Vi is divided into 3 filling phases as follows: (i) phase 1: fill the embankment to height 0.8m, wait 6 months to reach ground endurance level of Ut = 80%; (ii) phase 2: fill the embankment to height of 1m, wait 6 months, reach ground endurance level of Ut = 80% and (iii) phase 3: fill the embankment to height of 2.6m (average embankment height of 0.8m).
- Section from Ong Nhu to Tan An Tay CPC (Ngoc Hien district): This section is divided into two filling phases as follows: (i) phase 1 with height of 0.8m, wait 3 months to reach ground endurance level of Ut = 80% and (ii) the second phase with the height of 0.7m reaches the height of 2.5m.
- Section from Trai Luoi Bridge-Vam Chung-Ong Gay Bridge (Nam Can district): This section is similar to the Bao Vi - Tam Giang Tay section with the height of 0 to 1.25 m, so there is no need to divide the filling process.
- Section from Ong Gay to Xeo Doi (Nam Can district): This section is divided into two filling phases as follows: phase 1 to filling height of 0.8m, wait 3 months to reach ground endurance level of Ut = 80%, then phase 2 to filling height of 0.7m and at that time the embankment elevation of 2.6m.

1.5.2.2. Construction steps

Based on the embankment segments as mentioned above, the construction will be divided into either one-phase or multi-phase comprising the following steps:

- Step 1: Preparation: (i) Clearing and grubbingthe site; and (ii) build the material yard
- Step 2: Dredging and expanding of the canal, including: (i) Using dredger with capacity of 1.25 m^3 to dredge and excavate soil from the fields to the embankment depending on the width of the digging compartments that 1 bath, 2 baths or 3 baths excavation method will be applied; (ii) Then the soils will be transferred to the embankment, using 100 CV bulldozer and combining with a dredger to finish building road on the embankment surface.
- Step 3: Roadbed treatment, including (i) Excavate the roadbed to the designed elevation using a dredger of 0.8 m^3 and treating the roadbed according to the design drawing and (ii) filling 2 talus, 2 shoulders of the road using the soil from excavating the roadbed. Any site that lacks excavation soil, the soil will be taken from digging inside the farming land using the gasoline dredger or Kobe to pack the surface to the designed elevation, including the

compensated road to shape the road according to the design and compress the surface k = 0.85 by the 9T compactors.

- Step 4: Construction of roadbed, pavement, including: (i) Laying geotextiles, covering the bottom layer of the foundation with sand to the designed elevation; (ii) Construction of road pavement; (iii) Construction of 0-4 stone layers ; (iii) Construction of flattening sand; (iv) Spreading the waterproof plastic canvas and (v) Constructing cemented concrete.
- Step 5: Leveling roads according to the design, clearing the ground.

1.5.3. Reservoir construction method

It is estimated that the total volume of earth work in reservoir construction is 3,455,000 m^3. In which 629,065 m^3 will be generated from excavation activity and 2,826,460 m^3 will be from dredging. Excavation will take place in dry season while dredging will be carried out in rainy season. The excavated materials will be reused for construction of reservoir embankment while the dredged materials will be stored in a disposal site. The method of dredging is described below.

The longest distance from the construction site of the reservoir for landfilling in the resettlement area of Khánh An Commune, U Minh district is 3000m, and the construction method is to use a suction dredger (*Figure1.13*):

- Dredging the reservoir bed using a suction dredgerof 2,000 CV to the depth below <8 m, and height of exhausting pipe <5 m, length of the exhaust pipe 500 –2,000m, blowing to disposal sites;
- A bund will be built to surround the disposal sites forming a sedimentation tank. On the bund, there are overflowing gates to drain water, every 100m an overflowing gate will be installed.

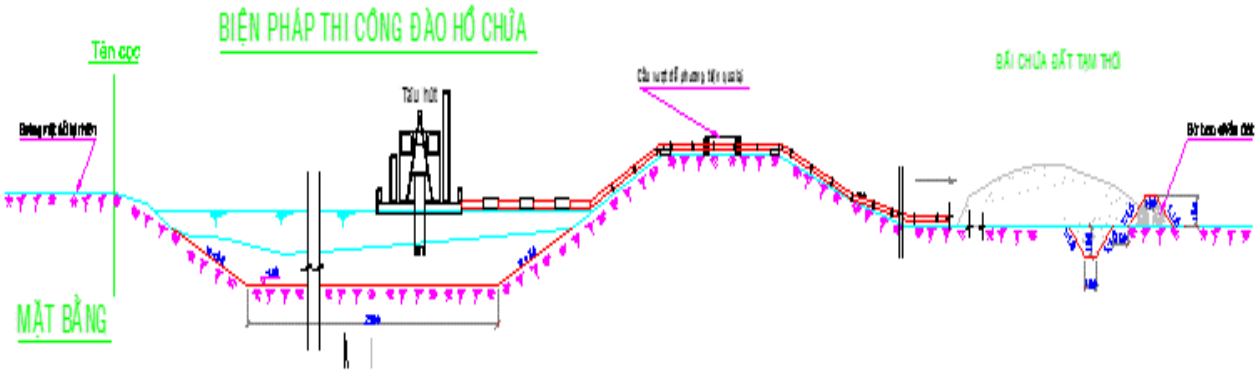


Figure1.13: Typical cross section of the reservoir construction with a suction dredger

1.5.4. Afforestation method

The methods of mangrove afforestation at the forest - shrimp ponds are shown in*Table1.7.*

Table1.7: Organizing mangrove plantation at shrimp ponds

No	Work Categories	Content
I	**Tillage:**	
1	Procedure:	Lining
2	Method	Making beds
3	Tillage duration	June to August

II	**Afforestation:**	
1	Type of plant:	*Rhizophora apiculata* BL
2	Planting Procedure:	Purebred
3	Planting Method:	Seedlings will be planted directly in the area designed continuously.
4	Planting Season:	-Seedlings collection: from August to October. -Seedlings plantation: from August to October.
5	Planting density:	6.000 Seedlings /ha
	-Distance between each line (m):	Line to line: 1m
	Distance between each trees(m):	Tree to tree: 1,7m
6	Seedling standards:	Seedlings need to be 20-25cm long, the stem must remain intact, green yellow or light brown, not rooted, no pests.
II	**Care and Maintenance**	
1	**Care in the first year**	From two to four times
-	Content	-After planting 1-2 months, removing moss, garbage on the body, leaves of the plant. -Rebuild the tilted tree -Control water collection, restricting the submerge time of the seedlings within 7 days.
-	Replantation	-After planting for 1-2 months, it is necessary to check the area for dead plants, if less than 10% and not scattered then replantation is not needed. -Replantation will be carried out in the first 3 years (first year of the plantation and the next 2 years). -Requirements: plants must be planted with seedlings, and have the same the age of the planted plant. The percentage of replantation is 15%
2	**Care in the second, third and fourth year**	
	-Phase 1	May
	-Phase 2	September
	Content	Restore the tilted tree; good control of the water intake to shrimp ponds in order to prevent flooding of the seedlings for more than 7 days.
	Replantation	The percentage of replantation in the second year is 10% and in the third year is 5%.
3	**Protection:**	-Aquaculture activities should avoid damaging to the planted forest for the first 5 years. -Control the water collection, preventing flooding of the seedlings for more than 7 days.

1.6. LIST OF MACHINERY AND EQUIPMENT

The list of machinery and intended equipment for construction is summarized in *Table1.8*and *Table1.9*, and most of the equipment was used, however, the depreciation rate is only 10-20% and they will be regularly maintained.

Table1.8: List of machines for the embankment construction

No	Device	Per construction site	Number of construction sites
1	Excavator 0,8 m^3	1	6
2	Concrete-mixer of 500 L	1-2	6
3	Compactors	1	6

Table1.9: List of machines for the construction of wave breaker (5 segments)

No	Machine	Unit	Quantity
1	Pile driver	item	5
2	200 T Barge	item	5
3	400 T Barge	item	5
4	150CV Tugboat	item	5
5	Motorboat, boat machine	item	10
6	25 T Crane	item	5
7	<=1,25 m^3 Excavators	item	5
8	500 Litre Concrete-mixer	item	5
9	Water Pumps	item	10
10	Jumping jack compactor, needle vibrator	item	10
11	Motor welding machine	item	5
12	Electric welding machines	item	5
13	Steel bending machine	item	5
14	Steel cutting machines	item	5
15	Electric Generator	item	5

The demand for labor of the subproject is expected to be 190 persons at peak (*Table 1.10*) during the construction phase and 10-15 persons in the operation phase. In the construction phase, the subproject will arrange camps for construction workers at the construction sites, with mobile toilets, health centres, clean water tanks... In the operation phase, the operator will be at the site manager.

Table 1.10: Demand for the construction workforce in the peak period

Component	Reservoir	Embankment	Wave breaker	Forest planting	Total
Number of workers (people)	30	60 (4 teams)	50 (5 teams)	50 (10 teams)	190

1.7. AREA OF INFLUENCE OF THE SUBPROJECT

The policy safeguard screening of the Subproject provides the results that the subproject works are located in different locations and assume different tasks, therefore their negative impacts are local, short and independent, as follow:

- Construction phase:
  - The wave breaker: The impact radius is 100m. The impact period of each embankment section is a year. In this radius, there is no inhabitant and can be controlled by ECOPs and other specific measures to be developed for the subproject.
  - The embankment: The impact radius is 200m. Within this radius are mainly aquaculture ponds and without inhabitants. The impacts happen in short-term, along the embankment and can be controlled by ECOPs and other specific measures to be developed for the subproject.
  - The reservoir and WSP: The impact radius is 200m. There are no inhabitants within this radius. The impacts take place about 2 years and can be controlled by ECOPs and other specific measures to be developed for the subproject.
  - The mangrove plantation: there are no significant environmental impacts.
- In the operation phase: the environmental impact is mainly positive. In addition, the afforestation helps the shrimp farming in the ecological model area reduce the volume of waste.

Areas of influence of the subproject items are illustrated in*Figure1.14*and*Figure1.15*.

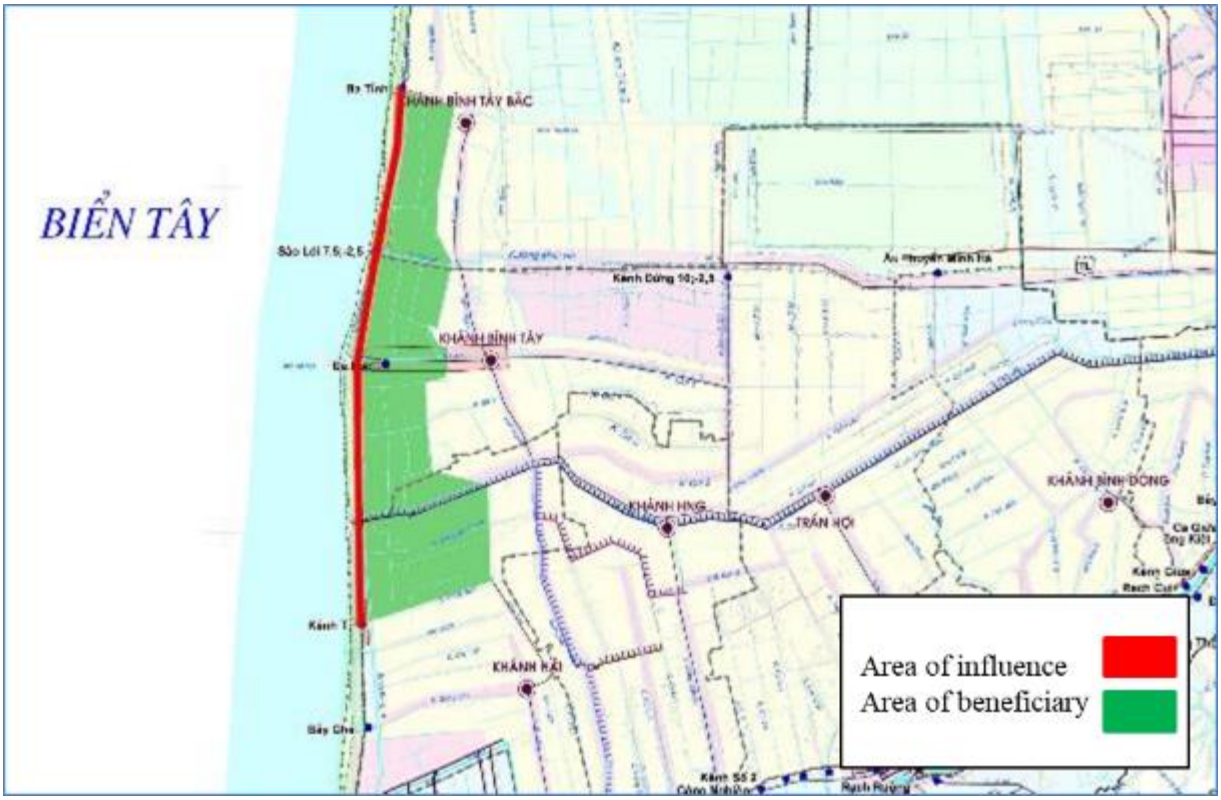


Figure1.14: Areas of influence of the wave breaker

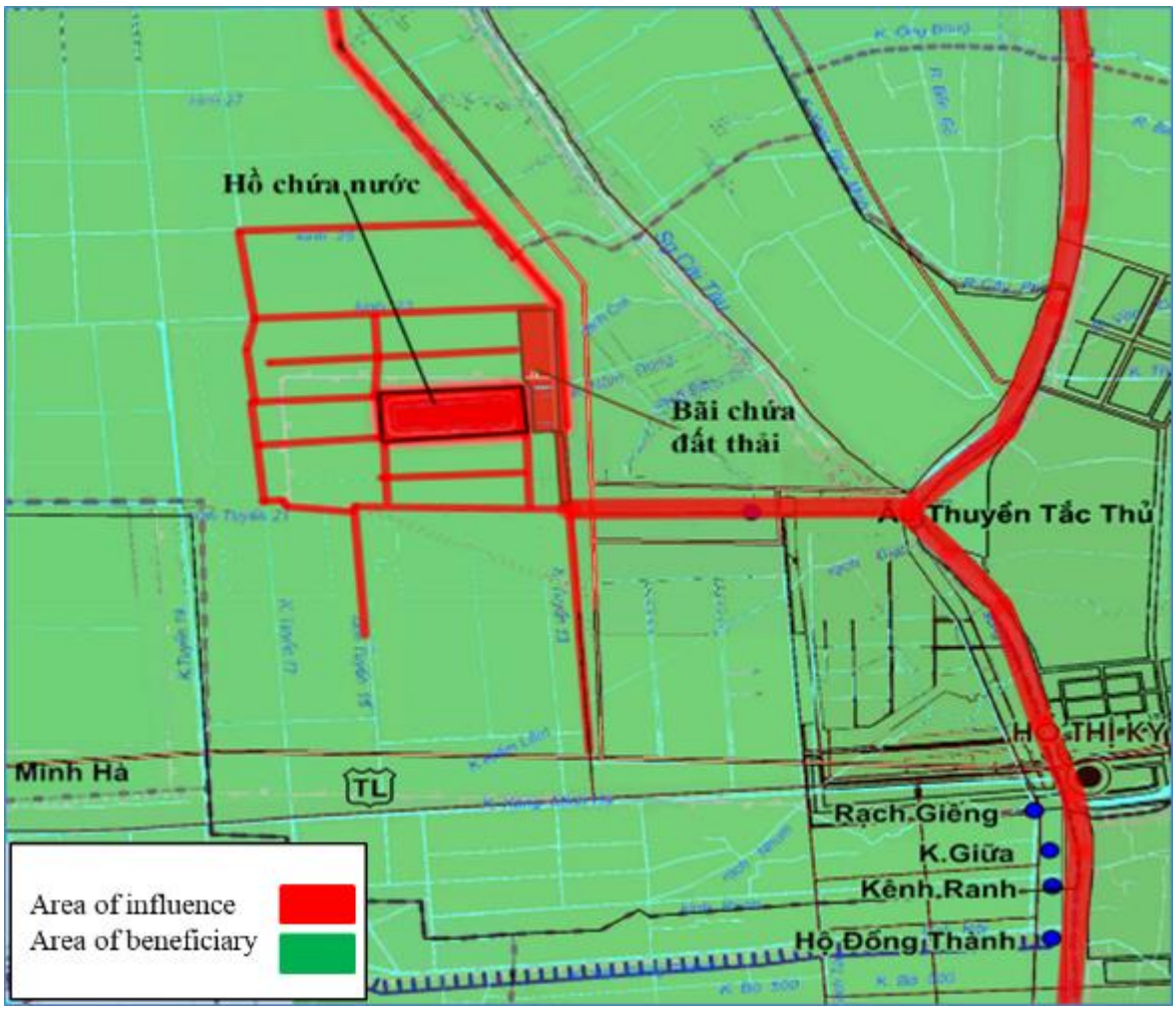


Figure1.15: Areas of influence of the reservoir and WSP

There are no historical, cultural, spiritual and archaeological sites of interestat all levels (local, provincial, national as well as international).

Sensitive areas within a radius of 10km are schools, docks, production sites. The sensitive receptors are not cultural functions at national as well as international levels. There is Hon Da Stone relic site located near the wave breaker, but the environmental impact of this wave breaker construction on the site is not significant and the scope of influence not to this relic.

Sensitive natural, social-economic receptors in the subproject area are shown in*Figure1.16*to*Figure1.18*and the distance from these receptors to the nearest works mentioned in *Table1.11*to*Table1.13*.

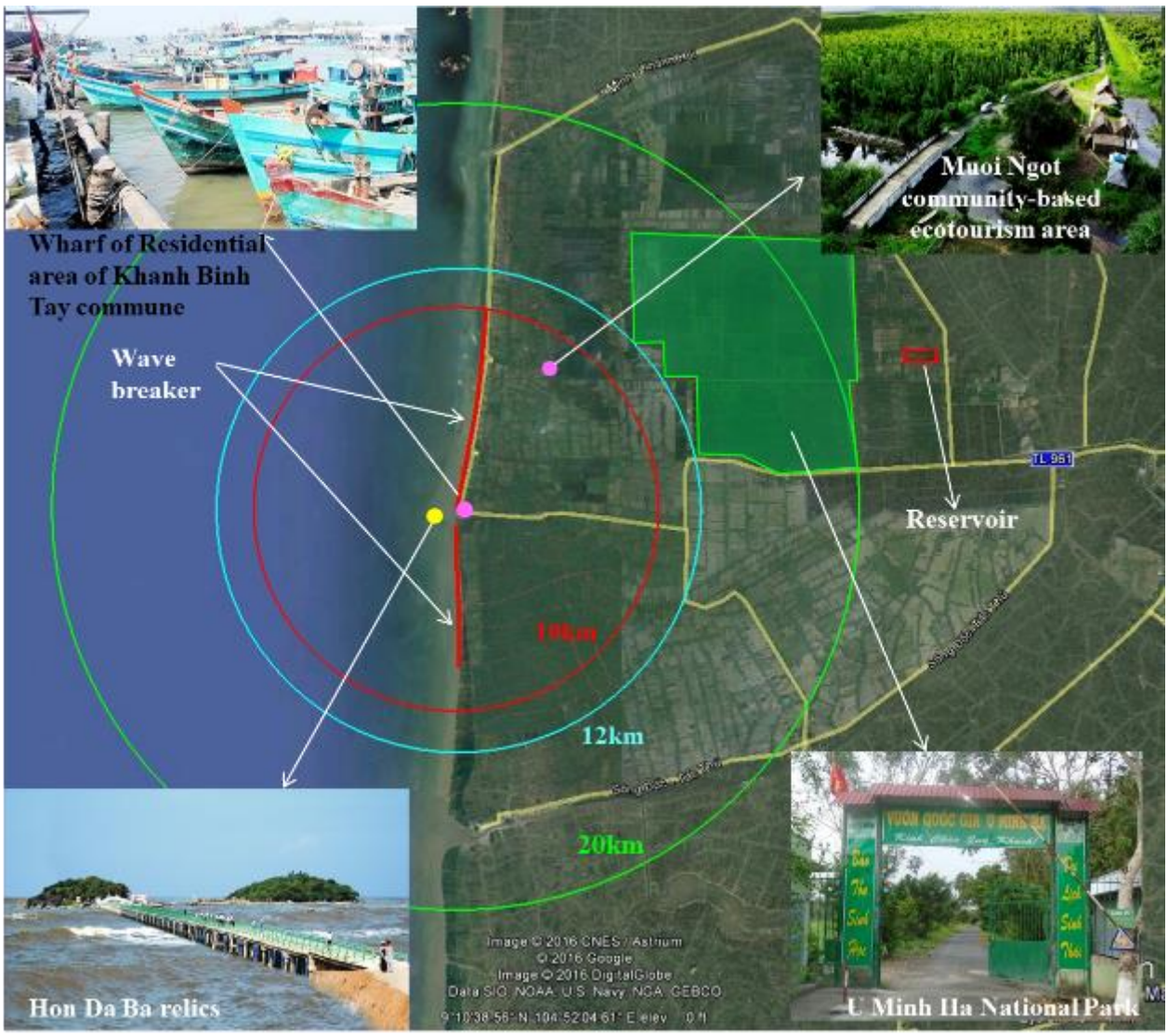


Figure1.16: Some sensitive subjects in the construction area of the wave breaker

Table1.11: Distance from sensitive receptors to the waver breaker

No.	Name and photo of sensitive receptors	Nearest distance to the wave breaker (m)
1	U Minh Ha NP 	7.311

2	Dock of Khanh Binh Tay residential area (RA)		455
3	Muoi Ngot Eco-tourism area		3.372
4	Hon Da Bac relics		258

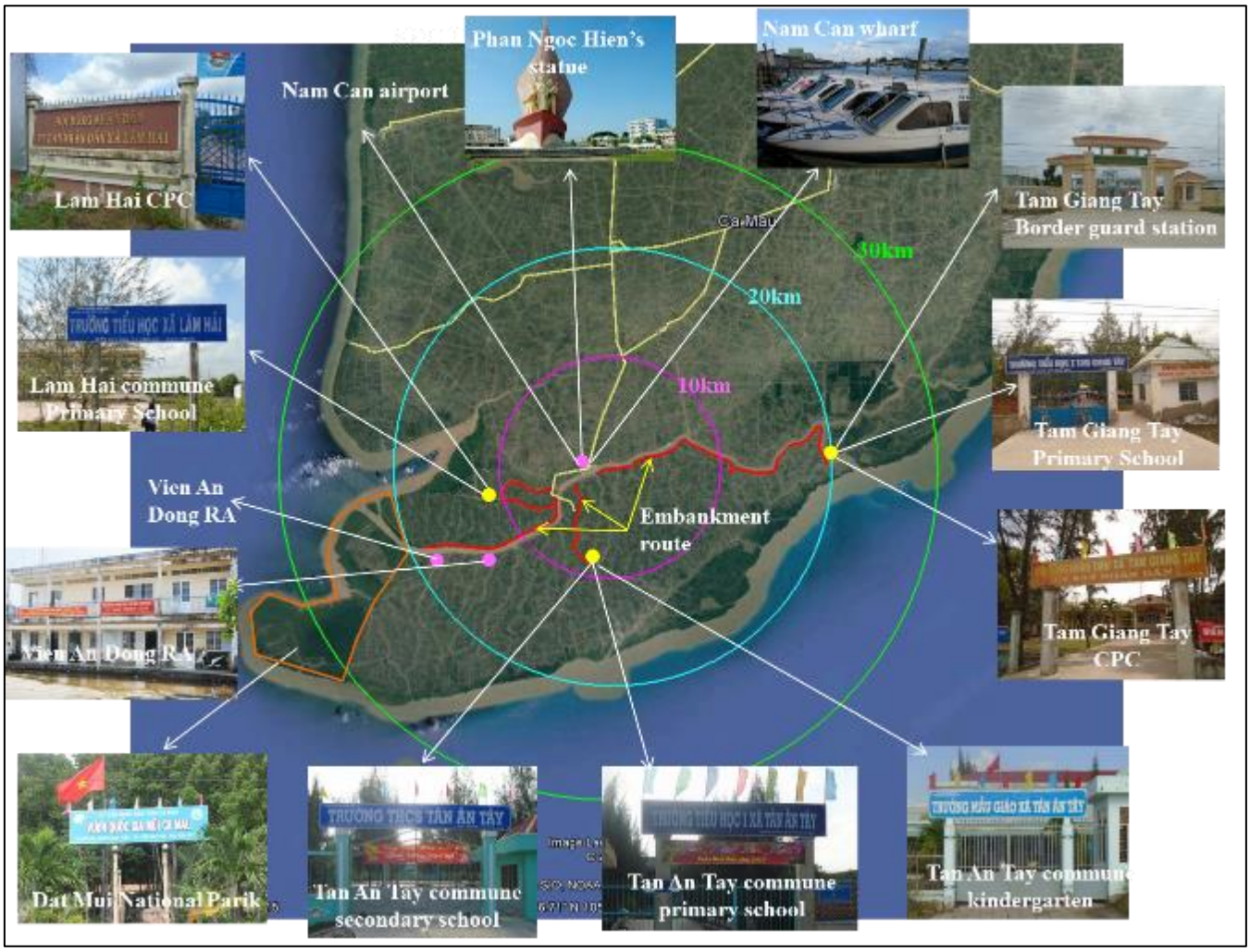


Figure1.17: Sensitive receptors in the area of embankment construction

Table1.12: : Distance from sensitive receptors to the embankment

No.	Name and photo of sensitive receptors	Nearest distance to the embankment (m)
1	Lam Hai CPC 	600
2	Primary School of Lam Hai Commune 	226

No.	Name and photo of sensitive receptors		Nearest distance to the embankment (m)
3	Vien An Dong RA		1.229
4	Dat Mui NP		1.460
5	Tan An Tay commune Secondary school in		507
6	Primary School I of Tan An Tay commune		1.886
7	Tan An Tay commune Kindergarten		402

No.	Name and photo of sensitive receptors		Nearest distance to the embankment (m)
8	Tam Giang Tay CPC		95
9	Primary School of Ta, Giang Tay commune		43
10	Tam Giang Tay border guard station		96
11	Nam Can dock		960
12	Phan Ngoc Hien monument		1.035

Figure1.18: Sensitive receptors in the area of reservoir and WSP construction

Table1.13:: Distance from sensitive receptors to the reservoir and WSP

No.	Name and photo of sensitive receptors		Nearest distance to the reservoir and WSP (m)
1	Song Trem Biological and Fishery Complex		8.509
2	Ca Mau Gas-Power-Fertilizer Complex		4.889

No.	Name and photo of sensitive receptors		Nearest distance to the reservoir and WSP (m)
3	Khanh An Secondary School		650 m (to the reservoir) 1.303 m (to the pipeline)
4	Khanh An High School		991 m (to the reservoir) 353 m (to the pipeline)

1.8. NEEDS AND SOURCE OF CONSTRUCTION MATERIALS

The volume of materials to be used for the construction of the subproject is shown in *Table1.14* to *Table1.16*and these materials will be from (i) Sand, stone and gravel: purchased in Ca Mau city; (ii) Steel and Cement: purchased in Ca Mau city; (iii) Melaleuca forests: purchased in U Minh.

Table1.14: Volume of materials for the wave breaker construction

No	Content	Unit	Volume
1	Production of the staking flatform	ton	66,2
2	Production of the positioning pole	ton	36,8
3	Depreciation of the positioning pole	ton	18,7
4	Different types of M300 sulfate durable reinforced concrete braced beams	m^3	2.158,0
5	Steel beams D<=18	ton	125,6
6	Steel beams D<=10	ton	23,3
7	Steel blinding prestressed reinforced concrete poles with beams d<=18	ton	114,7
8	Steel blinding prestressed reinforced concrete poles with beams d<=10	ton	27,58
9	Steel plates in concrete	ton	31,5
10	Different type of beam formworks	$100m^2$	105,1
11	Freestones into the embankment body	m^3	20.317,5
12	Cajeput pile 4,7 m	100m	1.117,8

Source: Feasibility Report of the subproject 2018

Table1.15: Volume of materials for construction of reservoir and WSP

No	Item	Unit	Volume
I	**Excavated and Packing the soil**		
1	- Level 2excavated and packing by blowers	m^3	2.283.852
2	- Reservoir shore packing soil	m^3	1.365.072
3	- Extra excess soil to be transferred to the sediment tank 2 km away	m^3	918.780
II	**The reservoir crest**		
1	-M200 reinforced concrete balustrade	m^3	867,00
2	- M100- 5cm concrete lining	m^3	141,45
3	- Þ8÷10cm Cajeput pile, L =4.5m	pile	49500
4	-Steel pipe Þ40mm	m	3300
5	- Steel pipe Þ30mm	m	3.300
6	- Different type of Steel	kg	26.010
III	**Roads on the reservoir's verge**		
1	- Hot and 5cm fine asphalt concrete	m^2	16502,5
2	-Adhesive plastic 1,5 kg/m^2	m^2	16502,5
3	-Crushed aggregate base course type 1 Dmax= 37,5 mm,15cm thick	m^3	5469,75
4	-Sand filling K>= 0.95, Etk = 30 Mpa	m^3	11834,65
5	-M150 concrete shield	m^3	1414,5
6	- M100- 5cm concrete lining	m^3	188,6
IV	**The reservoir shore roof**		
1	-M200 horizontal concrete beam	m^3	575,55
2	- M100- 5cm concrete lining	m^3	95,93
3	-Different types of Steel	kg	23022
4	16cm thick hexagonal concrete	m^3	16.419,84
5	Beam Filter-10cm	m^3	10.262,4
6	Geotextile	m^2	102.624
V	**The reservoir base**		
1	- M200 concrete base tray	m^3	556,20
2	- M100- 5cm concrete lining	m^3	55,62
3	- Þ8÷10cm Cajeput pile, L =4.5m	pile	46.350
4	- Different types of Steel	kg	27.810
VI	**Landfill**		
1	Capacity	m^3	1.057.612
2	Cajeput pile gate	gate	76
3	Þ8-10 Cajeput pile, L=3m	pile	2.736
4	Bamboo fence	m^2	182,4
5	Soil Cover	m^3	28.500

Source: Feasibility Report of the subproject 2018

Table1.16: Volume of materials for the embankment building

No.	Item	Unit	Section				Total
			Vam Ong Dinh - Tam Giang Tay	Ong Nhu-Tan An Tay	Trai Luoi-Vam Chung	Nam Can-Xeo Doi	
1	Land clearance	$100m^2$	3,325.0	1,019.4	1,246.0	1,996.4	**7,586.8**
2	Excavated soil	$100m^3$	6,097.2	928.8	1,018.5	2,567.5	**10,612.0**
3	Filling soil	$100m^3$	6,356.8	940.4	1,112.8	2,363.7	**10,773.7**
4	Geotextile	$100m^2$	2,178.5	552.2	674.9	1,240.6	**4,646.2**
5	Soil	$100m^3$	600.4	98.1	119.9	341.9	**1,160.2**
6	Aggregate course	$100m^3$	187.1	32.1	58.1	99.8	**377.2**
7	Waterproof nylon fabric	$100m^2$	951.5	237.9	290.7	541.9	**2,022.0**
8	Concrete	m^3	12,269.6	2,548.5	3,634.1	6,987.4	**25,439.6**
9	Steel	ton	180.4	37.5	53.4	102.7	**374.0**
10	Formwork	$100m^2$	235.4	62.9	76.8	134.0	**509.1**

Source: Feasibility Report of the subproject 2018

1.9. DISPOSAL SITES AND TRANSPORTATION ROUTES FOR CONSTRUCTION MATERIALS

1.9.1. Transportation of construction materials

Construction of the wave breaker: construction materials will be purchased from Ca Mau city and transported via Tac Thu River (10km), Doc River (40km), and along the coastal line to the construction sites (25km). The transportation routes are on big rivers in Ca Mau province (*Figure1.19*).

Figure1.19: The material transport route for the construction of the wave breaker

Construction of the embankment: Taking advantage of the terrain of Nam Can and Ngoc Hien districts where there is large and intermittent canal system, the material will be transported to the construction sites by waterway. The material used for the embankment construction is purchased from Nam Can town (Nam Can district) and transported along rivers and canals like Cai Lon River (about 50 km), Trai Luoi canal (7 km), Vam Chung canal (6km), and Ong Nhu canal (9km). See details in *Figure1.20*.

Figure1.20: The material transport route for the construction of embankment

Construction of the reservoir: Excavation and filling soils are transported on site within the work area. Other types of material used for the construction will be purchased from Ca Mau city and transported to the works by waterway along Tac Thu River (22km). For the installation of water pipeline (25km) from the reservoir to U Minh district, the material will be transported by road. Please see *Figure1.21*for details.

Figure1.21: The material transport route for the construction of a reservoir and WSP

1.9.2. Transport of waste soil

Among the subproject items, the wave breaker does not require excavation and filling, the afforestation does not generate waste soil, the embankment will take out the surface layer soil and excavate soil, however, as the soils are used up for filling the embankment and covering the embankment slope, no waste soil is left. Therefore waste soil generated from the subproject construction will be mainly from digging the reservoir (*Table1.17*).

Table1.17: Quantity of waste soil (m^3) from subproject construction

No.	Works items	Surface soil	Excavated soil	Filling soil	Waste soil
1	Wave breaker	0	0	0	0
2	Embankment	227,604	1,061,202	1,288,806	0
3	Reservoir and WSP	2,283,852		1,365,072	918,780
4	Afforestation	0	0	0	0
	Total	**3,572,658**		**2,653,878**	**918,780**

The waste soil from the excavation will be directly blown from the reservoir to the 70 ha dumpsite managed by Ca Mau Economic Zone Management Board (*Figure1.22*), as follows:

- The estimated height for soil disposal: H = 2.2m (in which: The height of the dump site is 1.5m, and the actual depth of the dump site is 0.7m).
- The total area of soil storage is 60,000m^2, and the end of the site of about 10,000m^2 is used for a settling tank.
- The soil storage capacity V = 1,057,612m^3.

The disposal area is next to the reservoir and only a few households are living in this area. The topography of this area is low, the surface is covered by weeds, the land is not leveled, so the excavated soil will be used for leveling the area. Details of the disposal area are described

in *Table 2.26*.

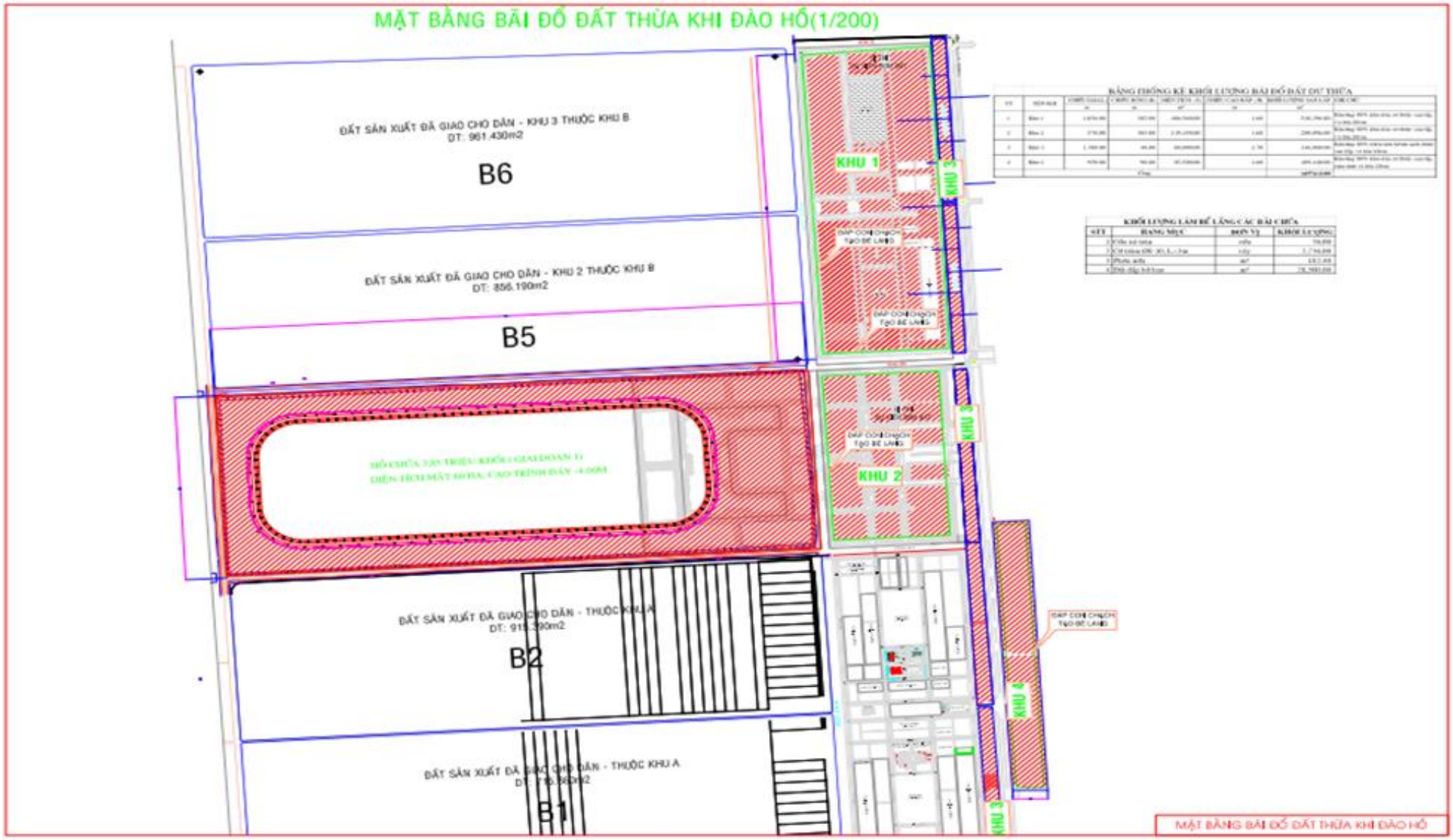


Figure1.22: Layout of the dump site

1.10. AUXILIARY WORKS

As the 05 construction sites of 05 wave breaker segments will be built by neatly scale construction method and completely on the sea, there will not be workers' camps on shore except barges as camps for workers. At the end of construction hours, workers will use boats to move to people's houses inland to live temporarily. This method is also similar for embankment construction. Only the reservoir construction is required workers' camps. The details of the reservoir site are provided in *Annex 2*.

1.11. INVESTMENT COST AND TIME SCHEDULE FOR THE SUBPROJECT

The implementation duration of the subproject is four - year, which starts in 2018 and will end in 2022, in which:

- Wave breaker construction is 3 years.
- Embankment construction is 3 years.
- Reservoir and WSP construction is 2 years.

The total investment cost of the subproject is:792,883.59 million VND, in which:

- ODA fund: 657058.59million VND
- Counterpart fund: 112,625million VND
- Private fundings: 23,200million VND

1.12. ORGANIZATIONS OF THE SUBPROJECT MANAGEMENT AND IMPLEMENTATION

- Ca Mau PPC is the investment decision maker, which will approvethe subproject implementation, procurement plan, audit report of the subproject; its agencies include Ca Mau DARD and Ca Mau Province Management Board of ODA & NGO Projects (Ca Mau PPMU), that are responsible for implementing the subproject's contents.
- Ca Mau DARD is the subproject owner which will be managing the subproject.
- Ca Mau PPC, Nam Can, Ngoc Hien, U Minh DPCs will coordinate with Ca Mau PPMU to direct the subproject, responsible for the whole work of compensation, site clearance, resettlement of the subproject in the locality.

Organization chart of management and implementation of the subproject is described as in *Figure1.23*.

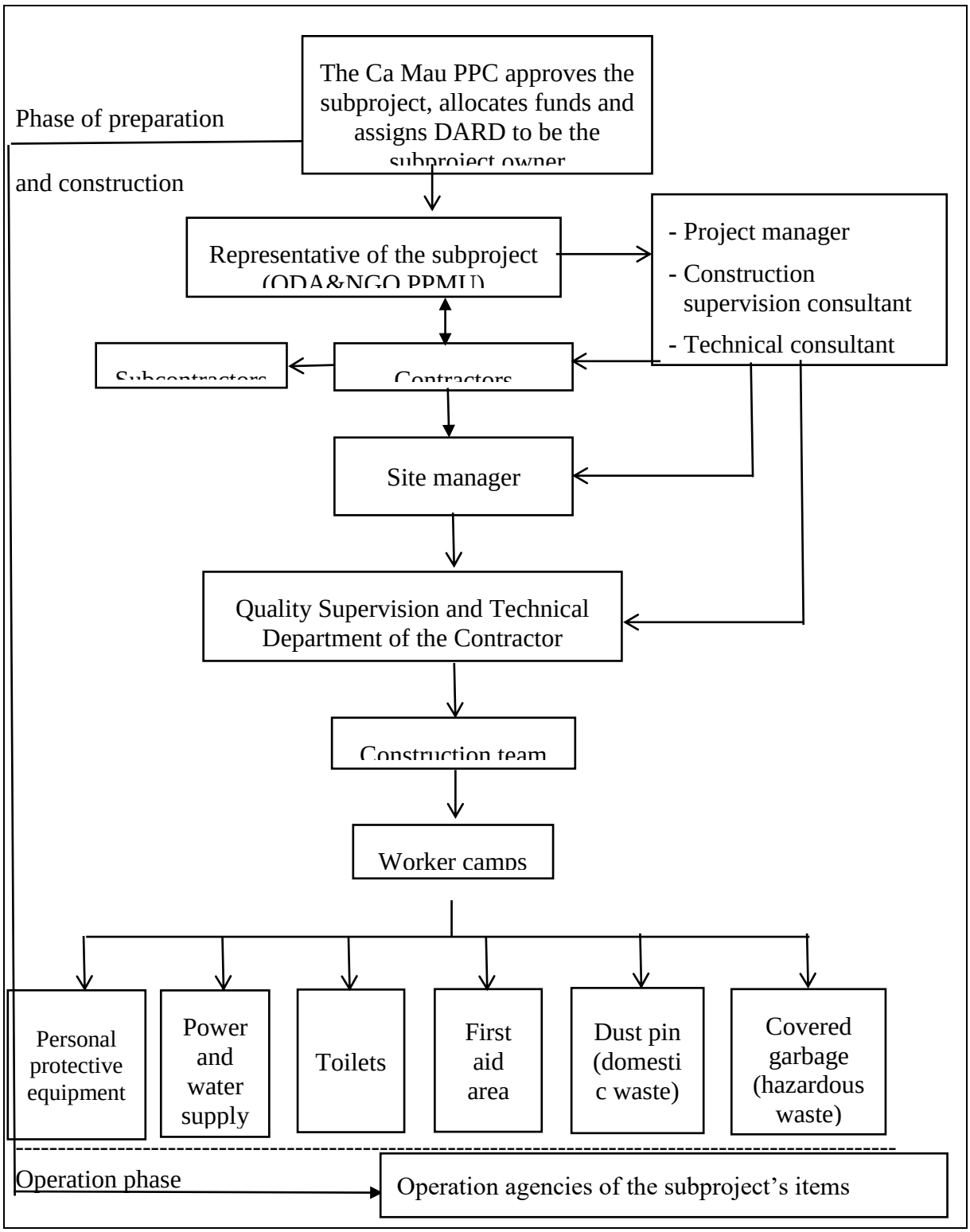


Figure1.23: Organization chart of the subproject

CHAPTER 2. BASELINE NATURAL, ENVIRONMENTAL AND SOCIO-ECONOMIC OF THE SUBPROJECT

Chapter 2 describes: (i) natural conditions including geographical location, terrain, geology, engineering geology conditions , condition of climate, meteorology, hydrology, natural resources and minerals; quality of air, water environment; (ii) socioeconomic conditions, natural disasters in the area; and (iii) assessment of site suitability of subproject selection with socio-economic characteristics of the subproject

2.1. NATURAL CONDITIONS

2.1.1. Topographic conditions

Ca Mau is a plain area with many rivers and canals. The terrain is relatively flat and low, tilting gradually from North to South, from the Northeast to Southwest, the average elevation is from 0.5m to 1.5m compared to sea level. Localized dipped areas of Thoi Binh, Ca Mau connected to Phuoc Long, Hong Dan, Gia Rai (Bac Lieu) belong to the central hollow area of the Mekong Delta with the topography connection of the old river bed. The dipped areas of U Minh and Tran Van Thoi lowlands are inland "hollow" areas limited by the natural embankments of the Ong Doc, Cai Tau and Trem river systems and the western highlands. The topography of the province is also severely fragmented by the dense rivers and canals that are both favorable and unfavorable for the allocation of water resources in the province (*Figure2.1*). Topography conditions in the subproject items as follow:

- In the wave breaker: this work will be built on the sea surface. The inland terrain altitude is quite low at 0.2-1.0m only, averaging at 0.5m.
- In the embankment: the terrain is quite high compared to the general topography of Ca Mau province. The elevation tends to rise toward the east. Accordingly, the elevation of the embankment ranges from 0.6 to 1.4m, averaging 1.0-1.4m above sea level, in Ngoc Hien district, from 0.6 to 1.4 m, averaging 0.6-1.0m above sea level in Nam Can district.
- In the afforestation: the mangrove will be planted on the existing aquaculture area with the elevation is from 0.6 to 1.0m in Nam Can and 1.0 to 1.4m in Ngoc Hien district.
- In the reservoir and WSP: This is a low lying area of Ca Mau province. The elevation is quite low, ranging from 0.2-1.0m and common at 0.2-0.6m.

2.1.2. Geological and works geological conditions

Based on the drilled holes in the field and the results of the experiments to determine the mechanical characteristics of the soil samples, the soil at some sewers in the area within the survey area to a depth of 30 m. There are 3 classes as follows:

- Layer 1: Mud, grey, dark green-grey and mix with organic. This has a layer thickness from the natural ground level to an average depth of 21.5m.
- Layer 2: clay, greyish-brown in color, hard to semi-hard, lying below grade 1 to an average depth of 25.8m.
- Layer 3: Lightning, grey-brown, grey-white, hard plastic. Lying below layer 2 to the depth of the hole has not yet appeared bottom layer.

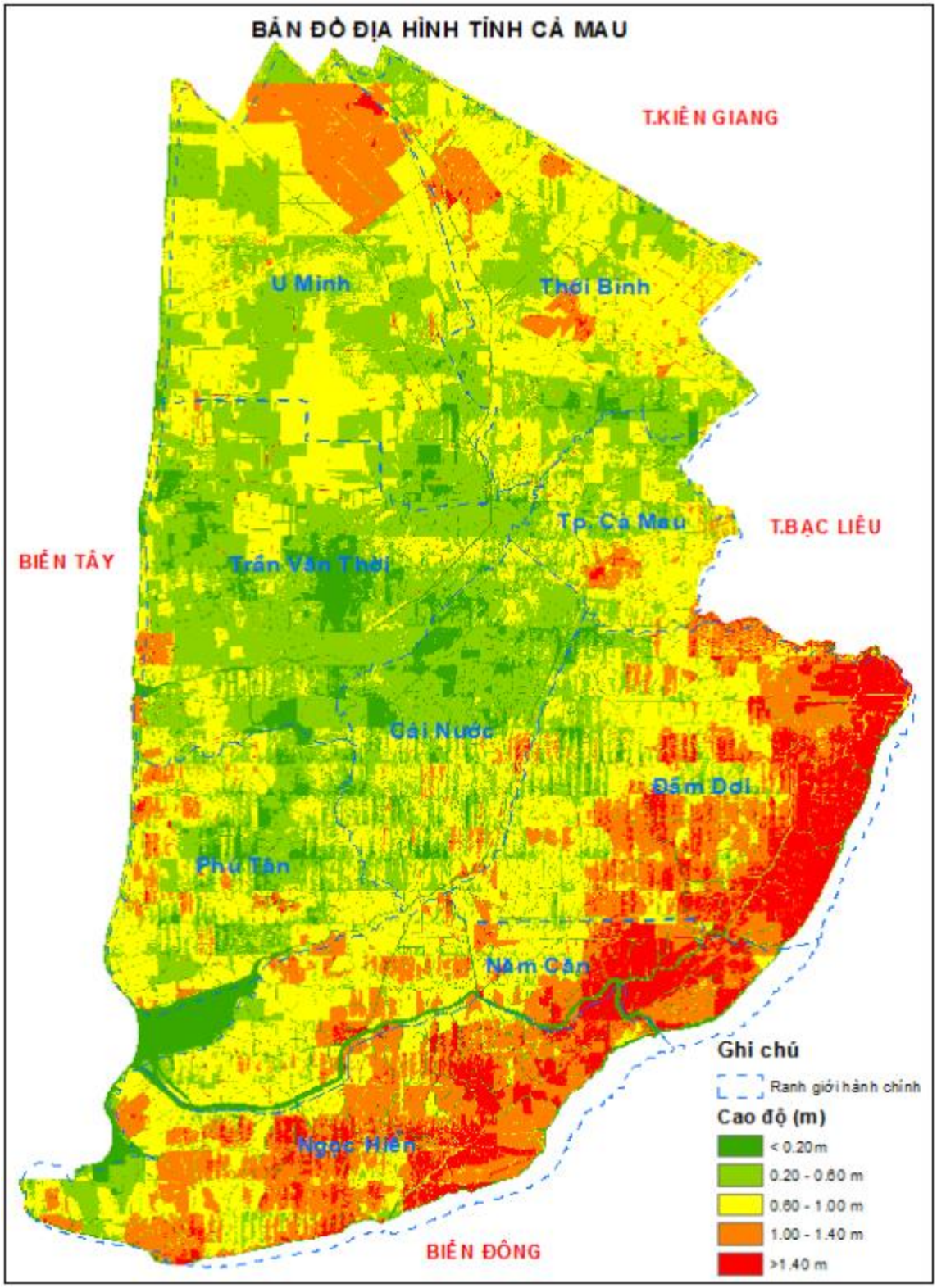


Figure2.1: Elevation map of Ca Mau province

2.1.3. Weather and meteorology conditions

The subproject is located in the distinguish climate characteristics of the Mekong Delta, which is tropical monsoon, fairly mild, there are two distinct seasons in the year, the rainy season lasts for 6 months with relatively high rainfall with the relatively flat topography condition causing heavy flooding in many areas; Dry season almost has no rain, leading lack of fresh water while the temperature is quite high, evaporation of water has a direct impact on the life and production of people.

2.1.3.1. Temperature

Ca Mau has a high temperature, the average annual temperature is about 27.8^{o}C, it is not much different in the average temperature in recent years from 27.5 to 28.2^{o}C. However, during the months of the year, there is a large difference in the temperature. January has the lowest average temperature is only 26.4^{o}C and the month with the highest average temperature in April reached 28.8^{o}C

The total annual heat of about 9.918^{o}C, belonging the group with a high grossing throughout the country. Temperatures in months vary widely, the temperature difference between the hottest month and the coldest month is around 3-4°C.

2.1.3.2. Rainfall

Being close to the West Sea, the subproject area receives direct southwest wind so the rainfall here is very large. The annual rainfall from 2011 to 2016 varies from 1,925-2,382mm/year. The average number of rainy days in a year is quite high, average from 163 - 176 days.

Monsoon regimes give this area profuse season of the rainy season and dry season. The rainy season lasts for 6 months (usually from May to November) which coincides with the Southwest monsoon. Rainfall in the rain season accounts for 82-94.5% of the annual rainfall. The dry season begins in December and ends in April next year, coinciding with the Northeast monsoon with rainfall of 6 - 18% of the annual rainfall.

The intensity of the rain shows clearly the monsoon tropical rain, mainly rain showers, heavy rain but the time of each rain is not long. Heavy rains usually occur at the end of the season due to storms, tropical low pressures, and tropical convergence.

The distribution of rain over time and space is very unstable. During the rainy season, there are many rainy days (rain season), then they would stop without any rain, causing drought even in the rainy season.

2.1.3.3. Hours of sunshine

The subproject area has 5-6 months of the dry season, so the sunshine duration is quite long, with an average annual of 1,886-2,372 hours. In March and April, the number of sunny hours is quite high of 242-251 hours per month and decreases in the rain season to only 120 hours in September. From December to April next year the average sunshine hour is > 6.5 hours/day, the average sunshine hour of February & March with the most sunshine is > 7 hours/day. During the rainy season, the average hour of sunshine is only 4 - 5 hours/day.

2.1.3.4. Humidity

Annual humidity is about 80%. During the rain season (May to November), the monthly average humidity ranges from 80.7 to 86.3%, the month with the highest humidity is September with the average humidity of 86.3%. During the dry season, the humidity drops to about 75.2 -78.7%. The driest month is January with the monthly average humidity of only 75.2%.

2.1.3.5. Evaporation

With a high temperature, hot sun all year, in Ca Mau annual evaporation is 1,003 mm/year. The highest evaporation occurs in the dry season, with an average of 3.3 to 5.5 mm/day.

Comments: Ca Mau is located in the coastal area with distinct climate conditions (rain and dry seasons), with heavy rainfall of more than 80% in rain season. In the rain season, if it is

used properly, the rainwater will be sufficient for daily life and agricultural production in the area, with heavy rainfall, that is meeting not only the demand for use but also accumulation for use in the dry season.

2.1.3.6. Direction and wind speed

In one year in Ca Mau there are two main directions of wind:

- Southwest monsoons from June to September;
- Northeast monsoon from November to April.

Generally, in the Northeast monsoon season, winds to the East coast will turn clockwise on the West coast. In contrast, in the Southwest monsoon season, winds to the West coast will turn counterclockwise on the East coast. Deviation increases when the wind strengthens and decreases as the wind weakens. In the transitional months, the wind speed is weakening and on the two coasts, the two winds are in the same direction, the wind surface is more homogeneous on land (*Table2.1*).

In general, the wind speed on the west coast is less than on the east coast. The average wind speed at the west coast is 3.6m/s in the northeast and 3.4m/s in the southwest monsoon. In the East Coast, during the Northeast monsoon, the average wind speed is about 4.5 m/s and the southwest monsoon is 3.5 m/s. During the storms, Wind speeds can range from 15 to 20m/s.

Table2.1: Distribute the wind direction in the east and west coastal areas of Ca Mau

Month / **Direction**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
The Eest coast	← E	↖ SE	↖ SE	↖ SE	↖ SE	→ W	→ W	→ W	↗ SW	↙ NE	← E	↙ ENE
the East Coast	↙ NE	↙ NE	← E	↖ SE	↖ SE	↗ SW	↗ SW	↗ SW	↗ SW	↘ NW	↙ ENE	↙ NE

Source: Vietnam Maritime Administration

2.1.4. Hydrogeography and marine conditions

2.1.4.1. Sea and main river network

Ca Mau has a coast length of over 254 km, accounting for 1/3 of the coastline of the Mekong Delta, equal to 7.8% of the coastline of the country and have many estuaries open to the sea such as Ganh Hao, Bo De, Ong Doc, Ong Trang, Bay Hap, Khanh Hoi, etc. On the sea, there are Hon Khoai, Hon Chuoi, Hon Buong, and Hon Da Bac islands, which is very convenient for boats anchored, storm shelter, marine economic development. Ca Mau has an exploration area of 71,000km^2, which is considered one of the four key fishing grounds of the whole country. Coastal waters are capable of breeding high-value fisheries.

Ca Mau has a spider web system of rivers, canals, and interlaced canals, accounting for 3.02% of the natural area, including many large rivers, deep water, leading alluvial accretion into the soil such as Tam Giang, Ganh Hao, Bay Hap, Song Doc, Dam Doi, Cai Tau, Trem Trem... The total length of the rivers is about 7,000 km, with an average density of 1.34 km/km^2, with a total water surface area of 15756ha, accounting for 3.02% of the natural area of the province, which is very convenient for water transportation.

Some major rivers in the province:

- Cua Lon River: 56 km long, originating from the Ong Trang River flowing out to Bo De. It is characterized by large water flowing through Nam Can and then to the sea. The river has many mangrove trees, parrots ...
- Ganh Hao River: 55 km long, originating from Giong Ke River (Ca Mau), flows through Ao Kho, Muong Dieu and then into the sea. The mouth of the river is nearly 20m deep, 300m wide.
- Bay Hap River: 48 km long, originating from the channel of Doi Cuong, flowing to the mouth of Bay Hap. 5-6m deep on average. The mouth of the river about 500m wide.
- Ong Doc River: 44 km long, originating from the confluence of Cai Tau River into the Gulf of Thailand.
- Trem Trem River (also called Trem River): 42 km long from Kien Giang to confluence of Cai Tau. The average depth is 3-4m, the width is about 80m.

2.1.4.2. Flow

a. Wind flow

Wind currents in the East Sea: during the dry season, the cold and saltwater flow from the North to coincide with the Northeast monsoon, which approaches the Eastern coast of the Ca Mau peninsula, with an average speed of 0.4 - 0.9 m/s. In this period, sea currents could cause severe erosion of areas absent of the wind and face the unprotected winds and transfer mud and sand to the South. During the rainy season, the southwest monsoon pushes the cold water outward from the shore, facilitating the water slides bearing alluvium of the Mekong River to the South.

b. Total flow

The total flow in the coastal area of Ca Mau province shows:

- In the dry season (Northeastern wind), the flows along the East Coast flow southward at an average speed of about 40-90 cm/s, in the case of tidal flow, wind flow, flow densities of the same direction - speed can reach 150 cm/s. Reaching Ca Mau peninsula and turn to the Northwest along the West - forming the confluence area in the Mui area, which is the main source of sediment on the beach.
- During the Southwest monsoon season, the flows are in the opposite direction - moving counterclockwise. The average speed is about 40 - 50 cm/s. The flow of alluvium from this period is less.

2.1.4.3. Tide regime on the East Sea and the Gulf of Thailand

On the Eastsea coast, the tide is irregular semi-Diurnal. Each day the tide changes 4 times (2 times the high tide, 2 times the low tide). The tide is reversible - runs along the shoreline. The actual data shows that the largest tidal volume in the Cuu Long River mouth, which was 3.7 m in the High tide period, 2.7 m in the poor water period, decreasing toward the Ca Mau peninsula, Tidal amplitude at large water of 3.2 m in Ganh Hao gate; 3.0m in Bo De gate and 2.2m in Mui area. Big tides reduced rapidly at Bay Hap to 1.1m (*Table2.2*).

Table2.2: Water level in Bo De and Ong Trang stations

Location	**H_{max}(cm)**	**H_{min} (cm)**	**ΔH (cm)**
Bo De Gate	146	-179	325
Ong Trang Gate	73	-52	125

Difference	***73***	***127***	***200***

On the West coast, from Ca Mau peninsula to Ong Trang and Go Cong, the tide is irregular Diurnal (the tide changes twice a day), running along the shore. Slow tide from the East Sea to the top of the bay. The tidal currents rate reached 1.2-1.5 m/s on the East Coast 0.5 - 0.8 m/s on the west coast. During the tidal phase withdraw with the smaller speed.

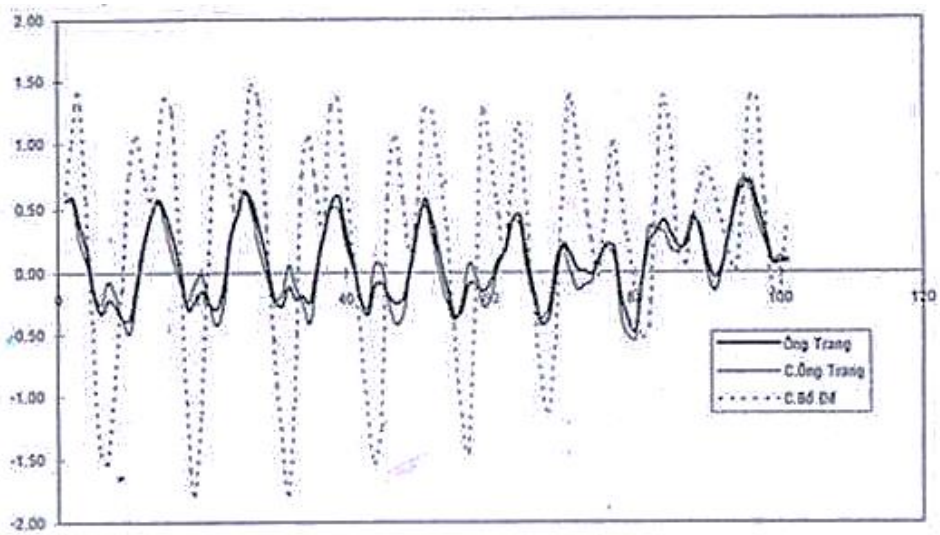


Figure2.2: Water level process in Bo De and Ong Trang gates

2.1.4.4. Water level

The water level of Ca Mau is the highest inclining from the East Sea to the West Sea, and vice versa, the lowest water level is from the West Sea to the East Sea. The average water level decreases from the field to the East and West seas, showing the process of withdrawing the field water to both sides.

The whole area of Northern Ca Mau is in the area with small tidal amplitude, the average annual tidal amplitude here is only 30-50cm, even lower than 30cm in the Thoi Binh area. In the area near the Doc river, the average tidal amplitude is higher than 50-100 cm. The average tide amplitude in September is slightly lower than the average annual tidal amplitude.

The highest tide amplitude is in the Northern part of Ca Mau, which is about 100-150 cm, and in the lowland tide, the amplitude is lower but still larger than 70cm.

The Southern Ca Mau area has difficulties in water exchange (low tide amplitude) located along the Doc River to the East Sea. These areas locate in Tran Van Thoi, Cai Nuoc followed by Tay Dam Doi with tidal amplitude varies from 30-50-100cm.

2.1.4.5. Wave regime

Wave regime in the coastal areas of Ca Mau is quite suitable with wind regime. Wave regime has two distinct seasons similar to the wind regime. The Northeast wave frequency peaks in November last year to January next year, the wave height in the northeast monsoon is quite large, December is typical for the Northeast wave season. Southwest wave frequency peaks in August and September. In the Western part of the Ca Mau peninsula, the winter wave is more scattered, the trend is to the South (reaching 28%), while the Western wave is about 52%. The Southwest monsoon starts in March and ends in September. It can be said that the Southwest monsoon season is almost throughout the year. The prevailing wave directions are West (62.7%) and Southwest (14.7%). Average wave height is quite large up to 1.2m. July and August are months with large waves.

2.1.5. Land resources and current land use status

the Institute of Agricultural Planning and Rural Projection, there are 6 mainland groups, classified into 26 categories (unit annotation in land map), of which two large groups of land are alum soil: 279,928 ha, accounting for 52.53% of the area; Saline soil: 212,877 ha, occupying 39.95% of the area. The remaining four groups of land are mudflats: 12,193 ha, peatland: 8,903 ha, red soil: 708 ha, at least sand land: 671 ha (rivers, canals: 17,636 ha). The details are in *Figure2.3*.

According to the statistics results on land use in Ca Mau province period 2010 - 2015 shows that agricultural land and residential land are quite stable over the years, other land types have fluctuation but not significantly(*Table2.3*).

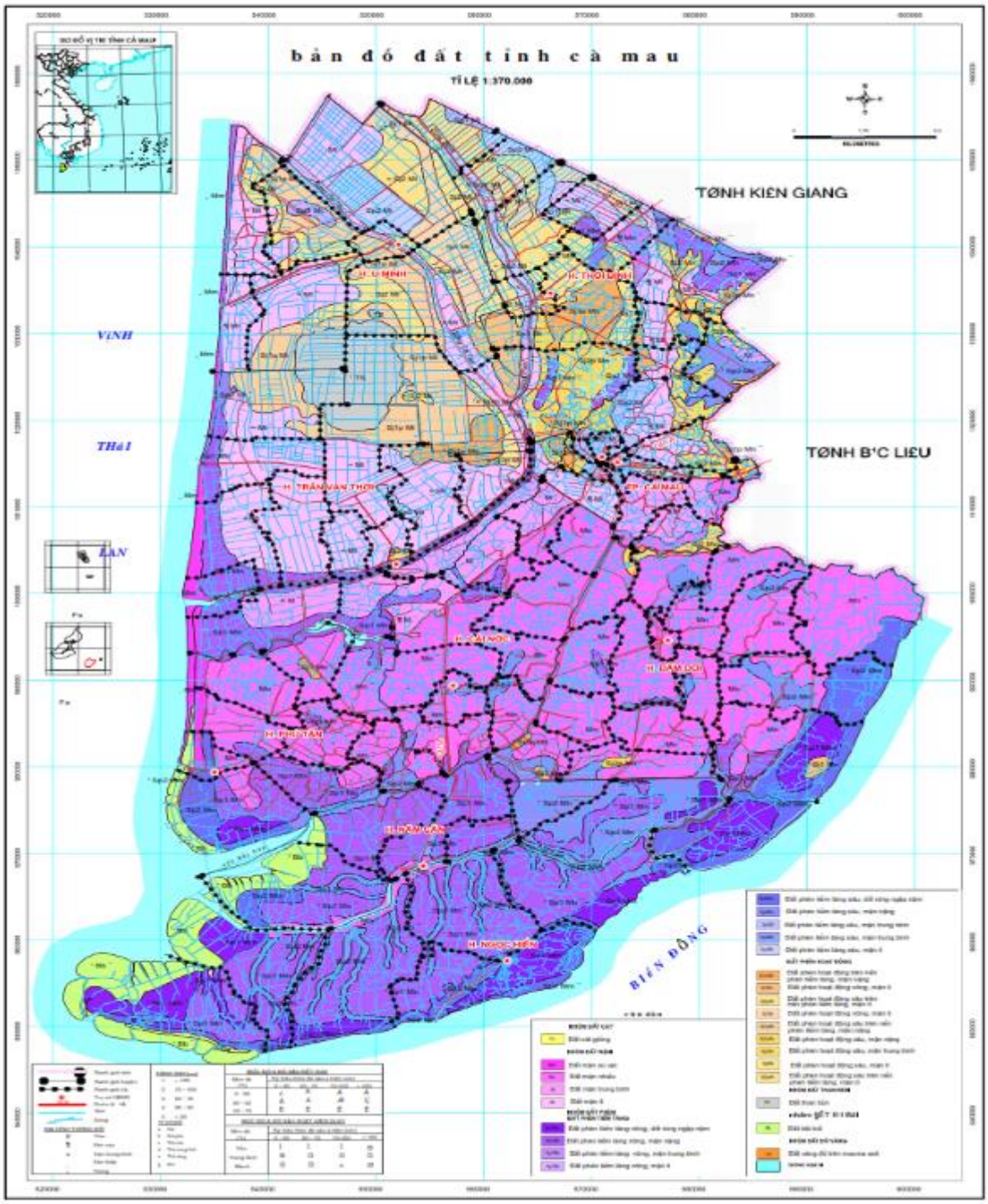
Table2.3: Land use change from 2010-2015 in Ca Mau province

No.	Land	Area (ha)					
		2010	**2011**	**2012**	**2013**	**2014**	**2015**
1	Argicultural land	464,249.31	463,246.95	462,922.75	462,708	460,847	460,847
3	Built up land	6,260.51	6,302.26	6,319,04	6,340.67	6,450.00	6,450
4	Specialized land	26,934.39	27,872.89	28,179.05	28,374.97	23,713.00	23,713
5	Unused land	8,976.27	8,545.27	8,544.76	8,543.03	4,890	4,890
6	Others	23,066.30	23,519.41	23,521.18	23,519.96	26,244	26,244
	Total	529,486.78	529,486.78	529,486.78	529,486.78	522,144.00	522,144

Source: Ca Mau Statistical Yearbook, 2016.

Main soil categories in the province:

- Sandy soil: cover area of 671 ha, distributed mainly in Ngoc Hien district.
- Saline soil: area of 212,877 ha, accounting for 39.95% of natural area (MB), distributed in many areas in Dam Doi, Phu Tan, Tran Van Thoi, is land with a smoother mechanical compositionwith the presence of potential acid sulfate soil or acid sulfate soil, all saline soils in the coastal area are affected from seawater with varying salinity levels, such as high salinity, medium salinity, and low salinity.This land is mainly used for coastal mangroves plantation, brackish and brackish shrimp farming, a small number of areas are planted with fruit trees.
- Acid sulfate soil: cover an area of 279,928 ha (52.53% of the natural area), accounting for most of the land, distributed mainly in U Minh, Tran Van Thoi, Ngoc Hien and Nam Can districts. Currently, the alum soil is being used for a variety of purposes such as planting of mangrove, Melaleuca, annual trees, fruit trees and raising aquaculture. Note, the depth and thickness of acid sulfate soil layers are a high change in areas, or even in each area.
- Peat soil is 8.903 ha, distributed mainly in Melaleuca forest area (U Minh Ha NP). However, after the fire of Melaleuca forest in 1982 and 2002, the area of thick peat layer was reduced so much, there are only about 5,000ha.
- Mudflat soil area is about 12,193ha, mainly distributed in the southwest of Ngoc Hien district, Nam Can district and Phu Tan district. This is a very young land, the whole is a soft mud layer, the composition, and many organic residues.



Source: Southern Institute of Agricultural Planning and Projection

Figure2.3: The soil map of Ca Mau province

2.1.6. Water resources

2.1.6.1. Surface water

Surface water (including water of river, canal, field and coastal area) of Ca Mau province is mainly from rain and from the sea flow into rivers. The river system in Ca Mau province is not related to the Mekong River system. Fresh water from elsewhere flows to almost none. Water resources involved in hydraulic processes, used for irrigation and livelihoods, are primarily derived from rainwater. According to preliminary calculations, the amount of rainwater in the site after the evaporation was subtracted, provided the river system with a

large amount of water, an average of 3,500 - 13,500 m^3/ha, which reduced the salinity content and sweeten some parts of the province in the rainy season, breaking some tide rules on the river system.

Surface water is fresh water mainly concentrated in U Minh Ha Melaleuca forest area, agricultural production area north of Tran Van Thoi district and Thoi Binh district. This is a source of rainwater that is kept in place, which is suitable for the development of animal husbandry, cultivation, and fishing.

Referring to the analysis results of rainwater quality of the Hydrometeorological Observatory Station of the Southern region during the rain season from April to December of 2013, 2014 and 2015 show that the criteria of the standards for domestic use were met (QCVN 01: 2009 / BYT), indicating that the quality of rainwater is still good, well-served for the purpose of daily life of people in unsupplied areas or limited water quality for living (*Table2.4*). However, the pH indicator is not up to standard, should be treated before use.

Table2.4: Analysis results of rain water quality

Parameter	**QCVN 01:2009/BYT**	**2013**	**2014**	**2015**
pH	6.5 - 8.5	5.3 - 6.35	5.48 - 7.94	5.70 - 6.45
Colour	No Colour	No Colour	No Colour	No Colour
Smell	None	None	None	None
Taste	No strangetaste	No strange taste	No strange taste	No strange taste
Na^+	200	0.394 - 3.487	0.321 - 14.69	0.31 - 12.37
NH_4^+	3	0.203 - 2.16	0.082 - 3.545	0.202 - 1.957
Cl^-	300	0.524 - 4.362	0.409 - 18.81	0.497 - 15.24
SO_4^2-	250	0.801 - 5.934	0.371 - 20.43	0.403 - 18.57
NO_3-	50	0.127 - 1.366	0.074 - 1.445	0.026 - 0.533
NO_2^-	3	0.004 - 0.035	0.002 - 0.038	0.003 - 0.022
F^-	1.5	0.015 - 0.083	0.007 - 0.136	0.008 - 0.102

Source: Hydro-meteorological Observatory Station of the Southern region

Surface water is brackish water, saltwater (this is the water that comes from the sea, or mixed with rainwater), which accounts for most of the province's surface water and is suitable for aquaculture development.

In general, the potential freshwater source for the Peninsula is relatively abundant, but for Ca Mau province, it is very difficult to access because the canals that reverse and supply freshwater to Ca Mau are limited due to the system of coastal works along NH 1A in Bac Lieu, which is open for saltwater withdraw in the dry season. The freshwater sluice gates are not effective, leading to uneven distribution of freshwater to Ca Mau province during the year. The rain season is over-flooded even to harmful levels leading flooding; while the dry season is lacked freshwater due to saline intrusion (and acidification in shallow areas) to the level that is insufficient for production.

For the construction items of the anti-overflow dike system: because not a work has been built for operating the canals, they are still directly flowing into the sea. There is no freshwater source coming from other places, therefore the surface water source here is completely dominated by salty water all year round. With a dense canal system and the short distance to

the sea, the amount of water exchanged in this area with the sea water is very large, which can be calculated by the hours, making the saltwater plentiful for aquaculture. In addition, the production activities here are mainly in shrimp culture and there is neither large concentration of residential areas nor industrial zones, so the water quality in this area at present is quite good for saltwater aquaculture.

For the construction item of the submerged embankment to create mudflats: The embankment is entirely located on the West Sea, so the seawater source completely dominates it throughout the year. As the water source regularly exchanges with the sea via tidal waters, while there is no large source of wastewater (there is not a residential area, industrial park, large fishing port...), the water quality in this area and the surrounding area remains very good. In some locations, because the seabed is shallow, the waves disturb the seabed, making the water turbid but this is a good source of silt for creating mudflats after the embankment is built.

For the construction item of the fresh-water reservoir: This area is located in the freshwater zone surrounded by Cai Tau River, Ong Doc River, and Bien Nhi Canal - these are saltwater rivers and canals. As located in the freshwater zone, the surface water in this area is completely dependent on rainwater. With seasonal rainfall characteristics, while the total annual rainfall leads the top of the country (about 2,360 mm), this is a good source of valuable water for domestic consumption. However because there is not a reservoir built for storage of rainwater, water is drained out in rainy seasons. In the period of heavy rains (from August to October) the drainage system is overloaded and the flooding appearance affects the production and living of people. In dry seasons, the surface water on the canals quickly runs dry due to evaporation, making the surface water supply really lacked. Thus, if there is a large enough reservoir, it not only stores fresh water in rainy seasons for exploitation in dry seasons, it also contributes to reducing flooding in this area, which will be the balance of the surface water source that helps efficient exploitation and use of water in service of daily life and production of people in the area.

2.1.6.2. Groundwater

The total groundwater exploitation potential of Ca Mau province is about 2 million m3/day. Currently, groundwater in the province is exploited mainly in the upper Pleistocene aquifer (qp_{2-3}), lower Pleistocene aquifer (qp_1) and middle Pliocene aquifer (n_2^1) (for household water wells mainly exploited on the Pleistocene aquifer between Upper and Lower Pleistocene). In addition to industrial wells in Ca Mau city, district towns, factories. The number of wells drilled by households is very large, up to 137,590 wells (*Table2.5*). Water output currently accounts for 17.83% of the potential reserve.

Table2.5: Summary of current groundwater exploitation status in the province (m^3/day)

No.	District	Total		Wells located in the corridor of the water plant		Exploration wells locate under plants, factories		The well is under the Water Resources and Environmental Sanitation Center		Rural small wells	
		Number of wells	Volume	Number of wells	Volume	Number of wells	Volume	Number of wells	Volume	Number of wells	Volume
1	Ca Mau	12,533	67,608	19	26,064	82	15,884	17	830	12,415	24,830
2	U Minh	13,568	38,596	8	2,148	21	9,120	5	260	13,534	27,068
3	Dam Doi	20,621	48,178	3	1,113	13	4,707	16	1,180	20,589	41,178
4	Phu Tan	8,414	18,502			8	550	15	1,170	8,391	16,782
5	Thoi Binh	21,159	48,831	2	864	16	5,085	15	630	21,126	42,252

No.	District	Total		Wells located in the corridor of the water plant		Exploration wells locate under plants, factories		The well is under the Water Resources and Environmental Sanitation Center		Rural small wells	
		Number of wells	Volume	Number of wells	Volume	Number of wells	Volume	Number of wells	Volume	Number of wells	Volume
6	Tran Van Thoi	24,810	61,188	4	2,028	33	8,680	18	970	24,755	49,510
7	Cai Nuoc	20,080	46,991	2	924	24	5,205	12	778	20,042	40,084
8	Nam Can	8,532	24,806	5	2,792	14	4,250	11	760	8,502	17,004
9	Ngoc Hien	8,271	18,632			1	30	34	2,130	8,236	16,472
	Total	**137,988**	**373,332**	**43**	**35,933**	**212**	**53,511**	**145**	**8,708**	**137,590**	**275,180**

2.1.7. Mineral resources

Ca Mau in particular and Ca Mau Peninsula, in general, are formed mainly by the deposition of silt from the Mekong so the mineral here is not much.

Coastal sand:From Gia Long Den to Ca Mau Cape with 56 km long (Ngoc Hien district) has sandy beach located near the coast with a width of sand beach about 1km, not large reserves, fine sand and many humus substances, no significant exploitation of the industry, the main purpose is to develop coastal tourism (Khai Long beach). However, it is necessary to continue surveying to be able to exploit in suitable locations to meet the demand for construction sand leveling. Along the coastline of the West Sea is mainly accreted by alluvium from the Long Xuyen quadrangle located far from the estuary, so alluvial deposits seem to be no longer sand, but mainly clay.

Peat: U Minh Ha peat area of Ca Mau is one of the largest peat deposits in Vietnam, mainly in U Minh Ha NP. The total area of peat remaining (after the fires in 1982 and 2002) was 5,640 ha, about 14.1 million tons (a decrease of nearly 12 times compared to 1976), of which reserves are 4.8 million tons. According to the land map of Ca Mau province, all construction sites of the subproject have no structures built in peat areas. The freshwater reservoir is the closest one to peat source but the distance is far from about 5 km.

Tile clay and ceramic clay: Ca Mau coastal area has great potential of brick and ceramic clays, the survey result shows total reserves about 250 million m^3. The quality of brick and tile to build or make Ceramic brick (mixed with other types of clay), the rate of clay can be used as the ceramic brick body is about 30 - 40% of clay extraction. This is the source of raw materials for the development of the construction materials industry, especially in the coastal area of Ca Mau can use fuel by natural gas source (Khanh An Industrial Park).The coastal work of the subproject is the wave breaker. However, in the face of the increasingly serious west-coast landslide, it is necessary to build this waver breaker to protect the protective forests and the inland dykes, therefore the area is not exploited for tile clay and ceramic clay.

Petroleum: On the continental shelf of the Southwest (especially in the Gulf of Thailand), there is a great potential for oil and gas, and there are many sedimentary basins with oil and gas prospects, most notably the Malay - Tho Chu basin. These are lots having considerable reserves and potential for natural gas. This is a precious resource of the country, a condition for industrial development in the Mekong Delta in general and Ca Mau province in particular (Ca Mau Gas – Electric - Fertilizer Project, Khanh An Industrial Park, ...). This resource is far away from the subproject area, therefore the activities of the subproject have absolutely no impacts on the resource and the exploitation of the resource.

Thus, on the construction items of the subproject, there are no mineral resources to be protected for conservation or for future exploitation.

2.1.8. Biological resources

2.1.8.1. Terrestrial biological resources

Forests in Ca Mau include coastal mangroves forests (mainly in Ngoc Hien, Nam Can, Dam Doi, and Phu Tan districts) and Melaleuca forests flooded with alum (mainly in U Minh and Tran Van Thoi districts). These are two typical forest ecosystems in the Mekong Delta with high biological productivity, especially mangrove forests and U Minh Ha Melaleuca forests, which play important roles in ecological balance, climate regulation and coastal protection.

Results of forest inventory in 2017, the total area of forest in Ca Mau province 164,587ha, including protection forest 36,482.63 ha, special use forest 24,403.34 ha and production forest 103,701.03 ha. The mangrove ecosystems of the province play an important role and function in coastal protection, coastal stabilization, climate regulation and carbon storage, and maintenance of community livelihoods (aquaculture under forest canopy). Ca Mau mangrove forest accounts for 50% of the total mangrove forest in Viet Nam.

Especially, Ca Mau has Mui Ca Mau NP (of Ngoc Hien and Nam Can districts) with an area of 41,861 ha (of which forest and mangrove forests area is 15,262 ha). This is a natural mangrove ecosystem (estuarine ecosystem). U Minh Ha National Park (of U Minh and Tran Van Thoi districts) with the area of 8,527 ha: This is the ecosystem of alum Melaleuca forests. Both national parks have high values of biodiversity, natural landscape, and environment and have been recognized by UNESCO as World Biosphere Reserve. This is one of the important sites of Vietnam's national biodiversity conservation program.

2.1.8.2. Aquatic life

In order to assess the current state of the aquatic environment in the area, the consultant unit conducted three types of aquatic samples in the subproject area, including phytoplankton, zooplankton, and zooplankton sampling. Aquatic sampling locations are the same with surface water samplings'. The results of the survey in the Appendix show that

a). Phytoplankton

In the subproject area, there are always species of phytoplankton typical for marine and brackish environments. The presence of species in the subproject area depends on the salinity and the level of contamination in the water environment. The surface water quality of the reservoir has the present of *Euglena Ehrenbergii*, *Euglena graciliscell*, *Euglena sp*, *Euglena viridis*, which indicates the presence of contamination, due to the decomposition of organic compounds.

Detected species belong to 5 different algal species, in which the diatom (*Bacillariophyta*) are the most diverse. The analysis shows that the diatom (*Bacillariophyta*) had 75 species, accounting for 75% of the total species. Then there are 17 species of *Cyanophyta*, accounts for 17% of species; 4 *Euglenophyta* species account for 4%; 3 species of *Dinophyta*, accounts for 3% of species; *Chlorophyta* 1 species, accounts for 1%.

In the canals of the embankment upgrade area, there are 57 diatom species on that average account for 76%. Followed by the 11 species of blue algae accounting for 14.67%, 3 *Euglenids* species accounted for 4%, *Cyanobacteria*, and green algae: 4 species each species accounts for 2.67%.

In the canals of the wave breaker area, diatom has 64 species, and on average they account for about 81%. Followed by the blue algae with 61 species accounting for 7.59%, *Euglenoids*, *Cyanobacteria* and green algae each with 3 species, accounting for 3.8%.

In the canals of the reservoir construction area, there are 52 diatom species, accounting for 65% of the average. Followed by the 13 species of blue algae, accounting for 13%, the number of *Euglenoids* increase compared to other regions with 6 species accounted for 7.5%, green algae have 7 species accounts for 8.75%, the number of *Cyanobacteria* species is small with 2 species accounts for 2.5%.

Results of biomass analysis show that the phytoplankton biomass has a wide range of 960 to 2840 cells/L. Diatom not only dominates the species composition but also dominates the biomass.

b). Zooplankton

The analysis results of aquatic fauna at the sampling sites in the subproject area show that there were four groups of 22 zooplankton species detected, of which the *Copepoda* group had 15 species, followed by *Chaetognata* with 4 species, two species of *Decapoda* and one species of *Cladocera*, and also some species of larvae. In general, the number of zooplankton species is not much. There are a large number of species typical for typical brackish-salt water habitat. There are also presences of shrimp larvae, Zoe crabs in relatively high numbers, fish eggs - juveniles in the sample, which shows that canals in the subproject area remain the main entry route of shrimp-crab and juveniles fish to the inland to complete their growth and development cycle.

Zooplankton density ranges from 1805 to 2765 individuals/m^3, indicating significant biomass differences between sampling sites.

2.1.9. Current status of environmental quality

2.1.9.1. Air quality

The results of air samplesin *Table2.6*and *Table2.7*showed that the air quality at the sampling sites hasSO_2andNOx contents within the permitted standard (QCVN 05-2013), the average noise level reached QCVN 26: 2010/BTNMT standard, however, sometimes the noise level is higher than the standard due to the operation transportation vehicles (motorbikes, boats) but these noises reduce as soon as the vehicles pass. Therefore, during the construction of the subproject items, especially the high noisy items in the vicinity of residential areas such as the construction area of the embankment, Contractors should implement measures to minimize the impact on the air environment of the area.

Table2.6: Results of air quality analysis in the subproject area in the dry season

No.	**Label**	**SO_2**	**NO_2**	**Noise**
		mg/m^3		*dBA*
In the area of embankment construction				
1	**Đ_K1**	0.017	0.023	45 - 67
2	**Đ_K2**	0.022	0.026	42 - 64
In the area of wave breaker construction				
3	**K_K3**	0.017	0.033	41 - 68
In the area of reservoir and WSP construction				
4	**H_K4**	0.014	0.031	46 - 69

5	**H_K5**	0.013	0.036	49 - 71
6	**H_K6**	0.020	0.038	50 - 70

Table2.7:: Results of air quality analysis in the subproject area in the rainy season

No.	**Lable**	**SO_2**	**NO_2**	**Noise**
		mg/m^3		*dBA*
In the area of embankment construction				
1	**Đ_K1**	0.015	0.024	40 - 62
2	**Đ_K2**	0.019	0.022	43 - 62
In the area of reservoir and WSP construction				
1	**H_K3**	0.015	0.028	42 - 66
2	**H_K4**	0.015	0.033	45 - 65
3	**H_K5**	0.021	0.032	48 - 67

2.1.9.2. Surface water quality

In the area of embankment: The water quality in the area is quite good, the water is not contaminated with alum even in the rain season (pH ranges from 7.3 to 7.9). The content of dissolved oxygen, organic pollutant (COD, BOD_5), the content of nitrogen and phosphorus compounds (NH_4^+, NO_2^-, NO_3^-, PO_4^{3-}) meet environmental standards (QCVN 08-MT: 2015 column B). The TSS content in some locations is higher than the permitted standard. However, the reality is that TSS content is mainly due to silt in water so it does not affect the quality of water source. Remarkably, the water source is often salinized with the high salinity in the water from 24.2 to 29.1 ‰.

In the area of wave breaker: The water quality in the area is quite good, the water source is not contaminated with alum even in the rain season (pH ranges from 7.78 to 8.05). Dissolved oxygen content, organic pollutant content (COD, BOD_5), the content of nitrogen and phosphorus compounds (NH_4^+, NO_2^-, NO_3^-, PO_4^{3-}) meet environmental standards (QCVN 08-MT: 2015 B column). Similarly, the water source in the embankment, the water source in the wave breaker has high TSS content and fluctuates from 23 to 180 mg/l and most of the sites have a higher TSS than the B column standards, however, the reality is that TSS is mainly due to silt in water so it does not significantly affect water quality. Frequently high salinity intrusion from 28.7 to 29.2 ‰ showed that even in the rain season, salt water seemed to be no different from the dry season.

For the area of reservoir and WSP: the results of the analysis show:

- pH value: Most of the sites located outside the Vo Doi Special-use Forest (H_N24 - H_N30) tend to be heavily infected with alum. It is noteworthy that the phenomenon of alum is quite heavy in the dry season (pH value is mainly around 3), in the rain season thanks to rainwater and fresh water from the Vo Doi area, the alum is tended to be improved. However, the pH value is still quite low, mainly in the range of 3.5-4.5. Although most of the sampling sites have a pH value that is not part of the surface water quality standard for home use, this is not a very difficult task to solve, which only need neutralize the solution to ensure the quality of water supply for the living. However, due to the particularity of the water source frequently contaminated with alum, the consultants unit in the system design team should pay special attention when designing the neutralization technology in order to ensure the stable quality of water supply for the living. At locations in the national park (H_N21 - H_N23) the pH value is quite stable

ranging from 5.66 to 6.39 and most of them are in accordance with surface water quality standards column A (*Figure2.4*).

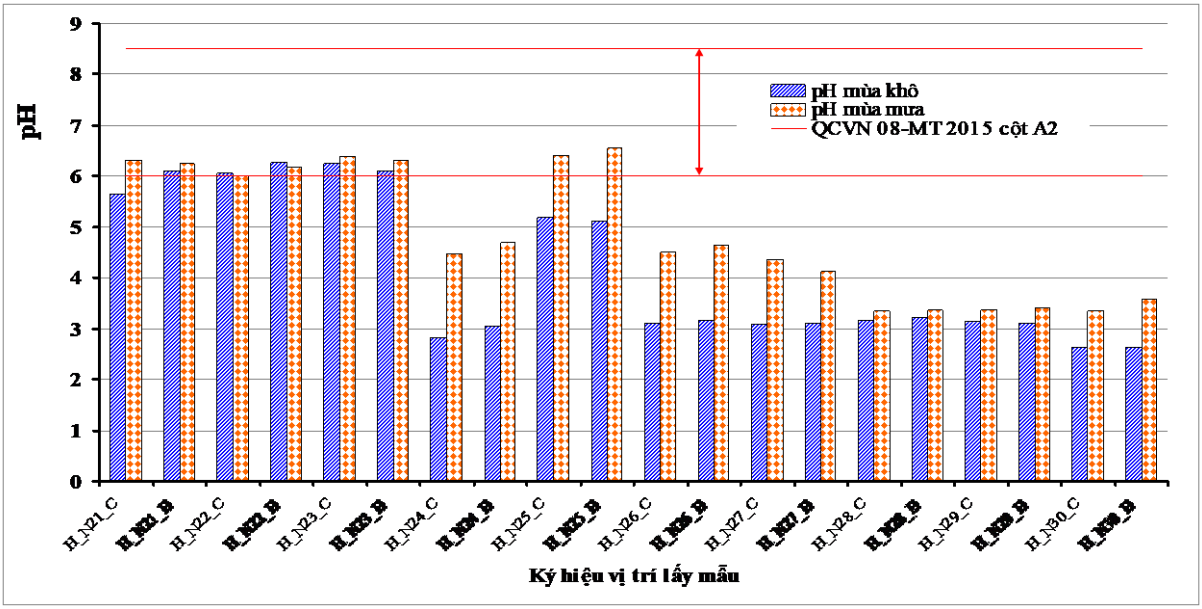


Figure2.4: pH change of the water in the reservoir and WSP item

- COD content in water sources is quite high. There is a large difference in the value of COD in the water at locations in the Vo Doi Forest with the proposed reservoir area. At locations within the Vo Doi forest the COD values are quite high up to 266 mg/l at position H_N23, but the reality is that the nature of the COD in the water source is derived from the decay of Melaleuca leaves and from the peat layer released to the water, so the COD value is high, but it does not affect the quality of the water source and the aquatic system severely. At locations outside the forest, the value of COD exceeds the water quality standard for use in daily life (QCVN 08-MT: 2015 column A2). <u>However, the reality is that at the present time the water source of the area tends to be influenced by the water source inside the forest. This is what the design consultant needs focusing on treatment technology in case the water is seriously affected by Melaleuca forests when the forest discharge into the rainwater during the rainy season or focusing on the solution to control the Melaleuca water flow from the forest to the area supplying water to the reservoir (*Figure2.5*)</u>.

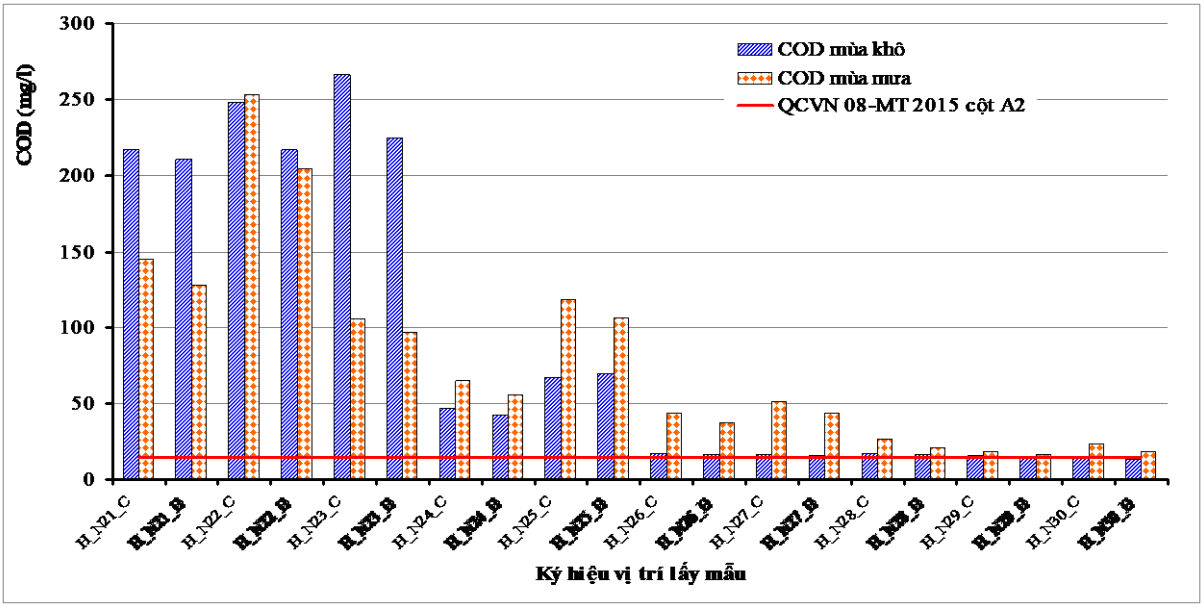


Figure2.5: COD values change in water source of the reservoir and WSP item

- Salinity: Although the reservoir location is in the freshwater zone, however, in the dry season, the water source still tends to be slightly salty due to the Cl- value in water at locations outside the forest, which is mainly more than 250 mg/l; locations located in the forest due to the availability of fresh water reserves should be completely unaffected by salinity intrusion, with relatively low Cl value, which is less than 58 mg/l. At the time of the rainy season thanks to the dilution of rainwater, the value of Cl- in water at the points outside the forest decreased significantly to meet the quality standards of surface water column A2 (QCVN 08-MT: 2015), some points still have higher than standard values but the level is not large and in fact the water source is still able to be used for living when mixing many different sources (*Figure2.6*).

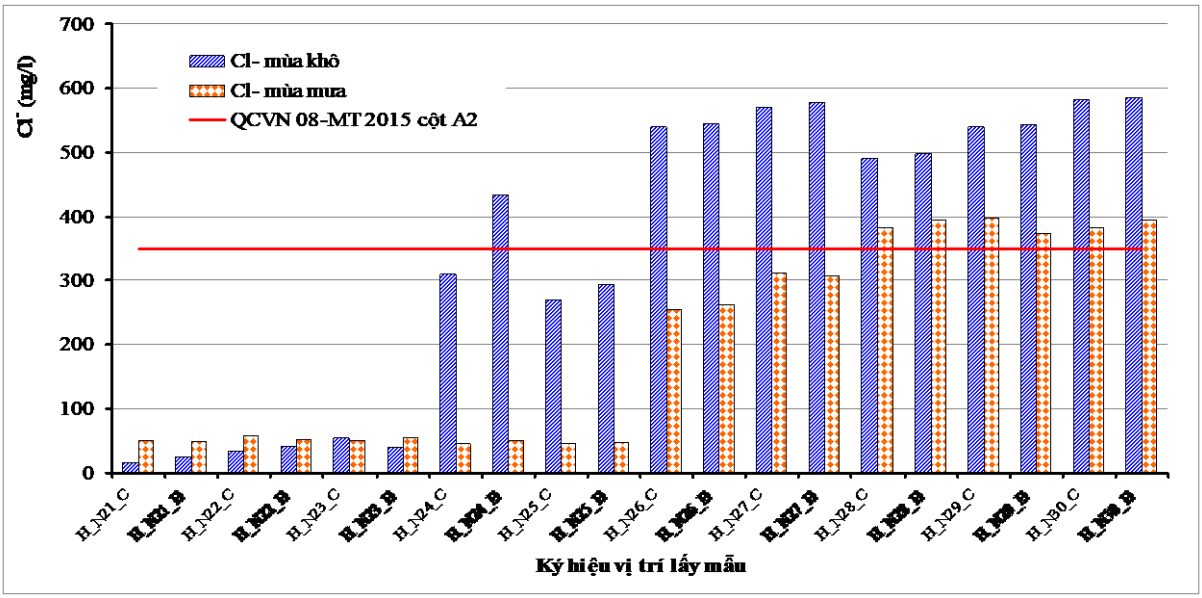


Figure2.6: Cl values change in water source of the reservoir and WSP item

- Coliform index: Coliform values at all sites meet the national standards (Coliform < $7,5\times10^3$ MPN/100ml), which show that the water source in this area is not affected much by wastes.

2.1.9.3. Groundwater quality

Groundwater source in the subproject is quite abundant, however, some area the quality of this sourceis quite poor due to acid sulfate soil and salinity intrusion. The water that can be exploited for daily use is usually at a depth of 100-400 m.

The analysis shows that (*Table2.8*): The quality of groundwater in the subproject is quite good; most of the indicators meet the requirements of water supply standards. The concentration of heavy metals meets the standard. However, all samples of groundwater show signs of saline intrusion with a high content of Cl^- (mainly around 629-693mg/l) which was 2-3 times higher than the standard (QCVN 09: 2015) leading to the groundwater resource in the area is not used directly for the water supply purpose. <u>This is also a difficult factor in the daily water supply in Ca Mau province in general and in the subproject in particular.It is also possible to see the effectiveness of investing in the reservoir to supply water to the area.</u>

Table2.8: Results of groundwater quality analysis

No	Indicator	Unit	Forest planting	Embankment	Wave breaker	Reservoir		
			Đ_G1	Đ-G2	Đ-G3	Đ_G4	Đ_G5	Đ_G6
1	pH		8.14	7.73	7.75	7.22	7.71	7.65

2	EC	mS/cm	2100	2420	2630	2445	2430	2501
3	Turbidity	NTU	0.9	3	5	3.7	5	1.8
4	TSS	mg/l	<2	4.3	4.5	5.1	4.6	3.4
5	DO	mg/l	6.3	7.7	7.1	7.7	7.8	7.4
6	TN	mg/l	4.76	3.5	3.57	3.5	3.51	2.87
7	TP	mg/l	0.6	0.31	0.29	0.35	0.29	0.27
8	$P\text{-}PO_4^{3-}$	mg/l	0.53	0.29	0.27	0.29	0.28	0.22
9	Hardness	$mgCaCO_3$ /L	150	711.5	750	711.5	682.7	721.1
10	Cl^-	mg/L	271	629.8	693.8	629.8	649.8	669
11	SO_4^{2-}	mg/L	98.1	17.4	22.1	17.4	19.7	18.7
12	Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
13	Cd	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
14	As	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
15	Fe	mg/L	0.07	0.19	0.11	0.15	0.11	0.16
16	Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
17	Zn	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Cr	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Coliform	MPN/ 100 ml	0	0	0	0	0	0

2.1.9.4. Soil and sediment qualities

In the area of embankment: the analysed results of soil and sediment samples in the subproject area showed that heavy metals concentrations in the soil and sediment in the area are lower than the standard 03: 2008/BTNMT and as well as the Dutch standard. Therefore, soil and sediment can be used as the material for building the embankment.

In the area of reservoir and WSP: the analysed results of soil and sediment samples in the subproject area, both of the measured values of the samples are lower than the standard 03: 2008/BTNMT and as well as the Dutch standard. Therefore, soil and sediment can be used as the material for building embankments during the construction phase of the subproject.

In the area of reservoir and WSP: the analysis results indicate that soils are heavily contaminated with acid sulfate soil through the pH value is only about 3. <u>This is the factor that Contractors need to pay attention to control the risk of acid sulfate soilleachate during construction and operation phases of the reservoir.</u>

Table2.9: Analysis results of subproject soil quality (February 10th-13th, 2017)

No.	Symbol		pH_{H2O} 1:5	pH_{KCl} 1:5	Salinity	CHC	TP	TN	K_2O	SO_4^{2-}	Al^{3+}	Fe_{TS}	Fe^{3+}	Mn^{2+}	Cd	Pb	As	Cu	Zn	Cr	Mn
					‰	%				mg/100g					mg/kg						
Component 2. Embankment																					
1	**D1**	**T1**	6.84	6.53	6.00	2.54	0.043	0.25	2.29	392.3	<0.5	521.5	308.4	11.7	0.12	34.6	0.52	40.1	113.5	65.5	485.1
2		**T2**	7.54	7.34	5.80	2.39	0.036	0.20	1.70	360.6	<0.5	483.0	178.6	6.1	0.10	35.1	0.48	34.9	123.5	69.9	446.9
3		**T3**	7.15	6.60	6.90	2.37	0.040	0.16	1.59	462.1	<0.5	444.0	287.4	10.7	0.09	32.5	0.36	36.3	124.3	78.8	411.8
4	**D2**	**T1**	5.15	4.41	3.40	4.44	0.033	0.19	1.75	169.7	0.9	389.7	261.3	9.8	0.10	34.7	0.35	35.7	115.5	62.3	362.9
5		**T2**	5.91	5.35	3.20	4.80	0.036	0.19	1.86	202.7	0.9	398.5	186.6	6.6	0.17	34.9	0.33	36.1	113.8	69.5	370.9
6		**T3**	6.06	5.75	4.70	4.94	0.042	0.16	1.52	269.1	1.9	301.6	104.7	3.2	0.09	35.1	0.31	34.9	109.9	84.0	281.8
7	**D3**	**T1**	6.67	6.33	4.80	5.19	0.046	0.19	1.82	307.4	<0.5	624.0	366.6	14.0	0.10	36.6	0.49	34.8	136.6	62.1	575.9
8		**T2**	7.48	7.34	4.30	4.89	0.040	0.16	1.57	238.5	<0.5	685.8	400.4	15.3	0.12	32.7	0.36	33.1	130.1	79.6	630.8
9		**T3**	7.12	6.70	3.90	4.98	0.035	0.16	1.59	242.6	<0.5	483.6	199.6	7.0	0.09	34.5	0.42	36.4	132.4	67.7	447.8
10	**D4**	**T1**	7.05	6.91	6.00	3.16	0.051	0.20	1.94	379.0	<0.5	642.9	347.4	13.2	0.10	33.7	0.34	38.4	122.6	72.6	594.0
11		**T2**	7.16	7.00	5.20	3.67	0.037	0.19	1.84	311.4	<0.5	524.2	289.3	10.8	0.13	35.2	0.47	33.1	133.9	68.4	485.9
12		**T3**	7.21	7.09	5.00	3.31	0.036	0.15	1.76	219.7	<0.5	415.8	212.6	7.6	0.08	34.9	0.51	38.4	120.4	66.3	386.9
13	**D5**	**T1**	7.42	7.21	4.70	5.06	0.045	0.21	2.35	254.2	<0.5	637.3	324.8	12.3	0.11	31.8	0.55	35.3	118.4	55.4	591.2
14		**T2**	7.34	7.08	4.40	4.60	0.032	0.19	1.84	241.5	<0.5	534.6	297.1	11.1	0.10	34.4	0.49	37.1	112.5	57.8	494.9
15		**T3**	7.06	6.97	4.00	4.33	0.031	0.19	1.74	235.1	<0.5	492.3	253.6	9.3	0.14	35.1	0.41	39.4	110.8	55.7	455.9
Component 4. Reservoir																					
16	**D1**	**T1**	3.15	3.07	0.30	3.86	0.036	0.20	1.67	81.4	68.2	97.1	46.1	1.1	0.11	35.6	0.52	33.4	136.4	62.0	95.8
17		**T2**	3.48	3.33	0.30	3.15	0.034	0.17	1.68	87.8	37.4	139.8	93.2	3.0	0.09	32.4	0.28	31.0	129.7	58.7	134.8
18		**T3**	3.17	3.00	0.60	2.81	0.030	0.19	1.76	177.1	93.5	158.7	106.0	3.6	0.13	33.5	0.48	35.4	132.4	63.6	152.9
19	**D2**	**T1**	3.26	3.01	0.50	3.34	0.048	0.25	2.26	145.4	93.5	84.5	45.2	1.2	0.12	32.3	0.33	38.5	122.6	57.0	88.1
20		**T2**	3.47	3.13	0.50	3.17	0.047	0.24	2.09	148.9	44.9	136.7	87.6	2.9	0.11	34.4	0.61	33.3	128.2	61.2	134.0
21		**T3**	3.09	3.02	0.70	3.14	0.034	0.24	2.21	205.0	89.8	185.8	126.8	4.6	0.14	35.7	0.57	36.8	129.9	65.1	180.1
22	**D3**	**T1**	3.33	3.11	0.60	4.14	0.051	0.22	2.02	176.4	65.5	89.5	46.7	1.2	0.11	37.2	0.28	39.8	122.4	72.6	91.0

No.	Symbol		pH_{H2O} 1:5	pH_{KCl} 1:5	Salinity	CHC	TP	TN	K_2O	SO_4^{2-}	Al^{3+}	Fe_{TS}	Fe^{3+}	Mn^{2+}	Cd	Pb	As	Cu	Zn	Cr	Mn
					‰	%				mg/100g					mg/kg						
23		**T2**	3.19	3.05	0.40	3.00	0.039	0.18	1.79	113.5	75.6	127.2	85.4	2.8	0.10	35.2	0.34	40.4	131.8	76.6	123.9
24		**T3**	3.26	3.13	0.70	3.71	0.036	0.17	1.60	201.8	46.8	157.9	131.5	4.6	0.10	35.5	0.33	37.4	123.4	69.1	151.8
25	**D4**	**T1**	3.30	3.00	0.30	2.70	0.041	0.33	2.14	87.5	94.5	92.2	49.8	1.3	0.15	33.5	0.38	35.8	121.5	71.0	94.1
26		**T2**	3.39	3.04	0.30	2.44	0.033	0.25	2.28	87.3	78.6	136.1	90.5	3.0	0.13	34.7	0.37	33.4	121.3	62.4	135.1
27		**T3**	3.23	3.00	0.60	2.44	0.029	0.14	1.46	175.1	93.5	194.6	126.2	4.4	0.09	32.9	0.35	33.5	119.2	55.1	183.7
28	**D5**	**T1**	3.31	2.94	0.30	3.92	0.057	0.17	1.72	87.2	121.6	98.5	56.3	1.5	0.10	31.8	0.31	37.4	122.5	66.5	97.9
29		**T2**	3.29	3.03	0.30	3.19	0.034	0.18	1.68	89.3	88.9	131.5	91.5	3.0	0.10	32.4	0.24	34.6	118.4	65.5	127.8
30		**T3**	3.28	3.12	0.60	2.72	0.030	0.15	1.58	176.4	52.4	182.8	112.9	3.9	0.12	33.9	0.34	37.9	132.6	56.6	173.8
Component 5. Water supply station, pipeline																					
31	**D1**	**T1**	3.36	3.04	0.30	2.39	0.047	0.21	1.94	86.3	86.9	101.1	45.6	1.1	0.10	36.4	0.27	37.7	123.3	55.4	101.0
32		**T2**	3.35	3.11	0.30	2.19	0.032	0.19	1.88	86.7	62.7	141.8	87.1	2.8	0.11	36.2	0.24	41.4	131.7	61.8	137.9
33		**T3**	3.27	3.05	0.50	2.04	0.028	0.20	1.73	147.9	79.5	175.3	91.1	3.0	0.12	34.2	0.23	39.4	122.7	66.1	167.9
34	**D2**	**T1**	3.48	3.07	0.30	2.38	0.051	0.25	2.27	87.0	70.2	95.0	50.5	1.4	0.13	33.4	0.44	35.6	123.3	56.4	97.1
35		**T2**	3.29	3.00	0.30	2.05	0.048	0.22	1.77	86.3	97.3	100.2	74.0	2.3	0.12	35.1	0.35	38.3	119.2	67.8	99.9
36		**T3**	3.26	3.05	0.40	1.97	0.041	0.20	1.97	117.0	77.6	145.5	102.6	3.5	0.11	31.6	0.38	36.3	120.2	72.6	142.0
37	**D3**	**T1**	3.23	3.11	0.20	2.67	0.056	0.21	1.74	57.9	64.5	91.2	46.7	1.2	0.11	32.3	0.24	39.7	121.6	70.7	90.9
38		**T2**	3.36	3.14	0.20	2.89	0.046	0.19	1.87	58.5	40.2	123.1	87.9	2.9	0.13	30.7	0.26	34.8	121.1	64.5	120.9
39		**T3**	3.24	3.00	0.30	2.24	0.042	0.17	1.54	87.4	92.8	183.0	126.0	4.4	0.10	32.4	0.45	39.7	135.3	68.0	173.8
40	**D4**	**T1**	3.28	3.12	0.30	3.12	0.056	0.21	1.69	88.1	56.1	101.0	51.8	1.4	0.14	34.4	0.41	40.3	121.1	75.9	99.8
41		**T2**	3.34	3.06	0.30	3.15	0.053	0.17	1.63	87.3	72.9	146.5	95.6	3.2	0.15	34.6	0.52	37.4	124.2	80.7	140.8
42		**T3**	3.17	3.01	0.40	2.32	0.051	0.15	1.52	117.7	91.7	203.4	132.8	4.7	0.14	31.5	0.34	38.6	124.4	72.6	192.8
43	**D5**	**T1**	3.21	3.04	0.20	2.49	0.036	0.25	2.24	56.4	84.2	81.3	41.3	1.0	0.12	32.8	0.26	38.5	115.8	52.6	85.1
44		**T2**	3.34	3.05	0.30	2.14	0.034	0.19	1.81	87.9	74.8	90.9	55.2	1.5	0.10	35.5	0.29	35.6	111.5	58.7	91.9
45		**T3**	3.37	3.12	0.30	2.06	0.031	0.17	1.66	87.4	53.3	131.4	93.5	3.1	0.09	34.4	0.31	39.4	119.9	62.7	127.8

Table2.10: Results of inland sediment analysis in the afforestation and embankment upgrade areas (February 10th-13th, 2017)

No.	Symbol	pH_{H2O} 1:5	pH_{KCl} 1:5	Salinity	CHC	TP	TN	K_2O	SO_4^{2-}	Al^{3+}	Fe_{TS}	Fe^{3+}	Mn^{2+}	Cd	Pb	As	Cu	Zn	Cr	Mn
				‰	%				mg/100g					mg/kg						
Component: Afforestation																				
1	**TT1**	7.31	7.18	8.20	4.01	0.079	0.22	1.85	556.3	<0.5	717.6	364.8	13.9	0.12	32.9	0.37	35.4	118.6	72.7	662.9
2	**TT2**	7.24	7.10	9.00	4.50	0.091	0.25	2.13	354.3	<0.5	753.4	391.3	15.0	0.11	33.7	0.46	34.9	109.4	83.7	697.1
3	**TT3**	7.19	7.09	9.30	4.13	0.080	0.33	2.47	583.7	<0.5	678.1	318.1	12.0	0.10	34.3	0.41	37.8	118.7	73.6	624.2
Component: Embankment																				
1	**T1**	7.46	7.40	5.60	4.80	0.097	0.31	2.71	291.7	<0.5	538.2	178.0	12.4	0.12	35.1	0.36	34.1	124.7	89.2	499.4
2	**T2**	7.53	7.21	5.90	3.97	0.088	0.25	2.08	361.4	<0.5	548.1	192.5	13.4	0.11	36.4	0.41	34.7	128.2	81.0	510.0
3	**T3**	7.27	7.19	6.10	4.29	0.073	0.24	2.15	388.0	<0.5	621.7	201.8	14.2	0.11	34.8	0.56	38.9	114.9	67.2	573.1
4	**T4**	7.45	7.25	6.50	4.56	0.094	0.22	1.98	397.0	<0.5	494.0	148.7	9.8	0.10	35.5	0.47	31.5	107.5	86.5	462.0
5	**T5**	7.34	7.16	6.30	4.25	0.090	0.19	1.92	404.5	<0.5	578.6	184.5	12.8	0.08	35.1	0.32	36.7	123.7	82.8	538.0

Table2.11: Results of coastal sediment analysis in the wave breaker area (February 10th - 13th, 2017)

No.	Symbol	pH_{H2O} 1:5	pH_{KCl} 1:5	TP	TN	Cd	Pb	As	Cu	Zn	Hg	Oil and grease
				%		mg/kg						
1	**TT1**	7.29	7.09	0.051	0.20	0.12	34.6	0.31	36.3	117.4	0.062	5.1
2	**TT2**	7.66	7.62	0.089	0.29	0.01	34.8	0.27	33.8	107.6	0.046	4.2
3	**TT3**	7.56	7.50	0.085	0.20	0.15	33.7	0.33	34.7	103.5	0.065	4.8

2.2. SOCIO-ECONOMIC CONDITIONS

2.2.1. Socio conditions

2.2.1.1. Population and population distribution

According to statistics, in 2015, the population of Ca Mau province is 1,218,821 people, of which 610,262 men and 606,126 women, with a density of 233 people/km^2. Population and population density are highest in Ca Mau city (222,991 people with a density of 895 people/km^2). In rural districts and communes, population and population density is often lower than the urban. The distribution of population between urban and rural areas in the province has a large difference, the total population living in rural Ca Mau accounted for 76.69% of the population of the province (*Table2.12*).

The population growth rate of Ca Mau in the period of 2013-2015 has slightly increased. By 2013, the province's population growth rate was 0.18%. By 2015, the province's natural population growth rate was 0.20%. It tends to decrease in urban areas and an increase in rural areas.

Table2.12: Distribution of area, population and population density by district in 2015

District	Area (km^2)	Average population (people)	Density (people /km^2)	Urban area (people)	Rural area (people)
Total	5221.44	1,218,821	233	275,096	934,725
Ca Mau city	249.23	222,991	895	142,950	80,041
Thoi Binh district	636.39	135,681	213	10,751	124,930
U Minh district	771.77	101,815	132	7,015	94,800
Tran Van Thoi district	697.46	189,126	271	44,499	144,627
Cai Nuoc district	417.09	138,444	332	14,340	124,104
Phu Tan district	448.19	103,894	232	15,601	88,293
Dam Doi district	809.96	183,332	226	9,775	173,557
Nam Can district	482.80	65,719	136	18,938	46,781
Ngoc Hien district	708.55	77,819	110	11,227	66,592

Source:Ca Mau Statistical Yearbook 2016

2.2.1.2. Labor and employment

In 2015, there have 704,125 people in working age and 688,262 employed people and 15,863 unemployed people (*Table2.13*) in Ca Mau province.

The structure of labor in Ca Mau province is mainly agriculture, forestry, and fishery (394,353 people), accounting for 57.3%; trading and repairing (96,826 people) accounted for 14.07%; manufacturing and processing: 65,825 people, accounting for 9.56%; The rest are other sectors.

2.2.1.3. Education

By 2015, there are 132 kindergartens in the province with 1,787 teachers and 32,175 pupils, with an average of 25 pupils per class. A number of primary, secondary and high schools is 414 with 12,575 teachers and 212,547 students. In addition, the province also has some vocational schools, 3 colleges and 2 universities providing part of the human resources for the province (*Table2.14*).

Table2.13: Labor distribution in Ca Mau province period 2013-2015

Items	Year 2013	Year 2014	Year 2015
Number of people in working age	696,233	700,143	704,125
1. Employed people working for	678,800	686,095	688,262
-State enterprises	43,748	633,744	1,308
-Private enterprises	42,111	640,202	3,782
- Foreign enterprises	43,224	644,848	190
2. Unemployed people	17,433	14,048	15,863
* Unemployment rate (%)	2.50	2.01	2.25

Source: Ca Mau Statistical Yearbook 2016

Table2.14: Number of schools, teachers and students in Ca Mau province

School classification	Items	Quantity		
		2013	2014	2015
Kindergarten	Number of schools (school)	130	132	132
	Teachers (people)	1,585	1,688	1,787
	Pupils (people)	33,314	32,367	32,175
Primary, secondary and high school	Number of schools (school)	415	416	414
	Teachers (people)	12,519	12,717	12,575
	Pupils (people)	209,130	212,432	212,547
Vocational school	Number of schools (school)	2	1	1
	Teachers (people)	105	37	28
	Pupils (people)	4,180	1,327	1,110
College	Number of schools (school)	3	3	3
	Teachers (people)	217	219	133
	Students (people)	1,080	5,002	6,455
University	Number of schools (school)	2	2	2
	Teachers (people)	15	17	69
	Students (people)	3,048	2,677	2,559

Source: Ca Mau Statistical Yearbook 2016

2.2.1.4. Health

By 2015, there are 128 health facilities in the province with 3,887 sickbeds contributing to improving the quality of care and protection of people's health and equipment for medical examination and treatment are upgrading and expanding. There is a general hospital in each district. The grassroots health care network has been expanded to 100% of wards and townships in the province with health stations; 100% of the clinics have midwives and pediatric physicians; 100% of hamlets and hamlets have health workers, by the end of 2015, 9.59 doctors/10,000 people will be on average, 100% of communes, wards and towns will have doctors (*Table2.15*).

Table2.15: Public health indicators in Ca Mau province in 2016

No.	Indicators	Unit	In 2016
1	Average doctors per ten thousand people	people	9.9
2	Average patient beds per ten thousand people	beds	26.2
3	Percentage of commune/ward health centers having doctors	%	100.0
4	Percentage of commune/ward health centers having midwives or topological physicians	%	100.0
5	Number of commune/ward health centers meeting the national health standard	%	100.0
6	Number of infected cases	cases	8.847.0
7	Number of deaths from epidemic diseases	people	4.0
8	Percentage of babies under 1 year of age who are fully vaccinated	%	116.3
9	Percentage of newborn babies weighing less than 2.5 kg	%	6.7
10	Percentage of children under 5 years of age who are malnourished	%	12.0
11	Number of children under 15 years of age suffering from vaccinated diseases	people	64.0
12	Number of children under 15 years of age who are died of vaccinated diseases	people	4.0

Source: Ca Mau Statistical Yearbook 2016

2.2.1.5. Ethnic composition and customs

Currently, there are 20 ethnic groups living in Ca Mau province, mainly Kinh, followed by Khmer and Hoa. The remaining 15 ethnic minorities and foreigners include ethnic groups such as Tay, Thai, Muong, Nung, Mong, Ede, San Chay, Cham, Co Ho, Hre, Tho, Ma, Lao, Lo Lo, Si La and foreigners. The ethnic minority population accounts for a small part of the population. Thus, the customs of the people in the area will be influenced mainly by 3 cultures of the main ethnic groups are Kinh, Khmer, and Chinese.

However, there are only a few Khmer households in the subproject area of in the area subprojects in Nam Can and Ngoc Hien districts, mostly Kinh, but they have lived in the area for a long time and integrate with Kinh communities here (*Figure2.7*).

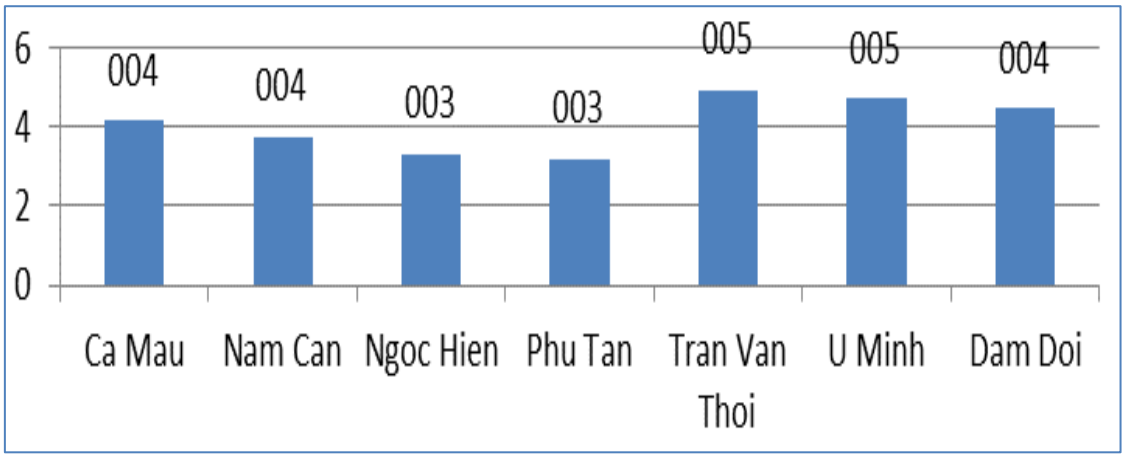


Figure2.7: Percentage of ethnic minorities in the subproject districts

2.2.1.6. Cultures, beliefs and cultural works

Cultures and beliefs of Chinese people: Referring to religions and beliefs of Chinese people in Ca Mau is their cultural and spiritual activities. They have two forms of belief in the families and in the community. In families, the Chinese dedicate the most formal place to worship their ancestors. In some well-to-do families, the altars are decorated gorgeously. The worship of Quan Cong (the Lost Bladesman – Zhang Fei) and Thien Hau (Mazu) is very important in spiritual life for both Chinese and Vietnamese. People come to temples, shrines for frequent worship, praying for fortune, peace, health... The majority of Chinese people in Ca Mau are Buddhists and a few are Catholics and Protestants (about 20 households in Tac Van, Ca Mau city). Some cultural works of the Chinese in Ca Mau now include the 3 large shrines and many small shrines in other places. The gods are worshiped in the temples such as Thien Hau Thanh Mau, Quan Cong, Phuoc Duc Chinh Than. In addition, in these shrines, there are Ba Hoa, Thanh Hoang Bon Canh, Than Ho, Na Tra,... These are the gods of the Chinese community in Ca Mau province. Thien Hau Thanh Mau was the most popularly worshiped by the Chinese community. There are many places of Thien Hau shrines (Thien Hau Palace) such as: Ca Mau, Ngoc Hien, Dam Doi, Thoi Binh, etc. In addition, they often go to Quan De shrine and Thien Hau Thien Hau Palace, Giac Thien Tu (pagoda),...

The main religion of the Khmer group is Buddhism: Theravada Buddhism (primitive Buddhism) has become an integral part of Khmer people. To a certain extent, it is the belief, the world view, the human life of the Khmer community. The essence of Theravada Buddhism is viewed by the Khmer as values to be reached. In ancient times, the Theravada Buddhism of the Khmer in the Mekong Delta had a unified system of institutions for the religious execution and canon. The cultural works of Khmer people include Monivongsa pagoda and other pagodas in Ca Mau province.

2.2.1.7. Gender issues

In recent years in Ca Mau province in general and the subproject area in particular, local authorities have made great efforts to promote gender equality and achieve significant results. Women have more opportunities for development, equal access to education, improved access to health care, access to and enjoy basic services and social welfare. The number of women participating in the political, economic, cultural and social fields has increased and contributed significantly to the overall achievement of the province.

According to statistics, women in the province account for 49.6% of the population, 40% of female workers are working in economic sectors, 51% in education sector and 54% in health sector, 11.47% in party committee, 23,29% in 3 levels of People's Council, 20% in leadership

of the government organizations, hundreds of women are business owners. In addition, rural women are a source of wealth for society through the diversification of crops, livestock, handicrafts, and traditional crafts, and through the effective implementation of cultural and social programs.

However, the proportion of female official involved in social management and state management is still low, the percentage of trained women remains low, many localities are not fully aware of the importance of gender equality for development causing limitation of the implementation, lack of specific activities and solutions to shorten the gender gap in their activities.

2.2.1.8. Living quality

In recent years, people's quality of life in the area has been improved with relatively adequate utilities such as electricity, water, medical services, schools, culture, sports, internet, etc.

According to Ca Mau Statistical Yearbook in 2016, the per capita income of Ca Mau people in 2016 is 28.3 million VND/person/year, in urban areas is 43.2 million VND/person/year and in a rural area is 24.1 million VND/person/year. Particularly in the subproject communes in Nam Can district (Lam Hai commune) and Ngoc Hien district (Vien An Dong, Tan An Tay and Tam Giang Tay communes), the socio-economic survey shows that the per capita income these areas is higher than the average income of the whole province (ranges at 30 to 35 million VND/person/year) because these are saltwater aquaculture areas.

The poor rate in Ca Mau province in 2016 is 7.96%. The districts have a high rate of poor households such as U Minh (16.78%), Tran Van Thoi (10.03%), Dam Doi (12.8%), and Ngoc Hien (9.35%). These are the beneficiarydistricts of the subproject. The details are in *Table2.16*.The total number of poor households in the subproject communes is 985, of which Lam Hai is 275 households (12.46%), Vien An Dong is 372 households (11.39%) and Tam Giang Tay is 250 households (9.2%); Tan An Tay is 88 households (3.43%). The average expenditure is 1.734 million VND/person/month (equivalent to 20.8 million VND/person/year).

Table2.16: The poor rate in Ca Mau province in 2016

No.	District/city	Poor rate (%)
	The average across the province	**7.96**
1	U Minh district	16.78
2	Tran Van Thoi district	10.03
3	Phu Tan district	6.76
4	Nam Can district	6.3
5	Ngoc Hien district	9.35

Source: Ca Mau Statistical Yearbook 2016

All subproject communes have medical stations that meet national standards and these stations also have the patient beds so that patient can be treated. Access to health centers is relatively easy. In addition, the affected communes have adequate schools, post offices, and culture houses.

Water supply, electricity, telephone use, and environmental sanitation

- At the present, in affected communes by land acquisition, the water used for a living is mainly rainwater (230 households) and well-water (558 households), rainwater is mainly

used in the dry season. See for *Table 2.17* details. Water used for production is 100% from the river and canal.

- Environmental sanitation of affected households: 304/560 affected households have septic tanks (54.3%), 228/560 households (40.7%) use temporary toilets, 28 households two compartments toilets and sanitation in the field (5%), see for details *Table 2.18*.
- 100% of affected households use the national electricity line for lighting, living, and aquaculture, of which 534/560 households (accounting for 95.4%) have their own electricity meters and 26/560 households are using electricity meters with other households (*Table 2.19*).
- There are 409/560 households using the telephone (73.0%).

Table 2.17: Daily water use of affected households by the subproject

No	Commune	District	Number of HHs using water for living (HHs)			
			Rainwater	River water	Well Water	Tap water
1	Tam Giang Tay	Ngoc Hien	132	0	219	0
2	Tan An Tay	Ngọc Hien	69	0	80	0
3	Vien An Dong	Ngọc Hien	0	0	57	0
4	Lam Hai	Nam Can	29	0	202	0
Total			**230**	**0**	**558**	**0**

Source: Results of the socio-economic survey

Table 2.18: Environmental sanitation of affected households

No	Name of commune	Name of district	Number of households using toilets for living (household)			
			Two compartments toilets	Septic tank	Temporary toilets	Sanitation in the field
1	Tam Giang Tay	Ngoc Hien	12	116	85	6
2	Tan An Tay	Ngọc Hien	0	40	40	0
3	Vien An Dong	Ngọc Hien	0	39	18	0
4	Lam Hai	Nam Can	0	109	85	10
Total			**12**	**304**	**228**	**16**

Source: Results of the socio-economic survey

Table 2.19: Electricity using by affected households

No	Name of commune	Name of district	Own Electricity Meter		Not using Own Electricity Meter	
			Household	(%)	Household	(%)
1	Tam Giang Tay	Ngoc Hien	211	37,7	8	1,4
2	Tan An Tay	Ngọc Hien	80	14,3	0	0,0
3	Vien An Dong	Ngọc Hien	57	10,2	0	0,0
4	Lam Hai	Nam Can	186	33,2	18	3,2
Total			**534**	**95,4**	**26**	**4,6**

Source: Results of the socio-economic survey

Awareness of climate change

Climate change effects like abnormal weather and sea level rise, which may destroy livelihoods and challenge human development, have occurred and have been observed by the

respondents across the subproject area. But knowledge of climate change is still vague, particularly among women. HH survey results showed that 67% of male respondents have heard of the term 'climate change' compared to only 36% of female respondents (*Table 2.20*). Furthermore, even if they have heard of this term, it is not clear to them.

Table 2.20: Males and females who have heard the term "climate change"

	Already heard		**Never heard**	
	Respondents	%	Respondents	%
Male	46	67	23	33
Female	27	36	47	64

Source: Results of the socio-economic survey

Coastal livelihoods and socio-economic vulnerability factors

During the HH survey, 143 interviewees were asked to rank the level of 14 vulnerability factors that affect their own livelihood options. They used a three-score scale (1: lowest, 2: moderate and 3: highest vulnerability) to rank every factor. Due to the use of the three-scored scale the possibility of each scale is assumed equally 1/3 (33%) of respondents. The more people scored a factor with a high scale (score 3), the more this vulnerability factor affects their livelihood. Therefore, 33% was the threshold of calculation showing how many people have high exposure and sensitivity to every single factor, including socio-economic and environmental aspects as well as climate change impacts.

All factors related to poverty and financial statuses such as low income, few available jobs, limited access to markets and low prices negatively affected all HHs in four groups. Whereas, having small farms only affected the laborer and collector groups (*Figure 2.8*). Unlike the fishery group, whose livelihoods depend on boats and fishing gear, extension shrimp farming groups need large ponds to generate income. Among the four groups, wage laborers and those who gather wild resources were the most vulnerable since almost all factors negatively affect them.

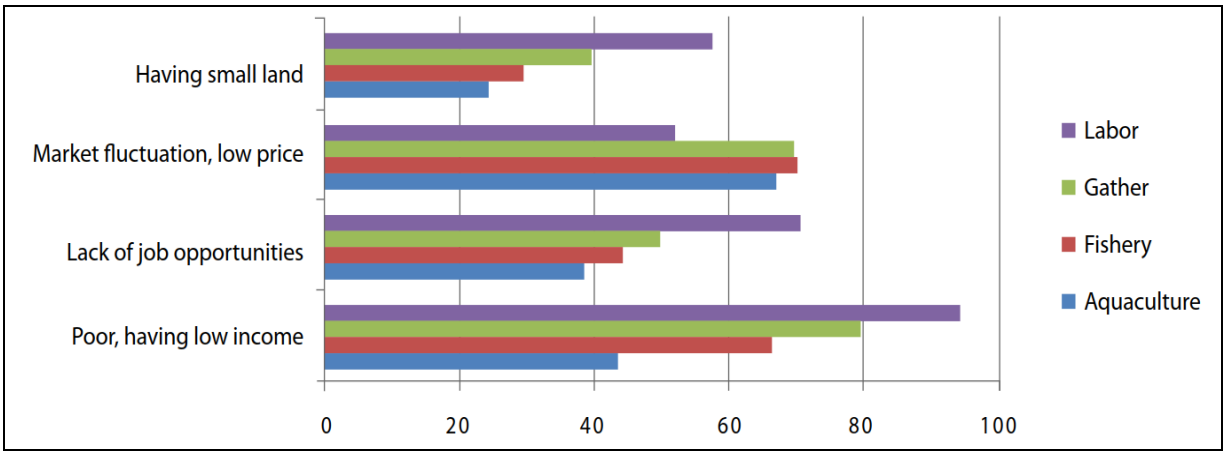


Figure 2.8: Socio-economic factors affecting four livelihood sectors in the subproject area

Figure 2.9 shows how anthropogenic vulnerability factors affect the four livelihood sectors differently. Around 63% of day-laboring HHs reported that illness was the strongest factor to vulnerability since sick laborers could neither earn a daily subsistence nor afford healthcare. 37% also stated that having a high dependency ratio of young children, elderly and disabled persons adding to their vulnerability. They need to be taken care of rather than be expected to

contribute to the workforce. When climate hazards occur, the HHs with many dependents may be strongly hit if they lack adequate evacuation policies.

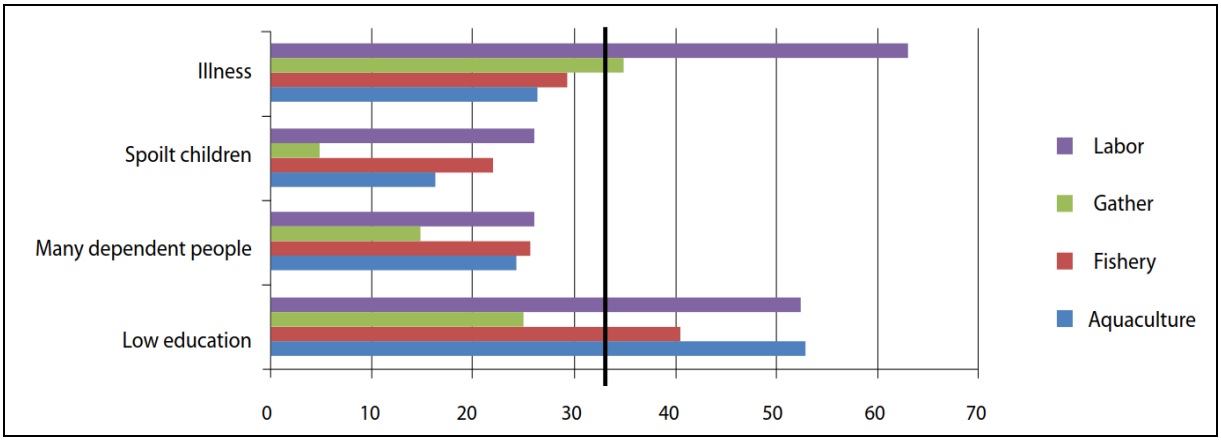


Figure 2.9: Anthropogenic factors affecting four livelihood sectors in the subproject area

About 52% of laborers and shrimp farmers reported that low education was a vulnerability factor that negatively affected their livelihoods. Low education has been linked to unemployment, inability to understand climate information provided in leaflets and to make accurate decisions. Having spoilt children was not a key vulnerable factor since all four groups underestimated this problem (*Figure 2.9*).

Around 37% of day-labor HHs reported that the lack of help and support from relatives brought difficulties (*Figure 2.10*). A kin relationship plays an important role for the poor by providing security and safety nets during or after climate-related disasters. Meanwhile, access to transport was highly limited for all four groups. The two main means of local transportation are motorbikes and boats, but the paths are slippery during the rainy season and the canals are shallow during low tide, thus making it inconvenient and costly, especially to send children to school. There are two to three primary and secondary schools in a village or commune, but often one high school in a district. This means older children have a longer distance to travel. All four groups often neglected and underestimated vulnerabilities related to infrastructure deterioration caused by climate change. They were satisfied with their living standards and had no complaints. However, good transportation, accommodation, electricity, clean water, and sanitation are the most important and necessary to them during or after climate-related disasters.

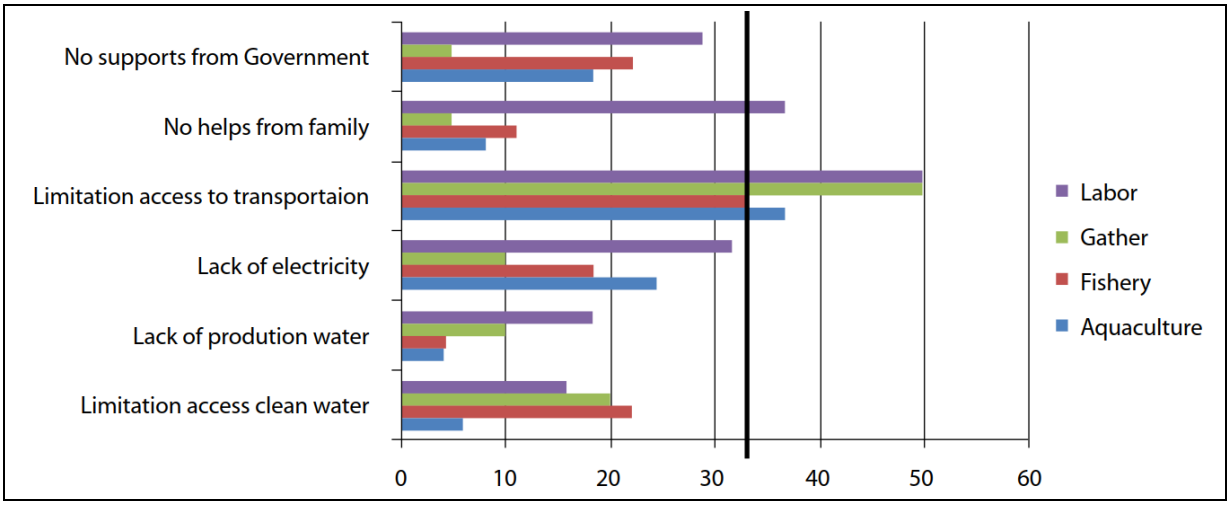


Figure 2.10: Social help and infrastructure affecting four livelihood sectors in the subproject area

86% of HHs involved in shrimp farming systems reported that their livelihoods are most vulnerable to shrimp disease. Shrimp disease, due to environmental pollution and climate variability, often occurs in winter, during the shift from dry to rainy seasons, during stormy seasons, during flooding and prolonged heat and heavy rains. The households that highly depend on water resources (water-reliant shrimp aquaculture) and those that gather marine and forest resources are more vulnerable to environmental degradation and the exhaustion of marine resources, of which those involved in the small-scale fishery and marine/forest resource collection were most vulnerable (*Figure 2.11*).

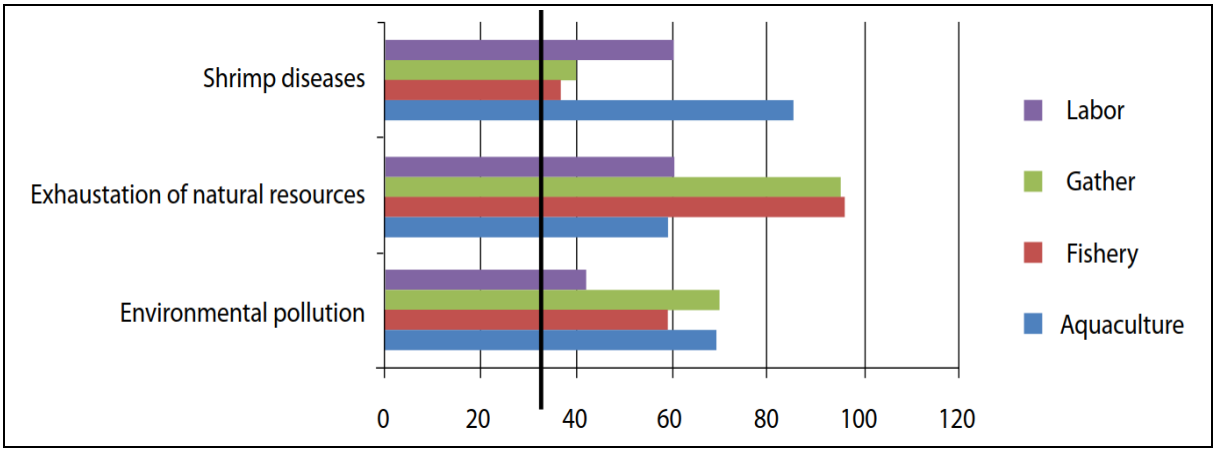


Figure 2.11: Environmental factors affecting four livelihoods sectors in the subproject area

2.2.2. Economic conditions

The economic composition of the subproject districts in 2016 in *Table2.21*shows that Ngoc Hien district is rural area, the infrastructure is still low, combined with specific natural conditions suitable for aquaculture, mainly extensive shrimp farming, shrimp-forest farming, so the rate of agriculture, forestry, and fishery production is higher than that rate of the remaining subproject districts and of the province.

Table2.21: Economic composition in the subproject districts and in Ca Mau province in 2016

No.	Structure of economic components	U Minh district	Nam Can district	Ngoc Hien district	Entire province
1	Agriculture, forestry and aquaculture sector (%)	38.0	30.4	62.9	36.1
2	Industry - construction sector (%)	22.0	46.9	21.3	36.3
3	Service sector (%)	40.0	22.7	15.8	27.6

2.2.2.1. Agricultural production

Rice is still the main crop. Over the past years, the agricultural sector has focused on the implementation of the project on improving the quality and efficiency of shrimp and rice production, promote the application of technical advances in production: such as the new rice varieties, application of 3 reductions 3 gains farming technique, mechanization in production, successful implementation and expanding of many models of rice production. Through the implementation of the project, above 80% of the rice production area is high quality. The average rice yield in 2016 increased by 5.06% compared to 2015, contributing to the shift of production structure and income for the people. In addition to producing intensive rice in the ecological zone, the agricultural sector has directed the implementation of over 40,000ha of

one rice crop, a shrimp crop providing over 160,000 tons of clean rice for the rice market outside the province.

Other crops: 8,039ha of coconut; 2,388ha of cane; 5.700ha of banana trees.

2.2.2.2. Current livelihood models in the subproject area

a). Shrimp farming under the forest canopy

In the period of 2009 - 2017, the area of shrimp culture under the canopy increased from 17,700 ha to 29,636 ha. By 2017, the area of shrimp farming concentrated in Nam Can, Ngoc Hien, Phu Tan, Dam Doi districts. The development of a shrimp-forest modelto protect the environment is associated with sustainable shrimp farming. The considered "ecological" shrimp farming model in recent years are focused and developed; ecological shrimp products are very attractive to consumers and are mainly used for export to major supermarkets in the world. So far, there are 1,065 households participating in the ecological shrimp farming, with the area of 8,815 ha achieving IMO certificates.

b). Shrimp-rice farming

From 2009 to 2016, the area of shrimp - rice farming increased by 3.2%/year (from 36.997 ha, up to 43,215 ha/year). In 2016 the area of shrimp - rice farming concentrated in the districts such as Thoi Binh: 24,185 ha; U Minh: 10,947 ha; Tran Van Thoi: 4,657 ha; Cai Nuoc: 2,249 ha; Ca Mau City: 1,000 ha.

Shrimp farming rotation with rice cultivation: During the dry season, salinity intruded soils, rice cannot be planted; the land is used for shrimp farming to increase land use efficiency and improve the environment. In fact, in recent years, many shrimp - rice farming areas have been moved to improved extensive or intensive aquaculture. Salinity intruded into the 2-rice cultivation areas leading to these areas have been converted into shrimp - rice farming. The technique used in shrimp rice farming is usually combined cultivation, yield 300-350 kg of shrimp/ha/crop.

c). Extensive shrimp farming

From 2009 to 2016, the area of extensive shrimp farming declined steadily with an average decrease of 7.5%/year (from 200,577 ha to 136,005 ha). However, extensive shrimp farming still accounts for the largest area of aquaculture of the province with 46% of the total farming area. Decreasing the area of extensive shrimp farming in the past has shown that people have accumulated experience and resources to move to higher levels of farming to increase productivity and economic efficiency. This is an important condition in the coming time to move from extensive farming to improved extensive and intensive farming. In 2016, the area of aquaculture in Dam Doi was 31,517ha; Phu Tan: 16,488ha; Cai Nuoc: 17,256ha; Thoi Binh: 21,508ha; Ngoc Hien: 13,449ha; Nam Can: 15.697ha.

d). Improved extensive shrimp farming

From 2009 to 2016, the area of improved extensive farming has continuously expanded. In 2009, the area of this farming was 8,540 ha but in 2013 it has increased to 60,200 ha with the average growth rate of 47.8% per year. In 2016, improved extensive shrimp farming concentrated in Dam Doi: 28,000 ha; Phu Tan: 12,000 ha; Cai Nuoc: 9,000 ha; Ngoc Hien: 5,000 ha; Ca Mau City: 900 ha; U Minh: 1,300 ha.

The rapid development of improved extensive shrimp farming area in the period of 2009-2016 is a gradual shift from extensive farming to improved extensive farming and is very suitable for farmers because it has many advantages and benefits over the industrialized shrimp

farming model, while the industrialized shrimp farming is in difficulty, diseases situation is complicated, there is no solution to prevent them; high investment capital with high risk ratio; unstable effect. Improved extensive shrimp farming may contribute to the solution of an increase in production to lack of industrialized shrimp farming's. This is a sustainable farming model and will continue to develop in the coming time, in order to stabilize the environment and balance the ecosystem, contributing to the sustainable development of shrimp farming.

e). Intensive shrimp farming

From 2009 to 2016, the area of intensive shrimp farming has an average growth rate of 43.7%/year (1,339 ha to 8,200 ha). By 2016, the area of intensive shrimp farming in Dam Doi was 2,700 ha; Phu Tan: 2,000 ha; Cai Nuoc: 1,572 ha; Ca Mau city: 1,000 ha; Tran Van Thoi: 650 ha; Thoi Binh: 42 ha; Nam Can: 150 ha; Ngoc Hien: 60 ha.

Although intensive shrimp farming has a high growth rate, it is not commensurate with the potential of the province, the intensive shrimp farming only accounts for 2.7% of the total aquaculture area of the whole province and remains fragmented, small, investments in planned areas for this farming are still low. Although plans and policies for farming have been supported, the development rate is still slow compared to the planned rate. According to Decision 06/2011/QD-UBND of Ca Mau PPC on approving the program of intensive shrimp farming development to 2015 and orientation to 2020, the area of intensivefarming to 2016 must reach 9,750 ha but in facts, it only reached 8,200 ha by 2016.

f). Fisheries

Fisheries in Ca Mau mainly focuses on marine. Domestic fishing activities are small, self-sufficient and not for production. Therefore, the analysis and planning calculations focus only on the field of marine exploitation.

Seafood production in Ca Mau is mainly from fisheries. In 2014, seafood catching reached 198,954 tons. Of which, 16,135 tons of shrimp accounted for 9.15%, fish accounted for 70%, squid and other seafood accounted for 20.85% of the total output. Although the annual harvest is still increasing, the contribution of the production is decreasing due to the increased contribution of aquaculture.

2.2.3. Irrigation system

Current status of irrigation in Ca Mau province includes 9.008 km of canals with the capacity to serve 538,000 ha of agricultural and fishery land (*Table2.22*); 108 km of sea dyke; 155km of river dyke; 264 km of the embankment (*Table2.22*) and 191 culverts (*Table2.24*).

Table2.22: Current canal system in the subproject area

No.	Canal	Number of item (item)	Total length (km)	Serving area (ha)
1	Axis canal	40	890	120,000
2	Primary canal	240	2,706	260,000
3	Secondary canal	828	3,647	130,000
4	Tertiary canal	971	1,765	28,000
	Total	**2,079**	**9,008**	**538,000**

Table2.23:Current sea dyke and embankment (km)

Area	***Sea Dikes***		***River Dikes***		***Primary Embankments***		***Total***	
	Total	***Existing***	***Total***	***Existing***	***Total***	***Existing***	***Total***	***Existing***

Total	**216**	**108.0**	**700.0**	**155.0**	**544.4**	**264.0**	**1460.4**	**527.0**
Northern Ca Mau		66	160	67	124			
Southern Ca Mau		42	320	98	420.4			
Coastal			220					

Table2.24: Current sluices in the subproject area

Area	***B=3-5***	***B=6-10***	***B=11-15***	***B=16-20***	***B=21-25***	***B>25***	***Sluice***	***ΣBwide***
Ca Mau	52	28	17	3			100	375
Northern Ca Mau, QLPH	31	21	17	3				
Southern Ca Mau	12	7						

2.2.4. Natural disasters

2.2.4.1. Damage caused by salinity intrusion, high tides

High tides combine wind, whirlwind, hurricane and salinity intrusion often occur in most coastal provinces of the Mekong Delta. Whirlwind usually occurs abnormally blowing off houses, trees, young rice, and vegetables. High tides combine withnortheast windsusually occur once every 5-7 years, causing sea level rises, plus heavy rains to overflow embankments in the fields, causing significant damages to agricultural and aquacultureproduction.The summary results of the damages in Nam Can and Ngoc Hien districts show:

- From 2010 to 2014:
  - Ngoc Hien District: High tides on 18and 19 October 2012 with the highest water level in history damaged 200 ha of land and 234 households.
  - Nam Can District: the most affected communes are Dat Moi, Ham Rong, Tam Giang Dong, Lam Hai, Hiep Tung, and Nam Can town. Due to high tides, waters broke some embankments of shrimp ponds along the rivers (188m); overflew over 1,000m; the total area of shrimp farming was damaged over 11,000ha, estimated the damage of nearly 2 billion.
- 2015: The tide is rising unusually, particularly in the first months of the year (Lunar New Year) and at the end of the year as ofNovember (Hmax in Nam Can on 14/02/2015 and 28/11/2015 were +1.65 and + 1.66m, respectively). High tides combined with northeast winds to overflow the embankments, breaking them causing heavy damage to two districts of Nam Can and Ngoc Hien, in which:
  - Nam Can District: On 11 February 2015, there were 20 broken embankments of about 559.5m (including 299.5m of bank break), affecting 86 ha of aquaculture land, causing damage of 1,350 million VND. On 28th November 2015, 11 overflown sections of about 599.3m were broken (including 47m of the embankment), affecting 9.1ha of aquaculture land, causing damage of 70 million VND.
  - Ngoc Hien District: 27 overflown sections of about 11,616m were broken at both times (in which the embankment broke 206m), affecting 303 ha of aquaculture, causing damage to 1,850 million VND.
- 2016: According to the water level monitoring in Nam Can,the tide level on 08/2/2016 is Hmax = + 1.65 and Hmax = + 1.69 on 16 November 2016, the water has overflowed, breaking embankments causing severe damages to the 2 districts, of which:

- Nam Can District: On 8th February 2016, there were 16 broken overflow sections with about 429.5m (including 104m of concrete roads, 87.5m of the embankment) affecting 86 ha of aquaculture land, causing damage of 2,096 million VND. On November 16th, 2015; there were 11 overflow sectionsof about 599m broken (of which the embankment break of 47m), affecting 9.1 ha of aquaculture and lost 70 million VND.
- Ngoc Hien district: both times had 32 overflowbreaks of about 7.285m (in which the embankment break of 205m, affecting 172 ha of aquaculture and lost 1.728 million.

2.2.4.2. Coastal erosion in the West Sea

In recent years, the coastal erosion, in the Mekong Delta in general and in Ca Mau, in particular, has become quite common, and a serious threat to the lives and property of the people and caused loss of coastal land, vegetation, natural environment, economic and social instability of the area, affecting the planning of land use in the province, impacted on the safety of the sea dike.

The West Coast of Ca Mau province starts from Kien Giang border (at Tieu Dua canal) to Dat Mui (Rach Tau Tourist Area). The total length of the West Coast is 147 km, passing through 5 districtswith 14 communes: Khanh Tien and Khanh Hoi (U Minh district); Khanh Binh Tay Bac, Khanh Binh Tay, Khanh Hai, Song Doc and Phong Dien communes (Tran Van Thoi district); Phu Tan, Tan Hai, Cai Doi Vam, Nguyen Viet Khai and Rach Cheo communes (Phu Tan district); Dat Moi commune (Nam Can District); Vien An and Dat Mui communes (Ngoc Hien district). Under the impact of climate change, sea level rise has caused serious landslide coast, from 2007 to now, the level of landslide averaging 15m/year, especially in some places up to 50m/year. According to statistics, about 3,810 ha of protective forest in the West Sea has been lost, 40,600m of coastline was severely eroded, including 17,000m of very dangerous landslide and 23,600m of the dangerous landslide (*Figure 2.12*).

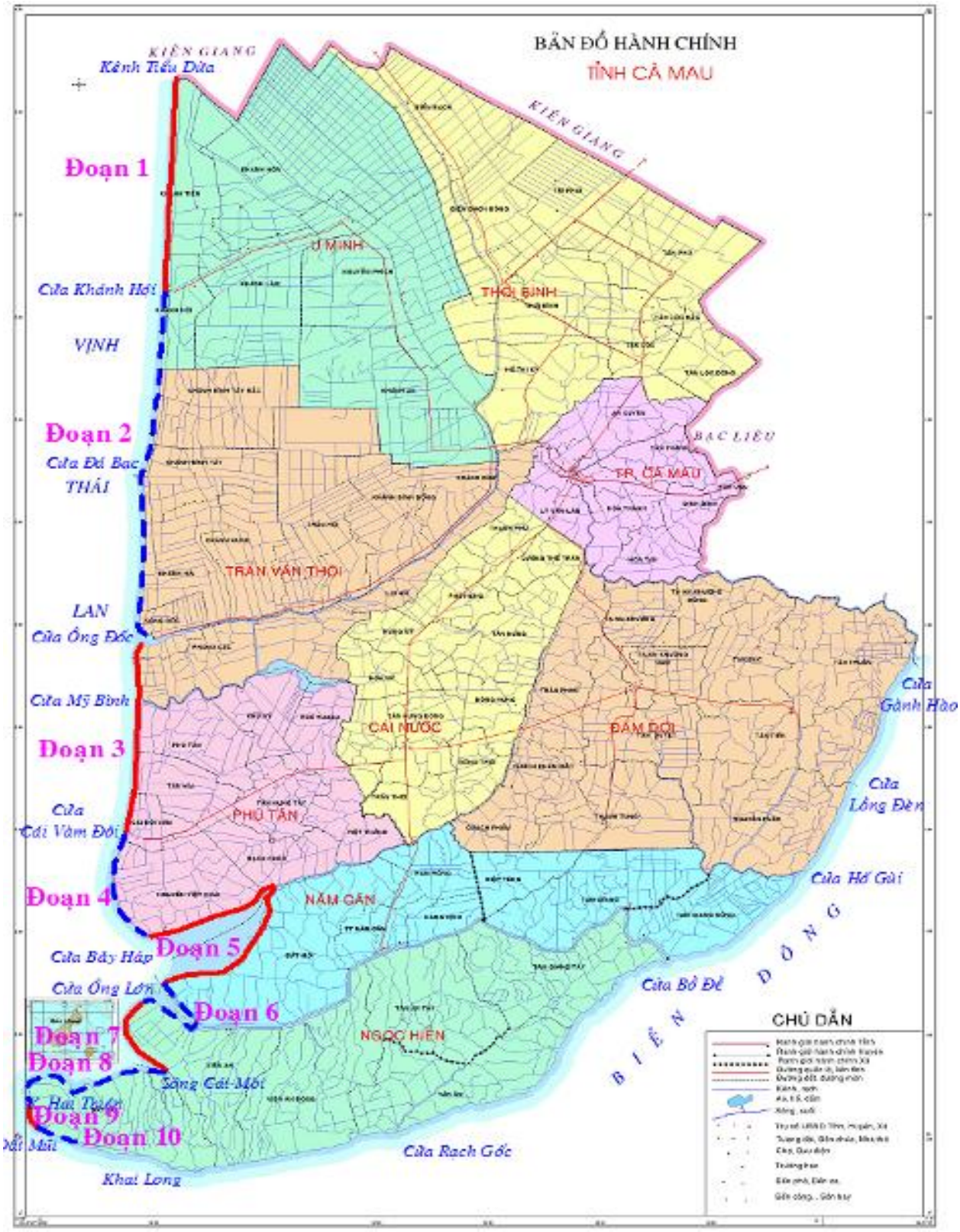


Figure 2.12: Erosion segments of the West sea coast, Ca Mau province

2.3. CHARACTERISTICS OF BACKGROUND CONDITIONS OF THE SUBPROJECT

Characteristics of background conditions at the construction sites of the reservoir and WSP are described in *Table 2.25* to *Table 2.29*.

Table 2.25: Background conditions at the construction sites of the reservoir

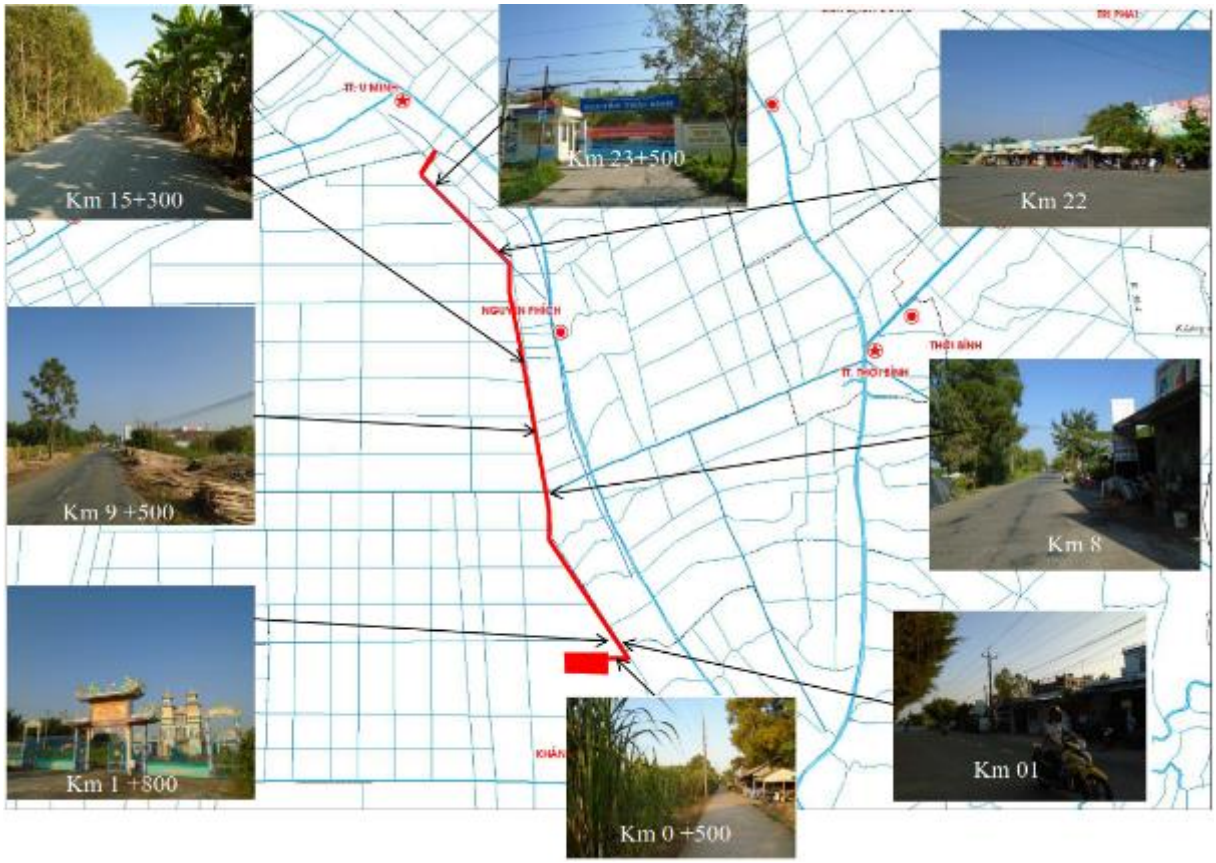
No.	Work Item/Location and photos/map	Noticeable Features
		
1	In the west of the reservoir  	This is Vien Phu Green Farm (Vien Phu Organic Farm) that cultivates and provides organic food chains such as organic rice, fish and fresh vegetables with an area of 340 ha.
2	In the north of the reservoir 	This is the area where farmers cultivate mainly 1-rice crop. People live scattered on the bank which is opposite the reservoir.
3	In the earth of the reservoir	This is the resettlement area of Khanh An commune. Currently, this is a low-lying area and the infrastructure in the area is not complete, there is only a school (Khanh An high school)

No.	Work Item/Location and photos/map	Noticeable Features
	 	
4	In the south of the reservoir 	This is the area where farmers cultivate mainly 1-rice crop. People live scattered on the bank which is opposite the reservoir.

Table 2.26:Background conditions at the disposal site

No.	Work Item/Location and photos/map	Noticeable Features
	   	The land to be used for store excavated soil from the reservoir is the resettlement area in Khanh An Commune (Zone 1, Zone 2 and Zone 4). This area is next to the reservoir and only a few households are living in this area. There have Khanh An High School and Khanh An Secondary School in this area. The topography of this area is low, the surface is covered by weeds, the land is not leveled, so the excavated soil willbe used for leveling the area.

Table 2.27: Background conditions along with the pipeline system

No.	Work Item/Location and photos/map	Noticeable Features
		
1	Km0 to Km 1+500  	This section is along the canal side of the Khanh An high school, along the concrete road to the school and out along Khanh An - U Minh. People mainly live at the entrance to the school.

No.	Work Item/Location and photos/map	Noticeable Features
	 	
2	Km 1+500 to Km 6+200  	In this section, people live scattered along both sides of the road, both sides of the road are planted Melaleuca and rice-shrimp ponds. There is Cuu Linh Chau Temple at Km 2 and the road leading to Khanh An Cemetery

No.	Work Item/Location and photos/map	Noticeable Features
	 	
3	Km 6+200 to Km10  	This section of the population is more crowded and concentrated in the intersection between the road from Thoi Binh Town to Khanh Lam and the road from Khanh An - U Minh. Both sides are planted Melaleuca trees and rice-shrimp ponds

No.	Work Item/Location and photos/map	Noticeable Features
4	Km 10 to Km 22  	In this section, people live scattered along the 2 sides of the road. Both sides are planted Melaleuca trees and rice-shrimp ponds
4	Km 22– Km 25   	This section is located in U Minh Town, people living crowded area along the road. The pipeline will connect with the water supply station of U Minh town. The section passes Nguyen Thai Binh Secondary School

No.	Work Item/Location and photos/map	Noticeable Features
		

Table 2.28: Background conditions in the construction area of the wave breaker

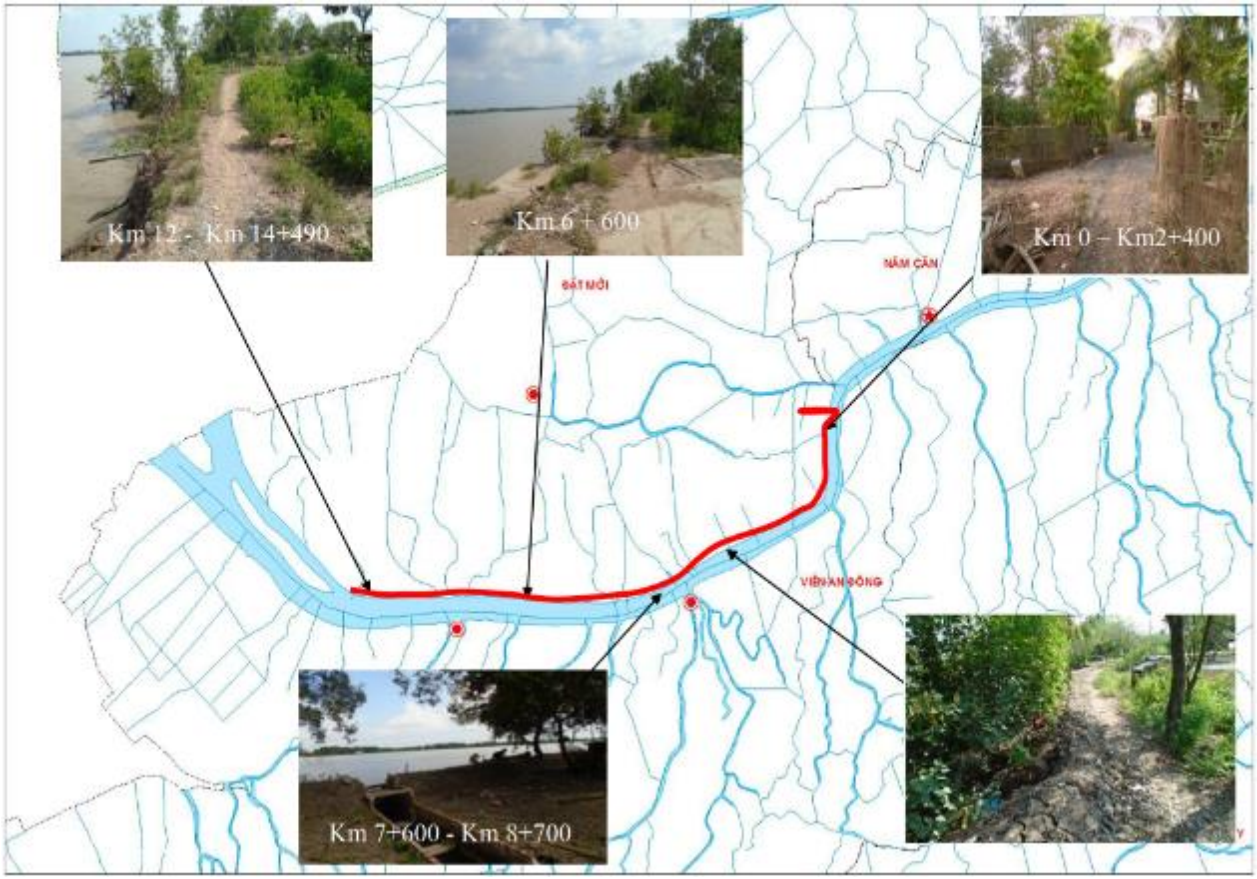
No.	Work Item/Location and photos/map	Noticeable Features
		
1	 *Section 1 and 2*	These 2 sections located along the West Coast, from Tu canal to Moi canal. This section is about 150m-200m from the shoreline, in the area of the protected forest is seriously eroded.

	 	
2	*Section 2 to section 5*   	These 3 sections located along the West Coast, from Sao Luoi to Vam Ba Tinh. This section is about 150m-200m from the shoreline, in the area of the protected forest is seriously eroded

Table 2.29: Background conditions in the construction area of the embankment

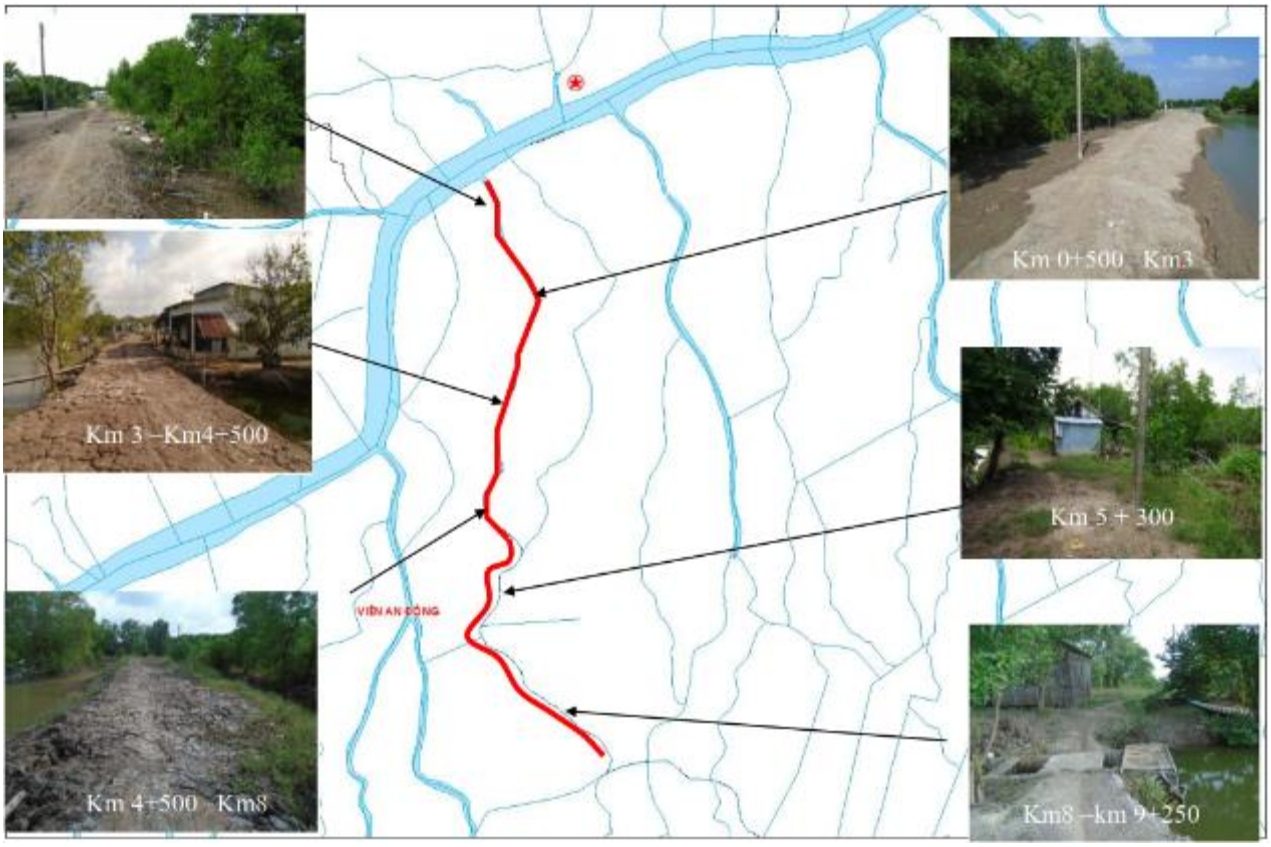
No.	Work Item/Location and photos/map	Noticeable Features
1	*Embankment route from Trai Luoi bridge to Vam Chung L=11.22km*	
		
1.1	From Km 0 to Km 2+600  	The population is sparsely populated, the starting point is near the Trai Luoi Bridge, this route passes through the embankments of shrimp ponds and existing canal banks.
1.2	From km 2+600 to Km 5+500	The population is sparsely populated, the population is concentrated on the other side of the river, the embankment passes through the existing banks of shrimp ponds and

No.	Work Item/Location and photos/map	Noticeable Features
	 	canals.
1.3	From Km 5+500 to Km 7+200  	People sparsely lives in this section, people contribute their money to build a concrete road about 2m wide, 1.5km long along the canal. The embankment will be constructed along this road.
1.4	From Km 7+200 to Km 11+200	There are few people living in this section and the embankment will pass through the existing banks of shrimp ponds and canals.

No.	Work Item/Location and photos/map	Noticeable Features
	 	
2	*Route from Nam Can bridge – Xeo Doi L= 14.94km*	
		
2.1	From Km 0 to Km 2+400	The first point of the route is near the Nam Can Bridge, sparsely populated, the embankment passes through existing banks of shrimp ponds and canals.

No.	Work Item/Location and photos/map	Noticeable Features
	 	
2.2	From Km 2+400 to Km 7+600  	In this section, people live sparsely along the river, the embankment will pass through small canals and the existing banks of shrimp ponds and rivers.
2.3	From Km 7+600 to Km 8+700	In this section, people live sparsely, mainly concentrated in the canal heads. The embankment will pass through a shrimp hatchery and existing banks of shrimp ponds and rivers

No.	Work Item/Location and photos/map	Noticeable Features
	 	
	From Km 8+700 to Km 12  	In this section, people live sparsely along the river, the embankment will pass through small canals and the existing banks of shrimp ponds and rivers.
	From Km 12 to Km 14+940	In this section, people live sparsely along the river, the embankment will pass through small canals and the existing banks of shrimp ponds and rivers.

No.	Work Item/Location and photos/map	Noticeable Features
	 	
3	*Embankment route from Ong Nhu to Tan An Tay CPC (L=9.25km)*	
		
3.1	From Km0 to Km 3	The embankment is located on the right bank of Ong Nhu canal, the first

No.	Work Item/Location and photos/map	Noticeable Features
	 	point connecting to the road along the Cai Lon river. The existing embankment has been leveled up to upgrade the embankment
3.2	FromKm 3 to Km 4+500  	This section has the existing embankment and there have few people living along this section.

No.	Work Item/Location and photos/map	Noticeable Features
		
	From km4+500 to km 8  	This section will pass through the existing banks of shrimp ponds and canals. There have few people living along this section
	Đoạn Km8 –km 9+250 	This section will pass through the existing banks of shrimp ponds and canals. There have few people living along this section. The end point of this section is 500m far from Tan An Tay CPC

No.	Work Item/Location and photos/map	Noticeable Features
		
4	*Embankment route from Vam Ong Dinh to Tam Giang Tay CPC (L=26.08km)*	
		
4.1	From Km 0 to Km 2+600 	People live sparsely in this section. The embankment will be in-field side and pass through shrimp ponds

No.	Work Item/Location and photos/map	Noticeable Features
		
4.2	From Km 2+600 to Km 8+200  	People live sparsely in this section. The embankment will be in-field side and pass through shrimp ponds
4.3	From Km 8+200 to Km 12+200 	People live sparsely in this section. The embankment will be in-field side and pass through shrimp ponds

No.	Work Item/Location and photos/map	Noticeable Features
		
4.4	From Km 12+200 to Km 14+700  	People live sparsely in this section. The embankment will be in-field side and pass through shrimp ponds
4.5	From Km 14+700 to Km 16 	People live sparsely in this section. The embankment will be in-field side and pass through shrimp ponds

No.	Work Item/Location and photos/map	Noticeable Features
		
4.6	From Km 16 to Km 25+700  	People live sparsely in this section. In this section, people contributed their money to build a concrete road of 1.5-2.0m wide along the shrimp ponds. The embankment route will be along this road.
4.7	From Km 25+700 to Km 26+080 	The end point of the embankment is located in the center of Tam Giang Tay Commune. The embankment will be built along the existing concrete road. There are Tam Giang Tay I Primary School, Tam Giang Tay Border Guard Station and few people living in this area.

No.	Work Item/Location and photos/map	Noticeable Features
	  	

2.4. ASSESSMENT OF THE SUBPROJECT LOCATION TO THE SOCIO-ECONOMIC CHARACTERISTICS OF THE SUBPROJECT AREA

In the area of reservoir and WSS construction: this area is facing challenges such as drought, regularly lack fresh water for living during the dry season, land subsidence due to over-exploitation of underground water. Some areas of no having groundwater to use anymore such as the canal No.29 of U Minh Ha Melaleuca forest, people here tried to drill more than 200m deep but still no water, leading to 20% of rural households not to have clean water to use. Groundwater extraction may occur land subsidence with the rate of 1.56-2.3cm per year. Construction of this item will meet very well the objectives and be consistent with the socio-economic conditions of the region, including (i) Ensuring water supply for people in U Minh district (with 113,780 people); (ii) Limiting groundwater exploitation, avoiding land subsidence (about 2cm / year); (iii) Contributing to creating livelihoods for people in U Minh Ha forest area and (iv) collecting excess rainwater from the area to the sea.

In the area of wave breaker construction: the erosion situation is becoming more serious, the mangrove forest is gradually losing, leading to the livelihoods of the coastal people being seriously affected. Prevention of erosion and rehabilitation of protection forest in the West sea coastline are urgent issues to be addressed immediately by the locality. Under the impact of climate change, the mangrove forest belt of West Sea dyke protection is in danger of completely disappearing (25,200ha), especially the section from Ba Tinh to Tu canal. Currently, along the whole belt, some locations are found to be at high risk of erosion (the

width of the forest belt is very thin, some places only have about 15-20m), if not handled early, it will be very dangerous. Especially, length of the erosion at the section from Moi canal to Hon canal, Khanh Binh Tay commune, Tran Van Thoi district is 3,700 m and 20 km for the section from Lung Tram to Da Bac. From the year 2001 to January 13, 2015, the west coast section from Lung Tram to Da Bac was eroded to 200m. The rate of deforestation 200 m/14 years = 14.2 m/year. This area is facing challenges such as the coastal protection function of the mangrove protection forest decreases, erosion increases (17km, 30-80m/7 years). Production in this area is low and, fragmented so the value is low, products are difficult to develop towards producing goods according to the product value chain. Construction of the embankment will protect the coast, protect the people, be in line with the production - living of the people here.

In the construction area of the embankment: this is low terrain and directly affected by the East Sea tide, irrigation works are quite simple, not enough to protect people and production. Most of the embankments here are low, they are used to protect aquaculture ponds. While due to impacts of climate change, sea level rise, the tide is increasing; although every year the people tried to improve the embankments did not withstand the high tide. According to the report of the specialized agency, if the water continues to rise by 20cm, there will be about 1,300 km of embankments at risk of being overflowed, the impact will be very serious. Upgrade existing embankments and build new embankment will meet the requirement for people and production protection for the area.

CHAPTER 3. SUBPROJECT ALTERNATIVES

The content of Chapter 3 compares the alternatives of the subproject regarding economic, social and environmental aspects, including: (i) with and without subproject alternatives and (ii) the technical options of the subproject's construction items.

3.1. ANALYSIS OF "WITH" AND "WITHOUT" ALTERNATIVES

The content of this section is intended to analyze the environmental and social impacts of the "with" and "without"alternatives of the subproject:

- In the case of "without" the subproject: when the subproject is not implemented, this means that environmental and social issues that are happening, such as lack of freshwater for daily life and production, difficult transportation, the area will be affected by salinity intrusion and sea level rise, people's awareness of climate change is still low and the income of people in the aquaculture area will be affected by the water quality and pollution in canals, water quality monitoring system, aquatic diseases, aquatic species are inadequate, the link between people and the market is not good leading to output products are not well consumed, and are forced in prices.
- In the case of "with" subproject: when the subproject is implemented, including building freshwater reservoirs to supply water for people in U Minh district, restricting underground water exploitation for living to reduce land subsidence; building coastal dikes to protect the coast from the impacts of sea waves and climate change; building embankments to protect the population and production activities against the effects of tides; aquaculture farms in Nam Can, Ngoc Hien districts have been planted to meet the requirements for ecological shrimp certification and supports to obtain the certification of ecological shrimp farming,...

Detailed analysis of environmental and social impacts with and without the subproject is presented in *Table3.1*.

Table3.1: Comparison of environmental and social impacts with and without the subproject

No.	Issues	Options	
		Without the subproject	**With the subproject**
1	**Environmentalissues**		
1.1	Environmental and ecological quality	- Water sources are polluted by wastewater from production activities - Production of aquaculture is inadequate due to the lack of techniques resulting in loss of forest - Unstable production due to water pollution, shrimp diseases, lack of cultivation techniques - The fresh ecological zone is affected by salinity intrusion, causing damage to production	- Improving water quality through supporting ecological shrimp certification, one of the requirements for certification is that the environment must be improved. - Reviewing and restoring the system of protective forests, mangroves afforestation and increase forest belts on a scale of 120ha (ensuring 300m of forest belts)
1.2	Adaptation to climate change	- The subproject is located in the coastal area, which is expected to be severely affected by salinity intrusion in the context of climate change, leading to scarcity of	- Raise local awareness on climate change by establishing a climate change adaptation unit. - Develop livelihood models for communities living within the

		freshwater resources. - The awareness of people on climate change is still low. - The current livelihood is unsustainable in the context of salinity intrusion and climate change.	forest belt
2	**Social issues**		
2.1	Increase the income of the households in the beneficiary area of the subproject	The income of people in the area is affected due to: - Salinity intrusion, maximum water level (Hmax) up from +1.65 to +1.69m causing damage of hundreds of hectares of aquaculture land and loss of billion VND - The area of forest shrimp farming is about 29,636 ha, of which there are 8,815 ha of organic shrimp farming, the rest is non-organic farming due to the forest rate is only about 42.5% (not meet the requirement of forest rate to get organic certification) - Erosion rate is about 14.2 cm per year	Contributing to the increasing income of the people due to: - Regulating the water source will reduce the damage caused by salinity intrusion into the production area. - Planting additional mangrove of 271.4ha in the shrimp – forest ponds of 444,252 people. After planting, forest rate in these ponds meet the requirement of organic shrimp certification. The price of organic shrimp is higher than that of non-organic shrimp - Controlling erosion for the region.
2.2	Provide freshwater for living	- At present, in the area, the freshwater source for daily life in the region is lacked due to salinity intrusion, people use groundwater for daily use. In U Minh, Tran Van Thoi and Thoi Binh districts, there are 65,000 groundwater wells with flow of 155,332 m3/day. Land subsidence in the region is from 1.56-2.3 cm/year. - Current groundwater extraction accounts for 17.83% of potential reserves	- Once the freshwater reservoir is built, water will be supplied to 113,780 people in U Minh district. - Minimize exploitation of groundwater for daily life, limiting land subsidence
2.3	Improve transportation infrastructure	Transportation infrastructure in some areas of the region has not been completed, such as in Nam Can and Ngoc Hien districts.	Once the 4 embankment routes have been built, they will fill the gaps in traffic of the communes in the area of Nam Can and Ngoc Hien districts.
2.4	Land acquisition and resettlement	No land acquisition and no resettlement required.	Land acquisition of households and no relocated households

3.2. CONSIDERING ENVIRONMENTAL AND SOCIAL ISSUES IN PREPARATION OF FEASIBILITY STUDY

In the preparation of the feasibility study report, apart from complying with the documents of the Feasibility Study Report (FSR) of the ICRSL project and the relevant regional plans and schemes, the owner of the subproject and the consultant have prepared of the feasibility report, which has been reviewed and the chosen route for the subproject is planned to minimize environmental and social impacts, as follows:

- For the water reservoir and WSP item: The site is located in the area with the least land loss, or in public land areas managed by the State, without using the land of the National Park, the number of relocated households is the lowest to minimize the impact on the environment and society.
- For the embankment: the selected route is in the area with the least land loss, affecting houses and structures, without any displaced households.
- For thewave breaker: It is located in the sea without land acquisition and does not affect houses and works.
- For the mangrove planting n: To be planted in the forest-shrimpponds to ensure the certification of ecological shrimp farming, no land is acquired, and no impacts on the people. Additionally, when the forest is planted, it will contribute to environmental protection, active adaptation to climate change, and the forest planting sites are to ensure the area of shrimp forest to meet ecological shrimp farming standards, which will contribute to the improvement of people's income.

In addition to the consideration when choosing locations, choosing the technical options, environmental and social issues are also considered, see details in *Table3.2*and*Table3.3*.

Table3.2: Selected technical options of embankment routes implemented in the subproject

No	**Compared content**	**Option 1** **Technology of centrifugal concrete pile**	**Option 2** **Technology of Groyne of hollow piers**	**Option 3** **Technology of Groyne of hollow piles**
1	Advantages	- Due to the cylindrical structure, the force of the dikes is toward the center, thus reducing the horizontal force, so suitable for the weak ground. - Very good wave reduction, up to 70% - The structure uses the anchoring principle, therefore, the high stable, and quick to install. - Centrifugal piles can be moved to other locations with deeper levels (to -2) to protect the protective forest when the protected area has been accelerated, regenerated forest trees.	- Due to the cylindrical structure, the force of the dikes is toward the center, thus reducing the horizontal force, so suitable for the weak ground. - Very good wave reduction, up to 80% - The ability to cause acceleration after works quickly, measured data after 1 year, sediment after the project from 40-60cm to create conditions for forest regeneration. - Hollow piers can be moved to other locations with deeper levels (to -2) to protect the protective forest when the protected area has been accelerated, regenerated forest trees.	- Due to the cylindrical structure, the force of the dikes is toward the center, thus reducing the horizontal force, so suitable for the weak ground. - Very good wave reduction, up to 70% - Apply anchor principle for the structure to ensure high stability, fast installation - Hollow piles can be moved to other locations with deeper beaches (to -2m) to protect the forest when the beaches nourished and trees planted
2	Disadvantages	- This solution is effective for reforestation, anti-landslide, but the long acceleration time. - Difficult to move to another location when	- Although the stability is high, good ability to reduce waves, very good accretion, these new works have only been applied in experimental	Although the stability is high, good ability to reduce waves, very good accretion, no real work applied in practice only anthe experiment.

		the forest has been regenerated	form and the technology is continuing to be studied.	
3	Socials impacts	- Located in the sea. - Social impacts will be insignificant and no households and public works will be affected by land acquisition	- Located in the sea. - Social impacts will be insignificant and no households and public works will be affected by land acquisition	- Located in the sea. - Social impacts will be insignificant and no households and public works will be affected by land acquisition
4	Environmental impacts	- Good performance on protecting the environment, reducing erosion, protecting forests, and maintaining ecological functions of mangrove ecosystems.	- Good performance on protecting the environment, reducing erosion, protecting forests, and maintaining ecological functions of mangrove ecosystems.	- Good performance on protecting the environment, reducing erosion, protecting forests, and maintaining ecological functions of mangrove ecosystems.
5	Economic efficiency	About 23 millions/md	About 17 millions/md	About 20 millions/md
	Conclusion	**Selected**	Not Selected	Not Selected

Table3.3: Technical options for the reservoir

No	Indicators	Option 1	Option 2	Option 3	Option 4
1	Specifications	- Surface area: 70 ha; - Elevation of the reservoir bottom - 2.50 m; - Elevation of the reservoir: +3.50m; - Reservoir flows: Width 10.0m, elevation around 0.0m; - Head water level: +2.50m; - Reservoir capacity: 3.85 mil. m^3.	- Surface area: 65 ha; - Elevation of the reservoir bottom - 3.50 m; - Elevation of the reservoir: +3.00 m; - Reservoir flows: Width 10.0 m, elevation around - 0.5 m; - Head water level: +2.00 m; - Reservoir capacity: 3.85 mil. m^3.	- Surface area: 60 ha; - Elevation of the reservoir bottom - 6.00 m; - Elevation of the reservoir: +2.00 m; - Reservoir flows: Width 10.0 m, elevation around - 1.5 m; - Head water level: +1.00 m; - Reservoir capacity: 3.85 mil. m^3.	- Surface area: 60 ha; - Elevation of the reservoir bottom - 7.00 m; - Elevation of the reservoir: +2.50 m; - Reservoir flows: Width 10.0 m, elevation around - 1.5 m and - 4.50m; - Head water level: +0.08 m; - Reservoir capacity: 3.85 mil. m^3.
2	Form of water collection	- Collect water to elevation + 1.00m - Pumping water for reservoir to design level + 2,50m	- Collect water to elevation + 1.00m - Pumping water for reservoir to design level + 2,00m	- Collect water to elevation + 1.00m	- Collect water to elevation + 0.80m
3	Reservoir Items	- 70 ha reservoir - 01 drain for water B = 3m - 01 pump station Q = 3,500 m^3/h	- 65 ha reservoir - 01 drain for water B = 3m - 01 pump station Q = 2,000 m^3/h	- 60 ha reservoir - 01 drain for water B = 3m	- 60 ha reservoir - 01 drain for water B = 3m
4	The volume of digging, cover and	- Digging: 2.03 mil. m^3	- Digging: 2.76 mil. m^3	- Digging: 3.47 mil. m^3	- Digging: 3.72 mil. m^3

No	Indicators	Option 1	Option 2	Option 3	Option 4
	land leveling	- Covering the reservoir: 0.8 mil. m^3 - Land for ground leveling: 1.20 mil. m^3	- Covering the reservoir: 1.0 mil. m^3 - Land for ground leveling: 1.7 mil. m^3	- Covering the reservoir: 0.98 mil. m^3 - Land for ground leveling: 2.5 mil. m3 *Meet the demand for land leveling in the subproject area*	- Covering the reservoir: 1.0 mil. m^3 - Land for ground leveling: 2.7 mil. m^3 *Meet the demand for land leveling in the subproject area*
5	Funding for construction of the reservoir (the estimates based on the volume of earthworks)	$ 71 billion	$ 87 billion	$ 97.6 billion	$ 105 billion
6	Loss of reservoir water for 1 year	- Surface loss: 1,049mm x 70ha = 734,300 m^3 - Loss due to seepage: 70.7mm x 70ha = 49.490 m^3	- Surface loss: 1,049mm x 70ha = 734,300 m3 - Loss due to seepage: 70.7mm x 70ha = 49.490 m^3	- Surface loss: 1,049mm x 60ha = 629,400 m^3 - Loss due to seepage: 70.7mm x 60ha = 42,420 m^3	- Surface loss: 1,049mm x 60ha = 629,400 m^3 - Loss due to seepage: 70.7mm x 60ha = 42,420 m^3
7	Management of the reservoir for one year	- Gradually intake water to the reservoir to level + 1.0m in 3 months (August, September, October) - Total water to be pumped: 1.4 mil. m3, pump cost: 140 mil. VND (100 VND / m^3)	- Gradually intake water to the reservoir to level + 1.0 m in 3 months (August, September, October) - Water pump to designed elevation + 2.5m on October. Total pumped volume: 0.7 mil. m3, pump cost: 70 mil. VND (100 VND/m^3)	- Gradually intake water into the reservoir to level + 1.0m *Simple operation management, no management costs so reduce the price of finished water*	- Gradually intake water into the reservoir to level + 0.8m *Simple operation management, no management costs so reduce the price of finished water*
8	Scalability of the subproject	- Limit the scalability of the system when the need arises.	- Limit the scalability of the system when the need arises.	- Can scale up the system when needed.	- Can scale up the system when needed.
9	Social impacts	- Land acquisition of 172,2 ha (102,2ha permanent acquisition, 70ha temporary acquisition, and no households and works will be affected).	- Land acquisition of 172,2 ha (102,2ha permanent acquisition, 70ha temporary acquisition, and no households and works will be affected).	- Land acquisition of 172,2 ha (102,2ha permanent acquisition, 70ha temporary acquisition, and no households and works will be affected).	- Land acquisition of 172,2 ha (102,2ha permanent acquisition, 70ha temporary acquisition, and no households and works will be affected).

No	Indicators	Option 1	Option 2	Option 3	Option 4
		- The volume of exceeding excavated soil (2.03 million m^3) has not met the demand for soil leveling in the area.	- The volume of exceeding excavated soil (2.76 million m^3) has not met the demand for soil leveling in the area.	- The volume of exceeding excavated soil (3.47 million m^3) has met the demand for soil leveling in the area.	- The volume of exceeding excavated soil (3.72 million m^3) has met the demand for soil leveling in the area.
10	Environmental impacts	Vulnerable to alkaline intrusions	Vulnerable to alkaline intrusions	Vulnerable to alkaline intrusions	Vulnerable to alkaline, salinity intrusions due to deep digging
	Conclusion	Not selected	Not selected	Selected	Not selected

Table3.4: Technical options for the embankment

No.	Option 1	Option 2	Option 3
I-1	***The route from Ong Dinh river to Tam Giang Tay Commune People's Committee of Ngoc Hien district (28,053 m long)***		
Description of option	**Aligning to the river bank and far 100 m away from the river edge in accordance with the river-dike standard**	**Aligning to the rural road of the district which was approved**	**Aligning to the rural road of the district which was approved**
Technical aspects	- Ensure long-term stability of the section - The section is straight - The construction time is prolonged - As the land foundation has just been leveled on shrimp pond, we must wait for its cohesive settlement, which takes much time	- Ensure long-term stability of the section, - The section is straight, - Coincide with the planned rural road of the district, - The boundary of the embankment is public land. - The filling soil acquires large quantity while the site is located between the shrimp ponds, which makes difficult for carrying soil, - The construction is implemented in many stages due to waiting for soil settlement.	- Ensure long-term stability of the section, - The section is relatively straight, - Some sections go deep into the farming field about 400m but others are close the river bank
Social impacts	The route passed fewer structures	Land for the embankment is the public land and impacts on structures is the lowest the route passes less architectural structures (house ...) so the social impacts are lowest	The route passed over many architectural structures and caused loss of large-scale production land
Environmental impacts	The route will be built from shrimp pond and current ground, it takes a long time for consolidation, higher impacts on the environment than option 2	The route will be built on existing roads, the construction time is lowest and lowest impacts on the environment	The route will be built from shrimp pond and current ground, it takes a long time for consolidation, higher impacts on the environment than option 2
Conclusion	Not selected	**Selected**	Not selected
I-2	***Route of Vam Ong Nhu – Tan An Tay CPC, Ngoc Hien district***		

No.	Option 1	Option 2	Option 3
Description of option	**Aligning to the river bank and far 100 m away from the river edge in accordance with the river-dike standard**	**Aligning to the existing trail (either front of households or back of households) filling tray into the farming field direction**	**Aligning to the existing power transmission line**
Technical aspects	- Ensure long-term stability of the section. - The section is straight. - Cannot make use of the existing road pavement.	- In line with the rural transport network, - Take advantage of stable road pavement, - The boundary of the embankment is public land.	
Social impacts	The highest impact on the structure and land acquisition	Fewer impacts on structures and land acquisition	Impacts on structures and land acquisition are lower than option 1 but higher than option 2
Environmental impacts	Take time to construct as the land foundation has just been leveled on shrimp pond, high impacts on the environment	The route will be built on existing roads, the construction time is lowest and lowest impacts on the environment	Take time to construct as the land foundation has just been leveled on shrimp pond, high impacts on the environment
Conclusion	Not selected	**Selected**	Not selected
II-1	***Route of Trai Luoi bridge – Vam Chung T-junction – Ong Gay, Nam Can district***		
Description of option	**Aligning to the river bank and far 100 m away from the river edge in accordance with the river-dike standard (behind people's settlement)**	**Aligning to the existing trail (either front of households or back of households)**	**Aligning to the river bank**
Technical aspects	- Ensure long-term stability of the section, - The section is straight, - Pass less architectural structures. - Loss of productive land and forests, - The construction time is prolonged.	- The embankment is stable, which only requires filling tray toward the farming field direction without roadbed treatment, - The construction is quick. - The filling soil acquires large quantity while the site is located between the shrimp ponds, which makes difficult for carrying soil.	- Save cost; save residential and production land, - Take advantage of existing shoreline. - Due to instability, the road-tray toward riverbank must be strengthened and costly, - The construction requires the clearance of many houses.

No.	Option 1	Option 2	Option 3
Social impacts	The highest impact on the structure and land acquisition	Fewer impacts on structures and land acquisition	Impacts on structures and land acquisition are lower than option 1 but higher than option 2
Environmental impacts	Take time to construct as the land foundation has just been leveled on shrimp pond, high impacts on the environment	The route will be built on existing roads, the construction time is lowest and lowest impacts on the environment	Take time to construct as the land foundation has just been leveled on shrimp pond, high impacts on the environment
Conclusion	Not selected	**Selected**	Not selected
II-2	***Route of Nam Can bridge – Ong Gay along Cai Lon river mouth – Xeo Doi creek, Nam Can district***		
Description of option	**Aligning to the river bank and far 100 m away from the river edge in accordance with the river-dike standard (behind people's settlement)**	**Aligning to the existing trail (either front of households or back of households)**	**Aligning to the river bank**
Technical aspects	- Ensure long-term stability of the section, - The section is straight, - Pass less architectural structures. - Loss of productive land and forests, - As the land foundation has just been leveled on shrimp pond, we must wait for its cohesive settlement, which takes much time, - The construction time is prolonged.	- The embankment is stable, which only requires filling tray toward the farming field direction without roadbed treatment, - The construction is quick, - Avoid compensation for site clearance. - The route is not much straight, - Although we avoid affecting houses but some must be moved	- Save cost; save residential and production land, - The construction is quick. - Due to instability, the road-tray toward riverbank must be strengthened and costly, - The construction requires the clearance of many houses.
Social impacts	The highest impact on the structure and land acquisition	Fewer impacts on structures and land acquisition	Impacts on structures and land acquisition are lower than option 1 but higher than option 2
Environmental impacts	Take time to construct as the land foundation has just been leveled on shrimp pond, high impacts on the environment	The route will be built on existing roads, the construction time is lowest and lowest impacts on the environment	Take time to construct as the land foundation has just been leveled on shrimp pond, high impacts on the environment

No.	Option 1	Option 2	Option 3
Conclusion	Not selected	**Selected**	Not selected

CHAPTER 4. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

Chapter 4 evaluates and forecasts environmental impacts, including positive, negative, accumulating impacts on the physical environment (soil, water, air), biological environment, and the socio-economic status of the subproject area relating to the selected plans for each subproject work and based on the current status of the natural and socio-economic environment of the area.

The subproject will cause certain impacts on the natural environment and the socio-economic condition. The task of the environmental impact assessment is to create an initial environmental baseline and to evaluate subproject impacts on environmental resources which should be detailed for each subproject activity. The forms and levels of environmental impact assessment of the subproject are considered in different perspectives and aspects: direct - indirect, longterm - short term, cumulative, non-cumulative, severe, medium, light, negligible, adverse or harmful, minimizable, unminimizable, unknown impacts.

It is noted that although the potential negative impacts of structure works (9km of the West coast wave breaker in Tran Van Thoi district; 61.942km of the Embankment in two districts of Nam Can and Ngoc Hien; the 60ha fresh water reservoir with a capacity of 3.85 millionm^3, and a water supply system of 12,000m^3/day for people in U Minh district) to be invested under this subproject is in line with the key findings of the REA or ESMF for the MD-ICRSL project that it will generally increase the level of air, noise, vibration, and water pollution as well as increasing local traffic congestion including road safety risks and disturbance to local residents and they could be mitigated by (a) ensuring that contractors apply good construction practices and initiate/maintain close consultation with local authorities and communities throughout the construction period; and (b) close supervision of field engineers and/or environmental officer as recommended in the REA. However, to comply with the Government's expectation for the EIA analysis, the ESIA also included the results of the analysis related to air/noise and water pollution in Section 3.4.1. As suggested by the REA, these impacts will be mitigated through the application of the Environmental Code of Practices (ECOP) and which has been prepared in line with the ESMF.

Potential negative impacts of the subproject activities during operation of the livelihood models have also been found to be small to moderate, and they can be mitigated through technical assistance to be provided during the preparation and implementation of the livelihood development models (in non-structure work of this subproject).

4.1. STRUCTURE WORKS

4.1.1. Positive impacts

- Socio-economic impacts:
  - When the wave breaker construction is completed, it will prevent erosion and deforestation, create conditions for the rehabilitation of mangroves forest along with the wave breaker, and protect the sustainable production and livelihood stabilization for residents inside the wave breaker. This includes about 6,000 ha of land (rice, aquaculture, agricultural production, etc.), and 13,500 people in the area.
  - When the Embankment construction is completed, it will strengthen infrastructure, create stable residence, and integrate the development of the coastal traffic in the

region. The operation of works will increase natural disaster prevention and regional navigation, promote production services, as well as solve the problem of production output. It will help to be active in water production, cultivation expansion, reduction of risks, an increase of productivity and output, and efficiency of land use. It will bring potentials and strengths for the region. This is a great way to diversify agricultural production, introduce high value crops and livestock which have stable market and international certification.

  - The combined function of the embankment with the road will facilitate the smooth traffic and traffic safety throughout the area.
  - When the reservoir and the water supply system is completed, each household of about 120,000 people in U Minh district will have access to clean water. People can build flush-toilets, gradually change the practice of using unhygienic latrines on rivers, canal, fish ponds, as well as build a civilized and cultural way of life in a rural area.

- Natural environment impacts:
  - When the wave breaker is put into operation, it will bring about ecological stability and minimize coastal erosion. At the same time, the new ecological system and the environment will be friendly and closer to human life which helps people to be active to restrict and prevent epidemic diseases.
  - When the reservoir is completed, it will provide good quality of water contributing to better environmental improvement in the subproject area. It will limit the exploitation of underground water via small and dispersed drilled-wells to combat against exhaustion and pollution of water sources.
- Impacts on climate change: In case of the subproject operation, it will limit negative impacts of climate change and loss of mangrove forests such as protection of the production, climate change adaptation due to sea level rise for an area of about 123,058 ha in Ngoc Hien and Nam Can districts. Building a wave breaker of 9,000m in Tran Van Thoi district has conditions to develop and protect people and production for the inner area of West sea dike when sea level rises. Developing livelihood models to adapt climate change such as aquaculture models for communities living along the protection forest belt; building models of livestock and poultry farming, etc.

4.1.2. Classification of Risks and Negative Impacts

The classification of potential negative environmental and social impacts and risks below are mainly applicable to the structural works. The type and nature of the impacts vary with the nature and scale of the interventions, locations, the environmental and social baseline, and duration. The scale of potential impacts is classified as below:

Significant impact (S):

- Significant changes, over a significant area, to key characteristics or features or to the landscape's character or distinctiveness for more than 2 years.
- The impact goes beyond regulatory standards or long-lasting and widespread impacts
- Altering the ecosystems or ecological functions on a large area causing losses at the moderate scale (lasting over 2 years) but having the ability to restore within 10 years;
- Tentatively affect human health;
- Causing financial damage to users or communities.

Moderate impact (M):

- Noticeable but not significant changes for more than 2 years or significant changes for more than 6 months but less than 2 years, over a significant area, to key characteristics or features or to the landscape's character or distinctiveness.
- Altering the ecosystems or ecological functions locally in a short time with potentially good recovering capacity. The impact level is similar to the changes at present but potentially causing accumulated impact.
- Possibly (unlikely) affect human health; may causes difficulties to some users.

Small Impact (L):

- Noticeable changes for less than 2 years, significant changes for less than 6 months, or.
- Changes occur only in the current variation range or barely discernible changes for any length of time, within acceptable standards and their impacts can be totally controlled.
- The impacts may affect the operation but do not hinder the users or the public.
- Mild impact on human health or quality of life.

No impact (Insignificant/Negligible) (N):

- Any change would be negligible, unnoticeable or there are no predicted changes -
- Changes that are not perceivable or can be measurable based on the basic operation;
- No mutual influence and therefore no changes occurred

The potential socio, environmental impacts, and risks associated with structural and non-structural works in this subproject are screened and assessed in*Table4.1*.

Table4.1: Matrix of impacts of the subproject

Impact	Physical			Biological		Social				Others		Note
	Air, noise, vibration	**Soil, water**	**Solid waste, dredged sludge**	**Forest, natural ecosystem**	**Fish, aquatic life**	**Land acquisition, resettlement**	**Indigenous people**	**Physical cultural resources**	**Livelihood, community disturbance**	**Local flood, traffic, safety**	**Off-site impacts**	
Item: Wave breaker												
Preparation	K	K	K	K	K	K	K	K	K	K	L	
Construction	N	N	N	K	N	K	N	K	K	N	L	
Operation	K	K	K	K	K	K	K	K	K	K	L	Impacts are mainly positive
Item: Embankment												
Preparation	K	K	K	K	N	M	M	N	M	K	M	
Construction	M	M	L	K	M	N	N	N	N	M	M	
Operation	K	K	N	K	K	K	K	K	K	K	L	Impacts are mainly positive
Item: Reservoir and WSP												
Preparation	K	K	K	K	K	K	K	K	K	K	L	
Construction	N	N	N	K	K	K	K	K	K	N	M	
Operation	N	N	M	N	N	K	N	K	K	N	L	Impacts are mainly positive
Item: Mangrove plantation												
Preparation	K	K	K	K	K	K	K	K	K	K	N	
Construction	K	N	N	K	N	K	K	K	K	K	L	
Operation	K	K	K	K	K	K	K	K	K	K	N	Impacts are mainly positive
Item: Livelihood models												
Preparation	K	K	K	K	K	K	K	K	K	K	N	

Impact	Physical			Biological		Social				Others		Note
	Air, noise, vibration	**Soil, water**	**Solid waste, dredged sludge**	**Forest, natural ecosystem**	**Fish, aquatic life**	**Land acquisition, resettlement**	**Indigenous people**	**Physical cultural resources**	**Livelihood, community disturbance**	**Local flood, traffic, safety**	**Off-site impacts**	
Construction	N	N	N	K	N	K	N	K	N	N	N	
Operation	M	M	N	K	K	K	M	K	M	N	M	

4.1.3. During pre-construction

4.1.3.1. Impact of land acquisition

The subproject will carry out land clearance, land acquisition for the following purposes:

- To extend and upgrade the embankment protecting hydraulic works in 2 districts of Nam Can and Ngoc Hien.
- To build the reservoir for domestic water supply for people in U Minh district.
- To create the bare ground for the construction works.

The impacts of land acquisition are assessed in detail as follows:

a) Impacts on land

The subproject permanently acquires 162.95ha and temporarily acquires 157.39 ha of land (see details in *Table1.5*and*Table1.6*), in which:

- The wave breaker: located offshore, no land acquires.
- The reservoir and WSP: As mentioned above, although the land used for the reservoir and WSP is up to 172.2 ha (102.2 ha permanently and 70 ha temporarily). For 102.2ha of permanent land is planting melaleuca trees. For 70ha of temporary land is bare land and is being used to fill the resettlement area of other projects. It can be seen that although 172.2 ha used for this item, all being managed by the Ca Mau Economic Zone Management Board. Therefore, there should not have negative impacts from the land acquisition and clearance but speeding up the condition of the construction of the resettlement land fund for other projects.
- The embankment: the total area of land acquisition is 148.14 ha (60.75 ha permanently and 87.39 ha temporarily) while the total length of the embankment is 61.5 km (details are in the section 1.4.2.2).

So the impact of land acquisition is mainly from the embankment, including:

- ONT + RST land: 112,539m^2 (accounting 6.91% of permanent land acquisition), in which Lam Hai commune is affected the most with 69,368m^2, followed by Tam Giang Tay commune: 22,598m^2, Tan An Tay commune: 11,668m^2 and finally Vien An Dong commune: 8,905m^2.
- TSL + RST land: 495,005m^2 (accounting 30.38% of permanent land acquisition), in which Tam Giang Tay commune is affected: 181,512m^2, followed by Lam Hai commune: 171,178m^2, Tan An Tay commune: 99,386m^2 and lastly Vien An Dong commune: 42,930m^2.
- The number of affected households: 560 households but no households have to relocate (*Table4.2*).
- There is 336,8m^2 of cemetery land that will be permanently acquired, but it does not affect any tombs of the households.
- The number of households that lost more than 5% of their production land is 95 households, of which Tam Giang Tay commune has 48 households, Lam Hai commune has 24 households, Tan An Tay commune has 20 households and Vien An Dong commune has 3 households. Of these, 2 are severely affected by the acquisition of more than 20% of production land (Tan An Tay) and the remaining 93 households lost 0.1-18.4%. No household has to relocate or resettle.

- No public infrastructure is affected.

Table4.2: Summary impacts due to land acquisition of the subproject

Total	**Ethnic minorities**	**Permanent impacts**					**Temporary impacts**	
No. of AH	No. of AH	No. of AH	No. of physically displaced HH	Production land acquisition (m2)	Residential land acquisition (m2)	No. of affected graves	No. of AH	Land acquisition (m^2)
560	0	560	0	49,5	11,25	0	560	157,39

Comments: The embankment route is along rivers and most of the land in this area is riverside land and aquaculture land, so the impacts are moderate. According to the survey, the embankment passes through 560 households, however, the total residential land area affected by the subproject is only 3.3 ha and the rest is other land and no households need to be relocated.In addition, data from the subproject preparation shows that the local authorities and Ca Mau PPMU have held meetings with all affected households due to the embankment construction.The outcome of the meetings showed that all affected households support the subproject implementation, concurrently sign the land donation agreement for the subproject to quickly implement the subproject (details of the meeting are included in the appendix).

b) Impact on people's psychology

Component of the wave breaker: Local people look forward tothis subproject because in recent years coastal erosion and loss of forestoccur seriously. Erosion (17km, 30-80m/7 recent years) have greatly affected the socio-economic life and the environment of the coastal areas reduced the coastal green belt and the ecology of the mangrove ecosystem.

Component of the embankment: It was planned to build the embankment against overflowing long time ago because high tide greatly affects production and transportation. Most are temporary embankments that combine with rural traffic, so the effect is significant. The upgrading of the embankment along the road will contribute to proactively protect aquaculture activities of the people and facilitate rural development simultaneously, contributing to improving living conditions of people in this area. This is the most expected work item which is proved by the voluntary donation of land.

Component of the reservoir and WSP: located far away from Hau River. People often face to lack of water for domestic use and for production. At present, most people exploit groundwater for daily life, but it is getting scarcer and worse. They desire to have stable water source with good quality so this component is highly supported by people in the region.

In a nutshell, the subproject receives high agreement among local people, which is a favorable condition for implementation.

c) Impacts on structures on land

Impact on historical and cultural sites: There are no cultural and historical relics in the acquired land.

Impact on public works:

- The wave breaker: This item is located on the sea so no public works are affected.

- The reservoir and WSP: located in the resettlement area, which is currently temporary production land, should not affect public works.
- The embankment is built mainly on the temporary embankment; some sections are now the rural roads so it will affect the rural traffic in the construction area.

Impacts on forests and vegetation:

- The wave breaker component: has no impact on forest and vegetation.
- The embankment component: is built on the existing embankment, with aquaculture and production land along two sides, so it brings no impact on forest and vegetation.
- The reservoir component: Most area in the reservoir is planted with Melaleuca so it will not affect the natural forest.

Comments: The impact of land acquisition is moderate, which can be minimized through the implementation of the resettlement action plan prepared for the subproject.

4.1.3.2. Impact of unexploded ordnances

Despite in the construction areas of the subproject are no longer appearing explosion accident, but, since the area was formerly a war zone, there is still a risk of unexploded ordnances in the ground. Incident and explosion can occur during construction and its impact can cause damage to people and workers and destroy construction machinery, constructed works.

In addition, during the construction process, due to the impact of the environment and shock waves of construction vehicles transmitting in the ground, potentially causing an explosion, damaging the works, injuring people and destroying facilities. Therefore, the cleanup of explosive ordnances in the area prepared for construction activities in order to ensure the safety of human life, equipment and machinery will be implemented seriously by the subproject owner before handing over the site to the construction.

Comments: The impact is high, long term, local, can be minimized.

4.1.4. During the construction phase

4.1.4.1. Construction activities and sources of impacts

In the process of subproject construction, the following activities will be carried out:

- Land clearance and ground preparation.
- Gathering construction machines, equipment, materials, and workers;
- Building structure works of the subproject
- Planting mangroves in aquaculture ponds

The construction of these items will result in the generation of wastes and non-wastes including:

- Waste related sources:
  - Dust and gases due to the transport of materials, vehicles and machinery.
  - Waste water and solid waste of workers.
  - Construction wastes: wasted oil, excavated soil, waste water, etc.
- Non-waste related sources:
  - Noise, vibration of means of transport of materials, machinery, construction equipment.

▪ Concentrating on-site workers increase social impact.

With the sources of impact as mentioned above, the objects affected by these activities are forecasted as follows:

- Surrounding water environment near the construction sites
- Air environment along the route of transportation of materials, on-site and around the site.
- Land environment at the site and surrounding.
- Security in the construction area.
- Aquatic life on the route of dyke, embankment.

The environmental and social impacts of this phase are summarized in*Table4.3*.

Table4.3: Summary of impacts in the construction phase of the subproject

No.	**Sources of impact**	**Impact**	**Influenced object**	**Level, duration of impacts and recovery capability**
1.	*Waste related sources*			
1.1	Transportation of materials	Dust, emissions from transporting machinery, construction materials	Air environment on transport routes	Medium, temporary and can be minimized through the implementation of good environmental management and will have no impact upon stopping transportation.
1.2	Worker's activity	– Domestic wastewater – Domestic waste	Air, soil, and water for construction camps	Small and local, temporary and can be minimized through good environmental management and can be restored as soon as construction is completed.
1.3	Operation of machinery and equipment	– Dust and exhaust of vehicles, construction machines – Construction waste – Construction hazardous and non-hazardous waste	Air, soil, and environment surrounding the construction site	Small, temporary and can be minimized through the implementation of good environmental management and can be restored after construction.
1.4	Maintenance of machinery and equipment	Waste oil	Land and water environment near the construction site. Occurrence is temporary mainly	Small impact, can be controlled.

No.	Sources of impact	Impact	Influenced object	Level, duration of impacts and recovery capability
			due to the consciousness of workers operating the machine.	
2	*Non-waste related sources*			
2.1	Prepare the bottom of the hollow embankment	– Movement of the bottom of the embankment – Increase the turbidity of the water source adjacent to the construction site	– Water quality in the vicinity of the site 50 - 100 m – Aquifers in the vicinity of the site 50 - 100 m	Small, local, short-term, can be controlled and can recover quite quickly after finishing
2.2	Worker's activity	– Noise and vibration from machinery and equipment.	– Air environment at embankment site and material transport road	Small, short term, can be controlled and terminated when stopping construction.
2.3	Operation of machinery and equipment	– Impact on social security. – Ability to create diseases and problems caused by worker concentration	People and local authorities	Small impact, can be controlled.
2.4	Incident	– Oil spill. – Occupational safety. – Waterway accident caused by waves and wind	Water, soil, aquatic life, workers	Medium, seldom occurs, can be controlled and can be restored after finishing

4.1.4.2. General impacts

The general impacts of the subproject during construction are as follows: (i) Dust, odor, noise, vibration; (ii) solid waste generation; (iii) wastewater generation; (iv) deterioration of water quality; (v) affect biological resources; (vi) disturbance and increased risk of traffic accidents; (vii) Increased risk of erosion, landslide; (viii) increase the risk of sedimentation, partial flooding; (ix) affect the landscape; (x) damaging, disrupting existing infrastructure services; (xi) damaging, reducing the aesthetics or disturbance of the area of archaeological and historical works; (xii) disturbance of people's leisure, study, cultural and belief activities; (xiii) social impact: arising conflicts, increased evils, disturbance of security and order; (xiv) health and safety risks for workers; (xv) risk of safety and health of the community. Details of these impacts are detailed below:

a) Impact on air environment

Air pollution arises from (i) dust, emissions, and noise from the transportation of material and construction machinery; (ii) dust from winding loose material; and (iii) dust, emissions and odors from construction activities, etc.

(a1). Pollution caused by the transportation of construction materials and machinery

Construction of the wave breaker: The construction of this submarine work-item to create warp will be on the sea. Material mainly includes centrifugal piles which have been manufactured in the factories and transported to the site by waterway. The material quantity estimated for building the wave breaker as shown in *Table1.14*includes material for mixing concrete, steel, stone, concrete piles, and melaleuca piles in a total amount of 37,000 tons. As mentioned in Section 1.9.1, all types of construction materials are transported by 100-ton barges (the distance from Ca Mau city to the construction site is estimated km/75single trip). As the Subproject is located in the coastal estuary area where southwest strong winds appear, the estimated transportation time will account for 50% of the construction period. The total construction period will be 3 years. Therefore the number of barges carrying materials for wave breaker construction will be 0.88 trips per day(*Table4.4*).

Construction of the embankment: Material is mainly filling soil. Excavated soil in place will be used for filling and combined with digging soil from shrimp ponds. In addition, other construction materials like sand, stone, concrete aggregate must be purchased from other places to the construction site, estimated at 266,500 tons. The embankment routes align adjacent to the river. There are almost no coastal roads for motor vehicles coming up with construction materials, so these materials will be supplied by boats and barges of 100T with a maximum distance of about 50km/single trip. As a result, boats and barges to be used for transport material for embankment construction will be estimated supplying 2,665 trips during 3 construction years, equivalent to 3.7 trips per day.

Construction of the reservoir and WSP: The quantity of materials used for the construction of the reservoir and WSP reaches up about 42,000 tons, which will be transported by barges of 100 tons to the construction site. The transportation distance is estimated 25km/ single trip.

Table4.4: Calculating the number of means to transport materials for the subproject

No.	Items	Total materials need to transport (T)	Transportation means	Number of trips (trips)		Distance for a round trip (km)
				Per item	Per day	
1	Wave breaker	37,000	100-ton barges	370	0.88	150
2	Embankment	266,500	100-ton barges	2665	3.70	100
3	Reservoir and WSP	42,000	100-ton barges	420	0.88	50

Air emission factors of the material transportation mean shown in *Table4.5*, the air pollution sources due to the transportation of materials are calculated *Table4.6*.

As can be said that the material quantity for the construction of the subproject items is relatively large but the material transportation is on waterway, by which the environmental impact is lower than the transport on road, in addition, the subproject items take place in 3 different areas during 2-3 years, which are not interrelated, therefore the air environment impact is small.

Table4.5: Pollutant loads of transportation means of materials of the subproject

No.	Means	Pollutants (kg/1000km)				
		Bụi	SO_2	NOx	CO	VOC
1	Ship, boat, barge	0.68	13.6S	9.07	0.0036	0.41
2	Truck of 3.5-16 tones	1.35	4.15S	14.4	2.9	0.8

Source: Assessment of Sources of Air, Water and Land pollution, WHO, 1993

Note: S contains in the DO = 0.025%

Table4.6: Pollutant load of barges transporting materials

TT	Items		Distance (km)	Pollutant load (kg)				
				dust	SO_2	NO_x	CO	VOC
1	Wave breaker	1 round trip	150	0.10	0.001	1.36	0.001	0.06
		1 day	132	0.09	0.0009	1.20	0.0005	0.05
		Per item	55.500	37.74	0.38	503.39	0.20	22.76
2	Embankment	1 round trip	100	0.07	0.001	0.91	0.0004	0.04
		1 day	370	0.25	0.0025	3.36	0.0013	0.15
		Per item	21.000	181.22	1.81	2,417.16	0.96	109.27
3	Reservoir and WSP	1 round trip	50	0.07	0.0001	0.72	0.15	0.04
		1 day	44	0.06	0.00	0.63	0.13	0.04
		Per item	21.000	28.35	0.04	302.40	60.90	16.80

(a2). Pollution caused by soil excavation and filling

The subproject work-items require excavation and filling for the construction of wave breaker, reservoir, and water supply pipelines, as follows:

Construction of embankment: The material used to embank is taken from its two sides, then geotextile is lined to pump sand in the middle when the foundation become stable concrete pavement will be poured according to the design. Because this is a lowland terrain and the soil is saturated with water, dust will not be generated during the excavation.

Construction of reservoir and WSP: As the earthwork volume (excavation and filling) is concentrated in certain locations, including digging reservoir and WSP, the calculation of dust air emission focuses on these locations. The digging reservoir is mainly in wet soil by blowing equipment, so the dust to be generated will not be much. The construction dust emission factor is shown in *Table4.7*. The pipeline is proposed along Ca Mau - U Minh road with 20 km long will be a potential risk of dust and air emission. The volume of excavated soil from the construction of the pipeline is calculated according to the construction norm as follows:

$$M = D \times R \times C \times 1.3 = 25{,}000 \text{ m} \times 0.5 \text{ m} \times 1 \text{ m} \times 1.3 = 16{,}250 \text{ m}^3 \text{ of soil.}$$

In which: D – pipeline length; R - pipeline width; C - pipeline installation depth; and 1.3 is the excavation coefficient. The road digging duration will be 294 days. The reservoir digging duration will be 180 days.

According to the data of excavated soil, the dust generated in the construction areas is calculated in *Table4.8*.

Table4.7: The dust emission coefficient (g/m3) caused by construction

No.	Pollution sources	Coefficient of dust emission

1	Dust from excavation and filling ground is winded off	1 - 100
2	Dust from loading and unloading material (soil, stone, etc.)	0.1 - 1
3	Dust from trucks that carry sand and soil and drop the material on the road	0.1 - 1

Source: WHO, 1993

Table4.8: Calculation of dust loading arising from earthwork on site

Work items	Quantity of excavated soil (m^3)	Quantity of filling soil (m^3)	Total (m^3)	Emission coefficient (g/m^3)	Total dust generation (kg)	Dust loading ($mg/s/m^2$)
Construction of reservoir	2,283,852	1,365,072	3,648,924	1	3650	0.01
Installation of water supply pipelines	16,250	0	16,250	50	815.5	0.12

(a3). Pollution caused by equipment and construction machinery

The use of diesel construction machinery and equipment will produce dust and air emissions (SO_2, CO, NO_x, HC, etc.). The loads of dust and emissions are calculated based on the number of machinery and equipment used for construction, and DO fuel consumption norms according to Decision No.1134/QD-BXD by the Ministry of Construction on the consumption norm for determination of construction machinery and equipment shift prices in 2015, and based on the emission coefficient introduced by the WHO. Loads of dust and emissions caused by the construction of works in the subproject area are presented in*Table4.9*.

Table4.9: Load of pollutant generated by construction equipment using DO

No.	Machinery and equipment	Oil volume (kg/h)	Dust (mg/s)	SO_2 (mg/s)	NO_2 (mg/s)	CO (mg/s)	HC (mg/s)
Emission factor of substances from diesel vehicles (kg / ton diesel) (WHO 1993)			***3,5***	***1***	***12***	***18***	***2,6***
A. Construction of the wave breaker							
1	Piling hammer 3,5T	6.55	6.37	1.82	21.83	32.74	4.73
2	Crane 25 T	5.28	5.13	1.47	17.60	26.41	3.81
3	Excavator <=1,25 m^3	4.54	4.42	1.26	15.14	22.71	3.28
4	Compactor 16T	3.99	3.88	1.11	13.31	19.96	2.88
5	Electric welding machine	3.8	13.30	3.80	45.60	68.40	9.88
6	Electric Generator 100KVA	23.66	82.81	23.66	283.92	425.88	61.52
B. Construction of the embankment							
1	Mobile electric generator	23.66	82.81	23.66	283.92	425.88	61.52
2	Bulldozer	4.01	3.90	1.11	13.38	20.07	2.90
3	Scraper	4.54	4.42	1.26	15.14	22.71	3.28
4	Crawler crane - lifting capacity 10 T	3.80	3.70	1.06	12.68	19.01	2.75

No.	Machinery and equipment	Oil volume (kg/h)	Dust (mg/s)	SO_2 (mg/s)	NO_2 (mg/s)	CO (mg/s)	HC (mg/s)
5	Handy dressing machine 80kg	0.48	0.47	0.13	1.62	2.42	0.35
6	Wheel-mounted crane	3.49	3.39	0.97	11.62	17.43	2.52
7	Compactor9T	3.59	3.49	1.00	11.97	17.96	2.59
8	Compactor16T	3.99	3.88	1.11	13.31	19.96	2.88
9	Concrete mixer	6.02	5.85	1.67	20.07	30.10	4.35
10	Concrete pump	3.19	3.10	0.89	10.63	15.95	2.30
11	Gravel spreaders	4.10	3.98	1.14	13.66	20.49	2.96
12	Piling machine 3,5T	6.55	6.37	1.82	21.83	32.74	4.73
C. Construction of the reservoir and WSP							
1	Bulldozer 110 CV	4.01	3.90	1.11	13.38	20.07	2.90
2	Excavator0,4 m^3	6.02	5.85	1.67	20.07	30.10	4.35
3	Sludge pumping machine 585 CV	60.5	58.79	17.0	201.70	302.50	43.72
4	Dressing machine 9T	3.59	3.49	1.00	11.97	17.96	2.59
5	Shredder	0.48	0.47	0.13	1.62	2.42	0.35
6	Automobile Crankshaft 5T	3.7	3.6	1.0	12.4	18.6	2.7
7	Piling machine 3,5 T	6.55	6.37	1.82	21.83	32.74	4.73
8	Concrete mixer 500L	6.02	5.85	1.67	20.07	30.10	4.35
9	Trucks	6.8	6.7	1.9	22.8	34.2	4.9
10	Concrete mixer5T	4.5	4.3	1.2	14.9	22.3	3.2
11	Fork lift truck 5T	3.7	3.6	1.0	12.4	18.6	2.7
12	Truck 3,5 – 10 T	6.8	6.7	1.9	22.8	34.2	4.9
13	Drilling machine80CV	5.7	5.5	1.6	18.8	28.3	4.1

In addition, the concentration of air pollutants emitted by vehicles, machinery, and equipment that serve the construction of the subproject largely depends on a number of vehicles, conditions of machinery and equipment, wind direction, the density of machinery and equipment. In order to assess the dispersion of the pollutants from the construction means, the Screen View model with the machinery and equipment specifications which produce the highest pollutant loads in each construction activity shows that (*Figure4.1*to*Figure4.3*):

- **Construction of the wave breaker**: Dust and emissions generated during the operation of construction equipment and machinery only affects the ambient air environment at a distance of 100m of wind downstream. The highest loads of dust and emissions show that the relevant dust concentration, SO_2, NO_2, releasing into the external environment, is 2400 $\mu g/m^3$, 680 $\mu g/m^3$, 820$\mu g/m^3$, at the source. At the scope > 100m, the dust concentration, SO_2, NO_2 arebelow the thresholds of the Vietnamese standard, QCVN 05:2013/BTNMT. On the other hand, these emission sources are low and the construction location is completely offshore, 150m away from the protection forest, within the radius of 200m wide and without living houses. As a result, they only cause local pollution, affect the wind

direction downstream, and directly affect workers on site. Therefore,the impact of emissions on local residents does not appear.

- **Construction of the embankment**: Dust and emissions to be released during the operation of construction equipment and machinery only affect the ambient air environment at a distance of 100m of the wind downstream. $NO_2$is released into the external environment at the maximum concentration of 900 900µg/m^3, at the source. Within a radius > 80m, the NO_2 concentration is below the Vietnamese standard, QCVN 05:2013/BTNMT (<200µg/m^3), which is also the low emission source and its far dispersion is less.

- **Construction of the reservoir and WSP**: In comparison with the Vietnamese standard on the ambient air quality - QCVN 05:2013/BTNMT, the dust emission, in the normal weather condition, at a radius of 50m, and at the construction phase of the water supply system and the road, is 1.5 times higher than the permissible level of the standard (0.3mg/m^3).

As a result, the impact of this source of dust and air emissions is small. The affected objects of this source are workers who are working on site. To minimize dust impacts from excavation the Subproject Owner requested the Contractors to prepare reasonable working plans and to take dust mitigation measure on hot days as proposed in Chapter 4.

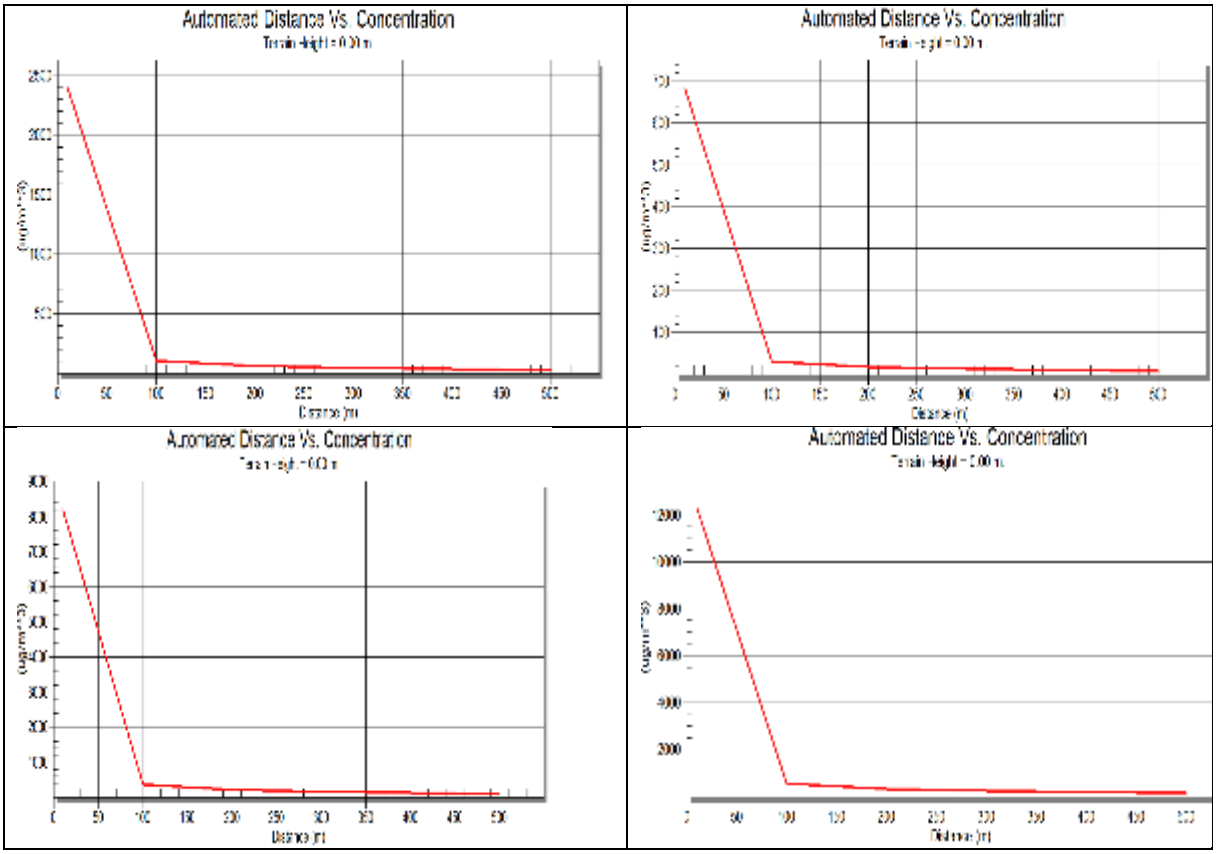


Figure4.1: Air emission dispersal due to the wave breaker construction

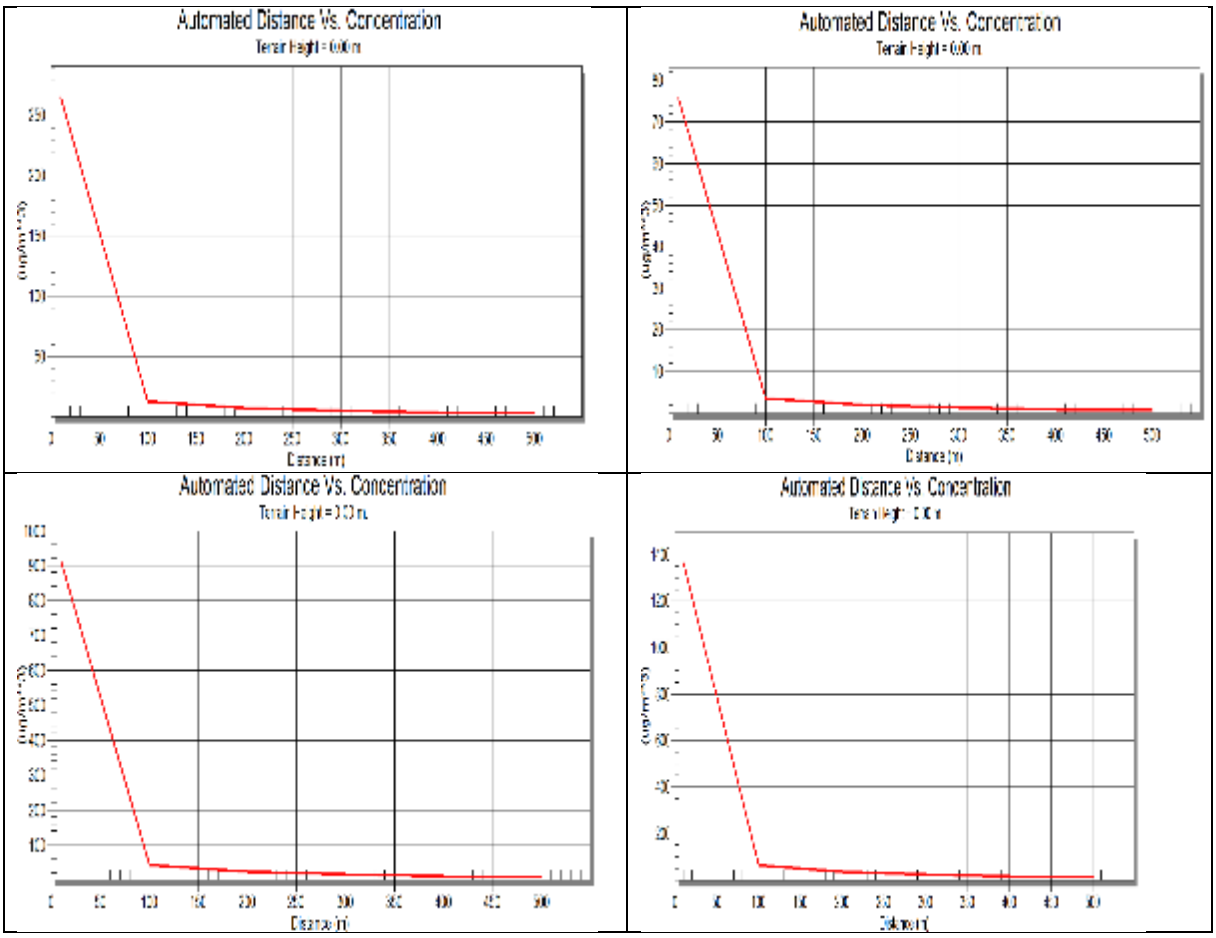


Figure4.2: Air emission dispersal due to the embankment construction

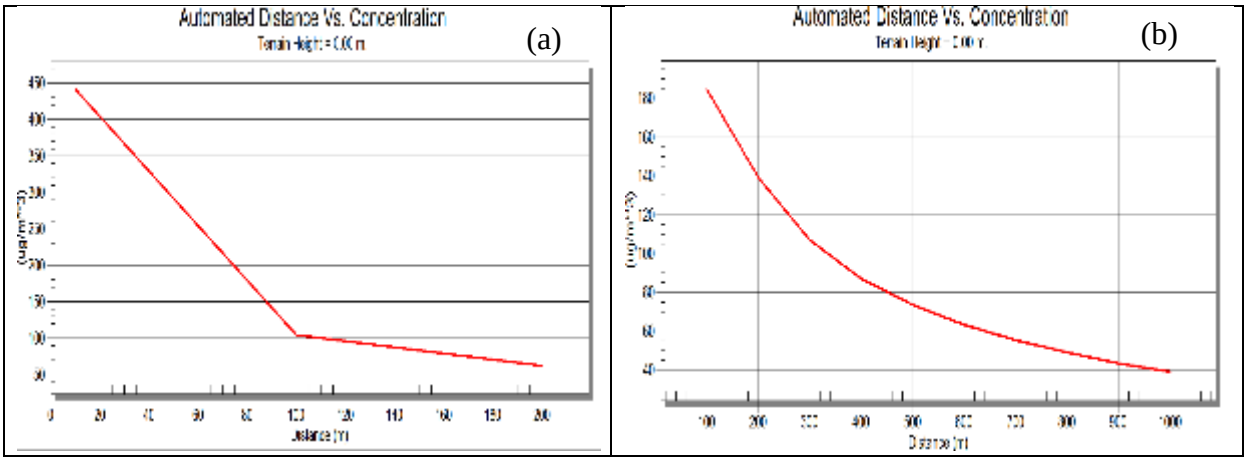


Figure4.3: Air emission dispersal due to (a)pipeline installation,(b) reservoir building

(a4). Dust and air emissions caused by concrete mixing equipment

Construction of the wave breaker: According to the design of the Subproject, the total concrete volume used for the wave breaker reaches 2311m^3. The concrete mixing emission coefficient is 5-50g/m^3. Thus, the total cement dust which may be generated amounts about 11-115kg. However, as the concrete mixing operation will take place in the coastal area, which is very far from residential areas, the impact of cement dust is considered small. With the method of using small-scale mixers (500 liters), dust only disperses on the mixing scale within a radius of 10 - 20m and is the risk for workers who work at the mixers. Due to the relatively small particles of cement dust, workers' health suffering from the long-time breath of cement dust will be worse. Therefore, the construction units must equip anti-dust labor protection amenities for workers who are involved in the concrete mixing as well as the

construction units must guide them how to work to avoid the spread of dust to protect their health.

Construction of the embankment: This activity mainly comes from the concrete mixing to pour road, however, the impact is spotty and instantaneous at the concrete mixing locations, and immediately ends after the concrete mixing is finished and contractors proceed to the next construction stage. As such, concrete dust possibly affects the air environment but it will be local and appear in each construction area in 1-2 days, therefore the impact of concrete mixing will be low if mitigation measures are taken appropriately.

Construction of the reservoir and WSP: The concrete volume used for the construction of the reservoir and WSP amounts up 12,919m^3, the total amount of cement dust may be about 65.6-566 kg. According to the experiences from the similar construction works, a concrete mixing plant capable of 30 m^3/h will cause the following major impacts: (i) dust may exceed the permitted levels of the Vietnamese standard - QCVN 05:2013/BTNMT at a distance of about 20 meters from the site when the equipment and machinery work and dust mainly affects mixing workers only, and (ii) for the mixing workers who work for a long time, there will be exposure to dust. Due to the relatively small particles of cement dust, without appropriate control measures, dust may directly affect workers' health in the long run.

Comments: The impact of dust and emissions during the construction phase of the Subproject appears small to moderate, which mainly affect construction workers and end when the construction finishes. The Contractors, however, need to adhere to the measures to minimize dust and emissions during the operation of concrete mixing equipment.

b) Wastewater generation

(b1). Domestic wastewater

According to the Vietnamese standard, TCXDVN 33:2006, the amount of water a worker uses daily is 45 liters/person/day, and 80% of this water will be discharged into the environment, therefore the wastewater the construction workers of the Subproject use will be about 6.84 m^3/day (*Table4.10*).

Table4.10: Wastewater volume from subproject construction workers

No.	Work-items	Number of construction teams (teams)	Number of workers in each team (persons)	The waste water volume in each team (m^3/day)	Total wastewater volume (m^3/ day)
1	Wave breaker	5	10	0.36	1.8
2	Embankment	4	15	0.54	2.16
3	Reservoir and WSP	1	30	1.08	1.08
4	Afforestation	10	5	0.18	1.8
	Total	**20**	**60**	**2.16**	**6.84**

Based on the Vietnamese emission coefficient, the pollutants in domestic wastewater are shown in *Table4.11*, the amount of pollutants in domestic wastewater of the construction workers is calculated in *Table4.12*.

The composition of domestic wastewater mainly includes suspended solids, grease, sediment, organic matters ($BOD_5$and COD), nutrients (nitrogen, phosphorus), and microorganisms. The average concentration of pollutants in domestic wastewater prior to discharge into septic tanks or similar facilities show that domestic wastewater pollutants are several times higher than the standards, which is allowed to discharge into the environment (QCVN 14:2008/BTNMT

column B), therefore if this amount of waste discharged into the environment, it will affect the environment quality.

Table4.11: Pollutant loads in domestic wastewater of subproject construction workers

No.	Pollutants	WHO pollution load (g/ca.day)	Vietnamese pollution load (g/ca.day)
1	BOD_5	45 – 54	50
2	COD	72 – 102	85
3	Total suspended solids	70 – 145	100
4	Oil and greases	10 – 30	20
5	Total nitrogen	6 – 12	9
6	Ammonia	2.4 - 4.8	2.5
7	Total phosphorous	0.8 - 4.0	2.0

Source: Rapid Environmental Assessment, WHO, 1995

Table4.12: Waste water pollution loads (kg/day) from subproject construction workers

No.	Pollutants	Wave breaker	Embankment	Reservoir and WSP	Afforestation	total
1	BOD_5	2.5	3.0	1.5	1.0	8.0
2	COD	4.3	5.1	2.6	1.7	13.6
3	Total suspended solids (TSS)	5.0	6.0	3.0	2.0	16.0
4	Oil and greases	1.0	1.2	0.6	0.4	3.2
5	Total nitrogen	0.5	0.5	0.3	0.2	1.4
6	Ammonia	0.1	0.2	0.1	0.1	0.4
7	Total phosphorous	0.1	0.1	0.1	0.04	0.3

Comments: It can be seen that the amount of waste from the workers at a construction site is not much, similar to the discharge of 2-5 households, therefore if this amount of waste is discharged into the environment, the impact is localized at the discharge site rather than on a wide scale and the impact level will be low and completed after the construction. In order to minimize impact, the Subproject Owner should require the Contractors to install portable toilets in the construction sites to meet the labor demand. Accordingly, the amount of domestic wastewater will be collected and treated, and *the impact on the environment will be low*.

(b2). Rainwater runoff

Overflowing rainwater from the construction site may sweep away pollutants from the surface to the water source. Its bringing sand, stones, and other materials into water is believed to be the main source of pollution and the increase of water turbidity. In addition, this runoff may be contaminated by oil but the concentration is estimated very low. According to the statistics of the WHO, the concentration of pollutants in rainwater runoff in embankment and road construction areas is about 0.5 - 1.5 mg N/L; 0.004 - 0.03 mg P/L; 10 - 20 mg COD/L; and 10 - 20 mg TSS/L. However, the impact depends on the sewerage drainage system on the site.

Construction of the wave breaker: The construction site is almost at sea and all working items are relating to concrete which does not cause pollution, therefore, the main risk, in this case, is runoff rainwater leaching from barges which are mobilized to serve the construction. Because barge area is very smaller than the water surface area at the construction site and most of the types of material are concrete, stone, steel, etc., which are mainly gathered on barges, there is only the risk of rainwater overflowing, if it happens, it is on barge surface and is inconsiderable. Other risks, such as oil/grease from barge engine leaks and uncovered waste oil barrels, etc., likely appear, which are possibly washed away by rainwater towards the water source, however, with only one tug barge and two pile driving hammers mobilized for the construction of a wave breaker section, the risk is not high and the impact level, if it happens, is only local where barges are mooring and can not disperse widely.

Construction of the embankment: Although the embankment route is quite long (61.5 km), its scale is relatively small. The works are mainly upgrading the existing embankments more sustainably which can cater the rural traffic, the impact level will not be high. The results of soil analysis in the embankment construction area show that all soil samples are not contaminated with alum, so the risk of washing alum is very low.

Construction of the reservoir and WSP: To estimate the amount of rainwater runoff on the construction site of the reservoir and WSP to the surrounding environment, the hydraulic drainage calculation method by the limit intensity formula as set out in the Environmental Technical Manual (2005) is as follows:

$$Q = \frac{C \times I \times A}{1000}$$

Of which:

Q - maximum overflowing water (m^3/day); C - flow coefficient, select C = 0.9; I-the highest rainfall (mm/day), the highest rainfall in Ca Mau is selected 150 mm/day occurring during the construction period; and A - construction area (m^2).

Thus, the amount of rainwater at the construction site of 100ha that flows over the day can be estimated as follows:

$$Q(m^3/day) = 0.90*0.15m/\ day\ *1{,}000{,}000m^2 = 135.000m^3$$

It is estimated that the amount of rainfall in time may be up to 135,000 m^3 but most of the rainfall will not form surface flows but accumulate in the reservoir area, therefore there will not be a surface flow of rainfall to the environment. Based on the results of soil analysis in the excavation area of the reservoir which is already heavily affected with alum and based on the characteristics of the water source in the area in rainy season, it seems that all the sites tend to be heavily infected with alum, so it is forecasted that this runoff water is also heavily affected with alum. The pH in this water source at the beginning of the rainy season is about 3 and fluctuates between 4-5 in the middle and late rainy season. Although in the surrounding area of the reservoir construction site, the water source is heavily contaminated with alum even in the dry season, for newly excavated soil and large excavated soil surface area, the runoff rainwater is a possibly higher risk of exposure to alum than the water in the surrounding canals. This is what the Contractors need to pay attention to neutralize alum preliminary before pumping out the water to the environment.

(b3). Construction waste water

Construction wastewater of the subproject includes wastewater from barges, operation, and maintenance of construction equipment, machines.

Wastewater from barges. Barges will be used to transport materials for the subproject construction andwastewater coming from the barges is estimated at about 4-5 m^3/day (barges

of 100T). Factors causing water pollution of waste water is grease, suspended solids, organic matter, nutrients (N, P) and microorganisms.

Wastewater from operation and maintenance of construction equipment and machinery. This kind of wastewater contains organic substances, oil, and suspended solids. The wastewater, generated from regular maintenance, includes: i) machine maintenance (about 5 m^3/day); ii) machine cleaning (about 8m^3/day); iii) machine cooling (about 6m^3/day). However, the volume of water supply required for this purpose on the site is heavily dependent on the compliance and operations of the contractors (*Table4.13*). To prevent drainage from reaching water bodies, equipment and truck maintenance areas will be captured and treated.

Table4.13:Wastewater from construction equipment and machinery

Source of wastewater	**Volume (m^3/day)**	**Concentration of pollutants**		
		COD (mg/l)	**Dầu (mg/l)**	**SS (mg/l)**
From maintenance	5	10-15	-	25-40
From cleaning	8	20-32	0,4-0,8	60-80
From cooling	6	2,5-5	0,1-0,25	2,5-12,5
QCVN 08-MT:2015/BTNTM (cột A)		10-15	0,1-0,2	20-30
QCVN08-MT:2015/BTNTM (cột B)		30-50	0,1-0,3	50-100

Comment: The impact of wastewater during construction is small to large, especially the overflowing rain for the construction area of the reservoir so the subproject owner and construction should have solutions to manage and control the wastewaters during construction.

c) Generating solid wastes

(c1). Domestic solid waste

Domestic solid waste on the construction sites includes cans, bottles (food, soft drinks), paper, etc. with a mass of 0.4 kg/person/day, the amount of waste from workers is about 76 kg/day (*Table4.14*).

The component of this waste contains 60-70% organic matters and 30-40% other substances, and bacteria and pathogens. This waste should be collected and treated to minimize negative impacts on human health and the environment in the area. It can be seen that the number of workers in the construction phase is average but divides into multiple sites and in independent regions, *so the number of solid waste from each site is small*. However, it should be collected and treated to ensure environmental sanitation in the area.

Table4.14: Waste volume from the subproject construction workers

No.	**Items**	**Number of team** (team)	**Number of workers in each team** (people)	**Waste amount per team** (kg/day)	**Total waste** (kg/day)
1	Wave breaker	5	10	4	20
2	Embankment	4	15	6	24
3	Reservoir and WSP	1	30	12	12
4	Afforestation	10	5	2	20
	Total	**20**	**60**	**24**	**76**

(c2). Common construction solid waste

Solid wastes in the construction process of embankments include excavated soil, scattered rock, soil and other materials, cement bags, ..., in which:

- **Excavated soils from site clearance, digging of foundation pit, digging reservoir**: As mentioned in Section 1.9.2, only the reservoir and WSP are generated by excavated soil with a volume of 918,780 m^3, see *Table1.17* for details.
- **Scattered rock, sand**: According to Decision No. 1329 /QD-BXD dated 19/12/2016 of the Ministry of Construction announcing the norms of using materials in construction, the volume of scattered rock, sand is estimated with the amount equal to approximately 1% of the used rock, sand. With the volume of rock and sand used for the subproject is about 186,972m^3 (wave breaker: 20,317m^3, embankment: 153,736 m^3, reservoir, and WSP: 12,919m^3), this amount of scattered wastes is 1,780 m^3.
- **Packaging**: the construction of the subproject will require 34,877m^3 of concrete (of which: 2.311$m^3$for wave,25.440m^3 for embankment, 1.870m^3 for reservoir and WSP) equivalent to use about 348,770 bags of cement.

Detail of common solid wastes volume of the subproject is calculated as in *Table4.15*, it can be seen that the volume of construction wastesis quite large.This waste, which is spread into the environment by wind and rain, affects the quality of the air, soil and water environment, especially for waste from digging reservoir with high alum content. However, most of the scattered rock, sand will be collected and managed by Contractors, which will directly affect the contractor's profits. In addition, the cement bag will be collected and sold to recycling facilities. The excavated soil will be stored in the embanked area so the environmental impact of the waste is moderate and the subproject owner will have solutions to manage and mitigate this impact in *Chapter 4*.

Table4.15: Volume of solid waste generated by the subproject

No.	Categories	Excavated soil (m^3)	Scattered soil and sand (m^3)	Cement bags (bags)
1	Wave breaker	0	203	23,110
2	Embankment	0	1,537	254,400
3	Reservoir and WSP	918,780	129	71,260
	Total	**918,780**	**1,870**	**348,770**

(c3). Construction hazardous wastes

Hazardous wastes from construction activities should be considered as (i) waste oil: for machine oil, every construction equipment will be replaced every 3-6 months (usually about 6 months/time, the amount of discharged oil from the means of transport and construction equipment on average 7 liters/time; (ii) other hazardous wastes such as oily rags, oil tanks, batteries, and bulbs on site.

Building the wave breaker: each site of wave breaker segment has only one bucket excavator, 1 pile hammer, 1 boat, 2 motorboats, 1 crane, 1 generator, but only 1 hammer and 1 crane are regularly operated, other equipmentis very little used and there are 5 construction teams. So the total amount of discharged oil in 5 segments is about 70 liters/6 months and 10 kg of other hazardous wastes generated per month.

Building the embankment: Embankment construction is divided into 4 teams, with the equipment used by 1 team including 1 dredger, 3 bulldozers, 4 compactors, 1 piling hammer, and 1 500-L concrete mixer, 1 concrete pump. The amount of waste oil from the four teams is

about 308 liters/6 months and other hazardous waste is estimated to be about 40 kg of other hazardous waste per month.

Building the reservoir and WSP: with the number of machines and equipment for the reservoir and WSP construction is about 25 items, therefore there will be 175 liters of lubricating oil generated every 6 months. The amount of other hazardous wastes generated is estimated to be 25 kg each month.

The total hazardous wastes generated by the subproject is summarized in *Table4.16*.

Table4.16: Hazardous wastes generated by the subproject

No.	Type of waste	Unit	Amount of hazardous wastes from			Total
			Wave breaker	Embankment	Reservoir and WSP	
1	Waste oil	L/quarter	35	154	87.5	**276.5**
2	Other hazardous wastes	Kg/ quarter	30	120	75	**225**

Comment: The impact of wastes during the construction phase is moderate. It is required that the subproject owner and contractor must implement management measures to minimize negative impacts on the environment.

d) Noise and vibration

The sources of noise during the construction phase are derived from: (i) the means of material transportation; and (ii) the construction machinery and equipment, as follows:

(d1). Noise of material transportation means

As mentioned above, the material will be transported mainly by the waterway by small barges (100 tons), of which:

- **Construction of the wave-breaker:** The increasing frequency of transport means is only 0.88 trips/day but they work about 50% of the days in the year. The working scope of barges is 10km along the coastline without passing residential areas, especially the barges move on the sea, which will be completely isolated from residential areas, therefore the impact of noise is small.
- **Construction of embankment:** the increasing frequency of means is 3.7 times/day and the work is on rivers.
- **Construction of reservoir and WSP:** the increasing frequency of means is only 0.88 per day.

(d2). Noise of construction machinery and equipment

With the construction machinery and equipment for building the subprojectas shown in *Table4.16*, the noise levels far from the noise source of 1m, 20m and 50m are shown in *Table4.17* show the noise from the construction machinery and equipment is quite high, especially the noise of pile hammer.

may occur over a long period of time is the noise of concrete mixing and the noise caused by the pile driving along with the noise of the pile presser.

According to Pham Ngoc Dang (1997), noise effects can be predicted at adjacent areas as follows:

$$Li = Lp - \Delta Ld - \Delta Lc$$

In which: Lp: Noise at the point away from source 15m; ΔLd: noise reduction at distance d and calculated according to the following formula:

$$\Delta L = 10 \lg (r_2/r_1)^{1+a} \text{ (dB)}$$

With a: coefficient calculated to affect the noise absorption of the terrain. The ground is considered empty, have no trees, should be a = 0; r: distance from the source to the measurement point, r = 15 m; ΔLc: the level of noise reduction when passing obstacles. In this case, have no obstacles, ΔLc = 0 (dBA)

Table4.17: Noise of the construction machinery and equipment

No.	**Equipment**	**Noise level 1m away from the source (dBA)(1)**		**Noise level 20m away (dBA)(2)**	**Noise level 50m away (dBA)(2)**
		Range	**Average**		
1	Front shovel loaders	72.0 - 84.0	78.0	52.0	44.0
2	Bulldozer	-	93.0	67.0	59.0
3	Roller	72.0-74.0	73.0	47.0	39.0
4	Tractor	77.0 - 96.0	86.5	60.5	52.5
5	Scraper, grader	80.0-93.0	86.5	60.5	52.5
6	Paving machine	87.0 - 88.5	87.7	61.7	53.7
7	Truck	82.0-94.0	88.0	62.0	54.0
8	Concrete mixer	75.0 - 88.0	81.5	55.5	47.5
9	Concrete pump	81 – 84	82.5	56.0	48.0
10	Pile hammer	81-115	98	82.4	65.6
11	Welder	71 – 82	76.5	48.5	40.0
12	Compactor	74 – 77	75.5	48.0	39.5
13	Mobile crane	76.0 - 87.0	81.5	55.5	47.5
14	Power generator	72.0 - 82.5	77.2	51.2	43.2
15	Air compressor	75.0 - 87.0	81.0	55.0	47.0
QCVN 26: 2010/BTNMT for common areas from 6-21h		**70 dBA**			

Source: (1): Mackemize, L.Da, 1985; (2): Air pollution, Pham Ngoc Dang, 1997.

With the method of construction described in Section 1.4.3, the extent of extreme effects that

Thus, the total noise generated at a point by all sources is calculated by the formula:

$$\sum L = 10\lg \sum_{i}^{n} 100Li \quad \text{(dBA)}$$

Calculated results of noise during the construction phase are shown in *Figure4.4* và *Figure4.5*.

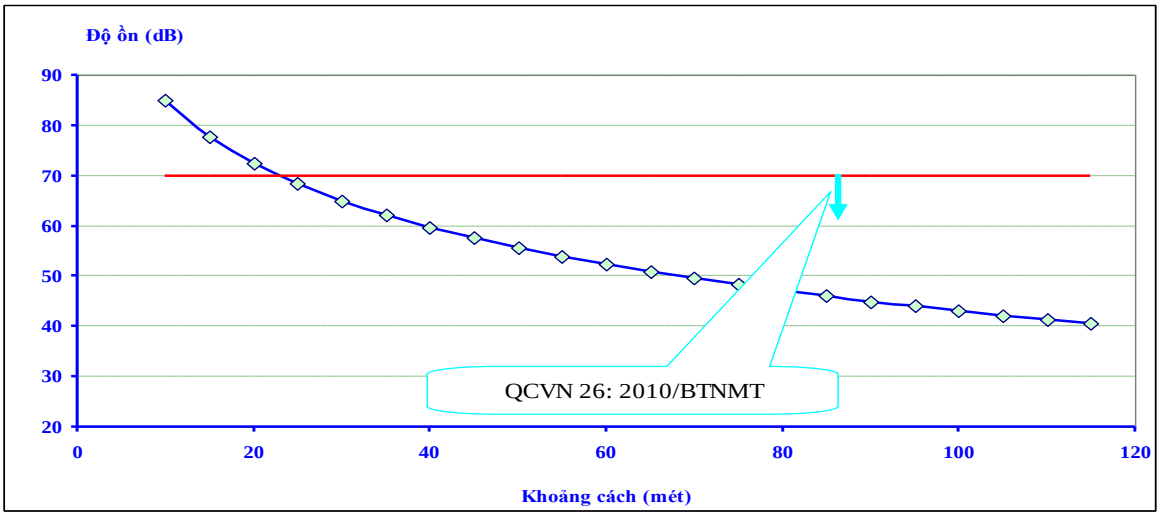


Figure4.4:Attenuation of construction noise from concrete mixing over a distance

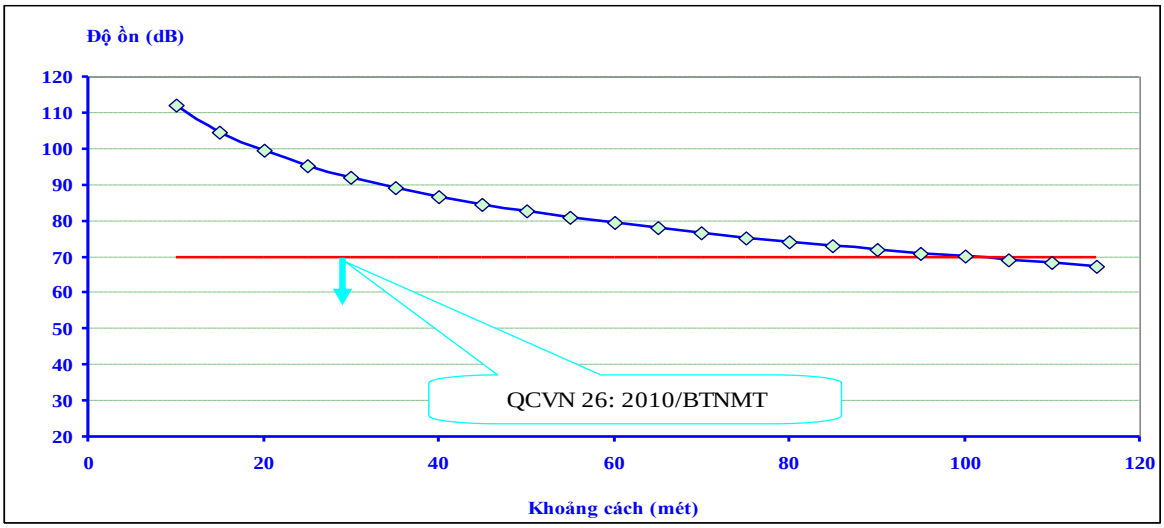


Figure4.5: Attenuation of construction noise from pile driving over a distance

Building the wave breaker: As mentioned above, all construction activities are carried out on the sea, away from the residential area. Although the noise level of the construction equipment is moderate to high but in a short time and the impact reaches between 20 - 50m. Based on the distance from the wave breaker to the sensitive works in *Table1.11* and *Figure1.16*, there are no sensitive receptors in the 20-50m range around the site.As a result, noise from the construction of the wave breaker will not affect the people in the area but will directly affect the construction workers on the barge. Thus, constructors should conduct measures to mitigate noise from the construction machinery and equipment to ensure the health and safety of workers.

Building the embankment: The construction of roads on the embankment surface, although the volume of mixing concrete is very large, but takes place on a very large scale (along 61.5 km). With the rolling process, the noise caused by mixing concrete to residential areas is temporary for a few hours in the vicinity of the mixer, which will then be transferred to other areas. Moreover, there are few houses on the embankment route and 43m far from the embankment is Tam Giang Tay 1 Primary School (*Table1.12*), so the impact is small.

The noise at 20 and 40m from the concrete mixer area was measured in a similar project in thesubproject in *Figure4.6*show that: above 20m far from the concrete mixing machine, the noise meets the allowable standard (QCVN 26:2010/BTNMT).

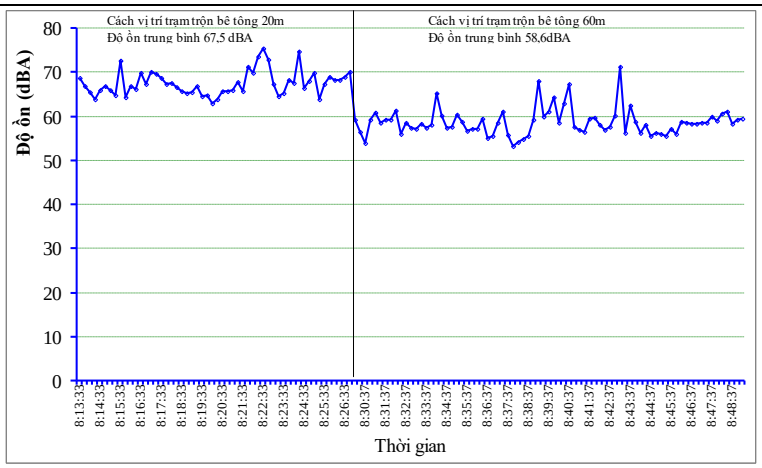


Figure4.6: Noise at locations of 20 and 60m far from the concrete mixing area in a similar project in Ca Mau

Building the reservoir and WSP:with the machinery and equipment used for the reservoir and WSP as mentioned above: In the distance 20m from noise source when all the sources noise is generated simultaneously, the noise level exceeds the permitted level for the working environment but it is not significant. However, in order to ensure that the working environment is not polluted by noise, special attention should be paid to the location during construction. In the distance 50m from noise source when the source is isolated or in bulk, the noise level is still within the allowable threshold for the working environment.

Comments: The negative impact of the noise caused by the construction of the subproject is small, but the Contractor should strictly follow the proposed noise reduction measures during the construction phase.

e) Water quality deterioration

The waste sources to water pollution include: (i) underwater construction like the wave breaker construction; (ii) temporary storage of material, solid waste; (iii) wastewater.

The wave breaker construction site is almost at sea. All items are concrete, which does not cause pollution, therefore the impact of rainwater runoff, in this case, is the risk of leaching waste on barge surface. Because the barge area is very small compared to the water surface area at the construction site and most of the construction material is concrete, stone, etc., the risk is rainwater overflow only on a surface barge. On barges, there are mainly steel concrete components and other risks as grease leaching, uncovered waste oil barrels, etc., which may be washed away by rainwater down the watersource. However, with one tug and two pile drivers, this risk is not high, the degree of impact is only localized at anchoring locations, if it happens, it is not enough to spread around, it only appears in 05 wave-breaker sections with a total length of 9km in the West Sea coastline.

The temporary storage of material, excavation soil, filling soil is the risk of dispersion dust in rainwater, which increases the turbidity of rivers and canals in irrigation and drainage areas, therefore appropriate mitigation measures should be taken.

The rainwater runoff will carry turbidity, sediment, construction material and possibly fill rivers and canals. However, this impact is controlled by adjusting the construction schedule in dry reason to limit rainy days.

Impact level: MEDIUM and can be minimized by mitigation measures in Chapter 5.

f) Impact on biological resource

(f1). Construction of the wave breaker

The execution process is quite simple: piling and dropping the gabion into the sea to reduce waves hitting the existing mangrove belt and at the same time create conditions for alluvial accumulating to plant mangroves. Most construction activities take place on barges on the sea. Impact of the wave breaker is on coastal ecosystems.

If only considering the location of piling and digging construction activities, these have an effect on bottom fauna in the. Bottom of this area is often eroded and moved due to wave and tidal so the benthic fauna is not much. The analysis result shows that there are no endemic species in the subproject area. The species found are regenerative after 1-2 months. Therefore, only 1 – 2 months after completion, the benthic fauna can easily regenerate, so the impact of embankment construction to benthic fauna is determined to be small, temporary and possible rapid regeneration.

For fish, zooplankton, and phytoplankton, they can actively move daily along tide into the subproject zone so the impact from construction activities to the fish fauna system and phytoplankton is considered to be negligible as embankment construction does not completely degrade their habitat.

For mangrove forest area: The wave breaker is built to reduce the waves to the forest so that the forest condition can recover faster.

The problem that needs to be addressed in the biota, in this case, is still waste oil: the waste oil is insoluble in water, floating on the water surface, creating a waterproof coating and sticking to the plant and can cause immediate death in aquatic animals. If it is uncontrolled, workers replace the oil and spread to the environment, the risk to affect the area of the organism will be quite large 1 to several km^2.

Disposal of the mop or leakage of fuel also causes water damage. However, this effect is only local and the contractor can easily manage.

Impactlevel: LOW, can be migitated by mitigation measures in Chapter 5

(f2). Construction of the embankment

Along the embankment, on one side is the canal, the other side is mostly aquaculture land. It has been decoded for a long time, not completely natural. It can be said that the construction of embankment slightly affect ecosystems. It is only needed to cut trees (mainly wild ones) lying on the boundary line.

Impact level: LOW, can be migitated by mitigation measures in Chapter 5

(f3). Construction of the reservoir and WSP

The impacts of these construction activities on biological resources: animals, plants and biodiversity and ecosystem are certainly affected but the affection level is medium, as follows:

At the reservoir location:

- Natural forest resources: The reservoir is 2.5 km far away from U Minh Ha NP, therefore it does not affect the National Park forest.
- Terrestrial plants and animals Inland flora and fauna: the construction may affect the habitats of some types of small animals like birds, reptiles, amphibians. During the construction of the reservoir, some animals may be hurt, died from the earthwork. The

vegetation in the reservoir area is mainly planted melaleuca so that the impact on plants is identified as small.

- Aquatic life: The concentration of motorized equipment will result in leaking or spillage of fuel and oil and incidents during the operation and repair of equipment. The fuel and oil are permeable in soil, flowing with rainwater into surrounding canals and contaminating the water source, and also causing adversely affects to the aquatic ecosystems such as algae, shrimp, fish, turtles, which may be affected. Some animals may get sick or die due to unable adaptation.
- Biodiversity: The construction does not change the biodiversity as the reservoir is not in the natural conservation area and the construction location of the reservoir is not the place of high biodiversity. In addition, the reservoir has no endemic species and species in need to be protected.

At the disposal site: Wastewater leaking from the dump siteincreasesthe SS andheavy metalsin the Canal No.22. Turbidity pollution also makes the oxygen in water significantly reduce and theaquatic animal hunting decreases as the food is limited or undetectable. When the sediment in water increases, water will become more opaque, affecting aquatic organisms. Most fish can not survive if the sediment reaches 2,000mg/L. Water with high turbidity and sedimentation contents prevent air from entering the water and impair the ability of the aquatic animal to find food. Particularly, in the digging area,which contains sulfate, the acid will increase while the pH will reduce in the water source, and the number of such ions as iron, aluminum, sulfate, and other heavy metal ionsincreases. In cases there is runoff water from the deposition pond with low pH, the acid concentration increases suddenly in the water of Canal 22, which may make some aquatic species unable to live in that environment and they must move elsewhere. If pH = 4.5 - 4.9, fish eggs will be affected. If pH = 4.0 – 4.4, many aquatic species are affected. If pH = 3.0 – 3.4, most aquatic species will die within a few hours. In cases where runoff water from the deposition pond contains low pH, the sudden increase in acid concentration in the water of Canal 22 may lead to the inability of some aquatic species to live in that environment and they must move elsewhere. The indirect impacts of water quality degradation will be mitigated through some of the above water quality control measures. The direct impact on fish and other aquatic species is largely unstoppable, however, these effects are temporary because the aquatic habitat system is generally quite sustainable and the fish species are constantly moving.

Impact level: MEDIUM, can be managed and minimizedby mitigation measures in Chapter 5.

g) Disturbance and increase the risk of traffic accidents

Construction of the wave breaker: the wave breaker is completely constructed offshore, so it will not affect the traffic. Based on the amount of material to be transported from the outside to the site, the average of one day will increase 0.8 trips of the barge to transport construction materials on the Tac Thu River, and along the West coastal line to the construction sites (*Figure1.19*). Thus, the impact on waterway traffic is small.

Construction of the embankment: The embankment sections in the subproject are constructed based on the existing ones are also the roads so the construction will inevitably affect the traffic of people. Because the existing embankment is low, most people still use two forms of transportation. In rainy days, high tides, or travel to the place where is no road, they move by boats; other days, road traffic is preferable. Although there are only 5 - 10 vehicles per day, the contractor still needs to ensure convenient transportation for the people or set up temporary routes for continuous traffic.

The embankment is not constructed on the waterway either blocking canals so it would not affect waterway. In the construction area, there is no road for motor vehicles, so materials are

transported on the waterway. Based on the amount of material to be transported from outside, the average traffic will increase by 3.7 barges/day in Cua Lon river, creeks of Trai Luoi, Vam Chung and Ong Nhu, so the impact is negligible (*Figure1.20*).

Construction of the reservoir and WSP: The total of materials used for the construction of the reservoir and WSP is about 42,000 tons. This will increase the density of barges 0.88 per day on Tac Thu River (*Figure1.21*). Large volumes of excavated soil, sand, construction materials, and mechanical equipment will be transported in the construction area by roads. This greatly increases the traffic on main roads leading to the water supply station. With the roads have not been upgraded, are relatively narrow in width can be local traffic jams. The installation of pipeline is only at the roadside, but due to the road is relatively small so if no traffic control measures when the pipe installation can affect the traffic at the installation location pipeline.

Impact level: MEDIUM, can be managed and minimizedby mitigation measures in Chapter 5.

h) Increasing risk of erosion, landslide

Building the reservoir and WSP: The process of digging the reservoir, land clearance for the construction of WSP and installing water supply pipelines will affect the soil environment. The construction process will disrupt the existing surface of the soil, allowing the soil to be washed away and eroded when it rains. However, after digging the reservoir and pipelines, the compaction and concreting the reservoir banks and vegetables recovering will be carried out immediately. So these impacts will be low and can be controlled.

In addition, slides and subsidence may occur in other activities of the construction of the reservoir caused by the following causes:

- Construction activities on the slope, roof structure, the soil compaction factor does not comply with the design drawings.
- Heavy rains during the excavation (from September to December) may also cause slides, erosion of the roof of the reservoir;
- Landslide and subsidence due to the geological structure which affected by changes in the quality of the works.

In case of landslides, subsidence in the reservoir building process will cause immediate effects on the site where the incident occurred. The amount of landslide will cause loss of environmental landscapes in the area, impeding the construction space and when raining, this amount of soil discharges into canals of 22 A, 22B, 22C, 22D leading to increasing turbidity in surface water, which directly impacts on aquatic systems (mainly phytoplankton and zooplankton) and on the flow regime of canal No. 22. At the same time when the incident occurs, it will affect the quality of works and construction progress due to the need to repair and surmount where the incident occurred. Details of mitigation measures are provided in *Chapter 4*.

Building the embankment: In bad weather conditions, as well as low quality may break the embankment. This leads to saline intrusion to the production area, causing damage to production and people live in the surrounding area. The occurrence probability of this issue is almost none, but the raising of this issue in this report is to provide the mitigation measure to deal with this.

Impact level: MEDIUM, can be managed and minimizedby mitigation measures in Chapter 5.

i) Increasing the risk of sedimentation in water drainage lines, local inundation

Wave breaker: the construction takes place entirely on the sea so do not cause sedimentation of water drainage and local flooding.

Reservoir and WSP: The risk of flooding during the construction of the reservoir is very easy to happen if before the construction of the contractor does not apply specific measures and methods of water diversion. Canals of No. 22A, 22B, 22C, 22D is responsible for water drainage for the area. This increases the possibility of flooding if the works do not apply specific mitigation measures. The detailed specific construction and water diversion measures will be applied in Chapter 4.

In addition, temporary storage of materials or wastes, if not properly controlled, can block existing drainage ditches in the area. It will cause local flooding when raining. This impact may stop when removing these wastes out of the construction sites.

Impact level: MEDIUM, can be managed and minimizedby mitigation measures in Chapter 5.

j) Impacts on landscapes and historical and cultural relics

Construction of the wave breaker: There are no historical and cultural sites in the area. The construction does not adversely affect the historical and cultural heritage of the area either

Construction of the embankment: There are no historical and cultural sites in the embankment area. The construction does not adversely affect the historical and cultural heritage of the area either.

Construction of the reservoir and WSP: Before the construction of the reservoir, WSP, this area is in the public land with mainly Melaleuca plantations, wild shrubs. After completion of the reservoir, tourism development will be developed that will change the landscape of the area in a positive way.Besides, the pipeline system is totally underground so it will not change the landscape of the environment compared to before the pipeline installation.

However, during execution, there is the possibility of archaeological discoveries. Change findings procedures are prepared for the Contractor and performed in *Chapter 5*.

Impact level: LOW, can be managed and minimizedby mitigation measures in Chapter 5.

k) Damaging, disrupting existing infrastructure services

The construction affects the existing infrastructure includingcrossing out the aquaculture ponds when the embankment passes through, affecting the water intake of the aquaculture ponds.

Impact level: MEDIUM, can be managed and minimizedby mitigation measures in Chapter 5.

l) Social impacts

The social impacts from the subproject construction which can be mentioned are the disturbance of people's lives, reduction of income from production activities due to disruption of infrastructure, conflicts between the subproject workers with the people in terms of benefits or behavior and the way of life, in which:

Disturbance of living and income of the people due to the disruption of infrastructure: the construction of the wave breaker will be taken place completely offshore, while the construction is in the state land. As a result, it does not disturb the lives and income of the people. However, when constructing the embankment, it is necessary to expand the existing embankment. Consequently, it will demolite the existing culverts for taking water into shrimp

and new culverts will be built. This causes affecting the taking water for shrimp ponds of farmers. However, most ponds are close to water sources and the embankment will be built in the form of "rolling", so this impact will be low and only happen in the period of building new culverts. This is the point that the subproject owner and contractors should pay attention to have the plan for people to get water favorably for their shrimp farms.

Social conflict between subproject workers and local people:

- **Buildingthe wave breaker**: As mentioned above with 5 construction sites of 5 segments and with the method of construction is neat and completely on the offshore, no building worker camps and using barges as camps for workers to rest. At the end of the day, workers will move to live temporarily with local people housesinland. Although there is a maximum of 10 construction workers at each construction site in a two-year period, the use of construction workers will cause major social impacts such as prostitution, drugs, and gamble; conflicts between workers and local people due to differences in culture and behavior. However, these impacts will be low if the contractors perform well in the management of workers, closely coordinates with the local authorities in the social security management, and coordinates with health authorities to control the disease.
- **Building the embankment**: the embankment is quite long so the construction will be divided into several packages and causing there is no need to build worker camps.In addition, the method for the construction of the embankment is quite simple, most activities will use local labor, only some of excavator and compactor drivers, technical staff is from other places. The number of staff from other places is only about 20-30 people in three years but divided into many areas of the site. As a result the risk of conflict between the subproject workers and local people in terms of benefits or behavior and lifestyle will be low so the impact on social security and order is small.
- **Building the reservoir and WSP**: Due to the construction areas are in rural areas, the construction activity almost has no impact on the business of people, it may increase the income by developing business activities for workers involved in construction. Construction of the WSP and pipeline system will also create opportunities for local idle laborers, especially in the idling period of the agricultural production. However, besides from the above mentioned positive impacts, the additional use of more than 30 workers on the site during three years also leads to conflicts between workers and local people, gambling, prostitution, drugs and disturbing public order can also occur if the contractor does not take strict measures to manage the workers.

Impact level: SMALL, manageable and can be minimizedby mitigation measures in Chapter 5.

m) Health and safety risks for workers

(m1).Risk of occupational accidents for workers

Environmental pollution can affect the health of workers on the site. Some pollution depends on the time and level of impact likely to cause serious injury, dizziness, fatigue, even fainting and need for prompt medical attention (usually female workers or unhealthy people).

The operation of equipment, especially crane lifting materials such as concrete, reinforcement can hurt the workers standing below. Workers who do not comply with the regulations on labor safety when transporting materials may fall, causing injury to others.

All construction sites have multiple means of transportation that can lead to accidents by the means themselves.

When constructed on rainy days, the likelihood of occupational accidents can increase: Sloping land leads to slipping, construction material piles, soft soil, and subsidence will cause incidents for people and construction machinery...

In general, these impacts negligibly affect the environment and in a short time. However, appropriate measures will be taken to control these impacts, which greatly affect the health and well-being of workers involved in construction.

(m2).Risks to occupational safety and health

Movement and operation of the equipment can cause injury to workers. The high dust content causes lung diseases, asthma, nose, eyes, etc., which impede visibility, affecting road users, especially during the transportation of sand and other material. Therefore, it is necessary to install a warning system, lighting temporarily so that people can identify the site area easily. It is compulsory for workers to comply with labor safety regulations, wear personal protection equipment during construction.

(m3).Risk of insect bite

Construction workers in the area near the forest, especially the wave breaker, reservoir, afforestation may encounter incidents caused by insect bites, such as bees, mites, beetles, worms, etc. if not timely treated, this easily cause many health damages or life-threatening.

(m4).Incidents and risk due to extreme weather

Extreme weather conditions cause great damage to the socio-economic as well as environment such as floods, landslides, floods and the danger of unsafe construction of works:

- Construction of the reservoir when raining or flooding: in rainy seasons, rainwater falls into the whole reservoir and stay there for a long time. However, in-reservoir items will be built in dry seasons, only in-ground items will be constructed in the rainy season. At the same time,all construction activities of the reservoir will temporarily stop when there are natural disasters, storm, and storms.
- Building the wave breaker: Construction in bad weather conditions such as storms causes boat overturning. This seriously affects human life, property and causes oil spills polluting the water environment.

(m5).Fire and explosion incidents

During the construction process, vehicles, machinery, equipment have to use fuel, petrol and oil DO. These fuels are stored in containers in storage. The carelessness of workers can cause fire damaging people lives and properties. Beside, carelessness in smoking, burning fire, cooking… might cause fire also.

Once the fire incident occurs, the impact on the environment is enormous, including:

- High damage to people and property.
- The air environment is polluted by burning products.
- Water pollution due to the amount of water that dissolves toxins.
- Impact on production and living of electric consumers.

(m6).Electrical incidents

Incidents such as electric shocks can occur when working with special construction equipment that can easily occur when muddy and in wet conditions. The accidental electric shock is likely to cause death for workers and people.

Most of the causes of accidents and incidents are the safety consciousness of workers is not high. Lack of labor protection equipment and unsafe working conditions are indirect causes of accidents and incidents. The consequences of these accidents can lead to property damage, damage to equipment, direct injury to the worker's health and life affecting their families. In

order to limit unfortunate accidents, strong measures need to be taken to ensure that workers comply with all applicable regulations and safeguards throughout the construction process.

n) Health and safety risks for the community

During construction, there will be safety and health risks for people around the construction site, including:

Spread of the disease: Mobilization of workers can spread the disease to local people (and vice versa) such as sexually transmitted diseases such as HIV, syphilis, etc. In addition, the water surface area in the subproject area is quite large, so if the sanitation conditions on site are not good will facilitate the disease (dengue fever, diarrhea ...) development. However, this risk is low and can be controlled.

Traffic accidents: due to overloading of goods, control of vehicles not in line with regulations; headlights, lights of vehicles are damaged during night traffic; transported in bad weather; encountered unexpected obstacle.Traffic accidents occur in the construction area due to the excavation and filling of the ground, causing muddy roads, slippery roads and damage to the construction site in the rainy season.Probability occurs depending on the sense of obeying the traffic law of local people, the driver of the vehicle and the construction workers. When an accident occurs, it will cause great damage to people's property and life.

Environmental pollution (dust, exhaust gas, noise pollution) affects the health of the people when producing around the construction sites. However, the exposure time with pollutants is small because farmers produce not so much in the area.

Risks of safety when people enter the construction site of the reservoir or being dangerous in the rainy season.

Impact level: SMALL, manageable and mitigable through measures in Chapter 5.

o) Change findings

Change findings that may occur during construction include:

- Cultural/archaeological objects found during excavation.
- Grave found while digging the ground.
- Explosives: Despite the good working environment regulations, the sub-contractors have contracted with the authorities to clear mines for the whole area. However, because the subproject area is quite wide, there is still the possibility of remaining explosive materials in the ground. Upon detection of explosive materials, the Contractor shall notify the Project Owner and stop construction and report immediately to the competent authority for handling.
- There are community complaints about environmental issues related to construction activities.

4.1.4.3. Site-specific impacts

a) Impacts on sensitive receptors

Sensitive objects may be affected during the construction of the subproject listed in *Table4.18*.

Table4.18: Sensitive receptors during the construction of the subproject

No.	Name of sensitive receptors	Impacts

No.	Name of sensitive receptors	Impacts
1	**Construction of the wave breaker**	
1.1	Natural marine habitat near Hon Da Bac relic 	- Impact on mangroves near the construction site. - Impact due to wastewater, solid waste generation of the construction activities - Impact on benthic plants and zoobenthos
2	**Construction of the reservoir and WSP**	
2.1	Reservoir	
	Khanh An Secondary School 	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety
	Khanh An High School 	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety
2.2	Disposal site	
	Khanh An High School 	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety
2.3	Pipeline system	
a	Km0 to Km 1+500	

No.	Name of sensitive receptors	Impacts
	Khanh An High School 	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety
	Residential area in the entrance to Khanh An high school 	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
		- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
b	Km 1+500 to Km 6+200	
	Cuu Long Chau Temple 	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
c	Km 6+200 to Km10	
	The intersection between the road from Thoi Binh Town to Khanh Lam and the road from Khanh An - U Minh	- Site safety

No.	Name of sensitive receptors	Impacts
		
d	Km 22– Km 25	
	Nguyen Thai Binh Secondary School  	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
	Residential area in U Minh town 	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
3	**Construction of the embankment**	
3.1	Lam Hai primary school  	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.

No.	Name of sensitive receptors	Impacts
3.2	Tan An Tay I Primary school  	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
3.3	Tan An Tay Secondary school  	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
3.4	Tan An Tay Kindergarten  	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
3.5	Tam Giang Tay I primary school  	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
3.6	Tam Giang Tay CPC  	Affecting the people's access to the CPC

No.	Name of sensitive receptors	Impacts
3.7	Vien An Dong residential area 	- Dust and air pollution - Noise pollution from machinery and equipment - Pollution due to wastewater and construction wastes - Site safety.
3.8	Aquaculture ponds are crossed by the embankment 	- Impact on water quality of ponds - Impact on farmers' income

b) Site-specific impactsof the wave breaker construction

Impacts on livelihoods of people living along the construction area: According to the survey results in 3/2017, in the area outside the sea dyke, there are no households raising salty and brackish shrimps, except households raising sea fish and blood cockles. The seafish farms are located kilometersfar from the construction sites. In the marine environment, the ability to dilute pollutants is very high, so pollutants from the construction activities cannot affect the area of sea fish farms. In the farms of blood cockles, blook cocles live in the sediment and organic humus is the main food for them, so the construction does not affect them.

Impact on fisheries: Fishing activities in this area are mainly near shore and offshore. Some households living near the foot of the dyke have exploited aquatic products under the canopy of mangrove forests such as oysters, snails, small fish, etc. Oysters and snails are a group of organisms that live in humus-benthic residues and in addition, the pollution from wastes of the construction activities is very small compared to self purification of the environment, so there no impacts from the construction activities on thespecies. Given that there were a number of extensive shrimp farming households in this area 10 years ago but mangroves have been lost due to coastal erosion so far this farming has almost ceased. In addition, fishing activities inside the protection forest have been prohibited.

Comment: Impacts of the subproject on livelihood and aquaculture activities are low.

c) Site specific impacts of the embankment construction

Impact of alum leakage from excavation: Excavation and filling by a bucket excavator produce an amount of leachate containing high turbidity and alum. The digging will lead to a capillary action, the alum from the bottom to the surface, pyrite (FeS_2) in soil exposed to air and turn into actual acid sulfate when reacting with oxygen. Consequently, a yellow layer of iron sulfate(because of oxidation of Fe^{2+}/Fe^{3+}) will appear on the surface of water source after a few days. Oxidation of iron sulfide in acid sulfate soils produces acid sulfate. This acid is released into the water causing low pH levels to affect the number of minerals in the soil,

causing imbalance in the carbonate system, the release of heavy metals and toxins into the water, which shortages the natural food sources for aquatic species, especially shrimps, resulting in slow growth or no crusting of shrimps. In addition, before shrimp stocking, farmers add urea and phosphate fertilizers to create favor condition for shrimp growth. When Fe^{3+}, Al^{3+} ions in this water source flow into aquaculture ponds, they will absorb the urea fertilizer, causing an impact on shrimp. Therefore, soil excavation for the embankment should be carried out during the dry seasons. Especially, for the embankment sections crosses over the shrimp ponds, the soil should be excavated in the period of 15 August to 15 October (solar calender) of years. This is the time when there are no shrimp farming activities.

Impact on water intake for shrimp ponds

The expanding of the existing embankment will affect the existing sewers for shrimp farming. This activity will partly affect the taking of water for shrimp ponds of farmers. As the shrimp ponds are also quite close to the source of water, and the embankment will be built in the form of "rolling", so this impact will be low and only happen in the period of building new culverts. This is the point of the subproject owner and the contractors should pay attention to have a suitable plan for farmersto take water favorably for their farms.

Comment: Impact on the aquaculture activities in the subproject area mainly comes from the soil excavation for the embankment. If there are no reasonable construction solutions, including the timing of construction coincides the time for taking water into the aquaculture ponds, impact on production activities is high. So the subproject owner and contractors must apply appropriate management and technical measures to avoid damaging to local people

d) Site-specific impacts of the reservoir and WSP construction

(d1). Emissions from sludge decomposition in the dump site

Excavated soil from the reservoir can have bad odors due to organic, clay sedimentor H_2S odors due to anaerobic digestion. When moving this soil to the dump site, the biochemical reaction continues to create leaked water and contaminated gas. Some organic matters in the soilare biodegradable and produce CH_4, NH_3, CO_2, etc.The anaerobic digestion in the dump is as follows:

$$\text{Organic matters} + H_2O \xrightarrow{\text{microorganism}} \text{Biodegraded organic matters} + CH_4 + CO_2 + NH_3 + \text{others}$$

The bad odor from the dump site resulting from organic residues deposited in the soil when the dredged anaerobic digestion occurs. Main gaseous products from the anaerobic digestion process include H_2S, Mercaptane, CO_2, CH_4. In this, H_2S and Mercaptane are the main odorants and CH_4 is a flammable substance if accumulated in a certain concentration. The composition of air emission generated by the decomposition of organic matters is shown in *Table4.19*.

Table4.19: Odor compounds contain sulfur by the anaerobic digestion

No.	Compound	Formula	Typical odor	Threshold
1	Allyl mercaptan	CH_2=CH-CH_2-SH	Garlic, strong coffee	0,00005
2	Amyl mercaptan	CH_3-$(CH_2)_3$-CH_2-SH	Uncomfortable, stinking	0,0003
3	Benzyl mercaptan	$C_6H_5CH_2$-SH	Uncomfortable, strong	0,00019
4	Crotyl mercaptan	CH_3-CH=CH-CH_2-SH	Skunk	0,000029
5	Dimethyl sulfide	CH_3-S-CH_3	Rotten vegetables	0,0001
6	Ethyl mercaptan	CH_3CH_2-SH	Rotten cabbage	0,00019

7	Hydrogen sulfide	H_2S	Rotten eggs	0,00047
8	Methyl mercaptan	CH_3SH	Rotten cabbage	0,0011
9	Propyl mercaptan	CH_3-CH_2-CH_2-SH	Uncomfortable	0,000075
10	Sulfur dioxide	SO_2	Pungent, allergic	0,009
11	Tert-butyl Thiophenol	C_6H_5SH	Garlic	0,000062
12	Mercaptan	$(CH_3)_3C$-SH	Skunk, uncomfortable	0,00008

Source: 7th International Conference on Environmental Science and Technology Ermoupolis. Odor emission in a small wastewater treatment plant, 2001

The analysis results of the sediment in the reservoir showed that organic matters only appear very little in the thin layer of the surface layer. So in the sludge from the reservoir almost no organic substances, the ability to generate odors is quite low.

Refer to the emission measurements of organic matters on the sediment from dredging Indiana Harbor canal in East Chicago at 6, 24, 48, 72 hours and 5, 7, 10, 14 days showed that the concentration of volatile organic compounds is low, ranging from 10-11mg/cm^2/h, under the threshold of detecting the odor of organic compounds (*Figure4.7*).

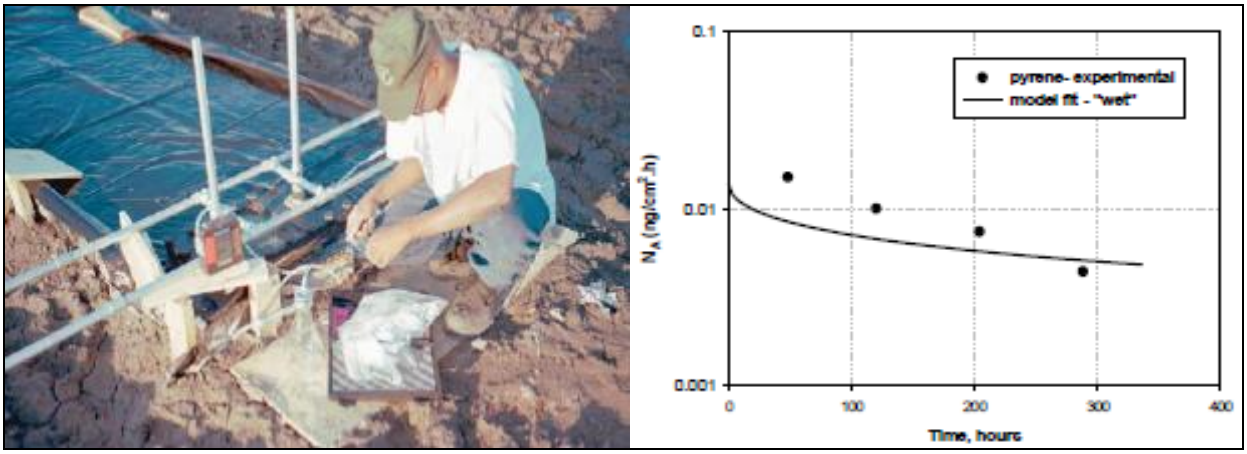


Figure4.7: Measurements of volatile organic compounds in Indiana Harbor canal sediment

Comment: The impact of odor from the reservoir digging is low. Moreover, around the dump site is empty land, the ability to disperse air emissions is large, completely isolated from the surrounding area so the effect of the odor is small.

(d2). Impacts of water from sludge pumping activities

A part of soil excavated is to be reused for leveling the water supply plant and embanking the reservoir bank, and the rest of 918,780 m^3 is transported to the dump site. It is expected that the transportation method is to pump this soil for land filling the resettlement area. Time for these activities is about 180 days.

The pumping solution will completely overcome the problem of air pollution due to no dust generation and no contamination in the transportation route. However, water should be added to execute the pumping process so there will be arising the risk of water pollution.

Technically, to pump soil through the pipeline, it is necessary to add 1.5 times more water than the amount of soil to be pumped, thus estimating the amount of water used to transport excess excavated soil to the leveling site at about 1,378,170m^3. The amount of water for pumping is taken from the reservoir and recirculated water on the dump site.

The amount of wastewater after settling is about 80% of pumping water, equivalent to 1,102,536 m^3. This effluent often contains a lot of sediment that is not deposited and is at risk

for alum contamination. If there is no good sedimentation solution, this will effect on water quality in canals around the dump site.

Referring to the analysis result of water quality at the effluent of the dump site of the project on dredging canals in the subproject area shown in *Table4.20*, it was found that the water quality from the dump site had a suspended solids concentration of 9 to 25 times higher than QCVN 40: 2011/BTNMT.

However, for the subproject, the suspended solids are the sediment from digging so the amount of suspended solids does not change many components in water. However, it can affect crops and livestock, especially aquaculture ponds around. In order to minimize the impact, the water from the digging will be recirculated to pump soil from the reservoir to the dump site and regularly monitor the water leakage through the embankment of the dump site. If the water leakage is found, the embankment will need to be reinforced at critical locations to ensure that the muddy water is not leaking out. In addition, the storage capacity of the dump site needs to meet the volume of excavated sludge to prevent overflow. Therefore, the subproject ownermust request that the contractor conducts to flow muddy water into the deposited pond to ensure sufficient time for sedimentation before discharge into the environment. The solutions are presented in *Chapter 4*.

Table4.20: Water quality at the outlet of the dump site for dredged sludge in Ca Mau

No.	**Section**	**Analysis result**				
		T(^{0}C)	**pH**	**DO (mg/l)**	**SS (mg/l)**	**F.Coli MPN/100ml**
1	Km0+150	30.2	3.12	1.1	1,452	210
2	Km0+500	30.4	2.98	1.4	1,224	110
3	Km1+850	30.1	3.03	1.9	869	90

Comment: Although the amount of wastewater for sludge pumping is very big, but the subproject owner has arranged a large dump site so there need to embank this site to ensure that no wastewater overflow outside as well as arrange continuous sedimentation tanks in the dump site, the risk of wastewater overflowing from the dump site is low and can be controlled.

(d3). Impacts at the dump site of Khanh An resettlement area

The results of soil quality analysis in the reservoir construction area in section 2.1.9.4 show that the excavated soil from the reservoir digging process is partially potential acid sulfate soil (with thickness of 1-2 m) and other soil layers are clay-free from acid sulfate.Acid sulfate soils are harmless when covered with waterand cannot be converted into actual acid sulfate soil. If exposed to air, through excavation or drainage, they react with oxygen to form sulfuric acid in the soil matrix and acidity from the oxidation of the soil can be flushed into the outside environment following rainfall events

The impact level of acid sulfate soil will depend on the amount of sulfuric acid conversion in the soil, the amount of rainfall. Levels of sulfuric acid conversion in potential alum soil include:

- When the rainy season ends, the soil becomes drained, sulfidic material pyrite- (FeS_2) containing soils is oxidized by oxygen in the air and converted to SO_4^{2-} simultaneously releases H^+ into the soil (this process happens 2 - 3 months after the end of the rainy season) and potential acid sulfate soil has been transformed to actual acid sulfate soil.
- When the rainy season comes, the ions in acid sulfate soil will be leached into the environment, especially the wash of H + ions, causing the water environment to be acidified and directly affect the receiving source.

Thus, if there has acid sulfate soil in excavated soil from the reservoir digging and it is not placed deep and directly contact with the air in the dry season, is turns into actual acid sulfate soil. In the rainy season, acidity in the soil will be washed away by the rain. In the reservoir construction area, the pH value of the rainwater washout is of 3 with the duration affected from 2 to 5 years.

In fact, handling acid sulfate soil by the preventing oxidation of acid sulfate soil and controlled oxidation (ém phèn) as water cover (keep potential acid sulfate soil below the watertable), reducing exposure of acid sulfate soil with oxygen in the air (place fill over potential acid sulfate soil) has been applied quite popularly and effectively in the acid sulfate soil area in the Mekong Delta.For the subproject, a part of excavated soil is contaminated with acid sulfate soil and the risk of affecting the surrounding environment is high if not properly managed while digging and leveling. To minimize the washout, the subproject will conduct the technique of preventing oxidation. Details are presented in Chapter 5.

Incidents at the disposal site

The excavation will create slopes, especially in areas with a weak foundation. It will increase the risk of erosion or landslides. Incidents at the dump site such as:

- People falling to the dump cause life loss.
- Water leakage, dredging mud flows into the surrounding area, affecting the production activities causing economic losses to people and the environment such as increasing the acidity of canal water entering the farms can lead to the death of shrimp, fish, crabs, and other aquatic organisms. The effects of acid (pH) of water resources on shrimp and fish are summarized in *Table4.21*.

Table4.21: Impacts of pH on fish

pH value	**Impact**
6.5 – 6.9	No negative impacts
6.0 – 6.4	No negative impacts unless in very high CO_2 level (> 1000mg/L)
5.0 – 5.9	No negative impacts unless high concentrations of CO_2 (> 20mg/L) or having Fe^2
4.5 – 4.9	Impacts on fish eggs, also impact on some fish in case of low concentrations of Ca^{2+}, $Na^{+,}$ and Cl^-.
4.0 – 4.4	Impacts on many kinds of fish
3.5 – 3.9	Killing salmonids, but not black fish (snakehead, Silurus, Tilapia, etc.)
3.0 – 3.4	Most fish die after a few hours.

Source: Wellburn 1988, from C.F. Mason 1991.

The main production activity of people in this area is cash crops, not aquaculture. But the Breakage of the embankment of dump site spills sludge and water into the surrounding canals that have the highest impact on aquaculture.

For cash crops, the impact is from the water of high acidity (pH <5). The results of previous studies indicate that the effect of pH on rice and sugarcane yields is not clear. But in the Mekong Delta, it has been reported in many localities that high acidity water has reduced yields of fruit and vegetable crops.

Besides, water with high acidity (low pH) can not be used for drinking of human and cattle. Especially, high acidity contains many harmful elements (Al, Fe, heavy metals) from the soil is easily dissolve into water source which is harmful to humans, livestock and aquatic life.

However, according to the survey in the subproject area, local people mainly use underground water from wells for daily life and production. Therefore, the impact on water supply of people is low.

These incidents, despite the very low probability of occurrence. However, if they occur, they will cause big damage to people and property. These impacts can be mitigated by proper implementation of prevention measures and, in the event of an incident, the subproject owner and the contractor must pay compensation for the people.

4.1.5. During the operation phase

4.1.5.1. Wave breaker component

The operation of the wave breaker does not generate wastes.Impact on the environment mainly from operational problems occurring during bad weather, as well as poor quality of construction works. These cause risks of erosion the wave breaker.

4.1.5.2. Embankment component

a) Impact on air environment

When the embankment is completed, the traffic system will be connected and traffic flow will be increased. This will contribute to increasing emissions of air, dust, and noise into the air. According to the field survey in the embankment area, this is a rural area, with less demand for travel, and the main means of transportation are bicycles and motorbikes. As such emissions will be low and this impact can be controlled with a solution of prohibiting motorized means on the embankment to protect it.

b) Risk and incidents

Risks and incidents of the embankment operation include an increased risk of traffic accidents due to the increased density of vehicles on the route that affects the health and well-being of people, and the incident occurs when breaking the embankment due to the quality of construction when handling the foundation and body of the embankment. These risks and incidents will affect the health, life, and production of the people.

In the event of water spills into fields affecting agriculture production, aquaculture, property and daily life of the people in protected areas, especially if it occurs at the time of harvesting, the damage is enormous. These losses have a great impact on people's incomes, local economy, debt growth. In addition, embankment failure does not only cause immediate damage to production but also long-term effects on the next crop because of saline soil.

4.1.5.3. Component of reservoir and water supply plant, pipelines

a) Impact on change of flow

The reservoir only stores rainwater in place, located in the delta area, this is not a dam and blocks water flow. There is no discharge to the outside, it onlypumps rain water from surrounding canals for thepurpose of living inthe dry season, there is no impact on the flow in the area. In normal conditions, there will be no significant water level difference between the reservoir and the canals. In order to have enough water for the dry season, in rainy season water from the canals will pump into the reservoir to increase its water level to 1.5m higher than the water level of the canals (*Figure 4.8*). Time for water pumping is shown in *Figure4.9*.

*Figure4.9*shows thattime to collect water from the canals is only in July with the highest number of days which calculated for the driest year (2005) is 14 days. From August to the end of November, the water intake will be closed, the water source for the reservoir will be from rains.

Because most of the volume of the reservoir is located under the natural ground, the soil is saturated with water all year round, so the capacity to penetrate outside is low. However, when the water level of the reservoir is higher than that of the canals, there is a risk that the water in the reservoir will flow intothe surrounding shallow aquiferto causing water loss. When the water level in the reservoir is lower than that of the canals, the risk of saline water from shallow groundwater source can permeate into the reservoir. As a result, it will affect the water supply. However, with the water level difference is not high with the application of waterproofing techniques, this problem will be solved appropriately in the design, so this impact can be controlled.

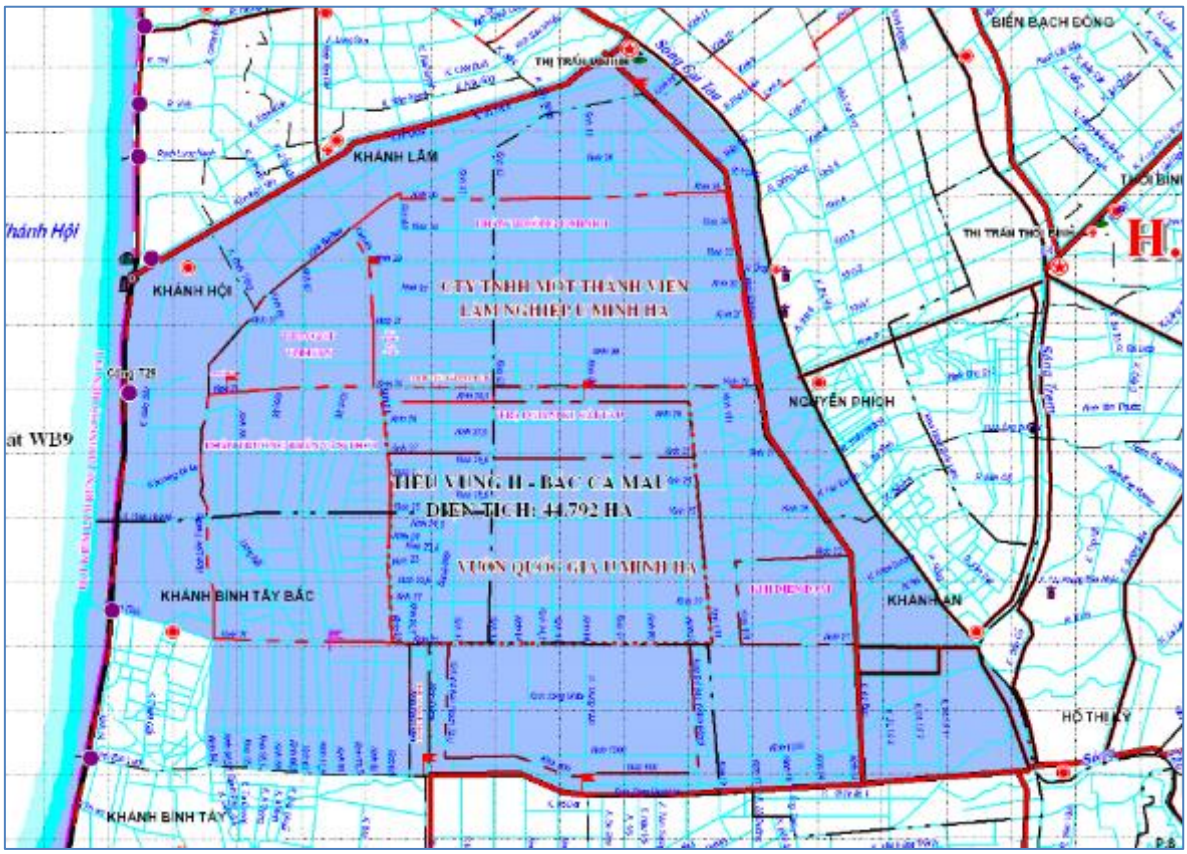


Figure 4.8: Water canal system in the area of water taking for the reservoir

TIME TO TAKE WATER TO THE RESERVOIR

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Rainfall	20	25	64	168	237	287	357	349	341	209	161	45	2,263

May, June: closing all sluices, draining the low quality water in the basin, during this period, the water source to the reservoir is rainwater

July: From 1 to 15 July, open sluices to take water for the reservoir by gravity to the elevation + 0.5m

From August to the end of rainy season, close sluices to take water for the reservoir from rainwater to the elevation + 0.5m

RESULT OF THE CALCULATION

No.	Option (PA)	Dimension of sluice		Q_{max} (m^3/day)	Number of day to take water to Z=0.5m
		B (m)	Z_d (m)		
I	With the rainfall in 2005 (p=90%)				
1	PA1	3	-1	8.58	14
2	PA2	3	-2.5	21.49	11
3	PA3	5	-1	35.73	10
4	PA4	10	-1	71.09	8
II	With the rainfall in 2006 (p=50%)				
1	PA1	3	-1	8.61	10
2	PA2	3	-2.5	21.5	7
3	PA3	5	-1	35.75	6
4	PA4	10	-1	71.07	3
II	With the rainfall in 2008 (p=10%)				
1	PA1	3	-1	8.59	6
2	PA2	3	-2.5	21.49	5
3	PA3	5	-1	35.74	5
4	PA4	10	-1	71.06	3

Figure4.9: Calculating the time to take water for the reservoir

In the case of rains, flooding cannot happen because there no having a water source from the outside area (the area is quite flat, the source of water is also the surface area of the reservoir).

This is a high precipitation area of about 2,360 mm, while most of the rainfall is concentrated only for 3-4 months (July to October) causing flooding in the area. During the period from June to October, all sluices in this area have to be opened to drain rainwater out to the sea. Thus, when it comes into operation, the water storage in the reservoir not only takes advantage of the excess rainwater to be discharged into the sea but also contributes to reducing flooding in this area.

b) Pollution of the reservoir

According to the morphological design and operation procedure, it can be seen that the reservoir is a static reservoir when operating. With such high of the reservoir, the distribution of nutrient salts and aquatic organisms between water layers is not much different. Characteristics of layers as follows:

- Surface layer: 0 to 0.5m deep. Water temperature varies according tothe externalenvironment, water is disturbed due to wind
- Middle layer: 0.5 to 2.5m deep. The temperature of the middle layer is unstable. At this layer, there is a disturbance in this layer itself due to the difference in temperature between the surface and bottom layers.
- Bottom layer: over 2.5m deep. The temperature is stable, the temperature difference between the bottom layer and the surface layer is up to 30.

In order to evaluate the metabolism of nutrients in the reservoir, the water source added to the reservoir is the surface runoff water that mainly flows through rice fields. For rainwater runoff to rice fields, concentrations of nitrogen and phosphorous are 0.21, 0.017mg/L, respectively. So N: P = 12.35 and N/P ratio: 12> P to be used for assessing the water quality of the reservoir.

Evaluation of the reservoir's eutrophication, the maximum allowable phosphorus loading formula in the reservoir of Vollenewedei (1996) is used:

Lc = 10qs x {1 + (D / qs) 0.5}

Lc is the critical phosphorus load (mg/m^2).

qs = 5.5 m the speed of water flowing through the reservoir (m/year).

The average depth of the reservoir: 7m.

Lc = 10 x 7m/yr {1 + (0.79) 0.5}

Lc = 132.22 (mg/m^2).

When the reservoir filled up with water, phosphorous content in water P = 17.5mg/$m^3$and total volume P calculated by surface 17.5 x 7m = 122mgP/m^2. As a result P, in case of worst water quality, is lower than critical Lc. At the same time, eutrophication occurs only when P is 2-3 times greater than. It means that no eutrophication happens in the reservoir.

c) Impact of acid sulfate exposure when digging on water quality

This is an acid sulfate soil, but the layer of acid sulfate is only about 1-2m thick and located on the top layer; Other soil layers are clay that is not contaminated with alum so that by technical solution, it is possible to actively treat acid sulfate for the waste dump and embankments of the reservoir. Details are presented in Chapter 5.

Acid sulfate affects the water quality of the reservoir primarily through low pH values but it is not too difficult to treat. In practice, water treatment plants are adding alum to increase the residue settling in the water. In this case, the source of water contaminated with alum is considered an advantage to the residue settling in the water. The water after being filtered will be neutralized to ensure that the pH of the water reaches the standard of water supply. Moreover, the effect of alum contaminated water occurs in the first 3 to 5 years of operation, therefore the impact is considered to be low completely controlled and its negative impact is turned into negative when using this water source for domestic water supply.

d) Waste generation from the water supply plant

(d1). Dust and gas emissions from machinery

Transportation of sludge and chemicals: Transporting means circulating in the area can disperse dust into the surrounding environment during high winds time, especially in areas which are not covered by concrete or asphalt. However, this impact is low and the operating agency will have appropriate control measures presented in *Chapter 4*.

Using chemical: especially chlorine, if not properly managed, can cause leakage and generate chlorine which damages the air and human health and damages the equipment. Exposure to high concentrations of chlorine can be toxic and burns the skin, eyes, nose and mucous membranes. Therefore, the operating agency of the water treatment system should comply with the regulations on chemical safety to ensure the health and safety of station operators, local communities and the environment. Chlorine will not cause serious harm if the workers of the WSP in contact with it receive training on the operational procedure of the WSP.

Operation of the electric generators using DO: Electric is the main power source for the WSP. However, in order to ensure the operation of the WSP when there is a sudden power failure, the plant will be equipped with a standby generator with a capacity of 500 KVA using DO oil. The volume of DO, which used in the process of running a generator, when using 100% capacity of 500KVA, is used at speed of about 96.5 liters/h, equal to 83.96 kg/h raw DO. The operation of the generator generates emissions such as dust, SO_2, NO_2, CO. The amount and concentration of substances in exhaust fumes generated by the electric generator

using DO are calculated based on the emission factor and the technical characteristics of the backup generator are shown in *Table4.22*.

Table4.22: Load and concentration of air emissions from the electric generator using DO

No.	Parameter	**Coefficient of emission (*)** (kg/tons of DO)	**Emission load** (kg/h)	**Concentration in facts** (mg/m^3)	**Concentration at standard conditions** (mg/Nm^3)	**QCVN 19:2009, column B** (mg/Nm^3)
1	Dust	0.71	0.06	32.65	51	200
2	SO_2	20S	0.84	457.2	709.3	500
3	NO_2	9.62	0.81	440.82	683	850
4	CO	2.19	0.18	97.96	152	1,000

Source: (*) Assessment of Sources of Air, Water, and Land Pollution - WHO, 1993.

Note:

- *S= 0,025 %*
- *Density of DO oil = 0.87 kg / l*
- *The process of running the generator for 1 hour will generate emission with the flow* $L=B*[V_0^{20}+(\alpha-1)*V_0]*[(273+t)/273] \approx 1.837,5\ m^3/h$. *In which:*
  - *B: The amount of fuel oil burned in 1 hour (kg / h); B = 83.96 kg/h*
  - V_0^{20}*: Smoke generated when burning 1 kg of DO;* $V_0^{20}=11,5\ (m^3/kg)$
  - *α: excess air factor α = 1.25÷1.3, chọn α = 1,25*
  - V_0*: amount of air required to burn 1 kg of DO;* $V_0=10,5\ (m^3/kg)$
  - *t: exhaust fumes temperature in actual conditions:* $t = 150^0C$.

Thus, when there is a power cutoff, the generator will operate, most of the concentration of pollutants from the generator air emissions are within the allowable limits, only the SO_2 concentration exceeds the permitted standard 1.4 times (QCVN 19: 2009/BTNMT, column B, [Kp = 1.0, Kv = 1.0]. Using the Screen View 4.0 emissions model toevaluate the emission of gas by wind velocity 1.5m/s. Select the emissions of redundant generators with the highest discharge and concentration to be assessed as SO_2 and dust with the following input parameters: SO_2 load: 0.023 g/s, Dust of 0.017g/s, pipe D = 0.3m,chimney height: 9m, temperature: 150^0C, rural terrain. The results in calculations simulate the effect of SO_2 concentration and dust dispersal to the environment is shown in*Figure 4.10*. It shows that emissions in the operation of the backup generator, when released into the external environment, have the highest concentration of SO_2: 23 $\mu g/m^3$, dust 17,23 $\mu g/m^3$ when measured at a distance of 100m away from the emission area. The concentration of dust and SO_2 below QCVN 05: 2013/BTNMT (SO_2<350$\mu g/m^3$, dust <300$\mu g/m^3$). In addition, the generator operates intermittently so the effects generated by the operation of the generator are negligible.

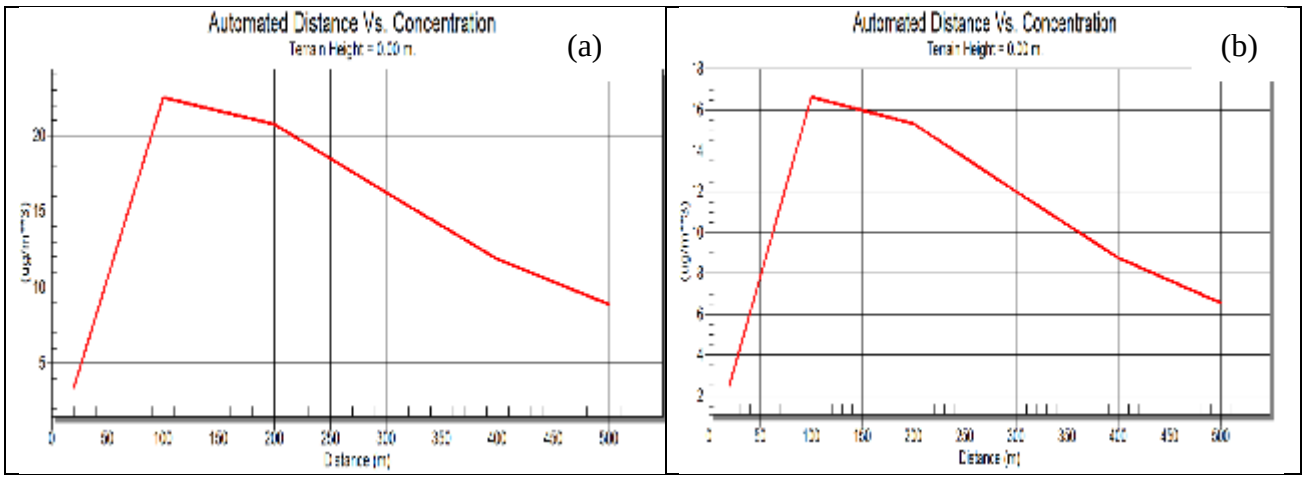


Figure 4.10: Emission from the generator (a) SO_2; (b) dust

(d2). Liquid waste

Wastewater from the WSP includes:

- Wastewater discharge from filtration, settling and drying sludge, in which: for filtration with 2 days filtration cycle with flow = 0.2%: Q = 50m^3; for cleaning the settling tank: Q = 15 m^3/h and for cleaning thesludge drying yard: Q = 24m^3/day. The composition of this wastewater mainly containthe sediment particles and an excess of alum deposited in the sediment with about 5-8% of the alum used. The wastewater generated from these processes is recycled in the mixing tank for re-treatment with raw water that is not discharged into the environment.
- Wastewater from the washing of laboratory instruments, chemical dilution: The amount is about 200L/ day, but the water content is not toxic and also not continuous so the impact is negligible, so the wastewater from the laboratory will go into the collection system with the domestic wastewater treatment system of the plant.
- Worker wastewater: The estimated water used for a worker is 45 L/day. Thus, the amount of domestic wastewater for 10 workers of the WSP is 10 people x 45 L/person/ day = 450 L/day.This wastewater is treated locally before being discharged into the environment.

(d3). Solid wastes

Solid waste from the treatment plant includes:

- Alum residue, sludge: Alum is used to settle suspended solids in water, forming sediment deposits. The required alum is expected to be 240 k/day. Alum 85% purity, when dissolved in water, requires commodity alum at 282 kg/day. It equal to 1g alum for 0.46 g Al(OH)3 sediment is settled to the bottom of the tank with residue in raw water and transferred to a drying yard. The amount of alum sludge discharged is 129 kg/day. Sediment is deposited with the sediment in the rough water at the bottom of the settling tank and discharged periodically into the two-stage sedimentation tank.
- Sediment from filtered water collection tank is calculated as follows:

$$20\ g/m^3 \times 12000\ m^3/day = 240000\ g/ngày = 240\ kg/day$$

Total amount of sludge discharged daily: 120 +240 = 360 kg/day

  - Flow rate of pump: Q = 150 m^3/h. Water washing time: t = 9 minutes, total volume of discharged water is 22.5m^3. The volume of top discharge: 10 m2 x (1 m + 1.2 m) = 22 m3

- Total amount of water discharged continuously form 2 filter compartments after 1 filter cycle: W = (10 + 24) x 2 = 78m^3
- Water retention time for sedimentation is 2 hours, filtered circulating water is 6 hours (at the same time, there is 1 hour for sludge discharge).
- Total filter volume of 6 tanks: 90 m^3.
- The volume of empty slurry containing sediment of 1m3 filter material: 110 liters
- The residue (dried) can be stored in 1 liter of the slurry of the filter material: 20 - 50 g/L, with an average value of 25 g/L.
- Total amount of residue can be retained in the filter of each tank for each filtration cycle: 90 x 110 x 25 = 247.5 kg
- Sediment concentration after sedimentation as calculated as well as design standards will be about 10 mg/L.
- With a capacity of 12,000 m^3/day (24h) total residue retained in the filter material: 12000 m3/day x 10g/m3 = 120 kg/day.

– Sludge from the sludge filter pressing tank: The tank works in close relation with the settling tank to protect the continuous sludge circulation in the sedimentation zone, at the bottom of the sediment trap. Taking into account the amount of alum left in the sediment with about 5 - 8% of the alum used daily. Sludge generated from sedimentation tanks:

$$20 \text{ g / m}^3 \text{ x } 12000 \text{ m}^3 \text{ / day} = 240{,}000 \text{ g / day} = 240 \text{ kg / day}$$

Total daily discharge: 120 +240 = 360 kg / day

If this sludge is not collected and treated, it will affect the surrounding environment. Therefore, this volume of sludge will be dried in the mud drying yard, then transported and treated in accordance with regulations.

(d4). Hazardous waste

When operating the reservoir, WSP, it is expected to use DO oil to operate the compressed air system and pump. The oil can be scattered due to the export, import of oil, leakage from the connecting pipe, from the valve... at the oil storage area. When it rains, it will cause oil pollution. Therefore, the operation agency will take appropriate measures to control the possibility of generating this source of pollution. Details are in Chapter 5.

e) Noise

The operation of water pumps, stirring equipment causing noise, vibration directly affects the health of the worker. Machines and equipment at the WSP should be the modern type.Therefore, they don’t cause noise or vibration excess the standards. The impact from noise and vibration from the operation of the WSP is considered as low.

f) Impact on microclimate in the area

Building the reservoir does not significantly affect the regional climate. Operation of the reservoir will, however, contribute to regulating the flow during the wet season and supply water during the dry season, resulting in increased humidity and groundwater reserves in the soil, creatingthe living condition for plants and species. The reservoir with 60 ha surface area is able to enhance the absorption of heat during the day and radiant heat at night, so the fluctuation of the heat of the area-surrounding reservoir reduces that is good for people’s health. In addition, when humidity in the reservoir area increases, insect pests, and pathogens also develop and lead to adverse effects on plants.

g) Impact on water quality in the area

As the area has high rainfall (2,360 mm) and more than 85% of the rainfall is concentrated from July to October, so the area outside the reservoir isdesalinated to become fresh.

The amount of fresh water collected for the reservoir is only 0.11% of the water resource in the area, and equal to 0.2-0.5% of the total drainage volume in U Minh area. So the impact of water taking for the reservoir is negligible.

Without water collecting for the reservoir, the water must be discharged to the sea to prevent flooding. This is considered to be a waste of fresh water which very lacks in dry seasons. The water taking will contribute to the balance of freshwater resource in the area during rainy seasons while it will be available for use in dry seasons.

h) Impact on the aquaculture

In the desalination area (the construction area of the reservoir), there are no significant aquaculture activities, especially in dry seasons due to the lack of water supply for aquaculture. In rainy seasons, the aquaculture is mainly raising natural fish in the canals. The water collecting for the reservoir only takes place in rainy seasons when the rainwater is abundant and must be drained out. Therefore, the water collection for the reservoir will not have a significant impact on aquaculture activities in the freshwater zone.

Outside the reservoir: The production activities outside the reservoir (outside the freshwater zone) are mainly following the shrimp-rice model. In rainy seasons, large rainwater sufficiently supplies to this area for the people to produce rice. Therefore, whether there is a collection of water in the reservoir or not does not significantly affect the water source for production as well as the aquaculture activities of the people in this area.

i) Impact on Melaleuca plantation

Although Melaleuca trees can live in a flooded environment for 3 to 5 months per year, during their submergence in water, they seem not to develop. They will grow well in dry condition and dry soil all year round. So now, local people make beds to create good conditions for Melaleuca plantation. As the water is collected to the reservoir, it will reduce the risk of flooding and make a good condition for Melaleuca trees to grow. Thus, the water accumulation to the reservoir is an advantage for the development of the Melaleuca trees.

j) Socio-economic impacts

Once the reservoir and WSP come into operation, it will provide high quality water, contributing to environmental improvement and minimize the exploitation of individual wells preventing pollution and degradation of groundwater. People can access to clean water, gradually change their habits of using unattended toilets on canals and fish ponds, building a civilized and cultured lifestyle in rural. Socio-economic impacts are positive. The construction works will limit the exploitation of groundwater, store of rainwater to provide for U Minh district, also contribute to the improvement of water quality, land reclamation, salt-washing and store fresh water at the necessary period.

k) Risk and incident

(k1). Risk on the water quality of the reservoir

Impact of pesticides: The maximum time for taking water is 14 days in July, this is the rice harvesting time of the summer-autumn season which is most farmers no longer use fertilizers

and pesticides. However, it is estimated that in the case of pesticide is used the frequency of pesticides at 3%.

According to the research by Pham Thi Minh Tri, the average times of using pesticides in farmers applying IPM are 4 times/crop, not applying IPM at 8.2 times/crop. The average pesticide use is 2.54kg / ha.

According to Baker 1985, Chesters and Schierow 1985, Johnson 1994, the percentage of pesticides in overflowing water from the fields is <5%.

The volume of pesticides that may flow into the entire basin is:

$$M = 2.54 \times 16{,}606 \times 3\% \times 5\% = 63.27\text{kg}.$$

Rainfall in basin in 14 days : Q= 64,619,142 m^3

Total concentration of pesticides in surface water:

$$C = 63.27/64619142 \times 1000 \times 1000 = \mathbf{0.98\ \mu g/l}.$$

Comment: The total concentration of pesticide in surface waters is very low, meet the Vietnamese standards: QCVN 08-MT:2015(total Dichloro diphenyl trichloroethane (DDTS) of 1 µg/L).

Impact of using fertilizer: According to data from the MARD, the amount of fertilizer used per unit of the cultivated area is as follows (*Table4.23*):

- The amount of nitrogen fertilizer is 80-120 kg N/ha on average, in the period of top dressing: 0-30 kg/ha (average 15 kg/ha).
- The amount of phosphorus fertilizer is 60 kg/ha on average, in the period of top dressing: 0-15 kg/ha (average 7 kg/ha).
- The amount of potassium fertilizer is 30-90 kg/ha on average, in the period of top dressing: 50 kg/ha.

Table4.23:The amount of chemical fertilizer for rice

Type of fertilizer	Nitrogen	Phosphorus	Potassium
Applied amount	15 kg/ha	7 kg/ha	50 kg/ha

According to Tran Thuc Son, 1998, the fertilizer use ratio for rice is 40%; phosphorus is 22% and potassium is 45%. In the case of using the time for collecting water is 14 days, 20% of total fertilizer application, the concentration of N, P, K dissolve in the water is shown in *Table4.24*.

Table4.24: Calculating the concentration of dissolved fertilizer in the water source

Parameter	Unit	Nitrogen	Phosphorus	Potassium
Acreage	Kg/ha	15	7	50
Total amount	kg	249,090	116,242	830,300
Dissolved amount in water for 14 days	Kg	29,890.8	18,133.75	91,333
Ratio	%	N= 46%	P2O5 =16%	K2O =50%
Concentration	**mg/l**	**N= 0.21**	**P2O5=0.04**	**K2O = 0.07**

Comments: The concentration of fertilizer dissolve in the surface water is very low, within the limits permitted by QCVN 08-MT:2015

(k2). Water quality risk due to domestic wastes

Residential land planning in the area to 2020 is 100 ha, with a total population of about 5,000 people. However, in the worst case possible, the risk of domestic waste from 20,000 people including local people as well as tourists in case of no septic tanks and with septic tanks are assessed and shown in *Table4.25*. As a result, *the concentration of pollutants from the living of people entering the surface water is very low, within the allowed limits of QCVN 08-MT:2015.*

Table4.25: Pollution load of domestic wastewater in the area

No.	Pollutants	Coefficient (g/man/24h)	Total load in the areafor a day (kg/day)	Total load in the areain the collecting water for the reservoir (kg/ 14 days)	Concentration in the case ofno septic tanks (mg/L)	Concentration in the case ofhaving septic tanks(mg/L)
1	BOD_5	45 - 54	900 - 1080	12600 - 15120	0.19 - 0.23	0.08 - 0.09
2	COD	72 - 102	1440 - 2040	20160 - 28560	0.31 - 0.44	0.12 - 0.18
3	SS	70 - 145	1400 - 2900	19600 - 40600	0.30 - 0.63	0.12 - 0.25
4	$N\text{-}NH_4$	3.6 - 7.2	72 - 144	1008 - 2016	0.02 - 0.03	0.01 - 0.01
5	Total N	6 - 12	120 - 240	1680 - 3360	0.03 -0.05	0.01 - 0.02
6	Total P	0.6 - 4.5	12 - 90	168 - 1260	0.00 -0.02	0.00 - 0.01
7	Oil and grease	10 - 30	200 - 600	2800 - 8400	0.04 - 0.13	0.02 - 0.05

(k3). Incident of the reservoir operation

In case of bad weather, as well as low quality of the works, the break of the reservoir will happen. However, the difference in water level in upper and lower delta z = 1.5 m, the difference of elevation of the top and bottom of the embankment (top-to-bottom) delta z = 3.5 m, thus the reservoir is not being able to become large dams when operating.

In addition, the total volume of the reservoir is 3.85 million m^3 but the risk of flooding is about 1 million m^3 only. The location of the reservoir is in the agro-forestry production area and the area without high earthquake risk, the number of households living in this area is not much, so the impact is determined to be low.

The results of the geological survey show that the load-bearing of the reservoir bottom is 82.5 kN/m^2, while the highest water level is 7m only ($70kN/m^2$), so the reservoir is completely stable. In fact, this reservoir completely submerged in the ground, the water level in the reservoir is only about 1.5 m higher than the natural ground so there will be no subsidence like dams.

In the case of rains, flooding cannot happen because there no having a water source from the outside area (the area is quite flat, the source of water is also the surface area of the reservoir). Therefore, the possibility of embankment break is rarely occurring, if any, the total amount of water flows only enough to raise the water level in the surrounding canal at about 0.5m high compared with the current status. Such a level would not affect U Minh Ha NP because the park was separated from this area by the surrounding embankment system, but cause damage to lives and property in the surrounding area. The probability of occurrence of the incident is almost none. However, this is mentioned to provide the plan to prevent and rescue when the incident happens, eliminating the unexpected situation.

(k4). Incidents from operating the WSP

During the operation phase of the water pipeline system, there may be cracks in the piping, obstructing the drainage pipe causing water to flow into the environment causing a flood to the area.

The risk of contamination from the wastewater collection system may arise if the distance between the water supply pipes and the drainage system does not comply with the standards set out in 20TCN 33-85. In the process of operating pipelines of new drainage systems built in the area, the incident also affected by cross-contamination. On the other hand, illegal connections to the water supply can also contaminate the water. These impacts can be minimized by complying with safety distance regulations as well as regular maintenance of water supply pipelines.

During the operation of the WSP, the change in water quality may affect public health. Incidents can occur due to abnormal factors such as sudden changes in raw water quality that exceed the capacity of the system, the failure of the pipelines to contaminate water source or ineffective treatment. Therefore, continuous monitoring is needed to ensure water quality from the supply station to the distribution network. However, health risks and impacts on water quality can occur if pollutants exist in undetected forms, such as pesticides.

Leaking and exploding chlorine gas cause unintended consequences for the lives and health of the workers and the surrounding people.

(k5). Fire incidents

Explosion and fire-related incidents are caused by the following: fire and other sources of ignition in explosive areas such as oil tanks; smoking and used cigarette; do not ensure good ventilation conditions in the operation house; selection of electrical equipment and wires is not suitable for current intensity, equipped with anti-overload devices; and lightning.

Impact on the environment when an incident occurs: Damage to property, life; The air environment is polluted by burning products; Water pollution due to the amount of water that is used to extinguish the fire; and affect the production and living of other electricity consumers.

(k6). Occupational incidents

The cause of occupational accidents is due to breaking rules of occupational safety such as Sleep during work; Errors in operating the electronic control panel; Careless use of electricity; and Software Error Controller.

Probability occurs depending on the compliance of the rules and regulations on occupational safety of workers in the operation. These impacts directly affect workers such as injuries of various kinds, occupational diseases, or loss of life, water supply.

4.1.6. Cumulative impacts

The results of the safety policy screening show that the components of the subproject are located in different locations, independent of each other and had different tasks, negative impacts of these components are short term and no cumulative impact. There is not much change in the scale and scope of the subproject in the ESIA preparation compared to in the screening, so there have no cumulative impacts in the subproject itself.

However, there are 4 projects in the area that have the potential to cause cumulative impacts with this subproject:

- Coastal Resources for Sustainable Development (CRSD) Project funded by the World Bank.

- The mangrove forest rehabilitation project through sustainable shrimp farming and emission reduction in Ca Mau funded by the Ministry of Environment, Nature Conservation and Nuclear Safety (BMU) of the Federal Republic of Germany through the Netherlands Development Organization (SNV/IUCN).
- Mekong Regional Water Security Project funded by the World Bank.
- Revised project on West Sea Dyke.

Environmental componentsmay be affected by the subproject: environmental components are selected for assessing based on relevant projects that may have cumulative impacts on the subproject area include (i) Air environment; (ii) Water environment; (iii) Soil environment and (iv) Human health

However, this subproject, along with other projects in the area are community projects, having more positive impacts than negative ones, with the objectives of providing clean water, improving environmental conditions, improve the traffic system so the cumulative impacts during the operation phase are mainly positive and the cumulative impacts during the construction phase include:

- Pollution of air, noise caused by increasing the density of traffic on the embankment.
- Market and disease risks when expanding shrimp models without finding the market for the product.
- Pollution of soil, water, air, noise due to increases transportation means of construction materials, equipment of this subproject and Mekong Regional Water Security Project in Nam Can, Ngoc Hien, Tran Van Thoi districts.

However, these cumulative impacts are assessed as moderate and short-term. Therefore, the Contractor's compliance with the environmental management plan during construction will contribute to minimizing this negative cumulative effect.

4.1.7. Induced impacts

a) Structure works

Impacts on the water environment

The use of dredged soil from the reservoir to level the ground for other projects in the province will contribute to the improvement of the infrastructure, which will increase the amount of wastewater and wastes that pollute air, soil, and water environment.

The increase in the amount of wastewater generated by the increase in rural water supply has been identified but this effect is negligible. This water source is available in canals in the Mekong Delta, and increased water use will not be large.

In the case of the completion of the embankment, the negative impacts of nature will be lowered. Production activities are not threatened by natural disasters, the total area of aquaculture will be expanded leading to the risk of increasing wastewater and agricultural waste causing the drainage can quickly fill up. As a result, frequent dredging and waste management are needed to maintain the quality of the environment.

In addition, when the embankment system is completed, shrimp farming activities are less risky, which can stimulate the people to cultivate shrimp farms to increase economic profits. This will increase the amount of wastewater from the ponds. If this amount of wastewater is not treated, it will affect the quality of fresh water, thus affecting the living of households in the area and surrounding areas in daily life, affecting people's health and productivity, aquaculture in long term.

However, the planning of shrimp culture areas is based on the shrimp-forest model. The productivity of this model is not high but stable and has no waste. Consequently, people should be encouraged and appropriate measuresare taken so that there is no shift to industrial aquaculture. Focus on income generation solutions for the shrimp and forest model. This solution takes advantage of favorable farming conditions and generates income for farmers in connection with environmental protection.

Impact due to increased waste

When the embankment system is completed, as discussed, aquaculture operations will be controlled and safer for aquaculture ponds. This may motivate people to switch to industrial shrimp farming. This model will generate a lot of waste including sludge from aquaculture ponds containing organic pollutants, nutrients, heavy metals, mineral components, and microorganisms if not treated. Properly polluting the country's environment, air and disease spread. However, the planning of shrimp culture area based on the forest-shrimp model, therefore, should have good control measures in order not to happen, people dislocate their own plans on the common environment.

b) Non-structure works

The expanding of livelihood models will lead to the use of a variety of chemicals, antibiotics. Some chemicals are toxic substances that need to be considered before being discharged into the environment. Although each type of chemical and medicinal product has the potential to kill certain pests, excessive use will result in air, soil and water pollution as they leach into the environment orare not discarded properly.

Animals such as birds may be poisoned by chemicals residues that remain on food after spraying. Fish and other aquatic biota may be harmed by pesticide-contaminated water.

Community health and safety issues during the expanding of livelihood models may include the following: i) Potential exposure to chemicals caused by spray drift, improper disposal and use of packaging and containers, and the presence of pesticides in potentially harmful concentrations in postharvest products; ii) Potential exposure to pathogens and obnoxious odors associated with the use of manure

Chemicals should be managed to avoid their migration into off-site land or water environments by establishing their use as part of an Integrated Pest Management (IPM) strategy and as documented in a Pesticide Management Plan (PMP).

In addition, once the livelihood models are successfully applied, there is a risk of massive development of uncontrolled livelihood models leading to changes in land use planning and other sector planning.

4.1.8. Impacts of climate change to the subproject and vice versa

Climate change is the change in the current and future climate system including atmospheric, hydrosphere, biosphere, lithosphere by natural and artificial causes. The main cause of climate change is the increase of activities that generate greenhouse gas emissions, over-exploitation of absorption tanks and greenhouse gas tanks such as biomass, forests, other marine, coastal and terrestrial ecosystems. The expressions of global climate change such as warming of the atmosphere and the earth in general, changes in atmospheric composition and quality are harmful to the environment of humans and creatures on the earth. The rise of sea level due to ice melting leading to flooding in the lowlandarea, small islands in the sea. The movement of climate zones that exist for thousands of years in different regions of the earth leads to leads

to threats such as the life of living organisms, ecosystems, human activities, changes in the intensity of atmospheric circulation process, natural water cycles and other geochemistry, ...

Sea level rise scenarios for Vietnam were developed in accordance with the IPCC methodology in the AR5 report; the latest research results of the world; Sea level rise scenarios of Australia, Netherlands and Singapore. Sea level rise scenarios are calculated from contributions, including (i) thermal expansion and dynamics; (ii) glaciers and jokul melting in continents; (iii) Balancing surface ice mass in Greenland; (iv) Balancing surface ice mass in Antarctica; (v) Greenland ice dynamics; (vi) Antarctic ice dynamics; (vii) changes in the amount of water stored in continents; and (viii) isostasy change. The thermal expansion and dynamics components are directly calculated from 21 ocean-atmosphere models (AOGCMs). The other components are determined according to the global calculation (IPCC, 2013). Sea level rise scenarios in this report have several updates compared to the sea level rise scenarios published in 2012, including (i) applying IPCC methodology in the AR5 report; (ii) based on calculations of atmospheric-ocean models; (iii) use of measured water level data and satellite data up to 2014 to verify the results of the model; (iv) determine the sea level rise for each coastal location, the Paracel Islands and Spratly islands area and the entire Vietnam sea region. Sea level rise scenarios only take into account changes in the average sea level due to climate change, without considering the effects of other factors causing sea level rise such as storm, monsoons, tides, geological lifting / lowering process and other processes.

Components contribute to sea level rise

NBD level totals in an area are calculated by the sum of components that contribute, including (i) thermal expansion and dynamics; (ii) glaciers and jokul melting in continents; (iii) Balancing surface ice mass in Greenland; (iv) Balancing surface ice mass in Antarctica; (v) Greenland ice dynamics; (vi) Antarctic ice dynamics; (vii) changes in the amount of water stored in continents; and (viii) isostasy change.

The total sea level rise in the region is calculated as the sum of such components as (i) thermal expansion and dynamics; (ii) melting of glaciers and ice mountains on the continents; (iii) equilibrium ice surface quantity in Greenland; (iv) equilibrium ice surface quantity in Antarctica; (v) ice force in Greenland; (vi) ice force in Antarctic; (vii) change in amount of water stored on the continents; and (viii) adjustment of ice isothermal (see*Table 4.26*).

For the Mekong Delta, Ca Mau is the most endangered area because of the long coastline impacted by two tidal regimes of the East Sea and the West Sea. Under current conditions, except for the two protected areas of U Minh Ha and U Minh Thuong, which are fresh ecosystems, store rainwater by dyke systems, sluices and temporary dams, most of the others area of the province are affected by two tidal regimes: the tide of the East Sea and the tide of the West Sea. During the dry season, areas which are intruded by salinity that exceed 28 g/l accounted for approximately 60% of the province's cultivated land, and at peak in April and May each year. The East Sea tide with high peak tide combined with East wind is the main cause of salt intrusion into the interior, especially in the coastal land. In addition, hydrological characteristics and the dense canal system are also the cause of saline intrusion from big rivers such as Ganh Hao, Dam Doi, and Bay Hap. According to the simulation results, the water level is wide and varied. High water levels along the East Sea, West Sea gradually decrease into interior field, so salinity was reduced as well in the field. The area between Trem and Cai Tau River, U Minh Forest Reserve, and some surrounding paddy fields are protected thoroughly from salinity intrusion, salinity in these areas is always <4 g / l. However, during the dry season, water levels in these areas are still lower than in the surrounding areas due to

the lack of additional sources, so the dry season is severely degraded, especially around April and May.

Table 4.26: The contribution of the total sea level rise components to the East Sea by the end of the 21st century compared to the baseline period

Unit: cm

Component	**Scenario RCP4.5**		**Scenario RCP8.5**	
	Global *(IPCC, 2013)*	**East Sea Viet Nam**	**Global** *(IPCC, 2013)*	**East Sea Viet Nam**
Thermal expansion and dynamics	19 (14 ÷ 23)	21 (15 ÷ 34)	27 [21 ÷ 33]	33 (25 ÷ 40)
Melting of glaciers and ice mountains on the continents	12 (6 ÷ 19)	14 (8 ÷ 20)	16 [9 ÷ 23]	19 (8 ÷ 25)
Equilibrium ice surface quantity in Greenland	4 (1 ÷ 9)	5 (2 ÷ 10)	7 [3 ÷ 16]	11 (7 ÷ 20)
Ice force in Greenland	4 [1 ÷ 6]	5 (2 ÷ 7)	5 [2 ÷ 7]	7 (4 ÷ 10)
Equilibrium ice surface quantity in Antarctica	-2 [-5 ÷ -1]	-3 (-4 ÷ 0)	-4 [-7 ÷ -1]	-5 (-8 ÷ -2)
Ice force in Antarctica	7 [-1 ÷ 16]	10 (3 ÷ 18)	7 [-1 ÷ 16]	10 (3 ÷ 19)
change in amount of water stored on the continents	4 [-1 ÷9]	3 (0 ÷ 8)	4 [-1 ÷ 9]	3 (0 ÷ 8)
Adjustment of ice isostasy	-0.1	N/A	-0.2	
Total sea level rise	**53 (36 ÷ 71)**	**55 (33 ÷ 75)**	**74 (52 ÷ 98)**	**77 (52 ÷ 106)**

Table 4.27: Maximum salinity in Ca Mau through sea level rise scenarios

Salinity (g/l)	**Baseline scenario**		**RCP4.5 scenario**		**RCP8.5 scenario**	
	Area (km^2)	*Percentage (%)*	*Area (km^2)*	*Percentage (%)*	*Area (km^2)*	*Percentage (%)*
<4	1,460	26.6	1,459	26.5	1,446	26.3
4 - 8	43	0.8	43	0.8	48	0.9
8 - 12	36	0.7	36	0.6	38	0.7
12 - 16	39	0.7	51	0.9	39	0.7
16 - 20	54	1.0	34	0.6	50	0.9
20 - 24	276	5.0	216	3.9	204	3.7
24 - 28	294	5.3	336	6.1	337	6.1
>28	3,295	59.9	3,324	60.5	3,334	60.7
Total	*5,497*	*100.0*	*5,497*	*100.0*	*5,497*	*100.0*

Table 4.28: Maximum water level in Ca Mau through sea level rise scenarios

Water level (m)	**Baseline scenario**		**RCP4.5 scenario**		**RCP8.5 scenario**	
	Percentage (%)	*Area (km^2)*	*Percentage (%)*	*Percentage (%)*	*Area (km^2)*	*Percentage (%)*
0,4 - 0,6	0.0	0.0	0.0	0.0	0.0	0.0
0,6 - 0,8	989	18.0	0.0	0.0	0.00	0.0
0,8 - 1,0	2168	39.4	804	14.6	0.00	0.0
1,0 - 1,2	978	17.8	2,288	41.6	1,021	18.6

1,2 - 1,4	390	7.1	941	17.1	1,800	32.7
1,4 - 1,6	259	4.7	465	8.5	1,084	19.7
1,6 - 1,8	256	4.7	238	4.3	617	11.2
1,8 - 2,0	270	4.9	268	4.9	224	4.1
>2,0	189	3.4	493	9.0	752	13.7
Total	*5,497*	*100.0*	*5,497*	*100.0*	*5,497*	*100.0*

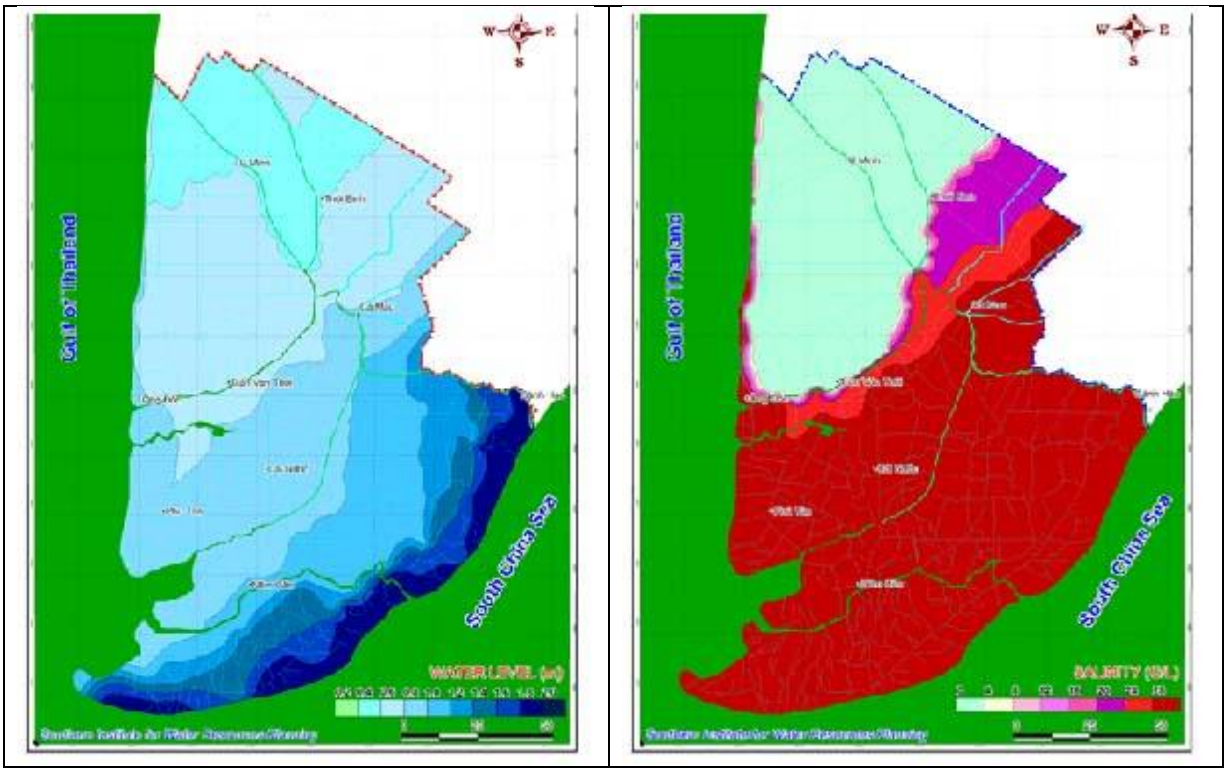


Figure 4.11: Maximum water level and salinity intrusion in the dry season – baseline scenario

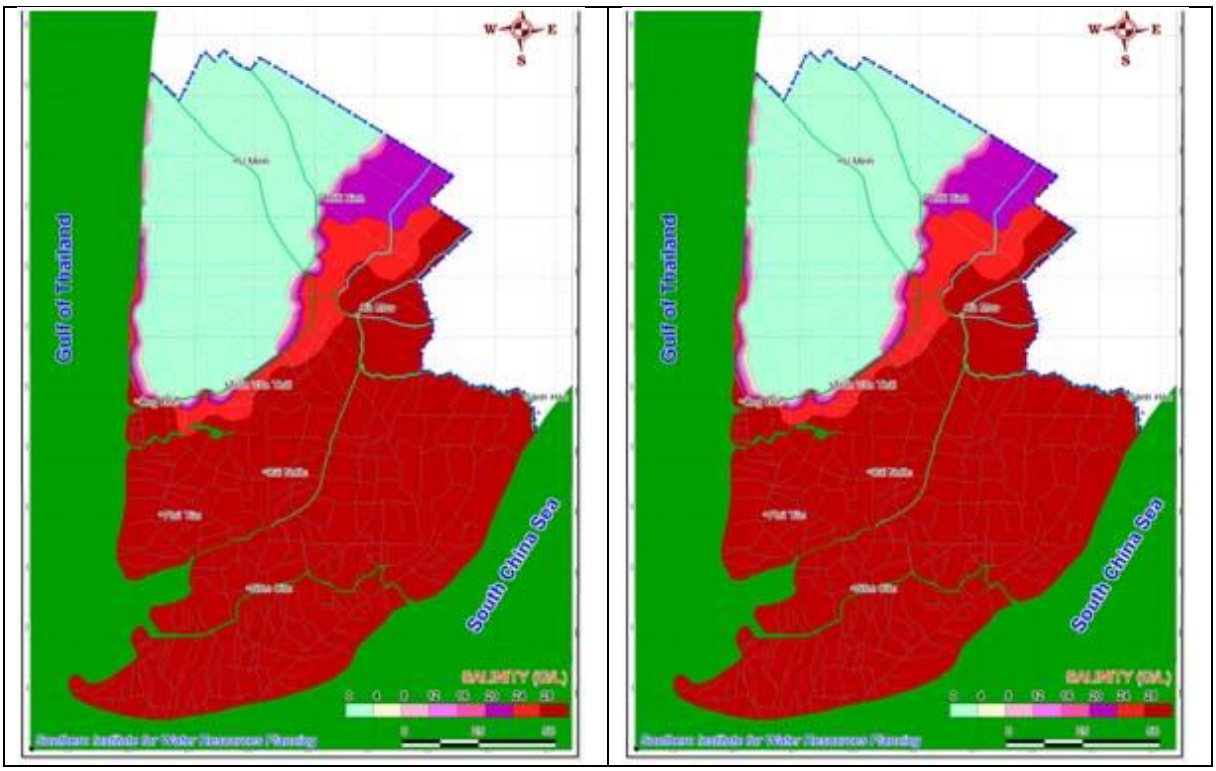


Figure 4.12: Maximum water level and salinity intrusion in the dry season – RCP4.5 and 8.5 scenarios

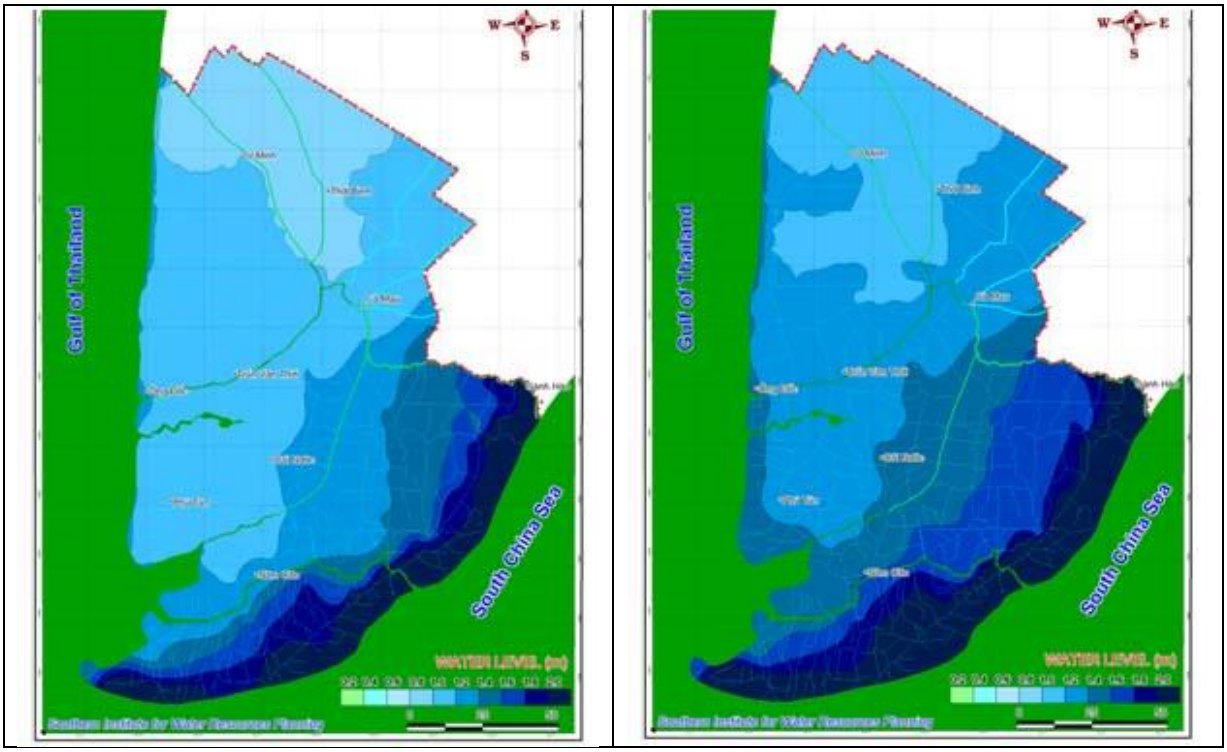


Figure 4.13: Maximum water level and salinity intrusion in the rainy season – RCP4.5 and 8.5 scenarios

Assessing the impact of sea level rise on the main economic components of the province:

- For agriculture, sea level rise affects the growth, productivity of crops, crop seasons, causing danger of narrowing agricultural land area.
- For aquaculture, when sea level rises, shrimp farming is affected the most due to changes in quantity and quality of water, especially in coastal areas.
- For forestry, sea level rise will reduce the acreage of mangrove area, impact negatively on Melaleuca forests and planted forests on alkaline soil. Increasing temperature and drought levels comes increasing in the risk of forest fires, pests and disease, etc.
- For traffic systems, about 4,500km of roads will be inundated, especially when typhoons and tides occur, this number is significantly increased to about 13,000 km.
- For homes, residential, sea level rise will affect about 275,000-325,000 households at different levels.

Climate change - sea level rise will potentially affect the existing water resources management system. Therefore, it is necessary to build and upgrade the system of river dykes, sea dykes, drainage systems, and reservoir to control the volume and quality of water in and out in the area. Protecting and develop coastal protection forests, pay attention to the forest type that adapts to climate change conditions in the future to minimize the impacts of climate change and protect the ecological environment. Diversify the development of agriculture and fisheries, change seasonal schedule, etc. to adapts to the climate change problem. Education and awareness raising on climate change - sea level rise to all communities and authorities at all levels to aware of the importance and joint efforts. Those activities are aiming to provide the most effective and practical solutions to respond and mitigate the impact of climate change - sea level rise.

In the future, it is forecasted that the sea level rise together with the tendency of heavy rain to increase and unusual changes in the flood season, the flooding situation of the subproject area will become worse.

The construction of the reservoir will change the microclimate of the area. When the reservoir is built, the buffer condition after the reservoir has a big change. In addition to the changes on global climate change, there is also a local change as follows: the change of the buffer surface to the change in moisture andtemperature of the reservoir area and its surrounding. After the reservoir construction form special weather phenomena and extreme values of moisture andtemperature tend to decrease and regulate, increasing the evaporation of the area to create a comfortable weather condition for the area of relatively large annual evaporation (1,049mm / year). However, this has both positive and negative impacts (mainly positive impacts), specifically:

- For humans, the temperature difference between water and soil creates a cool wind, especially in the dry season climate will have good results for sleep, nervous system and blood pressure, good for the health of people in the area
- The higher humidity in the reservoir area, the higher amount of pests and disease, this is a negative impact on the development of plants and crops.
- The reservoir construction will contribute to increasing reserves of groundwater, plants and species living near or in water body. Moreover, when plants in the area (mainly regenerated forests) have favorable conditions, they contribute positively to air conditioning and improve the environment. In addition, extreme weather events due to climate change and moisture and temperature characteristics tend to decrease, evaporation of water from the reservoir also contributes positively to regulating the regional climate.

The impact of climate change on water available of the reservoir: in the context of the climate change is taking place more and more complicated, unpredictable weather extremes, with the trend of increasing evaporation, water reserve in the reservoir still meets the designed capacity of the water supply station because the reservoir has a designed capacity of 3.85 million m^3, in which the amount of water reserved for dealing with extreme weather conditions is 749,798m^3, accounting for 24.19% effective capacity, evaporation capacity and permeability capacity.

The impact of climate change on water quality of the reservoir: at present, in the surrounding area, the land is agricultural land and production method is mainly organic farming there but land use at and surrounding the reservoir has been changing from time to time.In the future when other agricultural practice comes in there may be runoff through agricultural production land (if it switches from organic to using agrochemicals) into the reservoir. If agricultural land is maintained and crops are shifted as the result of climate change, there are more uncertainties about the “what” in the surface runoff that may finally enters and deposited in the reservoir. This causes removal of such substances as part of drinking water treatment process is technically very difficult and very costly.

So watershed protection planning is very important to protect both water quality and quantity of the reservoir.

4.2. NON-STRUCTURE WORKS

4.2.1. Positive impacts

Afforestation plays a very important role in mitigating the impacts of natural disasters and climate change. In addition, the mangrove ecosystem brings ecosystem values that contribute to the lives of people. The additional planting of 271ha of mangrove forest in aquaculture

ponds contributes to increasing forest coverage, ensuring ecological shrimp area, and stabilizing livelihoods under forest canopy through the combined forestry-aquaculture models.

When the livelihood models work, they will form residential areas, stabilize social life, create jobs, improve livelihoods and increase income for people who participate and implement the livelihoods models. The use of applied knowledge in production, business, generation will improve income, living standards and livelihoods, and develop the household economy.

This also helps strengthen the spirit of self-control, self-conscious in life, improve the ability to access the market. It helps people have knowledge of mastering their future and mastering their lives. People have the conditions to promote exchanges of social contacts not only for economics but also for culture and education.

This also promotes socio-economic development in deep-lying, remote and coastal areas of Ca Mau province. It raises the community awareness of forestry, environmental protection of coastal protection forests. At the same time, it raises awareness of the population in response to climate change and sea level rise.

Impacts on gender issues:

- Women's knowledge will be enhanced, which helps them more confident and creates an opportunity for them to develop and improve their capacity.
- Aquaculture linkage development will create more jobs for people.
- Men will be promoted in sharing family work with women.
- The role of women in family and society will be improved. Women will be active in life, in poverty reduction, mastering the future and life.

4.2.2. Negative impacts

4.2.2.1. Mangrove plantation

a) During the preconstruction phase

The areas of mangrove-shrimp ponds aremainlywater surface and agricultural lands with very few houses. The mangrove restoration will take place in the existing ponds, and no land acquisition and land clearance are required. Therefore, the social and environmental impacts in this phase are negligible.

b) During the construction phase

*Rhizophora*will be planted by putting about one-third of the seed length into the mud (*Figure4.14*). Given that mangrove trees will be planted on the existing shrimp ponds, the impact of mangrove reforestation during this phase is negligible.

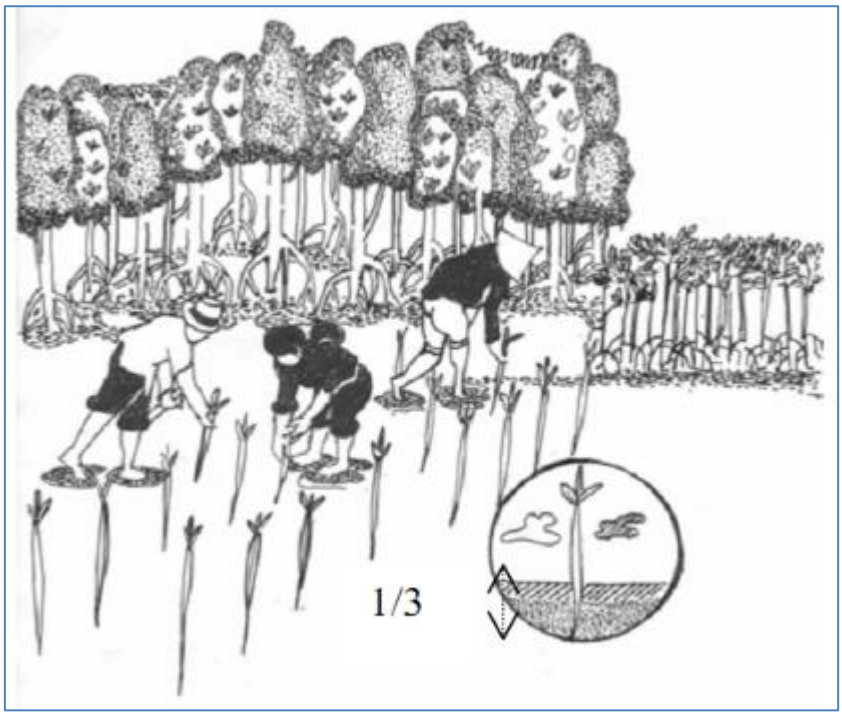


Figure4.14: Planting Rhizophora

Impact on water environment: The earthwork to make beds to grow trees will increase the turbidity, TSS, acidity in the water source, increase the content of some ions as iron, aluminum, sulfate and other heavy metals and toxins on the beds. However, the fieldwork results show that acid sulfate soil is not a serious problem in the subproject area.

Impact due to solid waste and hazardous waste: During the additional planting, workers do not have any domestic activities in the planting ponds, at the same time, small machines will be used to make beds and grow trees, so the source of solid and hazardous waste is almost negligible.

Noise: In the process of flattening to make pits for planting, the noise is mainly caused by small machines for flattening and planting. The impact is negligible as the surrounding is a forest, many trees, far from residential areas. The impact of noise during the planting process is almost negligible.

Soil erosion: Making beds to grow trees increases the risk of soil erosion, landslides, sedimentation of canals. However, this effect is temporary, localized and mainly in the additional planting ponds.

Impacts on fauna and ecosystem

- Terrestrial animals: The supplementary planting forest will more or less affect the forest animals (birds, storks, snakes, mice, etc.). The presence of planters will make animals move to neighboring areas, which is less disturbed and safer. In addition, the number of animals may be reduced due toaccidental catching during the planting. However, according to the assessment, the current species of animals in the area appear less so the impact is not significant. At the same time, there are no rare species living in the conservation program, so the impact level is small.
- Aquatic animals: In the process of flattening to make pits for planting, it will increase the turbidity and burial of mudflat creatures. Some species such as snails, shrimps, fishes, may be killed, resulting in reduced numbers in the area.

c) During the operation phase

Shrimp survival and biomass decreased significantly when the shrimp were cultured at the relatively higher concentrations of *Rhizophora* leaves and leachates (10-15g/l); in contrast, moderate amounts of *Rhizophora* leaves or their leachates had positive effects on shrimps (2.5-5g/l)[14]. But this impact is *low* due to water circulation may help to prevent low oxygen conditions and reduce local accumulations of mangrove leaves and good take care of *Rhizophora* to avoid defoliation of *Rhizophora.*

4.2.2.2. Livelihood models

a) During the pre-construction phase

These activities require no land acquisition and resettlement, as well as public infrastructure encroachment because they are developed on the existing production area.

b) During the construction phase

Demonstration sites are located in existing areas, taking advantage of the natural conditions of the area so there is no need to build infrastructure for the models but only minor repairs and only a few people living around,so impacts the environment and local people is small.

c) During the operation phase

(c1). Waste generation from the livelihood models in Southern Ca Mau

Demonstrating model of shrimp-forest

The ecological shrimp-forest model: the shrimp source is from natural tidal and additional stocking at the density of 1-3 fingerlings/m^2 without feeding. Farming, harvesting shrimps under the forest canopy are completely natural so that the environmental impacts by the model is negligible.

The development of some domestic poultry species of the pilot model has little impact on the environment. Therefore, the aquaculture co-management model does not affect the environment.

Actually, the shrimp-forest model is not new, since it has been applied quite popularly in Ca Mau province. However, as it is not synchronized without organization from production to consumption, the output to the market is not stable. Aggregating farmers and applying the ecological farming process will not increase negative impacts on the environment but become the foundation for better environmental protection.

Demonstration model of raising tiger shrimp in the form of improved extensive farming to ensure biological safety

During this process, feeds and chemical drugs will be controlled according to the Vietnamese standard, stocking density is 4-8 fingerlings/m^2. The productivity is from 400 to 600 kg/ha/year, equivalent to 200 kg/ha/crop.

[14] B. T. Nga, R. Roijackers, T. T. Nghia, V. N. Ut and M. Scheffer (2006). *Effects of decomposing Rhizophora apiculata leaves on larvae of the shrimp Penaeus monodon*. Aquacult Int (2006) 14:467–477 DOI 10.1007/s10499-006-9049-y

Refer to the results of calculation of pollutant discharge load due to shrimp farming in Cai Duoc, Ca Mau by Le Tuan Ngoc et al., 2012, a load of pollutants of the model are calculated in *Table 4.29*.

Table 4.29: Load of pollutants generated from the demonstrating model

No.	Pollutants	Pollution load (ton/ha/year)	Total load of the demonstrating model (ton/ha/year)
1	SS	4.98	1990.30
2	BOD	0.23	91.72
3	COD	0.47	188.88
4	Total N	0.07	28.27
5	Total P	0.04	15.06

This model, when implemented, will have a less environmental impact than the current model due to compliance with procedures and standards throughout the farming process. Farming methods use natural seed combined with additional stocking, no feeding, only water coloring; harvested according to the method of partial harvesting and additional seedling adding. The environmental impacts are very small.

Demonstration of intensive shrimp farming

Environmental impacts of the models depend on the hydrological conditions and self-purification of the receiving waterbody. Wastes from the models include excrement, excess food, soluble nutrients, chemicals, and pathogens as follow:

- Impact of shrimp feed use: The effluent carries a large amount of nitrogen, phosphorous compounds, and other nutrients, this causes eutrophication along with increased production and bacterial growth. The presence of carbonic and organic compounds will reduce dissolved oxygen and increase BOD, COD, hydrogen sulfide, ammonia, and methane content in the waterbody. The amount of shrimp waste discharged into the environment depends on the quantity of shrimp in the pond, stocking density, feed composition, ability to catch food and the ability to use a feed of shrimp in the pond. The amount of Nitrogen, Phosphorus and organic matter produced by one ton of shrimp in intensive culture varies with the feed conversion ratio (FRC) of shrimp as shown in *Table 4.30*.

Table 4.30: The relationship between FCR and amount of waste (kg) generated by 1 ton of intensive shrimp

FCR	Organic matters	Nitrogen	Phosphorous
1,0	500	26	13
1,5	875	56	21
2,0	1250	87	28
2,5	1625	117	38

In intensive shrimp culture, industrial feeds containing nitrogen, phosphorus, and organic matter were fed to shrimp. Only 17% of the dry weight of the feed was converted into shrimp weight. in the form of excreta, feces, solutes, minerals .... [Primavera, 1993]. Its impact on the environment is estimated at 45% nitrogen, 22% organic matter. Normally nitrogen compounds, phosphorus, and organic matter are deposited in the pond bottom and accumulate

in the pond at a rate of about 200 t/ha (dry weight) [Briggs et al., 1994]. In the pond preparation process, the bottom of the pond is sanitized and transferred to the canal within the culture area, nutrients continue to be released into the environment.

Table 4.31: Pollutant discharge load of the shrimp culture models

Item		**Model of white-leg shrimp intensive by Semi-Biofloc technology**	**Model of giant tiger shrimp, fish, and mollusk raising**	**Intensive model white-leg shrimp and tilapia for the environmental treatment**
Location		Districts of Dam Doi, Cai Nuoc, Phu Tan, Nam Can, Ngoc Hien	Districts of Dam Doi, Cai Nuoc, Phu Tan, Nam Can, Ngoc Hien	Districts of Dam Doi, Cai Nuoc, Phu Tan, Nam Can, Ngoc Hien
Area		200 ha	400ha	180ha
Productivity		14,3 ton/ha/crop	4 ton/ha/crop	9 ton/ha/crop.
Shrimp stocking density		160 fingerling/m^2	25 fingerling /m^2	80 fingerling /m^2
Stocking density of combined species			Mollusca10 fingerling/m^2	fish 2 - 5 fingerling /10 m^2
Conversion factor		1,012 *(Tang Minh Khoa, 2015)*	1,53 *(Duong Vinh Hao, 2009)*	1.1-1,3 (*Nguyen Khac Huong, 2007)*
Pollution reduction rate of combined species		-	Pollutant reduction factor of mollusca 30% pollutant	Pollutant reduction factor of fish 30% pollutant
Dissolution rateNguyen Thanh Long (2007)		N = 67,5% P= 2,25%	N= 67,5%	N= 67,5%
Accumulation rate of sediment		N = 3,37% P= 55%	N = 3,37% P= 55%	N = 3,37% P= 55%
Pollutant loads(ton/crop)	Organic compounds	1442.87	782.60	744.19
	Nitrogen	75.12	47.05	42.55
	Photphorus	36.60	19.09	18.42
In water(ton/crop)	Nitrogen	50.70	31.76	28.72
	Photphorus	0.82	0.43	0.41
In sediment (ton/crop)	Nitrogen	2.27	1.59	2.27
	Photphorus	1.24	0.87	1.24

The amount of industrial feed supplied to shrimp farming, if surplus, will cause water turbidity, the amount of oxygen will decrease, and the organic water in the water will increase to affect the aquatic life ... In addition, the amount of chemicals, drugs to Shrimp disease prevention also causes toxic residue in the water. Data from shrimp culture in Me Kong Delta in general and Ca Mau province, in particular,shows that, after a season of shrimp raising, the average amount of wastewater was about 9,000 - 12,000 m^3/ha, this water contains high concentrations of BOD, COD, H_2S, depending on the coefficient of feed and culture process.

Industrial shrimp wastewater has high organic content (BOD5= 12-35mg/L, COD =20-50 mg/L), nutrients, suspended solids (SS = 12-70 mg/L), ammonia (NH3= 0.5-1 mg/L), coliform (2.5.102 -3.104 MNP /100mL) ... need to be thoroughly treated before discharge to the receiving source.

- Impact of chemical use: The use of antibiotics in shrimp farming may cause concerns about the potential impact on the environment. Chemicals are used in stages such as disinfection of ponds, antibiotics and preventive medicines, heavy metals, growth stimulants, preservatives, color additives. The overuse of antibiotics and chemicals causes more damage than the cost to overcome. Normally, farmers use twice as much dose as the guideline. Therefore, lack of knowledge and guidance on training to use chemicals and antibiotics leads to poor effectiveness and causes negative impacts on the environment. The simultaneous presence of organic substances can cause a combination of transferring non-toxic substances into toxic forms. As hypochlorite and chloramine are non-harmful substances, in chlorine-containing environments, they create complex structures that seriously affect the environment. Therefore, the extension farming solution is extremely important to control the use of chemicals and antibiotics in a safe shrimp farming model.
- Impactof disease: Disease in industrial shrimp farming such as viruses, bacteria, fungi, parasites causing microbiological pollution to the environment. In addition, some organisms generate biological toxins such as mycotoxins and toxic algae that seriously pollute the water quality. Infected shrimp can cause disease to humans and other animals. However, all of the above environmental problems in safe shrimp farming environment will be controlled due to the process complying with the practice rules of good management in shrimp farming to ensure food safety while minimizing disease and environmental pollution, so the above mentioned environmental problems are negligible.
- Impact of bottom sludge: After each crop, due to excess feed, shrimp waste, aquaculture ponds accumulate in the bottom of the pond will form a layer of organic mulch. This place contains many pathogens and produces some toxic gases. It is these agents that not only affect the development of shrimp but also degrade the soil layer at the bottom of the shrimp pond. This sediment lacks oxygen and contains many dangerous substances such as ammonia, nitrite, hydrogen sulfide ... which causes shrimp stress. It is expressed through poor appetite, reduced growth rate, susceptibility to bacterial diseases and lead to mass shrimp death. In soil with many organic residues, the process of decomposing organic matter creates some toxic gases such as NH_3. Chlorine, when used, reacts with NH_3 to produce toxic substances that persist very long in the environment and very harmful to creatures

(c2). Environmental impacts of livelihood models inside the West Sea protective forest belt

Demonstration models of fish raising

The environmental impacts of fish raising are mainly due to excess food and fish excreta. It is estimated that only about 20% of dry food is absorbed by the fish, while the rest is released into the environment through digestive tract digestion.

Based on the research of Boyd in 1985, Gross, et.al in 1998 found that catfish only absorbed 27-30% of nitrogen, 16-30% of phosphorus and 25% of organic matter from food. Studies conducted by Yang - China in 2004 for catfish in 90 days showed that fish only absorbed about 37% of N content and 45% of P content in feeds into ponds. In order to produce 1 kg of

fish, 988 gram of dry matter (containing 870 gram of organic matters) was collected. The fish accumulated 290 g (containing 264 gram of organic) and wasted 698 gram of dry matter (containing 606 gram of organic matters), providing 37.17 g N and 8.48 g P, fish accumulated 17.41 g N and 2.17 g P, discharged to the environment 19.36 g N and 6.31 g. So it is possible to estimate the waste generated from the culture model as follows:

According to Truong Quoc Phu, the dissolution rate of the waste is 10% for organic matter; Nitrogen 9.5%, phosphorus 11%. As such, for the yield of 1 ton of fish production, the pollutant loads of the fish raising model are 0.2 ton of organic matter; 0.05 ton N; 0.0015 ton P and 0.21 ton BOD_5. With this amount, if no control solution is available, it will pollute the water environment.

Solid waste feedstuffpackages

Packaging waste from feeding and treatment of aquatic animals… The composition of food packages is mainly nylon, silk yarn, and organic matters – the main component of food attached to packages. The composition of antibiotic packages contains chemicals and antibiotics. According to the survey data from aquaculture households with the 2ha model, this waste amounts about 1kg/day.

Although the volume of waste generated from each model is small, it is a pilot model for replication in the region. Therefore, the subproject owner should have training programs on how to efficiently and environmentally manage this waste.

Impact of disease and antibiotic use from aquaculture

Most aquaculture processes are natural and populated but we cannot control all farming households. Increasing the aquatic density or using antibiotics or over feeding can cause water pollution.

In addition, poor farming techniques can cause disease, which affects the quality of water and spread the disease rapidly to surrounding and downstream areas.

(c3). Impacts of land use change

As mentioned above, the attraction from aquaculture income may lead to the expansion of the industrial aquaculture, which leads to the conversion of forest land into industrial shrimp farming and affects the mangrove forest. High income from industrial farming is only immediate, while the actual costs of environmental damage and social unrest are long-term and humanitarian. Immediate profits from industrial aquaculture may be applicable to some shrimp farmers. However, the entire population dependent on the coastal ecosystems, for example, fishing and aquaculture, will be affected.

In fact, mangrove forests may not be converted into industrial shrimp farming when people know the conditions and standards for getting certificates for the shrimp-forest model. At the same time, shrimp ponds will not be protected if the forest is cleared. Intensive shrimp farming is extremely risky because it does not control the environmental and natural factors.

(c4). Impacts on socio-economic conditions

Economic impact: Aquaculture is a key economic sector in the economy of Ca Mau province. Seafood from the province is exported to over 40 countries. Quantity of seafood, which was exported directly to other countries in 2013, reached 96,226 tons, the average growth is at 3.05% / year. Seafood export value in 2013 reached 1,058,823 thousand USD, in 2014 reached 1,260 million USD, the average growth is at 10.34%/year. The main markets are the US and Japan, EU, Korea, Australia, China. In the exported shrimp products, the

certified organic shrimp is very interested in customers, this is considered as a key product, creating added value in processing and exporting shrimp of Ca Mau in the future.

Changing livelihood models to improve economic efficiency and focus on preserving cultural, historical, biodiversity and ecological environment values of the region. Developing an important economic model for Ca Mau province will contribute to the poverty reduction program, creating a high export turnover and potential for strong development in the coming time. Raising income for communities under the forest canopy in the subproject area through an internationally certified livelihood model has a stable output market. Activities of local economic models are now mainly spontaneous and small, so the development of this industry has met many difficulties, especially for export. Organizing activities of economic development models of the sub-project towards sustainability will achieve food safety and hygiene products while minimizing disease and environmental pollution; improve economic efficiency for society and businesses. The economic impacts of the subproject are assessed as positive.

Livelihood activities that support poor households have many opportunities to successfully reduce poverty and improve their living standards. The two main livelihood resources of the subproject community are manpower and land including favorable conditions for the cultivation of brackish and marine fisheries. With the development of livelihood models such as Shrimp - Forest which is achieved international certification, improved extension tiger prawn farming ensures biosecurity, intensive farming of white leg shrimp according to Semi-Biofloc technology, raising tiger prawns combined with fish, mollusks, intensive farming of white leg shrimp combined with tilapia for environmental treatment, grouper farming in earthen ponds, breeding goats, sea ducks, rice cultivation combined with freshwater aquaculture will create opportunities for promoting the advantages of these two livelihoods, expanding the development of shrimp and other aquatic products. This will create more jobs, improve incomes and people's lives while contributing to protecting, developing mangrove ecosystems, and resilience to natural disasters and climate change.

Through the household survey, the number of regular workers per household is 3. This shows the potential for economic development but also a major challenge in employment issues in the subproject area. Workers in the project area have low education levels, their jobs depend mainly on the fisheries sector. In addition, young people can migrate to cities to work in industrial parks, construction, and maids. Women in the project area have low labor participation rates. The subproject on developing fishery production areas with certification as well as co-management, developing value chain links and creating sustainable livelihoods will increase the demand for local agricultural labor in accordance with the women's force. On the other hand, when agricultural growth, it also creates more opportunities to develop non-agricultural professions, creating many jobs in this area.

With the development of certified shrimp farming and co-management of mangrove protection in which shrimp-forest farming and the development of sustainable livelihoods under the mangrove canopy are an important factor to protect and develop local mangrove forests. In addition to the positive impacts during the implementation of the subproject, there will be unwanted impacts on the economic and political life of the locality as well as the livelihood of the people in the subproject area such as:

- Strengthen forest protection and sustainable forest development by community organizations that manage and produce under the forest canopy.

- Creating jobs, improving livelihoods and increasing incomes for people in the process of participating in and implementing project activities (planting mangroves, cultivating, producing eco-quality shrimp seed, tourism-services, environmental service costs, aquaculture, forest protection costs, etc.). Use the learned knowledge to apply in production, business, increase income, improve living standards, improve livelihoods. Developing a household economy, improving life.
- Enhancing the spirit of self-control, self-awareness in life, raising market access. Helping people with knowledge to master the future, master their lives. Creating conditions for people to enhance exchanges and wide exchanges not only economic but also culture and education,... The issue of sanitation and living environment hygiene in the process of implementing livelihood models is also improved.
- Equipped with the knowledge of economic development, knowledge of seafood value chain, co-management, sustainable livelihood development to respond to climate change, ...
- Improved skills of coordination, organization, and association of groups. Create a working atmosphere in groups of households and communities. This scale helps to increase economic efficiency, strengthen community cohesion, increase organization, discipline as well as the spirit of sharing and supporting in the community.
- Support to link enterprises and organizations that certify shrimp - forest.
- Support co-management of sustainable livelihood development under the mangrove canopy.

In general, the area of shrimp farming combined with mangroves is large, but only a few areas have been certified as shrimp - forests. This shows that there is still a lot of potentials for local farmers to have shrimp-forest certification to increase income and contribute to forest protection. However, the exact information on the number of farmers, area, productivity, production of tiger shrimp, silver shrimp, white-leg shrimp, soil shrimp, etc. in these models is still very small. In particular, there is a lack of extensive farming area data where farmers are adapting techniques that is similar to shrimp-forest farming, or a part of shrimp-forest farming techniques without any certification. Demand for seafood products in the world market still tends to increase, especially certified products. But in fact, consumers in developed countries lack information about the situation of food production they consume.

In the process of implementing the model, it is necessary to pay attention to the challenges related to social issues such as the access to training courses for the households as well as participating to associations and especially the information on value chain linkages in aquaculture and co-management of sustainable livelihood development under mangrove canopy is not yet well-know. Therefore, raising awareness for the people through the project is very important, especially the knowledge of household economic development, co-management, recording skills in the production process, group, market information, and market accessing help people gain more knowledge about economic development, exchanges to help each other and especially help people develop sustainable livelihoods.

For the establishment of a group, it is necessary to go in two directions to establish a group. Which are: set up a group under the management of the sub-zone and under the management of the hamlet because the project area has 2 different governing mechanisms. Therefore, the establishment of a group must also be in two directions to establish, for the management according to the sub-zone, it is possible to establish a group of households according to the

sub-zone. As for the management according to the administrative geography, the establishment should be implemented in the hamlet to have the best management and coordination among project implementation parties.

In summary, livelihood models do not cause serious impacts on social issues in the subproject implementation area. In addition, the subproject will contribute to the local economic development, increase the income of the people in the region, and improve the knowledge of economic development, develop the connected group to develop together and sustainably. At the same time, it contributes to the implementation of the development plan of the forest shrimp products sector under the "Scheme of restructuring the agricultural sector in Ca Mau Province" in the direction of increasing value and enhancing sustainable development.

Gender issues: the implementation of livelihood models according to the regional social impact assessment report, the implementation of the subproject livelihoods models will not change the gender issue in the area.Moreover, the livelihood models will contribute to improve knowledge, help women to be more confident, have the opportunity to improve and develop their capacity. Promoting men's participation in family work sharing for women. Enhance the role of women in the family and society, take initiative in life, in poverty reduction, knowledge of future mastery, master life.

Impact on cultural heritage: the implementation of livelihood models will not affect the cultural heritage in the area.The subproject is located in the area of aquaculture, agriculture, coastline around aquaculture ponds, rice fields. The area around the subproject does not have historical sites, architectural works as well as any rare and precious animals in the red book that need to be protected. Therefore, the activities of the sub-project do not adversely affect the cultural heritage in the region.

Increasing employment demand: the implementation of the livelihoods models such as aquaculture for communities living along the protective forest belt, raising cattle and poultry in natural conditions, cultivation in combination with fresh water aquaculture, especially the intensive shrimp culture with the application of Semi-Biofloc technology will create employment opportunities, especially for the poor.However, once the subproject livelihood models are developed in the region, they require a higher quality of seed, feed, fertilizer, and pesticides. This will affect the business of small company or households who not meet the requirement of the subproject.

Impact on ethnic minorities: As described in Section 2.2.1.5, in the subproject area the number of ethnic minority households is rather small. They have been living here for relatively long-term and have not been regarded as an ethnic minority community, therefore the impact of the livelihood models on ethnic minority community is not available.

Change of cultivation and production modality: the introduction of new livelihoods models or existing livelihoods models which has been changed in production scale and methods will affect the production modality in the area. However, the new methods are advanced and adapted to climate change and sea level rise, therefore, these effects are positive.

Impact on people's psychology: The introduction of new livelihood models will frighten farmers but this impact is small because before carrying out the new livelihoods model the Subproject Owner will organize training courses at site and workshops for farmers to visit and learn experiences when they participate in.According to the survey results of households living in the area implementing the livelihood models show that these models are in accordance with climate change and the general planning and development of the province. Encourage the development of these models but when developing, it must ensure environmental protection.

(c5). Risks and incidents

Disease risk: the mass production will cause disease outbreaks on a large scale, especially for expansion of aquaculture area. In production, the focus will increase the risk of livestock infection due to multiple sources of variation, or when a feeding unit is infected it becomes an infection source to the surrounding. Stamping infection out in large farms is also difficult due to the inability to destroy the disease at the same time in a large area. When a disease is extinguished at this point, it may retain in other points and becomes the source of disease emissions to the environment.

Market risk: Currently, it is unable to identify a clear and sustainable market for the products of the models. The transformation of the agricultural structure without adequate researches on the market, consumer demand, agricultural development planning trend, etc. will lead to failure. Therefore, the transition to new economic models on a large scale is likely leading to production failure when there is no demand for output and a stable price market. To mitigate this impact, trade promotion for outputs of livelihood models is of concern.

During the implementation of the livelihoods models, the Subproject will organize training courses for farmers on how to implement these models and how to implement in better production practices. However, when the models become successful, other households will imitate while they either did not have or have not trained about the process and fail to apply good practice standards, which will lead to environmental pollution and the output are not consumed. This will affect the lives of these farmers.

CHAPTER 5. IMPACT PREVENTION AND MITIGATION MEASURES

Chapter 5 will present the Subproject's measures to prevent, mitigate negative impacts and respond to risks and incidents in all 3 phases of site preparation, construction and operation.

Potential impacts by the Subproject will be minimized through the proposed mitigation measures during the preparation, construction, and operation phases. A number of mitigation measures and environmental solutions are also included in the technical proposal to enhance positive and sustainable impacts or to avoid, minimize or mitigate potential negative impacts which may occur during the construction or operation phases.

5.1. EFFORT TO MINIMIZE IMPACTS AND RISKS DURING FEASIBILITY STUDY PREPARATION AND DETAILED DESIGN

In order to promote environmentally friendly development and the adaptation to climate change as well as to ensure the achievement of the subproject objectives, a number of issues were integrated into the FS preparation phase and detailed design phase of the Subproject as follows:

- Minimization of land acquisition: the embankment routes were considered and selected to significantly reduce the impact of land acquisition, in particular, there are no relocated households.
- The livelihoods models related to aquaculture were reviewed through good international aquaculture practices.
- Sustainable building material: The choice of sustainable building material will be important in ensuring sustainable operation in the context of climate change and ensuring suitability to the natural conditions of the subproject, for example reusing all excavated soil for filling of the reservoir, using recycled plastic pads, preferably unburnt materials for embankment, spillway and reservoir construction and using ecological roofing sheets, recycled bricks in construction of water supply station.
- Safety signs during construction and operation were considered and included in the detailed design process of the Subproject.

5.2. MEASURES TO MITIGATE IMPACTS OF THE STRUCTURE WORKS

5.2.1. During the pre-construction phase

As discussed in the previous section, the key site-specific impacts for the subproject during preconstruction phase are (i) Impact on households whose land is acquired permanently and temporarily; (ii) Impact from landmines and explosives which still persist in the ground; and (iii) construction site clearance. To prevent and/or mitigate these impacts, the subproject owner will perform the following tasks:

5.2.1.1. Land acquisition

a) Implement efforts to minimize the impact of land acquisition

During the preparation of the subproject, the consultants of RAP and FS and Ca Mau PPMU have worked closely together in the formulation of technical measures, comparison, and a

selection of options. According to the principle of minimizing the impacts of land acquisition in the subproject area, priority is given to less land clearance or use state land for the subproject. Specifically as follows:

- Location of wave breaker is in the coastal area, the construction is completely offshore, so no land acquisition and does not affect the surrounding people.
- Location of the fresh water reservoir and water treatment plant is in area B3 and B4, with an area of 1,022,000m^2, in Khanh An commune, U Minh district, Ca Mau. This is the state land, so it is not necessary to carry out land compensation and site clearance.
- The location of the embankments: The construction of the embankments is subject to land acquisition but the selected route is the least land loss and no household needs to be resettled.
- Additionally, during the construction process, construction of embankment and wave breaker will be implemented in the back to back form in each section and the construction of the reservoir will be constructed on the reservoir area to reduce the temporary land acquisition area.

b) Compensation and support for land and assets on land according to approved policies

- Based on the contents of the meetings during the subproject preparation, affected people agreed to donate land for the construction of the subproject. The subproject owner, along with the local authorities and site clearance board will work with affected households for their sign on voluntary land donation form for land donate for the subproject implementation and they will not receive compensation, support. This procedure of land donation will comply with the principles of land donation approved by the WB in the RAP report.
- Ca Mau PPC mobilizes all active resources to donate land for construction of the embankments combined with rural roads.
- Subproject owner organizes propagandas and consults local communities about the land donation plan for construction work. The implementation plan for land donation must be united by the Ca Mau PPC, DPCs, CPCs and affected households in the area where building the embankment.
- In case there has household not to want to donate land for the subproject, the subproject CPCs, the Fatherland Front and the mass organizations coordinate with the Council for Advocacy to sum up the list and note the aspirations or difficulties. Settlements of each specific case to propose the next solution. In case of any problems, which cannot be resolved, they shall be reported to Ca Mau PPC and the subproject CPCs to handle.
- Support to stabilize the life, support for vocational conversion assistance, and support for vocational training and job creation for affected households.

5.2.1.2. UXO risks

As analyzed in Section 4.1.1.2, the impact of UXOs is significant, so to mitigate the impact of UXO, before handing over the site to the contractors. The following activities should be implemented:

- The subproject owner will sign the contract with the specialized unit to carry out mine clearance at the construction sites.
- The subproject owner will only hand over the site to the contractor when it is certified by the UXO clearance unit that the construction site is safe.

5.2.2. During the construction phase

5.2.2.1. General impacts

As discussed in Chapter 4, general impacts occurring during the construction phase include: (i) dust, emissions, noise, odor, and vibration; (ii) wastewater; (iii) solid waste and hazardous waste; (iv) deterioration of water quality; (v) impact on aquatic and terrestrial systems; (vi) Impact on landscape; (vii) Inundation, sedimentation and erosion; (viii) risk of land slide; (ix) traffic safety risks; (x) Infrastructure and utility services; (xi) Social impact; (xii) Impact on historical relics; (xiii) Impact on public health; (xiv) Occupational safety and health.

The potential impacts and risks from small to medium to large can be minimized by mitigation measures through the implementation of the detailed Environmental Code of Practices (ECOPs), as follow:

a) Mitigation measures on dust, emissions, noise, odor, and vibration

The following measures will be taken to minimize the impacts of dust, noise, and vibration:

- The Contractor is responsible for compliance with relevant Vietnamese legislation with respect to ambient air quality.
- The Contractor shall ensure that the generation of dust is minimized and is not perceived as a nuisance by local residents and shall implement a dust control plan to maintain a safe working environment and minimize disturbances for surrounding residential areas/dwellings.
- The Contractor shall implement dust suppression measures (e.g. covering of material stockpiles, etc.) as required.
- Material loads shall be suitably covered and secured during transportation to prevent the scattering of soil, sand, materials, or dust.
- Exposed soil and material stockpiles shall be protected against wind erosion and the location of stockpiles shall take into consideration the prevailing wind directions and locations of sensitive receptors.
- Dust masks should be used by workers where dust levels are excessive
- All vehicles must comply with Vietnamese regulations controlling allowable emission limits of exhaust gases.
- Vehicles in Vietnam must undergo a regular emissions check and obtain certification: “Certificate of conformity from inspection of quality, technical safety, and environmental protection” following Decision No. 35/2005/QD-BGTVT.
- There should be no burning of waste or construction materials on site.
- Cement processing plants should be far from residential areas
- The contractor is responsible for compliance with the relevant Vietnamese legislation with respect to noise and vibration.
- All vehicles must have appropriate “Certificate of conformity from inspection of quality, technical safety, and environmental protection” following Decision No. 31/2011/TT-BGTVT, to avoid exceeding noise emission from poorly maintained machines.
- When needed, measures to reduce noise to acceptable levels must be implemented and could include silencers, mufflers, acoustically dampened panels or placement of noisy machines in acoustically protected areas.

- Avoiding or minimizing transportation through community areas and avoiding as well as material processing areas (such as cement mixing).

b) Wastewater management

Contractors are responsible for controlling the quality of wastewater from the construction sites to ensure that wastewater is incorporated into surface water sources and water quality meets the requirements of QCVN 08-MT: 2015/BTNMT. Contractors have to ensure the following measures:

- The Contractor must be responsible for compliance with Vietnamese legislation relevant to wastewater discharges into watercourses.
- Portable or constructed toilets must be provided on site for construction workers. Wastewater from toilets as well as kitchens, showers, sinks, etc. shall be discharged into a conservancy tank for removal from the site or discharged into municipal sewerage systems; there should be no direct discharges to any waterbody.
- Wastewater containing pollutants over standards set by relevant Vietnamese technical standards/regulations must be collected in a conservancy tank and removed from the site by licensed waste collectors.
- Make appropriate arrangements for collecting, diverting or intercepting wastewater from households to ensure minimal discharge or local clogging and flooding.
- Before construction, all necessary wastewater disposal permits/licenses and/or wastewater disposal contracts have been obtained.
- At the completion of construction works, wastewater collection tanks and septic tanks shall be safely disposed or effectively sealed off.

c) Solid wastes management

Solid wastes:

- Solid waste will be managed in accordance with the Decree No. 59/2007 / ND-CP dated 09/4/2007 and Decree No. 38/2015 / ND-CP dated April 24, 2015.
- Before construction, a solid waste control procedure (storage, provision of bins, site clean-up schedule, bin clean-out schedule, etc.) must be prepared by the Contractors and it must be carefully followed during construction activities.
- Before construction, all necessary waste disposal permits or licenses must be obtained.
- Measures shall be taken to reduce the potential for litter and negligent behavior with regard to the disposal of all refuse. At all places of work, the Contractor shall provide litter bins, containers and refuse collection facilities.
- Solid waste may be temporarily stored on site in a designated area approved by the Construction Supervision Consultant and relevant local authorities prior to collection and disposal through a licensed waste collector, for example, URENCO.
- Waste storage containers shall be covered, tip-proof, weatherproof and scavenger proof.
- No burning, on-site burying or dumping of solid waste shall occur.
- Recyclable materials such as wooden plates for trench works, steel, scaffolding material, site holding, packaging material, etc. shall be collected and separated on-site from other waste sources for reuse, for use as fill, or for sale.

- If not removed off site, solid waste or construction debris shall be disposed of only at sites identified and approved by the Construction Supervision Consultant and included in the solid waste plan. Under no circumstances shall the contractor dispose of any material in environmentally sensitive areas, such as in areas of natural habitat or in watercourses.

Chemical or hazardous waste:

- All hazardous wastes (grease, organic solvents, chemicals, oily paints) are stored, processed and transported in accordance with Circular No. 36/2015 / TT-BTNMT dated 30/ 6/2015 of the Ministry of Natural Resources and Environment on hazardous waste management.
- The chemical waste of any kind shall be disposed of at an approved appropriate landfill site and in accordance with local legislative requirements. The Contractor shall obtain needed disposal certificates.
- The removal of asbestos-containing materials or other toxic substances shall be performed and disposed of by specially trained and certified workers.
- Used oil and grease shall be removed from the site and sold to an approved used oil recycling company.
- Used oil, lubricants, cleaning materials, etc. from the maintenance of vehicles and machinery shall be collected in holding tanks and removed from the site by a specialized oil recycling company for disposal at an approved hazardous waste site.
- Used oil or oil-contaminated materials that could potentially contain PCBs shall be securely stored to avoid any leakage or affecting workers. Ca Mau DONRE must be contacted for further guidance.
- Unused or rejected tar or bituminous products shall be returned to the supplier's production plant.
- Relevant agencies shall be promptly informed of any accidental spill or incident.
- Store chemicals appropriately and with appropriate labeling
- Appropriate communication and training programs should be put in place to prepare workers to recognize and respond to workplace chemical hazards
- Prepare and initiate a remedial action following any spill or incident. In this case, the contractor shall provide a report explaining the reasons for the spill or incident, remedial action is taken, consequences/damage from the spill, and proposed corrective actions.
- Material safety data sheets (MSDS) will be kept in a prominent place in the same contained storage space that hazardous materials are stored and in the first aid stations.
- An Emergency Contingency Response Plan (ECRP) will be in place to handle spills and ensure that clean-up materials are available on-site to control and clean up spills. The ECRP will:
    - Identify the positions and persons responsible for emergency response action (e.g., EHS, Contractor Site Engineer, DDIS, Works Foremen)
    - Specify the EHS Officer to be the leader of the Response Team and an Alternative leader (e.g., Contractor Site Engineer).
    - Include an organizational diagram specifying the positions and responsible persons within the Emergency Response Team, their work and home phone numbers, and the reporting lines among them, and the actions to be taken in cases of injury, and evacuation of personnel, and a spill of oil, diesel or hazardous substance.

- Ensure that clean-up chemicals and materials to absorb and remove spilled substances are available and stored undercover in locked facilities located next to first aid stations at construction sites and facility sites (yards, plants, diesel storage, and vehicle/equipment service depots).
- Hazard and risk management training will be provided to each EHS Officer (appointed by the Contractor), foremen, and all personnel handling chemicals and hazardous substances.
- Ensure that all personnel takes part in quarterly safety seminars.

- In cases of diesel, waste oil, or hazardous substance spills, the spilled material will be collected as quickly as possible and placed in drums. The spilled area will be cleaned in a timely manner to prevent potential contamination of surface and ground water and soil. Soil, clay or other materials that were "soiled" by the spill will also be collected and placed in drums. All spilled substances, materials, soil, and clay, etc., will be handled as hazardous waste and be transported and disposed of by a licensed waste management company in a DONRE approved site.

d) Water quality deterioration

Contractors are responsible for controlling the quality of wastewater from the construction sites to ensure that wastewater enters surface water and water quality to meet the requirements of QCVN 08-MT: 2015/BTNMT and wastewater management according to QCVN 14: 2008/BTNMT, contractors have to ensure the following measures:

- Fuel storage areas shall be located at least 25m away from surface water sources (rivers, canals), with roofs, fences. Restricting access to this area, only authorized people can enter and exit;
- Concrete mixing plants shall be located on non-permeable soils, at least 20m from any surface water source;
- Collect waste, store wastes on waterproof cement with drainage pits and sand settling;
- No maintenance and replacement of machine oil at the site; diesel and waste-oil will be stored in drums or tanks, raised on a platform above the ground (to prevent sweating), be under covered (to keep the rain out) on an impervious pad of concrete or clay, control rainwater overflow in this area.
- There are drainage holes, drainage ditch around the construction sites. Inspect, dredge open sewers at the site and surrounding areas periodically to prevent sedimentation in sewers that clog current and local surface water pollution;
- Covering material storage areas should be implemented during rainy times, temporary storage of construction waste on the sites will be no longer than 24 hours and it must be covered;
- Maintenance of oil change of vehicles and equipment in specialized workshops. Make sure there are no chemicals, gas, oil, grease leaks into the soil, sewers or water source. Use trays, mop buckets and other materials used in maintenance. To collect and treat hazardous waste according to regulations on hazardous waste management.

e) Mitigation measures on biological resources impacts

- Compliance with national and local regulations on policies related to protected areas, wildlife sanctuaries, and natural landscapes.

- All activities on the site are only allowed within the acquired land areas and ensure that construction material and waste will not fall into the surrounding areas.
- Vegetation removal will be minimized. At the edge of the road right-of-way, vegetation to be retained will be clearly marked and dead tree trunks and hollows will be kept as much as possible as they provide habitat.
- Where feasible, cleared vegetation will be chipped/mulched and reused for rehabilitating cleared areas (mulch provides a source of seeds, limits erosion, retains soil moisture and nutrients, encourages re-growth, and protects against weeds).
- Work sites will be cleared in short sections to meet construction needs and be stabilized (e.g., graded) and planted immediately after construction so as to minimize the area of exposed land at any point in time and to ensure the integrity of the works.
- Do not use chemicals to clear vegetation cover.
- Do not cut the trees to make camp, catch fish, birds to eat.

f) Disturbance and increase the risk of traffic accidents

Prior to commencing works, the Contractor will prepare a Draft Traffic Management Plan for consideration by the affected communities, traffic authorities and the police before finalization and approval. The Traffic Management Plan will include:

- Careful selection of traffic routes to minimize interruption of regular traffic and be away from communities as much as possible.
- Clear route directions, established speed limits and operating times (daylight as much as possible)
- Controls over the movement of vehicles particularly near villages and schools
- Provision and maintenance of temporary access for public and nearby communities
- Use of dust blankets or other means to cover the load
- Use of fine water spray on road surfaces to control dust in/near affected settlements
- Construction traffic giving way to regular traffic
- Installation and maintenance of appropriate warning signs, temporary traffic direction signs, markings, traffic signals, barriers, and lighting.
- Installation a sign that limits the speed of construction 100m from the construction site. Placing signboards with construction works 20m from the school gate, densely populated area, People's Committee, arranging traffic controllers at peak hours (if necessary).

g) Risk of sedimentation in water drainage lines, local inundation

- Material piles will be located away from water bodies and be surrounded by a bund to contain runoff from the pile. They will be carefully drained and controlled to prevent material flowing beyond the storage area. Material and waste piles will be covered to prevent rainfall, runoff or floodwater from carrying material in suspension.
- Water will be discharged only after the sediment has settled.
- Measures to control runoff, erosion, and sedimentation will include:
  - Diversion of natural runoff around construction areas
  - Temporary bunds to divert runoff to temporary or permanent drainage facilities
  - Water flow reduction barriers or steps to reduce flow velocity

- Water catchment sumps (sediment traps) silt aprons and/or straw bales to capture mud
- Settlement ponds and constructed settlement tanks to facilitate settlement of suspended sediment.

- Storm-water detention basins, sediment traps, and other protective measures will be installed on site prior to construction. Structures will be of sufficient size and located to collect and accommodate all runoff from the site.
- Drains, runoff, erosion and sediment controls will be monitored and maintained regularly (and repaired immediately after rain) to ensure their continued good condition and adequate capacity.
- Temporary diversion drains will extend beyond the embankment toe-line to avoid embankment erosion.
- The amount of excavated soil will be stored at sites agreed with local authorities and people. At the same time, the contractor will have no plans to build, dig in the flood season to avoid washing away, pollution of water. In the case of construction in the rainy season, contractors should have appropriate construction measures to prevent local inundation such as embankment, drainage ditch temporary and pump water out to avoid local flooding.

h) Risk of erosion and landslide

- For water supply pipeline installation: to prevent the risk of breaking down the existing surface of the land, creating conditions for drift and erosion when raining, contractors will apply the following measures: Thoroughly carrying out construction and compaction. During the period of lengthy rains from May to September, the construction of road embankment sections will be completed one by one, compacted and further strengthened to avoid erosion by rains. After pipelines are installed, the soil must be filled immediately. The repair of road pavement and sidewalks are in accordance with the design with the tightness of $K \geq 0.95$ based on test results before the acceptance of works to avoid subsidence after construction. Excess soil must be immediately transported into leveling sites as prescribed and the rest which is not transported to leveling sites will be kept shielding to prevent rains.
- For the reservoir excavation, the slope is 1:3 or reinforced by cajuput wall to avoid landslide. Because the working-load of the construction items of the reservoir is large therefore in the preparation phase of investment, the Design Consultant carried out the geological survey to complete the physical criteria of the soil foundation to calculate the foundation of the works during the design drawing for construction, ensuring the settlement of the works is within the allowed limit of 8.0cm. In the construction phase, the settlement of the works is monitored to take timely measures when necessary.

i) Damaging, disrupting existing infrastructure services

- Provide information to affected households on working schedules as well as planned disruptions (at least 5 days in advance).
- Interruptions of water supply to agricultural areas must be avoided.
- The contractor should ensure alternative water supply to affected residents in the event of disruptions lasting more than one day.
- Any damages to existing cable utility systems shall be reported to the authorities and repaired as soon as possible.

j) Social impacts

- Contractors strictly comply with the Construction Ministry's Circular No. 22/2010 / TT-BXD on construction safety.
- Register the temporary list of temporary workers with local authorities.
- Strengthen the employment of local workers with simple jobs, giving priority to the use of female workers and poor labor in the construction process.
- Health check for workers periodically. Persons with high infection will not be allowed to continue.
- The contractor informs the community about the construction plan at least 2 weeks prior to commencement of construction of the subproject.
- Avoid construction activities at night. Work areas at night must be notified at least 2 days in advance to the local community.
- Workers will be educated on appropriate behavior for interactions with the local community and risks of communicable diseases.

k) Health and safety for construction workers and local communities

- Provide personalprotective equipmentsuch as masks, helmets, shoes, gloves, glasses, belts, life jackets, life buoys (depending on the nature of work) and require workers to use when working.
- Provide training for workers on the environment, safety, and health, including awareness raising on HIV / AIDS and other communicable diseases.
- Prepare and implement an action plan for dealing with risks and emergencies.
- Prepare emergency support services at the site
- Install fences, barriers, safety/barriers around the construction site to let people know the area is dangerous.
- Contractorswill provide safety measures such as the installation of fences, barriers, warning signs, lighting systems to avoid traffic accidents as well as other risks to the people and sensitive areas.
- To ensure the safety of people and equipment involved in the construction of the subproject, the subproject is responsible for the removal of unexploded ordnance. This work is expected to be carried out at the same time as site clearance. This is a special task and will be carried out by the military. Removal of unexploded ordnance must be carried out prior to construction commencement to avoid danger.
- The contractor's contract covers the conditions to ensure occupational health and safety, non-discrimination between women and men, and people of the Khmer ethnic group, prevent the use of child labor, and comply with the labor laws of the government and related international treaties.

l) Impacts on landscape

- Install signs “sorry for any inconvenience caused” at construction sites located in densely populated areas or public areas;
- Minimize impacted area; return of vegetation, road surface, works are impacted immediately after the completion of works;

- Properly arranging temporary storage areas for waste materials and waste on construction sites;
- Set up fences around construction sites in sensitive locations such as schools, densely populated areas;
- Clear labor camps, temporary works used during construction, environmental clearance, return pavement when handing back to the local. Fill pits, ditches and temporary drainage ditches to ensure that there is no water retention causing environmental loss.

m) Chance find procedures

If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or individual graves during excavation or construction, the Contractor shall:

- Stop the construction activities in the area of the chance find.
- Delineate the discovered site or area.
- Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Department of Culture, Sports and Tourism take over.
- Notify the Construction Supervision Consultant who in turn will notify responsible local or national authorities in charge of the Cultural Property of Viet Nam (within 24 hours or less).
- Relevant local or national authorities are in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This will require a preliminary evaluation of the findings to be performed. The significance and importance of the findings should be assessed according to the various criteria relevant to cultural heritage; including the aesthetic, historic, scientific or research, social and economic values.
- Decisions on how to handle the finding shall be taken by the responsible authorities. This could include changes in the layout (such as when finding irremovable remains of cultural or archeological importance) conservation, preservation, restoration, and salvage.
- If the cultural sites and/or relics are of high value and site preservation is recommended by the professionals and required by the cultural relic's authority, the Subproject's owner will need to make necessary design changes to accommodate the request and preserve the site.
- Decisions concerning the management of the finding shall be communicated in writing by relevant authorities.
- Construction works could resume only after permission is granted from the responsible local authorities concerning the safeguard of the heritage.

5.2.2.2. Site-specific impacts

Below is site-specific impacts and mitigation measures that could not be addressed through the application of the ECOPs. This may be because the impacts are very site-specific in nature and thus require very site-specific mitigation measures.

a) Impacts on sensitive receptors

Measures to mitigate impacts on sensitive receptors presented in *Table5.1*.

Table5.1: Site -specific mitigation measuresfor sensitive receptors

No	Sensitive Area or Activity	Mitigation Measures
1	**The item of the wave breaker**	
1.1	Natural coastal habitat near the Hon Da Bac	- Dredging should be done at low tide. Results of soil quality analysis in the excavation area show that the soil is not contaminated with heavy metals and alum so the dredged soil needs to be disposed into the land inside for forest planting. Avoid dumping into the coastal area causing high turbidity of the water source. - Collect waste water, solid wastes to land to avoid pollution of surface water - Apply appropriate construction measures to minimize the loss and change of habitats of aquatic life. - Put the floating pontoon surrounded rigs to facilitate the collection of solid waste, floating objects accidentally falling flow. - Arrange 2 different trash containers on each floating rigs for containing oil rags and other solid wastes.
2	**The component of reservoir and WSP**	
2.1	Khanh An secondary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing a safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school
2.2	Khanh An high school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school

No	Sensitive Area or Activity	Mitigation Measures
2.3	Residential area in the entrance to Khanh An high school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school
2.4	Cuu Long Chau Temple	- Inform the temple management of the construction activities and their potential impacts of construction activities such as dust and noise one month before the start of the construction. - Use an axial compressive load pile driving method instead of using a pile driving hammer. - Spray sufficient water to suppress dust during dry and windy days. - Pay special attention to the above mitigation measures during religious events every first and 15th days of the lunar month and during festival days. - Immediately address any issue/problem caused by the construction activities and raised by the temple
2.5	The intersection between the road from Thoi Binh Town to Khanh Lam and the road from Khanh An - U Minh	- Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the residential area
2.6	Nguyen Thai Binh Secondary School	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the

No	Sensitive Area or Activity	Mitigation Measures
		school
2.7	Residential area in U Minh town	- Spray sufficient water during dry days to avoid dust around the residential area. - Do not allow construction activities before 6:30 am and after 8:00 pm. If night shift is unavoidable, prohibit the use of construction methods that cause noise at night. - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the residential area. - Provide good drainage to avoid water run-off to the residential area. - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the residential area and dispose of in a designated site. - Hold monthly meetings with the community on construction progress and issues and immediately address any issue/complaint raised by the community.
3	**The component of embankment**	
3.1	Lam Hai primary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school
3.2	Vien An Dong secondary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school

No	Sensitive Area or Activity	Mitigation Measures
3.3	Tan An Tay primary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school
3.4	Tan An Tay kindergarten	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school.
3.5	Tam Giang Tay primary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school.
3.6	Tam Giang Tay CPC	The construction of embankment near Tam Giang Tay CPC will affect the access road to it, the following measures will be done: - Arrange a bypass route for people to easily access to the committee - Ensure traffic safety by installing safety fence and

No	Sensitive Area or Activity	Mitigation Measures
		warning signs, traffic instruction around the construction area - Do not allow construction activities during working hours of the CPC. - Hold monthly meetings with the community on construction progress and issues and immediately address any issue/complaint raised by the community.
3.7	Vien An Dong residential area	- Spray sufficient water during dry days to avoid dust around the residential area. - Do not allow construction activities before 6:30 am and after 8:00 pm. If night shift is unavoidable, prohibit the use of construction methods that cause noise at night. - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the residential area. - Provide good drainage to avoid water run-off to the residential area. - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the residential area and dispose of in a designated site. - Hold monthly meetings with the community on construction progress and issues and immediately address any issue/complaint raised by the community.

b) Mitigation measures of site-specific impacts from embankment construction

As assessed in Section 3.1.2.3 f, the impact on local people's shrimp culture is mainly on the water intake culverts and the size of ponds when the current embankment is expanded. To mitigate this impact, the following measures will be taken:

- Notifying the construction schedule so that the people have timely plans on the use of canal water for their aquaculture. When the construction schedule is notified, people can take initiative in getting water.
- When constructing canal sections through the aquaculture area, the Subproject Owner should request the Contractors to embank, prevent all water intake culverts into shrimp ponds to prevent alum from overflowing into the production area of people.
- Providing reasonable construction plans and quick implementation when constructing these canals to return water for production.
- Building new water intake culverts for people during construction.
- When constructing new water intake culverts, the Contractors are necessary to cooperate with local people to select the locations as well as directions to ensure the needs and aspirations of the people and in accordance with the construction plan.

c) Mitigation measures of site-specific impacts caused by construction of reservoir and WSP

(c1). Measures to minimize water pollution caused by digging reservoir and pumping excavated soil to the dump site

- The soil in the reservoir excavation area is heavily contaminated with alum. Although after the rainfall, there is not surface water runoff there is the water accumulation in the reservoir, which has been excavated. When there are early season rains, the reservoir water will be heavily contaminated with alum, therefore, initially neutralization of the water in the reservoir after rains before pumping out is of necessity.
- Filling embankments in gathering areas of excavated soil for ground leveling of the resettlement sites to prevent unsettling water from flowing out which influences the daily life and production of people.
- Design of settling compartments in the storage areas in order that after being pumped into the storage areas the soil is deposited in these compartments for at least 24 hours to ensure that sediment is deposited before water is discharged to the canals surrounding the storage compartments.
- Taking good water drainage measures, avoiding water stagnation on road or in the works (because of water arising from digging road), making the road muddy, unhygienic, obstructing traffic and causing environmental pollution.

(c2). Control of leachate in Khanh An resettlement site

- Soil, sludge is dredged from the reservoir to landfill. The landfill of 60 ha wide for storage of dredged soil is embanked with soil and covered with a layer of PVC fabric to prevent water penetration through the embankments.
- The embankment is filled by an Excavator, which excavates soil in place about 0.5 - 0.7m deep to fill the embankment. Clay is selected to fill the embankment at the compaction density, K ≥ 0.85. Clay must be free from sand and other impurities such as trees, gravel, etc. to prevent water leakage from breaking the embankment. The embankment surface is 1m wide. The embankment slope is 1:1. The height of the dredged soil layer is 1.5m. The embankment elevation is 1.7m high. The embankment is higher than the soil layer about 20cm to avoid soil overflowing when being pumped into the landfill.
- The landfill is divided into cells which are surrounded by appropriate embankments. The cells will be filled in order during the dredging process, from outside to inside. At the end of the landfill is a deposition pond with an area of 10,000 m^2 wide. The pond functions as a filter before water is discharged into the canal, avoiding the discharge of sediment into the canal and causing sedimentation against. In case, when the reservoir is dredged and needs supplying more water, water will be pumped from the pond to the reservoir for reuse.
- The discharge outlet of the deposition pond is made of Geobag geotextile, nylon canvas melaleuca piles, and sandstone which drains water through the ditch to Canal 22. The dimension of the outlet is 3.0m wide, the water level is <+ 1.5m high. The water including sludge is pumped up the cells, and in addition to depositing in the cells, it deposits in the pond capable of 40,000 m^3. As calculated, the total wastewater is about 6,079 m^3/day, thus the settling time is equivalent to 6.7 days, before draining water through the ditch into Canal 22, so as not to affect the environment. The chart of the surface water flow and the cross-section of the landfill are shown in. *Figure5.1*and*Figure5.2*.
- Monitoring the water resource from the deposition pond is to ensure that this water source does not pollute the surface water environment. When the deposition pond water has pH <4, lime-power will be added to the landfill to increase to pH > 5.
- In the case of water overflowing from the deposition pond to the surrounding environment, the construction team will take measures to terminate construction in order to immediately correct the problem and work with local authorities and people to compensate damages (if there are).

- In case, the water quality does not meet the standard, the constructor must stop pumping the soil into the landfill so that the SS does not exceed the standard.
- Temporarily stop all dredging works when it rains or in any emergency.

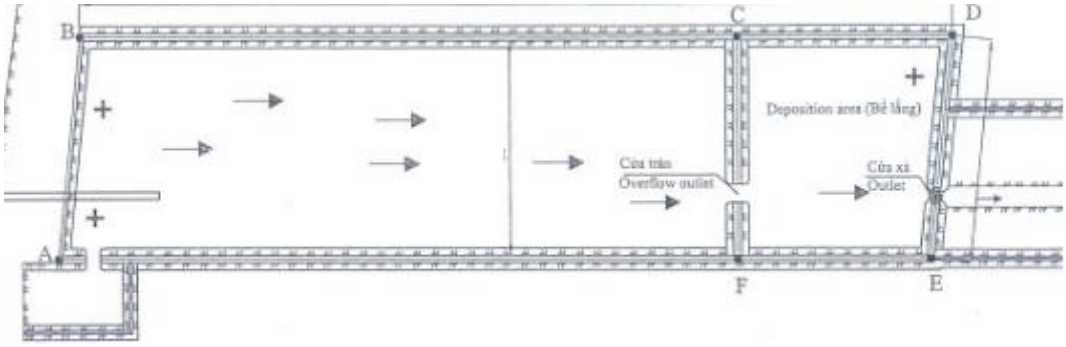


Figure5.1: Layout of the dump site

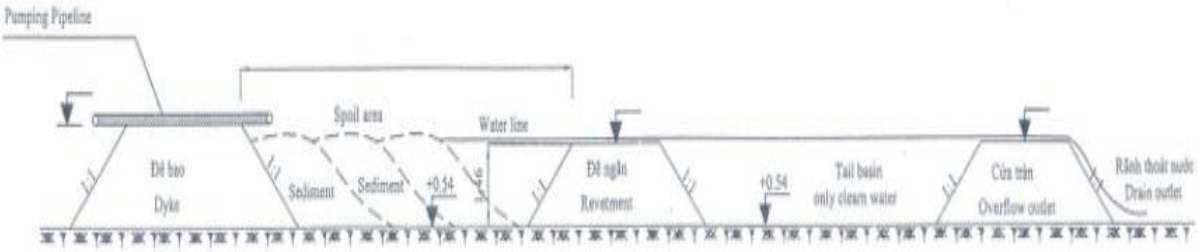


Figure5.2: Cross-section of the dump site

(c3). Management of Excavated and Dredged Materials at the reservoirat the water treatment plant

As described in subsection 1.5.3, the reservoir construction will invole both excavation (should be carried out in dry season to deal with dry materials in the reservoir, excavated materials will be stored on-site then for constructing reservoir embankment construction and backfilling landscaping at the wastewater treatment plant) and dredging should be carried out in rainy season to remove wet materials in the reservoir. The baseline data in Table 2.9 indicates that the soil--in the areas of reservoir and water treatment plant—contains acid sulphate with low pH (ranging from 2.94 to 3.48) while the contents of Al+3 is relative high. Therefore, management of the excavated and dredged materials during construction phase is critical, particularly ensuring that the leaked water through acid sulphate soil would not cause adverse impacts on the biological resources in the surrounding areas.

Available information at this ESIA stage is inssuficient for proposing a detail plan for management of excavated and dredged materials. The subproject PPMU will require the detail design consultant to prepare a Dredging and Excavation Management Plan (DEMP) for inclusion into construction bidding document.

The DEMP preapred by the detail design consultant should cover at least the followings:

- Descriptions on the quality of the excavated/dredged materials
- Description on the disposal site and surrounding area potentially affected by construction/ operation
- List sensitive receptors in the areas of influence and distance to construction sites/the works

- Assess the potential impacts and risks associated with excavation, temporary storage, transportation and disposal of the excavated materials including those being reused.
- Prepare an excavation and transportation plan which include mitigation, monitoring and reporting requirements. Public consultation can also be part of this plan.

The following principles should be followed in the DEMP:

- dredged acid sulphate soil should be stored in controlled disposal site(s) which consists of several cells.
- embankments of these cells should be lined with impermeable materials in order to prevent water from the site infiltrated/discharged directly into the surrounding environment.
- Water quality (pH, turbidity) at the outlet cell should be tested/monitored. If pH is lower than allowable limit, lime powder should be added to neutralize the acidic water until it meets the applicable standards before the water is discharged to the environment.

After contract-signing, the contractor will be required to prepare Contractor's Environmental and Social Management Plan (C-ESMP) and Contractor's Dredging and Excavation Management Plan (C-DEMP) (outlines are given in Appendix 6). C-ESMP and C-DEMP will be prepared based on the project's ESMP, C-DEMP and contractual ESHS requirements.

(c4). Mitigation of impacts from reservoir construction area on production

As analyzed in Chapter 4, reservoir construction activities are potential to affect production at the landfill and drainage activities on Canal 22, and other connection canals. The analysis shows that negative effects can be controlled through management solutions including:

- When preparing for construction, the construction units must coordinate with local authorities and people to inform the appropriate plans and the construction times on the local mass media to inform farmers and producers to plan to collect water appropriately or not to collect water when the water source is affected by landfill overflowing water as well as to take water before construction time.
- Arrange the construction time in the dry season, especially, during the time for collecting production water, the reservoir excavation is not permitted, as well as the construction in the rainy season should be restricted to avoid the phenomenon of washing alum.
- Do not organize construction in the middle of the month and the end of lunar months so that people have time to get good water for aquaculture.
- Circulate the landfill and replenish water for the digging area of deposition pond.

(c5). Risk on the breakdown of landfill embankments, breakdown of sludge pipeline

- Set up a guard fence to limit unauthorized people accessing the landfill.
- Arrange manpower checking and protecting pipeline 24/24 at the landfill.
- Rescue solutions for breaking of embankment or sludge pipeline: When an incident occurs, the construction team will stop construction, fill sandbags in broken section to stop the incident. And negotiation with local people and local communities to compensate for damages must be implemented.
- Notify the local authorities and people to not use water when an incident occurs for any purpose.

(c6). Measure for reservoir safety

In the detailed design and construction phase of the subproject, the subproject owner will mobilize qualified engineers to ensure the construction of the reservoir is safe and this could not affect living and production, assets and including subproject-financed assets of local people.

5.2.3. During operation

5.2.3.1. Measures to mitigate impacts caused by the operation of thewave breaker

In order that the wave-breaker works effectively, during its operation, the management unit responsible for operating the embankment should take the following measures:

- In response to the impact of waves that reduce the life span of the wave-breaker,regularly check defects on the wave-breaker to take measures to patch, repair broken parts, add rocks and concrete components into the sections where waves drift components.
- When detecting a large landslide, firstly check the erosion depth at the wave-breakerfoot to prepare rocks and components to fix the landslide. Prepare piles with appropriate size and length for each landslide section. The piles are driven in place close together to avoid strong waves. The pile head is about 30 to 50 centimeters above the normal water level to reduce the impact caused by wave motion. Install rocks and components behind driven piles to fill damaged sections.
- Periodically check at the edge of the river bank to take timely measures when sediment occurs. For the estuary which is deposited, upon the actual situation, dredge sediment to ensure navigation safety.
- Regularly check defects on the wave-breakerto take measures to patch, repair broken parts, add rocks and components to fix the sections which were drifted by waves.
- Monitor the deformation and defects on the wave-breakerto take appropriate measures.
- Do not allow boat anchorage in the wave-breakerto cause unsafety to the works.
- Forbid excavation near the wave-breaker.
- During the management, if any incidents are detected, reports must be sent to the competent authorities for timely settlement.

5.2.3.2. Measures to mitigate impacts caused by the operation of the embankment

When the embankment is put into operation, the operation units should take measures to ensure that the embankment is operating effectively as follows.

- Install traffic signs to prohibit motorized means of transport from entering the embankment.
- Perform maintenance for the embankment.
- Regularly dredge canals to create good ventilation for the water source to protect the environment.
- There should be proper planning for agricultural development and aquaculture in the new conditions.
- To prevent erosion, the embankment slope is designed to reduce maximum speed and impacts of boat waves, reinforcing the embankment at the most important sections. After the construction of the embankment, vegetation is covered on both sides of the canal to

prevent erosion, protect the safety corridor, and regulate the ship speed to limit the effect of shore waves.

- Local authorities need to focus on solutions to market and create stable output for forest shrimp products and to increase income for people who are engaged in shrimp-forest model in order that they can have peace of mind in the shrimp-forest model and do not cut down forest to switch to industrial shrimp farming (that creates risks, waste as well as environmental pollution).

5.2.3.3. Measures to mitigate impacts caused by the operation of reservoir and WSP

a) Mitigation measures of noise

During the operation phase of the water supply system, noise mainly comes from the operation of the secondary pump station that supplies water to the distribution network. The mitigation measures to negative impacts are as follows.

- Provide personal protective amenities for operation workers.
- Regularly check machinery, avoid damage and perform maintenance in time.
- Design mufflers right at the pump room, design enough baseplate thickness, rubber cushions, and anti-vibration springs.
- Use advanced water pumps which are manufactured in accordance with environmental safety standards without noise and regularly check and maintain.

b) Waste management measures

- Gaseous wastes: The gaseous effluent from the operation of this item is mainly chlorine, therefore for the management of this waste, the operation units should take the following measures.
  - Equip labor protection tools, gas masks, air cylinders ... for workers who directly work in the chemical room. Outside a chemical room, install showers for spraying body in the event of a chlorine leakage to ensure the health of workers. Inside the room, arrange exhaust fans to ensure ventilation, minimizing chlorine gas that arises.
  - Fully equip warehouses that contain liquid chlorine as wind turbines to monitor main wind direction when there is a problem of chlorine leakage and exhaust fans at the maximum of 1.5m high above the ground because chlorine is heavier than the air and exists low and will be sucked, which will not affect operators.
  - Equip with emergency water taps for eye washing: water is the best means of treatment when skin and eyes are damaged by chlorine.
  - Prepare emergency and treatment procedures for chlorine leakage.
  - Install 5% ammonia bottles to quickly identify chlorine leakage points.
  - Properly implement safety techniques in the storage and use of liquid chlorine; specialized vehicles must be used when chlorine tanks are transported.
  - Train workers involved in the transportation, storage and use of liquid chlorine.
- Liquid waste:
  - The backwash water in the treatment process will be transferred to the head of the treatment cluster.
  - Rainwater runoff in the water supply station is collected by an internal rainwater drainage

system and escape to the general drainage system.

- Solid wastes: Domestic waste from operators of the water supply station is collected on site by tanks, trashes. Sludge from the treatment of water will be contracted with functional units to collect and treat in accordance with the regulations.

c) Mitigation measures for impacts on groundwater

In the process of reservoir operation, the changes in the water speed and morphology of water exchange between the reservoir and the shallow groundwater must be controlled; strengthening the covering and water storage in the reservoir will increase the groundwater water level in the dry season. Every year, the Subproject Owner shall plan to monitor the underground water level in the vicinity of the reservoir.

d) Mitigation measures for impacts on water ecosystem and biodiversity

The construction of the reservoir system will increase the area of the water surface. The water ecosystem will change in a simpler direction, increase the total area of the water surface. To protect water quality as well as organisms in the reservoir, we should implement such methods as control of leakage, spillage of oil and chemicals in the fuel storage area, repair area, equipment maintenance area, equipment storage area, workshops and warehouses for storage, charging fuel ... of the water supply station.

e) Management measures of reservoir water quality

- Plant trees around the reservoir to keep soil from landslides.
- Plant grass to protect slope against erosion for the canals: T21, T22, T23, K99 and K100 to provide drainage for freshwater reservoir with the total length of 7,216 m.
- Regulatewater-flow, protect and distribute rational use of water resource in the dry season.
- Coordinate with functional agencies to control the use of fertilizers and pesticides in the water intake area.
- Coordinate with local authorities in propagating and mobilizing people not to rinse tools or packages of plant protection drugs or liter them into canals that supply water to the reservoir.
- Coordinate with the environmental management agency to disseminate information on the use of fertilizers and pesticides, environment sanitation and disseminate the importance of the irrigation canal system to the population through: banners, loudspeakers, leaflets, meetings ... to raise the awareness and encourage the participation of the whole community,launching“cleaning days” to clear canals, drains, sewers in hamlets, communes.
- Coordinate with local mass organizations and farmer associations to organize community awareness raising campaigns on environmental protection through the mass media.
- Every year, plan to blow up the reservoir bed to ensure the circulation of oxygen and reduce organic matters at the reservoirbottom.
- Planwater surface areas for planting aquatic plants (such as water hyacinth, ...) to create water-based mats and water filters.
- Survey and treat toxic chemicals in the catchment area that supplies water for the reservoir.
- Take water quality samples in the canals before water is supplied to the reservoir
- Annually, survey the soil use and management.

- Set up a mailbox in the communes to receive feedback from people when they detect illegal encroachment and actions that can lead to damage to the reservoir system and the canals that supply water to the reservoir.

f) *Measures to manage pollution from agricultural production*

To prevent water pollution in the reservoir from agricultural activities, the subproject owner coordinates with local authorities on IPM to minimize potential negative impacts.

- Developing a roadmap to reduce risks, minimize the use of pesticides, specifically: reduce the annual use of drugs by 30-40%, especially on rice and reduce the number of active ingredients in the list of 30 - 40%.
- Irrigation is not exceeded as needed: irrigation water increases the potential of pumping equipment into groundwater and surface water. If the rate of irrigation water is higher than the permeability of the soil, excess water will overflow. The irrigation equipment at the irrigation site may be carried with runoff water. The rate of irrigation water must be lower than the permeability coefficient of the soil. Preserve water and soil to prevent runoff and runoff. Utilization of drugs: right medicine, right time, right way selective.
- Increasing the use of bioproducts to avoid toxic residues in the environment.
- Developing a comprehensive program or concept to expand the application of new technological advances to reduce and prevent the abuse and increase the effectiveness of pesticides as IPM, 3 reductions3 gains, application of BVN, SIR, Vietgap.
- Strengthen the inspection of the use of pesticides, the application of new technical advances. Establish and strengthen the organization and policy content of the plant protection services network - grassroots extension.
- Develop and circulate training materials on management and use of pesticides, training programs for new technical advances. Pay attention to the training of technicians, farmers and drug dealers.
- The subproject has triggered the pest management policy and has been agreed by local authorities in the project area. Moreover, Vietnamese regulations prohibit the use of toxic and noxious insecticides and fertilizers.
- Encourage people to use effective fertilizers such as:
  - Appropriately select the fertilizer type and timing of fertilizer application;
  - Kill the worms before using fertilizer
  - Using fertilizer in days of low rain and apply in the evening;
  - Make the right way to use and dosage.

g) Measures for the reservoir safety

The reservoir is unlikely to become a large dam during operation. However, in order to ensure that the reservoir works effectively and safely, the operation must follow by the following procedures:

- Only open the water-intake culverts in July in the middle of the rainy season. The water level in the reservoir always ensures the maximum difference of 1.5m.
- Drain water when there are signs of slope damage, there is a large water influx into the reservoir, or there is the phenomenon of vibration, subsidence, erosion. Make discharge ways at lower places to allow water to spill over so as not to cause significant material losses and can recover quickly after floods.

- Comply with OP 4.37 – Safety of dams of the World Bank (for small dams)and the Decree No. 114/2018/ND-CP on Safety Management of Dams and Reservoirs issued by the Government on September 4, 2018, the subproject owner will allocate necessary resources and efforts for safety measures for the operation and maintenance of the reservoirand associated works as follow:
  - The water reservoir safety assurance is the highest priority in construction, management, and exploitation of the reservoir.
  - Safety management of the reservoir must be carried out regularly and continuously throughout the process of survey, design, construction, management, exploitation, and protection of the reservoir.
  - The owner of the reservoir is responsible for the dam safety and reservoir that he owns.
  - Organizations and individuals exploiting the reservoir shall be responsible for managing and exploiting, ensuring safety and promoting its effectiveness.
  - Staff involved in the reservoir operation must have professional certificates on reservoir management.
  - Periodically, every May, the subproject owner will check the safety of the reservoir, and associated works (as water intake sluices, valve, etc.). Fixing all damage and errors before the rainy season.
  - Conduct safety registration of the reservoir; develop a reservoir operation procedure; monitor water quality, meteorological and hydrology condition of the reservoir; status check, inspection and safety assessment of the reservoir; maintenance, repair, upgrading and modernization of the reservoir's banks; protection and security of the reservoir; keep records as prescribed by law.
  - When there is a risk of causing unsafety of the reservoir, it should be promptly notified to the authorities; mobilize armed forces,border guards, etc. coordinate localities to have action plans; Notice people living around move away from the flooding area to avoid human and property losses.

h) Measures to mitigate climate change impact on water quality and quantity of the reservoir

- Within the subproject, a green area with long term trees for watershed protection will be set up together with reservoir construction as following:
  - Type of trees: native trees as Melaleuca, etc.
  - Place of tree planting: in the banks of the reservoir and in some areas in the final disposal.
  - Time for tree planting: after completing the reservoir construction.
- In the future, the subproject ownerwill recommend the Ca Mau PPC to plan to expand the green area for tree planting such as: in the buffer zone of U Minh Ha NP, in the buffer zone of the water taking for the reservoir and the agricultural production around the reservoir.
- Develop a watershed protection planning in the reservoir area.
- Encourage people to apply climate-smart livelihood models.

5.3. MEASURES TO MITIGATE IMPACTS OF THE NON-STRUCTURE WORKS

5.3.1. Item of mangrove plantation

5.3.1.1. During the construction phase

a) Dust and air emission

The impact of dust from making beds for planting is negligible, so there is no need to apply mitigation measures. The measures to control air pollution impact from the transportation of mangrove trees to the area are as follows:

- Request the vehicle owners that transport plants and materials comply with the traffic safeguard rules, running at the right speed to limit dust released into the air.
- Use low sulfur fuel.
- Do not allow vehicle engine working while the vehicle is stopping to load plants or waiting for loading plants.
- Lubricant from the maintenance process will be thoroughly collected.

b) Impacts caused by noise and vibration

Since this area is relatively far from residential areas, noise from bulldozers, flattening machines, dredging machines to make beds for planting, etc., directly affects construction workers. To minimize the impact of these activities, the following measures will be taken:

- Arrange to work in the daytime; do not operate all machinery at the same time, the same place, and do not work at night, etc.
- There are regular plans for monitoring and maintenance of construction equipment on the site (checking the detailed wear, regular lubricating, replacement of damaged parts, etc.).
- These mitigation measures will be implemented during the flattening to make beds for planting, and reforestation to minimize the impact of noise on the surrounding environment.

c) Impact on fauna and flora

In order to protect the fauna and ecosystem, the Subproject Owner will take the following measures:

- To keep the undisturbed vegetation and fertile soil to increase soil holding and erosion control, the Subproject Owner will apply manual combined with mechanized planting methods.
- It is strictly forbidden to demolish the forest outside the area under the new planting area of the subproject.

d) Economic and social impacts

The measures for mitigation of socio-economic impacts caused by the afforestation will be implemented by the investor as follows:

- Prioritizing the employment of local workers for the afforestation.
- Providing timely information to local authorities and local people on the afforestation plan before commencement of construction.

5.3.1.2. During the operation phase

- Forest area must be at least a certain percentage of the area of the land plot depending on the types of certificate. So, farmers always keep the forest area as requirements of certification authorities.
- Obtain permission from the before planting, thinning or harvesting mangroves, including (i) thinning tree as first thinning to a density of 5,000 trees/ha at 9 to 10 years of age and second thinning to a density of 2,000 -2,500 trees/ha at 14 -15 years of age; (ii) Harvesting at about 20 years of age, after harvesting, prepare to plant a new cycle and obtain permission from the before planting, thinning or harvesting mangroves.
- Do not place soil from pond construction or cleaning in mangrove areas, because *Rhizophora* trees do not grow well or may die on high land without flooding by the tide.
- Do not pump soil from pond construction or cleaning into waterways.
- Use soil from pond construction and cleaning to build up an area of high land for domestic use or where other crops can be grown.
- Regularly circulate water in the ponds to prevent low oxygen conditions and reduce local accumulations of mangrove leave

5.3.2. Livelihood models component

5.3.2.1. During the construction phase

As mentioned above, the implementation of pilot livelihood models will be carried out in the existing sites and no new infrastructure or minor repair will be conducted. Therefore, the subproject will apply the ECOPs for minor repairs to reduce the environmental impacts.

5.3.2.2. During the operation phase

a) Control of environmental impacts

The environmental impacts from the forest-shrimp shrimp model that is certified by GAP are negligible. Appropriate planning and management solutions can be used to control environmental problems of livelihood models, including:

- Building wastewater and waste treatment facilities that meet the permitted standards for the models.
- Collection, reuse, recycle solid wastes from the models.
- Installation of noise control works for the models.
- Support people to survey and design the shrimp forest model in accordance with the certification standard.
- Provide technical guidelines for afforestation in shrimp-forest in accordance with the standard.
- Provide technical support and part of the cost for repairing and upgrading toilet facilities in accordance with the standard.
- Training shrimp farming techniques combined with forest plantation for people.
- Encourage people to form groups of production households for experienceexchange.
- The government assists people in linking businesses and organizations applying for certification of ecological shrimp culture in mangroves.

b) Impact of land use change

The results of the shrimp-afforestation model certified by GAP is protecting the coastal area by the mean of the sustainable, market-oriented livelihood. The government implements measures to encourage farmers to increase the coverage of mangrove forest to at least 50% of the area, thus their shrimp price will increase by 10%. The objective of the subproject is to expand the ecological shrimp-afforestation model in the area. To achieve this goal, the governments at all levels will implement the following measures.

- Local governments will provide financial support to farmers who are able to raise shrimp and expand the area of mangroves.
- The Department of Agriculture and Rural Development (MARD) assists farmers in designing model, supplying mangrove trees, certification cost, links farmers to the market,and supports for replanting of forest for the farms that do not meet the GAP standard.
- The Agricultural Extension Center organizes training courses for farmers such as the introduction of the GAP model, the value of selling shrimps from the farms that meet the GAP standard.
- Organize training at the site on the farms that are certified by GAP for farmers who are not certified by GAP. This includes training them to practice shrimpraising standard and commerce standards that meet the international biosafety standard.
- Establishan internal control system in the agro-ecological shrimp-mangrove community.
- Establish the organizations that manage the agro-ecological shrimp-mangrove community.
- Guide people to keep shrimp culture records and documents according to international standards.
- Organize market linkages between companies and shrimp farmers.
- Organize workshops to establish linkages: from seed supply, supplies, to products.
- Build and promote the international brand of the ecological shrimp-mangrove certification.

c) Disease prevention and control

The measures to prevent diseases in shrimp farming should be implemented as follows:

- Strengthen management and monitoring of farming areas: The Department of Agriculture and Rural Development organizes technical guidelines (appropriate time and stocking density);guiding rotation measures to improve the farming environment. The farming areas which are affected by diseases should be thoroughly treated before re-stocking. The processing time is at least one month.
- Organize technical training courses; build safe aquaculture models; strengthen propaganda and dissemination of the Veterinary Law,guiding documents of the Government, ministries, central branches, and Provincial People's Committee.
- Strengthen the coordination among the specialized agencies and socio-political organizations in propagandizing and encouraging farmers to actively participate in epidemics prevention and control foraquatic products, highly conscious in preventing the spread of diseases when diseases occur.
- When epidemics occur, epidemic surveillance and prevention should be implemented such as synthesis of disease information for warning and disease prevention,strengthening the inspection the monitoring, detection, and treatment of aquatic diseases in farming areas.

- Sampling for identification of pathogens when diseases occur to serve the diagnosis, treatment guidelines to avoid spreading.
- The Department of Agriculture and Rural Development instructs the subordinate units to take water samples for analysis and evaluation of hydro-physical and hydro-biological parameters;notify to timely limit the risk of a disease outbreak by the environment.
- Train on aquatic diseases, disease prevention and control regulations for farmers. In particular, attention should be paid to the dissemination of new regulations of the State on the prevention of aquatic epidemics new diseases

CHAPTER 6. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)OF THE SUBPROJECT

6.1. BASIC PRINCIPLES

As a part of the ESIA, an Environmental and Social Management Plan (ESMP) is a safeguards instrument that is typically used in many projects and which consists of information on and guidance for the process of mitigating and managing adverse environmental impacts throughout subproject implementation. Typically, in Vietnam, an ESMP comprises a list of typical mitigation measures to be carried out by contractors, an environmental monitoring program, organization arrangements, and an estimated monitoring cost.

There is a comprehensive regulatory framework in Vietnam related to ESIA preparation, environmental standards, protection and management of forest and cultural property, and other aspects related to construction and operation of facilities and infrastructures in Vietnam. This ESMP is consistent with these regulations.

To facilitate effective implementation of the ESMP, the PPMU will (a) Establish an Environment and Social Unit (ESU) responsible for ensuring timely implementation of the ESMP, including monitoring, reporting, and capacity building related to safeguards; (b) Assign the Construction Supervision Consultant (CSC) to also be responsible for supervision of the contractor's safeguard performance as part of the construction contract and this requirement will be included in the CSC's terms of reference; and (c) Hire qualified national consultants as the Independent Environmental Monitoring Consultant (IEMC) to assist the ESU in performing its task.

Ca Mau DARD will be responsible for the implementation of the mitigation measures during the operation stage of the project and they will ensure that the mitigation measures are implemented and adequate budget is provided. MARD will provide the overall policy guidance and oversight of the subproject implementation. Roles and responsibilities of the specialized agencies and the DONREs will also be critical.

Activities to be carried out to mitigate impacts due to land acquisition and resettlement are presented separately (RAP and RPF) and they will be carried out and monitored separately.

6.2. SUMMARY OF POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

6.2.1. Positive impacts

6.2.1.1. Structure works

- Socio-economic impacts:
  - When the wave breaker construction is completed, it will prevent erosion and deforestation, create conditions for the rehabilitation of mangroves forest along with the wave breaker, and protect the sustainable production and livelihood stabilization for residents inside the wave breaker. This includes about 6,000 ha of land (rice, aquaculture, agricultural production, etc.), and 13,500 people in the area.
  - When the Embankment construction is completed, it will strengthen infrastructure, create stable residence, and integrate the development of the coastal traffic in the

region. The operation of works will increase natural disaster prevention and regional navigation, promote production services, as well as solve the problem of production output. It will help to be active in water production, cultivation expansion, reduction of risks, an increase of productivity and output, and efficiency of land use. It will bring potentials and strengths for the region. This is a great way to diversify agricultural production, introduce high-value crops and livestock which have stable market and international certification.

- The combined function of the Embankment with the road will facilitate the smooth traffic and traffic safety throughout the area.
- When the reservoir and the water supply system is completed, each household of about 120,000 people in U Minh district will have access to clean water. People can build flush-toilets, gradually change the practice of using unhygienic latrines on rivers, canal, fish ponds, as well as build a civilized and cultural way of life in a rural area.

- Natural environment impacts:
  - When the wave breaker is put into operation, it will bring about ecological stability and minimize coastal erosion. At the same time, the new ecological system and the environment will be friendly and closer to human life which helps people to be active to restrict and prevent epidemic diseases.
  - When the reservoir is completed, it will provide good quality of water contributing to better environmental improvement in the subproject area. It will limit the exploitation of underground water via small and dispersed drilled-wells to combat against exhaustion and pollution of water sources.
- Impacts on climate change: Upon completion, the subproject will help minimize negative impacts on climate change and mangrove forest, protect civil works, and increase the coverage of mangrove forest in Ca Mau province.

6.2.1.2. Non-structure works

Afforestation plays a very important role in mitigating the impacts of natural disasters and climate change. In addition, the mangrove ecosystem brings ecosystem values that contribute to the lives of people. The additional planting of 271ha of mangrove forest in aquaculture ponds contributes to increasing forest coverage, ensuring ecological shrimp area, and stabilizing livelihoods under forest canopy through the combined forestry-aquaculture models.

When the livelihood models work, they will form residential areas, stabilize social life, create jobs, improve livelihoods and increase income for people who participate and implement the livelihoods models. The use of applied knowledge in production, business, generation will improve income, living standards and livelihoods, and develop the household economy.

This also helps strengthen the spirit of self-control, self-conscious in life, improve the ability to access the market. It helps people have knowledge of mastering their future and mastering their lives. People have the conditions to promote exchanges of social contacts not only for economics but also for culture and education.

This also promotes socio-economic development in deep-lying, remote and coastal areas of Ca Mau province. It raises the community awareness of forestry, environmental protection of coastal protection forests. At the same time, it raises awareness of the population in response to climate change and sea level rise.

Impacts on gender issues:

- Women's knowledge will be enhanced, which helps them more confident and creates an opportunity for them to develop and improve their capacity.
- Aquaculture linkage development will create more jobs for people.
- Men will be promoted in sharing family work with women.
- The role of women in family and society will be improved. Women will be active in life, in poverty reduction, mastering the future and the life.

6.2.2. Negative impacts

The implementation of the subproject would mainly cause land acquisition, increase dust generation, air pollution, domestic waste, and health and safety issues. Site investigation and document review were conducted for identifying and assessing these potential negative impacts, including consultation with the local communities and affected people.

The potential negative impacts of the subproject are identified in and could be minimized by applying the proposed mitigation measures developed for the project, which are described in*Table6.1*. The negative impacts of subproject could be summarized as follows:

- Increased negative impact on the physical and biological environment during construction and operation.
- Increased risk in the operation of structure works
- Increased risk of disease and market risk when operating and expanding livelihoods models.

Table6.1: Potential Negative Impacts of the Subproject

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
A	***Structure works***				
I	**During the pre-construction phase**				
1	Permanently and temporarily acquired land	The subproject will acquire 162.95 ha of permanent land and 157.39 ha of temporary land and no relocation households. Construction of the wave breaker is no land acquisition and 102 ha of permanent land acquisition and 70 ha of temporary land acquisition for the construction of the reservoir is public land and managed by the state. The land acquires to build the embankment is the people agreed to donate land for construction.	- 560 households in 4 communes: Lam Hai (Nam Can district), Vien An Dong, Tan An Tay and Tam Giang Tay (Ngoc Hien district) - Khanh An commune, U Minh district	Moderate	Long-term
3	Worker and public safety	Workers and local people may have an injury due to explosion and accident from searching and removing/destroying unexploded ordinances (UXO).	- Residents surround the construction areas - Workers at the construction site.	Moderate	Short-term
II	**During the construction phase**				
1	Land clearance	Land clearance will small impact on local people and environment because most demolition waste materials are suitable as fill materials and the affected households can produce wood fuel from the trees and compost from the rest of the waste vegetation materials and remaining wastes of demolition will be sold and no waste materials left in the construction sites and the number of workers in this activity is only 3-4 people and these are local people	- in 4 communes: Lam Hai (Nam Can district), Vien An Dong, Tan An Tay and Tam Giang Tay (Ngoc Hien district) - Khanh An commune (U Minh district)	Low	Short-term
2	Dust generation/ Air pollution	– Earthworks and excavation activities of the structure works will generate dust. – The amount of dust generated from these activities depends on the volume of digging and backfilling, and also depends on the number of machines and	- Residents surround the construction areas - Workers at the construction site.	Moderate	Short-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
		trucks working on site. - The total volume of soil excavation is expected to be 6,226,536 m^3in 24 months. The construction will take place along canals, saturated soil (for embankment), and digging of reservoirs by pumping (for the reservoir), in sequences, which will help to minimize dust generation issues so air pollution caused by soil excavationis *moderate*			
		Transportation of materials will small impact because materials will be transported by waterway and will take place at the start of construction and over a very short time	- Residents surround the construction areas - Residents along the transportation routes - Workers at the construction sites	Low	Short-term
		Activities of concrete mixing stations with a capacity of about 40m^3/h, the operation of the mixing station will be able to generate dust exceeds the allowable limit of QCVN 05: 2013/BTNMT at a distance of about 20 meters from the site.	- Residents surround the construction areas - Workers at the construction sites.	Low	Short-term
3	Impacts from noise and vibration	Operating the construction machines, vehicles will cause the noise and the biggest noise is from the pile driving. Noise level at location 100m is less than the limit. There have 1 residential area and 1 CPC and 1 school within 100m from the construction sites	- Residents surround the construction areas - Vien An Dong residential area - Tam Giang Tay CPC - Tam Giang Tay Primary School - Workers at the construction sites.	Low	Short-term
		For a mixing station with a capacity of about 40m^3/h, the operation of the mixing station will generate noise pollution at a distance of about 45 meters (in day-time) and 90 meters (in night-time).	- Residents surround the construction areas - Workers at the construction sites	Low	Short-term
4	Surface water pollution from excavation and	- Wastewater from construction machines and equipment maintenance containing organic	- Water quality and aquatic life on canals and rivers in the subproject	Low	Short-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
	filling activities, worker's camp and construction equipment and machinery	substances, oil and insoluble matters that are not controlled will pollute the surrounding water sources in the subproject area. It is estimated that if the maintenance activity would be implemented periodically, so the volume of water supply for this activity will include: i) equipment maintenance activity needing 5m^{3}of water per day; i) machine cleaning needing 8m^3 and iii) cooling needing 6m^3. Because the number of construction machines are not many and mobilized for a short time on the site, the discharge of wastewater from them and equipment is moderate. - Taking soil from shrimp ponds to embank the embankment will increase the turbidity of the pond water. - Runoff water on the construction site contains a high concentration of suspended solids and leakage oil from a machine that leads to increasing the concentration of pollution matters such as SS, COD, oil in the surrounding water sources. - Wastewater from worker's camps (6.84m^3/day) contains organics easy to decompose, so if this kind of wastewater is directly discharged into the environment it would make the receiving water sources polluted	area - Shrimp ponds in the area of taking soil for embankment building - Aquatic life in the west sea (along the wave breaker) - Water sources near the worker's camps		
5	Drainage and sedimentation	- Lacking control of the temporary material yards in the subproject area may be lead to erosion and sedimentation problems. - Flooding when building the reservoir, especially in rainy seasons	- The water source on the canals, rivers around the construction sites - Canal systemof 22A, 22B, 22C, 22D is around the reservoir (responsible for water drainage of the area)	Low	Short-term
6	Solid wastes	- Solid waste includes construction solid waste and	- In the construction sites and worker's	Trung bình	Long-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
		domestic solid waste. - Construction solid waste includes waste soil and waste rock. They will be reused for backfilling and the local authorities have a plan to reuse the remaining solid wastes. These are non-hazardous wastes but it needs to be handled to avoid impacts on air, water qualities, and big dirty masses in the subproject area. - Domestic waste and rubbish (domestic solid waste) generated from workers that contain organic wastes such as rubbish, paper, carton box, etc. and other wastes. The average generation volume of the domestic solid waste is about 0.4 kg/person/day. - This domestic waste will be collected to avoid environmental pollution. Due to the volume of this kind of waste is not big, they can be collected into the rubbish collection system along the subproject	camps		
7	Hazardous wastes	- The waste oil: change every 6/months with the amount of oil discharged each time is 07 litters, the amount of waste oil is 276L/quarter - Other: oily drags, tank, bulbs with the amount of 225kg/quarter. The amount of hazardous wastes is average, but they could cause adverse impacts to the environment, insanitary, source of diseases on the site. Therefore, it is necessary to collect, transport and treat appropriately.	At the areas of material and equipment storages, equipment maintenance.	Moderate	Long-term
8	Disruption of water intake for shrimp ponds during the construction of	The expanding of the existing embankment will affect the existing sewers for shrimp farming. This activity will partly affect the taking of water for shrimp ponds of farmers. As the shrimp ponds are also quite close to the source of water, and the embankment will be built	Shrimp ponds and farmers in the location of embankment construction	Moderate	Ngắn hạn

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
	replacement culverts	in the form of "rolling", so this impact will be low and only happen in the period of building new culverts.			
9	Worker and public safety	Workers and local people could be at risk if they travel around or close to construction sites, or fall to the open holes, buried in the material, etc.	At the construction area.	Moderate	Short-term
10	Traffic safety	- All the construction materials will be transported by waterway, accidents can occur due to boats colliding during the travel to the work sites. These incidents can cause serious impacts to the environment, especially to the water quality, such as increasing turbidity by stirring the bed on contact or through oil spills from engine damage - Building embankment: The embankment sections in the subproject are constructed based on the existing ones are also the roads so the construction will inevitably affect the traffic of people. Because the existing embankment is low, most people still use two forms of transportation. In rainy days, high tides, or travel to the place where is no road, they move by boats; other days, road traffic is preferable. Although there are only 5 - 10 vehicles per day, the contractor still needs to ensure convenient transportation for the people or set up temporary routes for continuous traffic.	- Along the transportation routes - All the embankment routes	Moderate	Short-term
11	Communication with local communities	Lack of communication and consultation with local communities can lead to opposition to the subproject delays in the construction process, increased costs, and unsatisfactory solutions.	Communities and local authorities in the construction areas	Low	Short-term
12	Workforce management	Worker concentration will cause the following impacts: - Increased demand for infrastructure and utilities.	Communities and local authorities in the construction areas	Moderate	Short-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
		- Pollution caused by waste and domestic wastewater. - Increase the risk of communicable diseases, such as malaria, HIV/AIDS, etc threaten the health of workers and local people. - Affect local social secure, increase crime rate, drug use, prostitution, social conflict, etc.			
13	Cultural impacts	- There are also no important historical and cultural sites identified in the subproject construction sites. - No adverse impacts on other historical and cultural heritage features are expected during the construction phase of the subproject	At any location in the subproject area if cultural work findings.	Low	Short-term
14	Oder at the dump site	The impact of odor from the reservoir digging is low. Moreover, around the dump site is empty land, the ability to disperse air emissions is large, completely isolated from the surrounding area so the effect of the odor is small.	- At the dump site - People around the dump site	Low	Long-term
15	Fire and explosive incident during the construction phase	Fire and explosion incidents could occur during transporting and storing fuel, or because of unsafe use of the temporary electric generation system, causing loss of life and property during construction. The reasons for fire and explosion are as following: - The temporary material storages serving the construction, machinery and technical equipment (paint, gasoline, DO oil, FO oil, etc.) are the source of fire and explosion. When the incident occurs, it can cause damage to people, economy, and environment; - Using the temporary power supply systems for machinery, construction equipment can cause electric shock, electrical leakage, fire, explosion,	All the construction site	Moderate	Short-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
		causing economic damage or accident at work; - Using heating equipment could cause fire, burns or accidents if no preventive measures.			
16	Incidents at the dump site	- Embankment breakdown causes the sludge to flow into the canal system, which effects on aquaculture activities. However, aquaculture is not the main occupation of the people in this area. - Impact on water supply for daily life and production. However, according to a survey in the subproject area, people mainly use groundwater from wells for living and production. Therefore, the impact of the incident does not affect the water supply for the purpose of living and production of people.	- People around - Aquaculture ponds around - Fields around	High	Short-term
17	Acid sulfate leakage in the dump site	This is an area of acid sulfate soil, but the sulfidic layer is only about 1-2 m and located on the top; Other layers are clay that is not contaminated with sulfuric acid. If there has acid sulfate soil in excavated soil from the reservoir digging and it is not placed deep and directly contact with the air in the dry season, is turns into actual acid sulfate soil. In the rainy season, acidity in the soil will be washed away by the rain. In the reservoir construction area, the pH value of the rainwater washout is of 3 with the duration affected from 2 to 5 years. Handling acid sulfate soil by the preventing oxidation (ém phèn) as water cover (keep potential acid sulfate soil below the watertable), reducing exposure of acid sulfate soil with oxygen in the air (place fill over potential acid sulfate soil) has been applied quite popularly and effectively in the acid sulfate soil area	- The soil in the Khanh An resettlement site - People around	Moderate	Long-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
		in the Mekong Delta. So the impact is low			
III	**Operation phase**				
1	Operation of the wave breaker	The operation of the wave breaker does not generate wastes. Impact on the environment mainly from operational problems occurring during bad weather, as well as poor quality of construction works. These cause risks of erosion the wave breaker.	- Mangrove forest along the wave breaker - People behind the sea dyke	Moderate	Long-term
2	Operation of the embankment	When the embankment is completed, the traffic system will be connected and traffic flow will be increased. This will contribute to increasing emissions of air, dust, and noise into the air. According to the field survey in the embankment area, this is a rural area, with less demand for travel, and the main means of transportation are bicycles and motorbikes.	- Production activities along the embankment - People along the embankment	Small	Long-term
		When the embankment system is completed, as discussed, aquaculture operations will be controlled and safer for aquaculture ponds. This may motivate people to switch to industrial shrimp farming. This model will generate a lot of waste including sludge from aquaculture ponds containing organic pollutants, nutrients, heavy metals, mineral components, and microorganisms if not treated. Properly polluting the country's environment, air and disease spread. However, the planning of shrimp culture area based on the forest-shrimp ecology model, therefore, should have good control measures in order not to happen, people dislocate their own plans on the common environment.	- Production activities along the embankment - People along the embankment		
		Risks and incidents of the embankment operation include an increased risk of traffic accidents due to the	- Production activities along the embankment	High	Short-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
		increased density of vehicles on the route that affects the health and well-being of people, and the incident occurs when breaking the embankment due to the quality of construction when handling the foundation and body of the embankment. These risks and incidents will affect the health, life, and production of the people. In the event of water spills into fields affecting agriculture production, aquaculture, property and daily life of the people in a protected area, especially if it occurs at the time of harvesting, the damage is enormous. These losses have a great impact on people's incomes, local economy, debt growth. In addition, embankment failure does not only cause immediate damage to production but also long-term effects on the next crop because of saline soil.	- People along the embankment		
3	Operation of the reservoir and WSP	Environmental pollution caused by dust, gas, wastewater and solid waste from operation of WSP	- The environment in the area around the water supply system - Operation worker the WSP - People around	Low	Long-term
		Leaching of alum affects the quality of water supply	- Water quality of the reservoir - The ability to supply water from the reservoir for living	Low	Short-term
		Risk of an incident during operation of the reservoir	- The environment in the area around the reservoir - Operation worker the reservoir - People around the reservoir	High	Short-term
B	**Mangrove plantation**				
I	In the preconstruction phase	In thelocations of mangrove - shrimp ponds for additional mangrove planting to achieve requirements	Mangrove - shrimp ponds	Negligible	Short-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
		of ecofarmingcertificationaremainlywater surface land and agricultural land, there have very few houses andreforestationwill take place in the existing ponds and no land acquisition and land clearance. So impacts in this phase are negligible.			
II	In the construction phase	*Rhizophora*will be planted by putting about one-third of the seed length into the mud. Therefore, the impact of reforestation during this phase is very low.	Mangrove - shrimp ponds	Low	Short-term
III	In the operation phase	Shrimp survival and biomass decreased significantly when the shrimp were cultured at the relatively higher concentrations of *Rhizophora* leaves and leachates; in contrast, moderate amounts of *Rhizophora* leaves or their leachates had positive effects on shrimps. But this impact is *low* due to water circulation may help to prevent low oxygen conditions and reduce local accumulations of mangrove leaves and good take care of *Rhizophora* to avoid defoliation of *Rhizophora.*	Mangrove - shrimp ponds	Low	Short-term
C	**Livelihood model**				
I	**In the preconstruction phase**	These activities require no land acquisition and resettlement, as well as public infrastructure encroachment because they are developed on the existing ponds or farms.	Aquaculture ponds and farms using for demonstrations	Negligible	Short-term
II	**In the construction phase**	Thedemonstration sitesare located inthe existing ponds, so no need to dig new pondsor buildinginfrastructureforthe demonstrations, only cleaning out the mud layer on the bottom of the ponds and very few people live surroundingso impactson the local environment and people in this phase is low.	Aquaculture ponds and farms using for demonstrations	Low	Short-term
III	**In the operation phase**	Environmental pollution due to wastes from implementing livelihood models	In the area of applying livelihood models	Moderate	Long-term

No.	Impacts/ Issues	Impact Description	Location / Affected Object	Significance of impacts	Impact duration
		Impacts due to upscaling livelihood: (i) increase environmental pollution due to waste from aquaculture; (ii) decrease income of local farmers due to market failure	- In the area of applying livelihood models - Farmers	Moderate	Long - term

6.3. MITIGATION MEASURES

6.3.1. Mitigation measures of general impacts

The mitigation measures of general impacts during pre-construction, construction, and operation phases, the environmental codes of practices (ECOPs), related to the general construction activities of the wave breaker, embankment and reservoir, and WSP are presented in *Table6.2*.

In addition, to manage the potential negative social impacts related to the workers/consultants who come to work in the subproject area from other localities, the Codes of Conducts must be included into biding documents and contracts of shopping contracts together with ECOP (*Table 6.3*).

Table6.2: Mitigation Measures (ECOP) of General Impacts related to Subproject's Activities

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
I. During the preconstruction phase				
1. Complaints due to subproject implementation	- Prior to the commencement of site works, the contractor will develop a grievance redress mechanism (GRM) or system that will allow for receiving/recording and immediate response to and resolution of construction-related complaints. The GRM shall be consistent with the GRM described in the ESIA. - The Contractor will inform the communities along the alignment and other stakeholders affected by the subproject about the GRM in place to handle complaints and concerns about the subproject. - The Contractor will also install notice boards at the construction sites to publicize the name and telephone numbers of the representatives of the Contractor, CSC, IECM, and PPMU who are designated to receive and document complaints.	- Law on Land No. 45/2013/QH13 Law on Environmental Protection No. 55/2014/QH13	- Contractor - PPMU	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
2.Inadequate disclosure of subproject information prior to construction	- Prior to site preparation and commencement of site works, the Contractor will meet stakeholders such as district and local authorities, e.g. DONRE; officers in charge of irrigation, navigation and transport; and community leaders in affected communities to provide relevant subproject information (e.g. activities, schedules, etc.) and to ensure that various concerns that may affect stakeholders are discussed and addressed.	- Law on Land No. 45/2013/QH13 Law on Environmental Protection No. 55/2014/QH13	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
II. During the construction phase				
1. Dust generation and air pollution	- The Contractor is responsible for compliance with relevant Vietnamese legislation with respect to	- TCVN 6438-2005: Road vehicles. Maximum permitted		- Supervision reports of CSC

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	ambient air quality. - The Contractor shall ensure that the generation of dust is minimized and is not perceived as a nuisance by local residents and shall implement a dust control plan to maintain a safe working environment and minimize disturbances for surrounding residential areas/dwellings. - The Contractor shall implement dust suppression measures (e.g. covering of material stockpiles, etc.) as required. - Material loads shall be suitably covered and secured during transportation to prevent the scattering of soil, sand, materials, or dust. - Exposed soil and material stockpiles shall be protected against wind erosion and the location of stockpiles shall take into consideration the prevailing wind directions and locations of sensitive receptors. - Dust masks should be used by workers where dust levels are excessive - All vehicles must comply with Vietnamese regulations controlling allowable emission limits of exhaust gases. - Vehicles in Vietnam must undergo a regular emissions check and obtain certification: "Certificate of conformity from inspection of quality, technical safety, and environmental protection" following Decision No. 35/2005/QD-BGTVT. - There should be no burning of waste or construction materials on site. - Cement processing plants should be far from residential areas.	emission limits of exhaust gas. - Decision No. 35/2005/QD-BGTVT on inspection of quality, technical safety, and environmental protection; - QCVN 05:2013/BTNMT: National technical regulation on ambient air quality.		- Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
2. Impacts from noise and vibration	- The contractor is responsible for compliance with the relevant Vietnamese legislation with respect to noise and vibration. - All vehicles must have appropriate "Certificate of conformity from inspection of quality, technical safety and environmental protection" following Decision No. 35/2005/QDBGTVT, to avoid exceeding noise emission from poorly maintained machines. - When needed, measures to reduce noise to acceptable levels must be implemented and could include silencers, mufflers, acoustically dampened panels or placement of noisy machines in acoustically protected areas. - Avoiding or minimizing transportation through community areas and avoiding as well as material processing areas (such as cement mixing).	- QCVN 26:2010/BTNMT: National technical regulation on noise. - QCVN 27:2010/BTNMT: National technical regulation on vibration	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
3. Water pollution	- The Contractor must be responsible for compliance with Vietnamese legislation relevant to wastewater discharges into watercourses. - Portable or constructed toilets must be provided on site for construction workers. Wastewater from toilets as well as kitchens, showers, sinks, etc. shall be discharged into a conservancy tank for removal from the site or discharged into municipal sewerage systems; there should be no direct discharges to any waterbody. - Wastewater containing pollutants over standards set by relevant Vietnamese technical standards/regulations must be collected in a conservancy tank and removed from the site by	- QCVN 08-MT:2015/BTNMT: National Technical Standard on surface water quality; - QCVN14:2008/BTNMT: National technical regulation on domestic wastewater; - QCVN 40: 2011/BTNMT: National technical regulation on industrial wastewater	- Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	licensed waste collectors. - Make appropriate arrangements for collecting, diverting or intercepting wastewater from households to ensure minimal discharge or local clogging and flooding. - Before construction, all necessary wastewater disposal permits/licenses and/or wastewater disposal contracts have been obtained. - At the completion of construction works, wastewater collection tanks and septic tanks shall be safely disposed or effectively sealed off.			
4. Drainage and sedimentation control	- The Contractor shall follow the detailed drainage design included in the construction plans, intended to prevent stormwater from causing local flooding or scouring slopes and areas of unprotected soil, resulting in heavy sediment loads affecting local watercourses. - Ensure the drainage system is always maintained cleared of mud and other obstructions. - Areas of the site not disturbed by construction activities shall be maintained in their existing conditions. - Earthworks, and fill slopes shall be properly maintained, in accordance with the construction specifications, including measures such as the installation of drains, use of plant cover. - To avoid sediment-laded runoff that could adversely impact watercourses, install sediment control structures where needed to slow or redirect runoff and trap sediment until vegetation is established. Sediment control structures could include windrows	- TCVN 4447:2012: Earth works-Codes for construction; - Circular No. 22/2010/TT-BXD on the regulation of construction safety; - QCVN 08-MT:2015/BTNMT-National technical regulation on the quality of surface water	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	of logging slash, rock berms, sediment catchment basins, straw bales, storm drain inlet protection systems, or brush fences. - The amount of excavated soil will be stored along the route at the locations agreed upon with the local authorities and people. At the same time, the contractor will try to avoid construction plans for earthworks in the rainy season to avoid leaching and water pollution problems. In the case of construction during the rainy season, the contractors should have appropriate construction methods to prevent local flooding such as embankments, shielding excavated land by canvas, digging temporary drainage ditches and pumping for drying the construction site and limit flooding.			
5. Management of stockpiles, borrow pits, and quarries	- An open ditch shall be built around the excavated soil storage area to intercept wastewater. - Stockpile topsoil when first opening a borrow pit and use it later to restore the area to near natural conditions. - If needed, disposal sites shall include a retaining wall. - If the need for new sites arises during construction, they must be pre-approved by the Construction Engineer. - If landowners are affected by the use of their areas for stockpiles or borrow pits, they must be included in the subproject resettlement plan. - If access roads are needed, they must have been considered in the environmental assessment. - PPMU's Environment Officer should conduct due	- Decree No. 59/2015/ND-CP - Decree No. 38/2015/NĐ-CP	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	diligence to make sure that borrow pits and quarries are legally operating, with licensed and that sound environmental and social standards are being practiced. - Include the requirement that the contractors shall be required to buy materials from licensed borrow pit and quarry operators into the civil work contractual documents. - PPMU's Environment Officer should undertake a rapid review of quarry sites to assess if operations are in compliance with Vietnamese laws and Bank requirements prior to construction. - Include monitoring of borrow pits and quarries.			
6. Solid waste management	- Before construction, a solid waste control procedure (storage, provision of bins, site clean-up schedule, bin clean-out schedule, etc.) must be prepared by the Contractors and it must be carefully followed during construction activities. - Before construction, all necessary waste disposal permits or licenses must be obtained. - Measures shall be taken to reduce the potential for litter and negligent behavior with regard to the disposal of all refuse. At all places of work, the Contractor shall provide litter bins, containers and refuse collection facilities. - Solid waste may be temporarily stored on site in a designated area approved by the Construction Supervision Consultant and relevant local authorities prior to collection and disposal through a licensed waste collector, for example, URENCO. - Waste storage containers shall be covered, tip-proof,	- Decree No. 38/2015/NĐ-CP on solid waste management - Circular No. 36/2015/TT-BTNMT on the management of hazardous substance	- Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	weatherproof and scavenger proof. - No burning, on-site burying or dumping of solid waste shall occur. - Recyclable materials such as wooden plates for trench works, steel, scaffolding material, site holding, packaging material, etc. shall be collected and separated on-site from other waste sources for reuse, for use as fill, or for sale. - If not removed off-site, solid waste or construction debris shall be disposed of only at sites identified and approved by the Construction Supervision Consultant and included in the solid waste plan. Under no circumstances shall the contractor dispose of any material in environmentally sensitive areas, such as in areas of natural habitat or in watercourses.			
7. Chemical or hazardous wastes	- Landfill site and in accordance with local legislative requirements. The Contractor shall obtain needed disposal certificates. - The removal of asbestos-containing materials or other toxic substances shall be performed and disposed of by specially trained and certified workers. - Used oil and grease shall be removed from the site and sold to an approved used oil recycling company. - Used oil, lubricants, cleaning materials, etc. from the maintenance of vehicles and machinery shall be collected in holding tanks and removed from the site by a specialized oil recycling company for disposal at an approved hazardous waste site. - Used oil or oil-contaminated materials that could potentially contain PCBs shall be securely stored to	Circular No.36/2015/TT-BTNMT on the management of hazardous substance	- Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	avoid any leakage or affecting workers. Ca Mau DONRE must be contacted for further guidance. - Unused or rejected tar or bituminous products shall be returned to the supplier's production plant. - Relevant agencies shall be promptly informed of any accidental spill or incident. - Store chemicals appropriately and with appropriate labeling - Appropriate communication and training programs should be put in place to prepare workers to recognize and respond to workplace chemical hazards - Prepare and initiate a remedial action following any spill or incident. In this case, the contractor shall provide a report explaining the reasons for the spill or incident, remedial action taken, consequences/damage from the spill, and proposed corrective actions.			
8. Management of excavated soil	- Characteristics of excavated soil should be determined by sampling and analysis if not already fully evaluated during the ESIA. Excavated soil that is heavily contaminated would require measures that go beyond the scope of these ECOPs. - Collected excavated soil has to be processed, as per Vietnamese regulations on waste collection, to ensure safe and environmentally secure transportation, storage, treatment, and management.	- Decree No. 38/2015/NĐ-CP on solid waste management - Circular No. 36/2015/TT-BTNMT on the management of hazardous substance	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
9. Disruption of vegetative cover and ecological resources	- Compliance with national and local regulations on policies related to protected areas, wildlife sanctuaries, and natural landscapes. - All activities on the site are only allowed within the	Law on Environment protection No. 55/2014/QH13	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	acquired land areas and ensure that construction material and waste will not fall into the surrounding areas. - Vegetation removal will be minimized. At the edge of the road right-of-way, vegetation to be retained will be clearly marked and dead tree trunks and hollows will be kept as much as possible as they provide habitat. - Where feasible, cleared vegetation will be chipped/mulched and reused for rehabilitating cleared areas (mulch provides a source of seeds, limits erosion, retains soil moisture and nutrients, encourages re-growth, and protects against weeds). - Work sites will be cleared in short sections to meet construction needs and be stabilized (e.g., graded) and planted immediately after construction so as to minimize the area of exposed land at any point in time and to ensure the integrity of the works. - The application of chemicals for vegetation clearing is not permitted. - Trees cannot be cut down unless explicitly authorized in the vegetation clearing plan. - When needed, temporary protective fencing will be erected to efficiently protect the preserved trees before the commencement of any works within the site. - No area of potential importance as an ecological resource should be disturbed unless there is prior authorization from CSC, who should consult with PPMUs, IEMC and the relevant local authorities. This could include areas of breeding or feeding for birds or animals, fish spawning areas, or any area			Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	that is protected as a green space. - The Contractor shall ensure that no hunting, trapping, shooting, poisoning of fauna takes place.			
10.Traffic management	- Before construction, carry out consultations with local government and community and with traffic police. - Significant increases in a number of vehicle trips must be covered in a construction plan previously approved. Routing, especially of heavy vehicles, needs to take into account sensitive sites such as schools, hospitals, and markets. - Installation of lighting at night must be done, if necessary, to ensure safe traffic circulation. - Place signs around the construction areas to facilitate traffic movement, provide directions to various components of the works, and provide safety advice and warnings. - Employ safe traffic control measures, including road/rivers/canal signs and flag persons to warn of dangerous conditions. - Avoid material transportation for construction during rush hours. - Passageways for pedestrians and vehicles within and outside construction areas should be segregated and provide for easy, safe, and appropriate access. Signposts shall be installed appropriately in both water-ways and roads where necessary.	- Law on traffic and transportation No. 23/2008/QH12 - Law on construction No. 50/2014/QH13 - Circular No.22/2010/TT-BDX dated 03 Dec. 2010 on labor safety during the construction of civil works	- Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
11.Interruption of utility services	- Provide information to affected households on working schedules as well as planned disruptions (at least 5 days in advance).	Decree No. 73/2010/NDCP on administrative penalization security and society issues	Contractor	- Supervision reports of CSC - Supervision and

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	- Interruptions of water supply to agricultural areas must be avoided. - The contractor should ensure alternative water supply to affected residents in the event of disruptions lasting more than one day. - Any damages to existing cable utility systems shall be reported to the authorities and repaired as soon as possible.			monitoring reports of Ca Mau PPMU
12.Restoration of affected areas	- Cleared areas such as borrow pits which are no longer in use, disposal areas, site facilities, workers' camps, stockpiles areas, working platforms and any areas temporarily occupied during the construction of the subproject works shall be restored using landscaping, adequate drainage and revegetation. - Start revegetation at the earliest opportunity. Appropriate local native species of vegetation shall be selected for the planting and restoration of the natural landforms. - Spoil heaps and excavated slopes shall be re-profiled to stable conditions, and grassed to prevent erosion. - All affected areas shall be landscaped and any necessary remedial works shall be undertaken without delay, including green-spaces, roads, bridges and other existing works. - Trees shall be planted at exposed land and on slopes to prevent or reduce land collapse and keep the stability of slopes. - Restore all damaged roads and bridges caused by subproject activities.	Law on Environment protection No. 55/2014/QH13	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
13. Worker and public Safety	- Contractor shall comply with all Vietnamese regulations regarding worker safety. - Prepare and implement an action plan to cope with risk and emergency. - Preparation of emergency aid service at the construction site. - Training workers on occupational safety regulations. - If blasting is to be used, additional mitigation measures and safety precautions must be outlined in the ESMP. - Ensure that ear pieces are provided to and used by workers who must use noisy machines such as piling, explosion, mixing, etc., for noise control and workers protection. - During the demolition of existing infrastructure, workers and the general public must be protected from falling debris by measures such as chutes, traffic control, and use of restricted access zones. - The contractor shall provide safety measures such as the installation of fences, barriers warning signs, lighting system against traffic accidents as well as another risk to people. - Construction contracts to include conditions to ensure occupational health and safety; do not differentiate payment between women and men, and those who belong to local ethnic Khmer groups, for work of equal value; prevent the use of child labor, and comply with the government's labor laws and related international treaty obligations. - Maximize employment of women and poor households during construction.	- Circular No. 22/2010/TT-BXD dated 03 December 2010 on the regulation of construction safety - Directive No. 02 /2008/CT-BXD on safety and sanitation issues in construction agencies - TCVN 5308-91: Technical regulation on safety in construction - Decision No. 96/2006/QD-TTg dated 04 May 2006 on management and implementation of bomb mine explosive material disposal.	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
14. Communication with local communities	- Maintain open communications with the local government and concerned communities; the contractor shall coordinate with local authorities (leaders of local wards or communes, leader of villages) for agreed schedules of construction activities at areas nearby sensitive places or at sensitive times (e.g., religious festival days). - Copies in Vietnamese of these ECOPs and of other relevant environmental safeguard documents shall be made available to local communities and to workers at the site. - Reduced playground space, loss of playing fields and car parking: The loss of amenities during the construction process is often an unavoidable source of inconvenience to users in sensitive areas. However, early consultation with those affected provides the opportunity to investigate and implement alternatives. - Disseminate subproject information to affected parties (for example local authority, enterprises and affected households, etc.) through community meetings before construction commencement, focusing on female headed households, poor and vulnerable populations. - Provide a community relations contact from who interested parties can receive information on site activities, subproject status and subproject implementation results. - Provide all information, especially technical findings, in a language that is understandable to the general public and in a form useful to interested citizens and elected officials through the preparation	- Decree No. 73/2010/ND-CP on administrative penalization security and society issues - Decree No. 81/2013/ND-CP on detailing a number of articles of and measures to implement the Law on Handling of Administrative Violations	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	of fact sheets and news releases, when major findings become available during the subproject phase. - Monitor community concerns and information requirements as the subproject progresses. - Respond to telephone inquiries and written correspondence in a timely and accurate manner. - Inform local residents about construction and work schedules, interruption of services, traffic detour routes and provisional waterway routes, blasting and demolition, as appropriate. - Provide technical documents and drawings to PC's community, especially a sketch of the construction area and the ESMP of the construction site. - Notification boards shall be erected at all construction sites providing information about the subproject, as well as contact information about the site managers, environmental staff, health and safety staff, telephone numbers and other contact information so that any affected people can have the opportunity to voice their concerns and suggestions			
15.Worker camp management	- The Contractor will consult with the local authority regarding the location of the worker camps and will provide appropriate water supply, garbage collection, toilets, mosquito net, and other health protection measures to all workers. Fishing, wildlife hunting, and other social disturbance to local societies are prohibited. Training of workers on safety, good hygiene, and prohibitions activities	- Law on Labor No.10/2012/QH13	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
16. Chance find procedures	If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or individual graves during excavation or construction, the Contractor shall: - Stop the construction activities in the area of the chance find. - Delineate the discovered site or area. - Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Department of Culture, Sports and Tourism take over. - Notify the Construction Supervision Consultant who in turn will notify responsible local or national authorities in charge of the Cultural Property of Viet Nam (within 24 hours or less). - Relevant local or national authorities are in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This will require a preliminary evaluation of the findings to be performed. The significance and importance of the findings should be assessed according to the various criteria relevant to cultural heritage; including the aesthetic, historic, scientific or research, social and economic values. - Decisions on how to handle the finding shall be taken by the responsible authorities. This could include changes in the layout (such as when finding irremovable remains of cultural or archeological importance) conservation, preservation, restoration	- Law on Cultural Heritage 32/2009/QH12 - Decree No. 98/2010/ND-CP	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

Environmental – social issues	Mitigation measure	Vietnam code/regulation	Responsibility	Verification to determine effectiveness of measures
	and salvage. - If the cultural sites and/or relics are of high value and site preservation is recommended by the professionals and required by the cultural relic's authority, the Subproject's owner will need to make necessary design changes to accommodate the request and preserve the site. - Decisions concerning the management of the finding shall be communicated in writing by relevant authorities. - Construction works could resume only after permission is granted from the responsible local authorities concerning the safeguard of the heritage.			
III. During the operation phase				
Dust and exhaust gases generation	- There is a measurable link between traffic noise and speed. Speed control is the most direct and economical way to reduce traffic noise. - Encourage the use of less noisy vehicles and periodic maintenance of vehicles	- QCVN 06:2009/BTNMT - TCVN 6438-2005 - Decision No. 249/2005/QĐ-TTg	Local government and traffic authorities	Ca Mau PPC
Generate dust, gas and waste from the operation of the WSP	- Collection and treatment of waste - Providing personal protective equipment for construction workers		The management agency of the WSP	Ca Mau DONRE

Table 6.3: Workers Codes of Conducts

Workers Codes of Conducts
1. Compliance with applicable laws, rules, and regulations, with applicable health and safety requirements; 2. Prioritize the use of local labors, particularly ethnic minorities 3. The transportation, storage and use of illegal substances including weapons are prohibited; 4. Do not involve in social evils. Do not quarrel or fight that cause social disorder 5. Do not catch, hunt, trade, keep in cage or usage of wildlife or wildlife products. Do not bring domestic animals in camps 6. Do not use alcohol during working hours, smoking at the construction site is prohibited; 7. Non-discrimination (for example on the basis of family status, ethnicity, race, gender, religion, language, marital status, birth, age, disability, or political conviction) 8. Interactions with community members with an attitude of respect and non-discrimination) 9. Sexual harassment (for example to prohibit the use of language or behavior, in particular towards women or children, that is inappropriate, harassing, abusive, sexually provocative, demeaning or culturally inappropriate) is prohibited 10. Violence or exploitation (for example the prohibition of the exchange of money, employment, goods, or services for sex, including sexual favors or other forms of humiliating, degrading or exploitative behavior) is prohibited 11. Protection of children (including prohibitions against abuse, defilement, or otherwise unacceptable behavior with children, limiting interactions with children, and ensuring their safety in project areas) 12. Avoidance of conflicts of interest (such that benefits, contracts, or employment, or any sort of preferential treatment or favors, are not provided to any person with whom there is a financial, family, or personal connection) 13. Respecting reasonable work instructions (including regarding environmental and social norms) 14. Protection and proper use of the property. Maintain sanitation and safe conditions in both camps and construction sites. Prohibit theft, careless usage of resources, set fire without being authorized or pollute the environment 15. Duty to report violations of this Code Violations of the Codes of conducts will lead to disciplinary actions.

6.3.2. Mitigation measures for site-specific impacts

Table6.9 presents site-specific impacts and mitigation measures that could not be addressed through the application of the ECOPs. This may be because the impacts are very site-specific in nature and thus require very site-specific mitigation measures.

Table6.4: Mitigation measures for site-specific impacts

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
A	***For structure components***				
I	***Preconstruction phase***				
1	**Land acquisition and resettlement**	Land acquisition and resettlement will comply with approval Resettlement Policy Framework (RPF) of the MDICRSL project and the Resettlement Action Plan (RAP) of this subproject, specifically: - Prepare the land donation procedure. - Organize the demarcation of the construction site, the location of the dump site for use as a basis for implementation - Develop a plan to exploit Melaleuca before the land clearance - Support affected households to restore their livelihood and living conditions. - The affected people are given priority to be recruited for the activities under the subproject.	- Law on Land No. 45/2013/QH13; - Decree No. 43/2014/ND-CP; - Decree No. 44/2014/ND-CP; - Decree No. 47/2014/NĐ-CP; - Circular No. 36/2014/TT-BTNMT; - Circular No. 37/2014/TT-BTNMT; - Decision No.52/2012/QD-TT	- Nam Can, Ngoc Hien, U Minh CPCs - PPMU Cà Mau	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
2	**Clearance of UXOs**	- The subproject will allocate fund for clearance of the UXO remained after the war at the construction areas. The subproject owner will sign a contract with the specialized military unit in Ca Mau province to carry out the UXO clearance at the construction sites. This activity will be implemented right after completing land acquisition and	Decision No. 96/2006/QD-TTg dated 04 May 2006 on management and implementation of bomb mine explosive material disposal.	- Contractor implementing the package of searching and removing/destroying UXO - Ca Mau PPMU	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		compensation and before any dismantling, demolition or ground leveling takes place. - Ensure that the contractors shall only commence site works after the subproject areas are already been cleared			
II	***During the construction phase***				
1	**The component of the wave breaker**				
1.1	Natural coastal habitat near the Hon Da Bac	- Dredging should be done at low tide. Results of soil quality analysis in the excavation area show that the soil is not contaminated with heavy metals and alum so the dredged soil needs to be disposed into the land inside for forest planting. Avoid dumping into the coastal area causing high turbidity of the water source. - Collect waste water, solid wastes to land to avoid pollution of surface water - Apply appropriate construction measures to minimize the loss and change of habitats of aquatic life. - Put the floating pontoon surrounded rigs to facilitate the collection of solid waste, floating objects accidentally falling flow. - Arrange 2 different trash containers on each floating rigs for containing oil rags and other solid wastes.	- Law on biodiversity - QCVN 10-MT:2015/ BTNMT Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
2	**The component of reservoir and water treatment plant and pipelines**				
2.1	Khanh An secondary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC Supervision and monitoring reports of Ca Mau PPMU
2.2	Khanh An high school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school	- QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT Circular No. 36/2015/BTNMT		
2.3	Residential area in the entrance to Khanh An high school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
2.4	Cuu Long Chau Temple	- Inform the temple management of the construction activities and their potential impacts of construction activities such as dust and noise one month before the start of the construction. - Use axial compressive load pile driving method instead of using a pile driving hammer. - Spray sufficient water to suppress dust during dry and windy days. - Pay special attention to the above mitigation measures during religious events every first and 15th days of the lunar month and during festival days. - Immediately address any issue/problem caused by the construction activities and raised by the temple	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
2.5	The intersection between the road from Thoi Binh Town to Khanh Lam and the road from Khanh An - U Minh	- Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the residential area	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
			- Circular No. 36/2015/BTNMT		
2.6	Nguyen Thai Binh Secondary School	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/complaint raised by the school	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
2.7	Residential area in U Minh town	- Spray sufficient water during dry days to avoid dust around the residential area. - Do not allow construction activities before 6:30 am and after 8:00 pm. If night shift is unavoidable, prohibit the use of construction methods that cause noise at night. - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		that adjacent to the residential area. - Provide good drainage to avoid water run-off to the residential area. - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the residential area and dispose of in a designated site. - Hold monthly meetings with the community on construction progress and issues and immediately address any issue/complaint raised by the community.	- QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT		
3	**The component of embankment**				
3.1	Lam Hai primary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		- Immediately address any issue/ complaint raised by the school			
3.2	Vien An Dong secondary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/ complaint raised by the school	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
3.3	Tan An Tay primary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site Immediately address any issue/ complaint raised by the school	26:2010/BTNMT - QCVN 27:2010/BTNMT Circular No. 36/2015/BTNMT		
3.4	Tan An Tay kindergarten	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/ complaint raised by the school.	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU
3.5	Tam Giang Tay primary school	- Spray sufficient water to suppress dust during dry and windy days - Prohibit the use of construction	- QCVN 05:2013/BTNMT - QCVN	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		methods that cause noise at school time - Do not transport materials in the period times that pupils go to school and go home - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the school - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the school area and dispose of in a designated site - Immediately address any issue/ complaint raised by the school.	06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT		
3.6	Tam Giang Tay CPC	The construction of embankment near Tam Giang Tay CPC will affect the access road to it, the following measures will be done: - Arrange a bypass route for people to easily access to the committee - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area - Do not allow construction activities during working hours of the CPC. - Hold monthly meetings with the community on construction progress and issues and immediately address	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau PPMU

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		any issue/complaint raised by the community.			
3.7	Vien An Dong residential area	- Spray sufficient water during dry days to avoid dust around the residential area. - Do not allow construction activities before 6:30 am and after 8:00 pm. If night shift is unavoidable, prohibit the use of construction methods that cause noise at night. - Ensure traffic safety by installing safety fence and warning signs, traffic instruction around the construction area that adjacent to the residential area. - Provide good drainage to avoid water run-off to the residential area. - Immediately collect any domestic wastes and construction spoils caused by the construction activities around the residential area and dispose of in a designated site. Hold monthly meetings with the community on construction progress and issues and immediately address any issue/complaint raised by the community.	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08-MT:2015/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT Circular No. 36/2015/BTNMT	Contractor	- Supervision reports of CSC Supervision and monitoring reports of Ca Mau PPMU
III	**During the operation phase**				
1	Water pollution caused by aquaculture activities in the embankment area	- Regularly dredge the canal system to create a fresh water source to protect the environment.	Law on Environment	- Nam Can, Ngoc Hien DPCs	Ca Mau PPC

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		- Develop planning for agricultural and aquaculture development is appropriate in new conditions.			
2	Risks and incidents caused by the embankment operation	- In response to the impact of waves that reduce the life span of the wave-breaker, regularly check defects on the wave-breaker to take measures to patch, repair broken parts, add rocks and concrete components into the sections where waves drift components. - Periodically check at the edge of the river bank to take timely measures when sediment occurs. For the estuary which is deposited, upon the actual situation, dredge sediment to ensure navigation safety. - Regularly check defects on the wave-breaker to take measures to patch, repair broken parts, add rocks and components to fix the sections which were drifted by waves. - Monitor the deformation and defects on the wave-breaker to take appropriate measures. - Do not allow boat anchorage in the wave-breaker to cause unsafety to the works. - Forbid excavation near the wave-breaker. - During the management, if any	- Road Traffic Law No. 23/2008 / QH12. - Law on dyke	- Nam Can, Ngoc Hien DPCs	Ca Mau PPC

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		incidents are detected, reports must be sent to the competent authorities for timely settlement.			
3	Air pollution and traffic safety on the embankment	- Install traffic signs to prohibit motorized means of transport from entering the embankment. - Perform maintenance for the embankment. - Regularly dredge canals to create good ventilation for the water source to protect the environment	- Road traffic law No. 23/2008/QH12. - Circular 22/2010/TT-BXD	Local authorities and transportation agencies	Ca Mau PPC
4.	Dust, emissions, and noise due to the operation of the WSP	- Provide personal protective amenities for operators. - Regularly check machinery, avoid damage and perform maintenance in time. - Design mufflers right at the pump room, design enough baseplate thickness, rubber cushions, and anti-vibration springs. - Use advanced water pumps which are manufactured in accordance with environmental safety standards without noise and regularly check and maintain.	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08:2008/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Decree No. 36/2015/BTNMT 08:2008/BTNMT - QCVN 19: 2009/BTNMT - Decree No. 36/2015/BTNMT	Center for rural clean water and environmental sanitation	Ca Mau DARD

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
5	Wastewater and solid waste of from the WSP	- The amount of water after cleaning filtration materials in the treatment process will be reused. - Rainwater runoff in WSP is collected byan internal drainage system. - Waste from daily activities of operation workers is collected on site by tanks, trash. Sludge after treatment of water will be contracted with functional units to collect and treat in accordance with regulations.	- QCVN 05:2013/BTNMT - QCVN 06:2008/BTNMT - QCVN 08:2008/BTNMT - QCVN 19: 2009/BTNMT - QCVN 26:2010/BTNMT - QCVN 27:2010/BTNMT - Decree No. 36/2015/BTNMT 08:2008/BTNMT - QCVN 19: 2009/BTNMT - Decree No. 36/2015/BTNMT	- Center for rural clean water and environmental sanitation	- Ca Mau DARD
6	Risks and incidents caused by the reservoir operation	- Investigation and treatment of toxic chemicals in the water collecting area for the reservoir. - Sampling to assess canal water quality before collecting water to the reservoir - Annual survey of land use and land management. - Propagate and mobilize people to manage and protect water quality in the reservoir - Set up a mailbox at the commune, to		- Center for rural clean water and environmental sanitation	- Ca Mau DARD

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		receive feedback from people when they detect illegal encroachment, actions that can lead to damage to the reservoir system and surrounding canals			
7	Risks and incidents caused by the wave breaker operation	- In response to the impact of waves that reduce the life span of the wave-breaker, regularly check defects on the wave-breaker to take measures to patch, repair broken parts, add rocks and concrete components into the sections where waves drift components. - Periodically check at the edge of the river bank to take timely measures when sediment occurs. For the estuary which is deposited, upon the actual situation, dredge sediment to ensure navigation safety. - Regularly check defects on the wave-breaker to take measures to patch, repair broken parts, add rocks and components to fix the sections which were drifted by waves. - Monitor the deformation and defects on the wave-breaker to take appropriate measures. - Do not allow boat anchorage in the wave-breaker to cause unsafety to the works. - Forbid excavation near the wave-	- Law on dyke	Ca Mau Department of Water Resources	- Ca Mau DARD

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		breaker. - During the management, if any incidents are detected, reports must be sent to the competent authorities for timely settlement.			
B.	**Mangroves planting in shrimp ponds**	- Forest area must be at least a certain percentage of the area of the land plot depending on the types of certificate. So, farmers always keep the forest area as requirements of certification authorities. - Obtain permission from the before planting, thinning or harvesting mangroves, including (i) thining tree as first thinning to a density of 5,000 trees/ha at 9 to 10 years of age and second thinning to a density of 2,000 - 2,500 trees/ha at 14 -15 years of age; (ii) Harvesting at about 20 years of age, after harvesting, prepare to plant a new cycle and obtain permission from the before planting, thinning or harvesting mangroves. - Do not place soil from pond construction or cleaning in mangrove areas, because *Rhizophora* trees do not grow well or may die on high land without flooding by the tide. - Do not pump soil from pond construction or cleaning into waterways. - Use soil from pond construction and	Law on Forest Protection and Development No. 29/2004/QH11	- Forestry division of Ca Mau province - Ca Mau PPMU - Aquaculture division of Ca Mau province - Agriculture and Fishery Extension Center of Ca Mau province	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau DARD

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		cleaning to build up an area of high land for domestic use or where other crops can be grown. - Regularly circulate water in the ponds to prevent low oxygen conditions and reduce local accumulations of mangrove leaves.			
C.	**Livelihood models**	- Constructing wastewater and waste treatment facilities that meet the permitted standards. - Collection, reuse, recycle solid waste. - Installation of noise control works. - Treatment wastewater from aquaculture farming before discharging into watercourse. - Develop and integrate real-time environmental monitoring tools into the livelihood component of the subproject. - Share and transfer lessons and experience between subprojects under the MD-ICRSL project. - Use farmer cooperatives or collective groups to implement livelihood adaptation models. - Locate pilot livelihood demonstrations near successful models in order to change farmer's perceptions. - Reduce the risk of over-supply by working with agribusinesses on a staged incremental approach.	- QCVN 08-MT:2015/BTNMT: National Technical Standard on surface water quality; - QCVN 02 - 19 : 2014/BNNPTNT: National technical regulation on brackish water shrimp culture farm - Conditions for veterinary hygiene, environmental protection and food safety	- Division of Aquaculture of Ca Mau province - Agriculture and Fishery Extension Center of Ca Mau province - Ca Mau PPMU	- Supervision reports of CSC - Supervision and monitoring reports of Ca Mau DARD

No	Sensitive Area or Activity	Mitigation Measures	Vietnam code/regulation	Responsibility	Verification of effectiveness of measures
		- Start-up capital needs to be provided to fund livelihood investments. - Hire aquaculture and agriculture specialists to support cooperatives/collective groups. - Reduce potential negative impacts due to the possible expansion of aquaculture farming and/or the models via providing technical assistance to establish a registration system for aquaculture farming			

6.4. ENVIRONMENTAL MONITORING PROGRAM

The main objective of the environmental monitoring program is to ensure that (a) the potential negative impacts of the subproject are minimized; (b) the ESMP is effectively implemented; and (c) the ESMP is adequate to mitigate the potential negative impacts. Given that monitoring the implementation of the RAP will be conducted separately, the environmental monitoring program will comprise: (a) monitoring the safeguard performance of the contractor during site clearance and construction; (b) environmental quality monitoring; (c) community-based monitoring; and (d) monitoring effectiveness of the ESMP.

The social monitoring program is to ensure that the livelihoods of affected households will not decrease due to the subproject implementation. Monitoring social issues to minimize exposure risk during construction. Supervising labor contracts to ensure occupational health and safety; regardless of the payment of wages between women and men, preventing the use of child labor; and comply with government labor laws and related international treaty obligations.

6.4.1. Monitoring of Contractor's Safeguard Performance

Three levels of safeguard monitoring will be implemented: routine monitoring, periodic monitoring, and community monitoring, as follows:

- Routine monitoring: The routine monitoring will be made by the Construction Supervision Consultant (CSC) as assigned by PPMU. The CSC will include the monitoring results in the subproject progress reports. TOR of the CSC for the subproject is in Appendix 7.
- Periodic monitoring (every six months): As part of the overall monitoring of the ESMP, the ESU assisted by the Independent Environmental Monitoring Consultant (IEMC) will also monitor the contractor performance every 6 months and the results will be reported to the PPMU and the WB. TORof the IEMC for the subproject is in Appendix8.
- Community monitoring: Monitoring by local communities will be conducted following the Government practices with the technical and management support from the PPMU.

6.4.2. Community-based monitoring

Community-based monitoring is a voluntary activity of people living in commune/ ward areas. Community Supervision Board will be established by Decision No. 80/2005/QD-TTg and other relevant regulations. Community Supervision Board will be responsible for:

- Monitoring and assessing the observance of investment management regulations by agencies competent to decide on investment, investors, project management unit, contractors and project-implementing units in the investment process (including environmental issues);
- Detecting and recommending to the competent state agencies on violations of regulations on investment management (including environmental issues) so as to promptly prevent and handle acts that violate regulations, cause wastage and/or loss of state capital and properties or infringe the interests of the community

6.4.3. Monitoring Effectiveness of the ESMP

The ESU assisted by IEMC will monitor performance of the ESMP implementation during the detailed design/bidding stage as well as during construction and first-year operation of the facilities to ensure that (a) appropriate dredging and disposal of drainage sludge is properly carried out, in accordance with the DMMP; (b) other impacts identified in the ESMP are effectively managed and mitigated; and (c) traffic management is adequate and the level of

impacts is acceptable (no complaints or outstanding cases). Results are to be properly kept in the subproject file for possible review by PPMU and the WB. Cost for the monitoring will be part of the PPMU cost.

6.4.4. Environmental Quality Monitoring

To ensure an acceptable level of environmental quality, monitoring of dust, noise, vibration, air quality, and water quality will be made at project specific locations that are likely to be significantly affected by the construction activities or requested by local authorities and communities for specific purposes. ESU/IEMC will be responsible for the monitoring of the program.

Below is a list of the key issues and scope of monitoring that will be considered in the implementation of the monitoring program: Monitor quality of noise, air water, and sediment during construction. This work will be directly carried out by the contractors, the subproject owner will supervise the environmental monitoring of the contractors and report the monitoring results to the Department of Natural Resources and Environment of Ca Mau province. During subproject operation, quality of water, soil and sediment will be monitored. This work will be coordinated with the Department of Natural Resources and Environment of Nam Can, Ngoc Hien, U Minh, Phu Tan and Tran Van Thoi Districts.

*Table6.5*provides general guidance on the monitoring program and estimated cost considering that the activities will be carried out during construction (assumed 1,5years), and during the first 2 years of subproject operation. Detailed monitoring programs will be prepared during the detailed design stage, map of monitoring site is figured out in *Figure6.1*to*Figure6.6*. An estimated cost for monitoring is incorporated into the ESMP cost (Section 6.7). Many of these measurements are required by Vietnamese regulations and would need to be done even if not directly related to expected subproject impacts.

Table6.5: Scope of environmental monitoring during the construction and operation phases

No	Contents	Specific requirements
I	**Construction phase**	
1	**Air/noise, vibration**	
a	Parameters	TSP, NO_2, SO_2, CO, noise
b	Locations (4 sites in the 4 embankment routes + 2 sites in the reservoir + 4 sites in the wave breaker)	10
c	Frequency	03 months/time during the construction phase
d	Applied standard	QCVN 05:2013/BTNMT,QCVN 26:2010/BTNMT; QCVN 27:2010/BTNMT
2	**Water + microorganism + aquatic life**	
a	Parameters	pH, turbidity, Salinity, DO, TSS, BOD_5, oil & grease, coliform, phytoplankton, zooplankton, zoobenthos
b	Locations (4 locations in the embankment + 2 locations in the reservoir + 4 locations in the wave breaker + 2 locations in the shrimp – forest area)	12
c	Frequency	03 months/time during the construction phase
d	Applied standard	QCVN 08-MT:2015/BTNMT

No	Contents	Specific requirements
3	**Sediment**	
a	Parameters	pH, Cu, Pb, Zn, Cd, As, salinity, oil & grease
b	Locations (4 locations in the embankment + 2 locations in the reservoir + 6 locations in the wave breaker + 2 locations in the shrimp-forest area)	14
c	Frequency	03 months/time during the construction phase
d	Applied standard	QCVN 03-MT:2015/BTNMT; QCVN 43:2012/BTNMT
II	**Operation phase**	
1	**Water + microorganism + aquatic life**	
a	Parameters	pH, turbidity, Salinity, DO, TSS, BOD_5, coliform, phytoplankton, zooplankton, zoobenthos
b	Locations (4 locations in the embankment + 2 locations in the reservoir + 4 locations in the wave breaker + 2 locations in the shrimp – forest area)	12
c	Frequency	03 months/time during the first 2 years of operation
d	Applied standard	QCVN 08-MT:2015/BTNMT
2	**Sediment**	
a	Parameters	pH, Cu, Pb, Zn, Cd, As
b	Locations (4 locations in the embankment + 2 locations in the reservoir + 6 locations in the wave breaker + 2 locations in the shrimp-forest area)	14
c	Frequency	03 months/time during the first 2 years of operation
d	Applied standard	QCVN 03-MT:2015/BTNMT; QCVN 43:2012/BTNMT;

Figure6.1: Air monitoring sites in the embankment

Figure6.2: Air monitoring sites in the wave breaker and reservoir

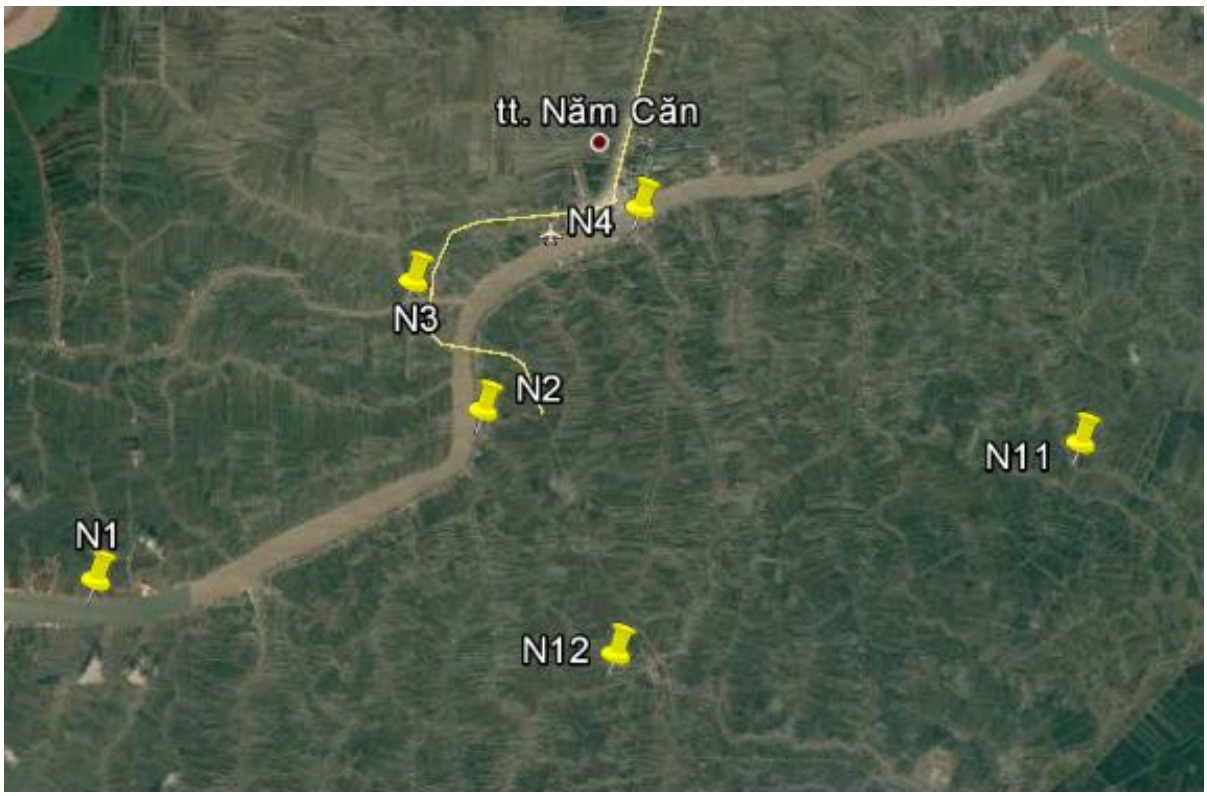


Figure6.3: Surface water monitoring sites in the embankment and shrimp-forest area

Figure6.4: Surface water monitoring sites in the reservoir and wave breaker

Figure6.5: Soil monitoring sites in the reservoir and wave breaker

Figure6.6: Soil monitoring sites in the embankment and shrimp-forest area

Table6.6: Number of samples in the environmental monitoring program

TT	Activities	Unit	Quantity	Unit price (VND)	Total (VND)
I	**Construction phase**				**1.125.928.640**
1	Total of sampling (48 months x 3 months/time = 16 times)	Time	16		
2	Air/noise (10stations x 1 times)	Sample	160	654	104.640
3	Water + microorganism + aquatic life (12 stations x 2 samples/station - (high tide and low tide) x 16 times)	Sample	384	2.177.000	835.968.000

4	Sediment (14 stations x 16 times)	Sample	224	1.294.000	289.856.000
II	**Operation phase (during the first 2 years of operation)**	Sample			**353.920.000**
1	Total of sampling (24 months x 3 months/time = 8 times)	Sample	8		
3	Water + microorganism + aquatic life (12 stations x 1 samples/station-(high tide and low tide) x 8 times		96	2.177.000	208.992.000
4	Sediment (14 stations /time x 8 times)	Time	112	1.294.000	144.928.000
	Total= I+II				**1.479.848.640**

6.5. ROLE AND RESPONSIBILITIES FOR ESMP IMPLEMENTATION

6.5.1. Implementation arrangement

Role and responsibilities for ESMP implementation are described in *Table6.7*and *Figure6.7*.

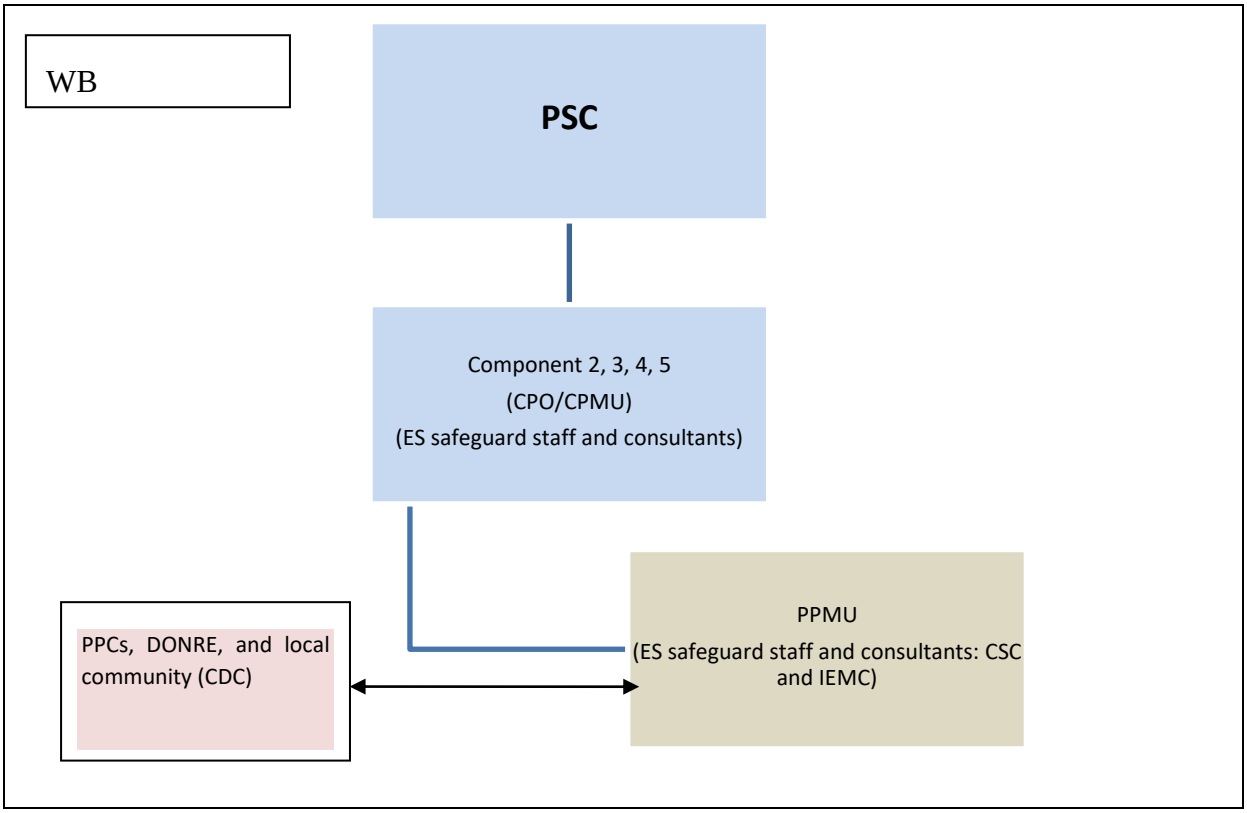


Figure6.7: Organization structure for safeguard monitoring of the subproject

Table6.7: Institutional Responsibilities for the subproject safeguard implementation

Community/ Agencies	Responsibilities
Project Implementing Agency (IA) and PMU (The IA means Ca	– The IA will be responsible for overseeing the Project implementation including ESMF implementation and environmental performance of contractors. – PMU, representative of the IA, will be responsible for monitoring the overall Project implementation, including environmental compliance

Mau DARD and Ca Mau PPMU)	of the Project. PMU will have the final responsibility for ESMF implementation and environmental performance of the Project during the construction and operational phases. – Specifically the PMU will: (i) closely coordinate with local authorities in the participation of the community during project preparation and implementation; (ii) monitor and supervise ESMP implementation including incorporation of ESMP into the detailed technical designs and bidding and contractual documents; (iii) ensure that an environmental management system is set up and functions properly; (iv) be in charge of reporting on ESMP implementation to the IA and the World Bank. – In order to be effective in the implementation process, PMU will establish an Environmental and Social Unit (ESU) with at least two safeguard staff to help with the environmental aspects of the Project.
Environmental and Social Unit (ESU) under PMU	– The ESU is responsible for monitoring the implementation of the World Bank's environmental safeguard policies in all stages and process of the Project. Specifically, this unit will be responsible for: (i) screening subprojects against eligibility criteria, for environment and social impacts, policies triggered and instrument/s to be prepared;(ii) reviewing the subproject EIAs/EPPs and ESIAs/ESMPs prepared by consultants to ensure quality of the documents; (iii) helping PMU incorporate ESMPs into the detailed technical designs and civil works bidding and contractual documents; (iv) helping PMU incorporate responsibilities for ESMP monitoring and supervision into the TORs, bidding and contractual documents for the Construction Supervision Consultant (CSC) and other safeguard consultants (SSC, ESC, IMA, and EMC) as needed; v) providing relevant inputs to the consultant selection process; (v) reviewing reports submitted by the CSC and safeguard consultants; (vi) conducting periodic site checks; (vii) advising the PMU on solutions to environmental issues of the project; and viii) preparing environmental performance section on the progress and review reports to be submitted to the Implementing Agency and the World Bank.
PPMU, DARD	– As the subproject owner, PPMU is responsible for the implementation of all the ESMP activities to be carried out under the Project, including fostering effective coordination and cooperation between the contractor, local authorities, and local communities during the construction phase. PPMU will be assisted by the environmental staff, safeguard consultants, and CSC/or field engineer. – Division of Aquaculture and Agriculture and Fishery Extension Center of Ca Mau province are responsible for livelihoods models. – During operation, the responsibility to operate will be transferred to the Provincial Department of Water Resources (PDWR) of Ca Mau DARD and they will be responsible for monitoring of water quality and ecosystem before and after the operation of the wave breaker, reservoir, embankment and submit water quality report to the Ca Mau DONRE one time per three months. – Center for the rural water supply of Ca Mau province is responsible for the water supply plan.

Construction Supervision Consultant (CSC) and/or Field Engineer	– The CSC will be responsible for routine supervising and monitoring all construction activities and for ensuring that Contractors comply with the requirements of the contracts and the ECOP. The CSC will engage a sufficient number of qualified staff (e.g. Environmental Engineers) with adequate knowledge on environmental protection and construction project management to perform the required duties and to supervise the Contractor's performance. – The CSC will also assist the PPMU in reporting and maintaining close coordination with the local community.
Contractor	– Based on the approved environmental specifications (ECOP) in the bidding and contractual documents, the Contractor is responsible for establishing a Contractor ESMP (CESMP) for each construction site area, submit the plan to PPMU and CSC for review and approval before commencement of construction. In addition, it is required that the Contractor get all permissions for construction (traffic control and diversion, excavation, labor safety, etc. before civil works) following current regulations. – The Contractor is required to appoint a competent individual as the contractor's on-site Safety and Environment Officer (SEO) who will be responsible for monitoring the contractor's compliance with health and safety requirements, the CESMP requirements, and the environmental specifications (ECOP). – Take actions to mitigate all potential negative impacts in line with the objective described in the CESMP. – Actively communicate with local residents and take actions to prevent disturbance during construction. – Ensure that all staff and workers understand the procedure and their tasks in the environmental management program. – Report to the PPMU on any difficulties and their solutions. – Report to local authority and PPMU if environmental accidents occur and coordinate with agencies and keys stakeholders to resolve these issues.
Independent Environmental Monitoring Consultants (IEMC)	– IEMC will, under the contract scope, provide support to PPMU to establish and operate an environmental management system, offers suggestions for adjusting and building capacity for relevant agencies during project implementation and monitor the CESMP implementation in both construction and operation stages. IEMC will also be responsible to support PPMU to prepare monitoring reports on ESMP implementation. – The IEMC will have extensive knowledge and experience in environmental monitoring and auditing to provide independent, objective and professional advice on the environmental performance of the Project.
Local community	– Community: According to Vietnamese practice, the community has the right and responsibility to routinely monitor environmental performance during construction to ensure that their rights and safety are adequately protected and that the mitigation measures are effectively implemented by contractors and the PPMU. If unexpected problems occur, they will report to the CSC and/or PPMU.

Social organizations, NGOs and civil society groups	– These organizations could be a bridge between the PPC/DPC, communities, Contractors, and the PPMU by assisting in community monitoring. – Mobilizing communities' participation in the subproject, providing training to communities and Participating in solving environmental problems, if any.
Province and District People's Committees (PPCs/DPCs), Provincial DONRE	– Oversee implementation of subprojects under recommendations of DONRE and PPMU to ensure compliance of Government policy and regulations. DONRE is responsible for monitoring compliance with the Government environmental requirements.

6.5.2. Environmental Compliance Framework

6.5.2.1. Environmental Duties of the Contractor

The contractor firstly shall adhere to minimize the impact that may be the result of the subproject construction activities and secondly, apply the mitigation measures under ESMP to prevent harm and nuisances on local communities and the environment caused by the impacts in construction and operation stages.

Remedial actions that cannot be effectively carried out during construction should be carried out on completion of the works (and before issuance of the acceptance of completion of works)

The duties of the Contractor include but not limited to:

- Compliance with relevant legislative requirements governing the environment, public health and safety;
- Work within the scope of contractual requirements and other tender conditions;
- Organize representatives of the construction team to participate in the joint site inspections undertaken by the Environmental Supervisor (ES) of the CSC;
- Carry out any corrective actions instructed by the Environmental Control Officer (ECO) of the PPMU and ES;
- In the case of non-compliances/discrepancies, carry out an investigation and submit proposals on mitigation measures, and implement remedial measures to reduce environmental impact;
- Stop construction activities, which generate adverse impacts upon receiving instructions from the ECO and ES. Propose and carry out corrective actions and implement alternative construction method, if required, in order to minimize the environmental impacts; Non-compliance by the Contractor will be cause for suspension of works and other penalties until the non-compliance has been resolved to the satisfaction of the ECO and ES.

6.5.2.2. Contractor's Safety and Environment Officer (SEO)

The contractor shall be required to appoint a competent individual as the Contractor's on-site safety and environment officer (SEO). The SEO must be appropriately trained in environmental management and must possess the skills necessary to transfer environmental management knowledge to all personnel involved in the contract. The SEO will be responsible for monitoring the contractor's compliance with the ESMP requirements and the

environmental specifications. The duties of the SEO shall include but not be limited to the following:

- Carry out environmental site inspections to assess and audit the contractors' site practice, equipment and work methodologies with respect to pollution control and adequacy of environmental mitigation measures implemented;
- Monitor compliance with environmental protection measures, pollution prevention and control measures and contractual requirements;
- Monitor the implementation of environmental mitigation measures;
- Prepare audit reports for the environmental monitoring data and site environmental conditions;
- Investigate complaints and recommend any required corrective measures;
- Advise the contractor on environment improvement, awareness and proactive pollution prevention measures;
- Recommend suitable mitigation measures to the contractor in the case of non-compliance. Carry out additional monitoring of noncompliance instructed by the ECO/ES;
- Inform the contractor and ECO/ES of environmental issues, submit the contractor's ESMP Implementation Plan to the ECO/ES, and relevant authorities, if required;
- Keep detailed records of all site activities that may relate to the environment.

6.5.2.3. Independent Environmental Monitoring Consultant (IEMC)

In order to minimize the environmental impacts during the construction stage of the Project, the Project owner shall ensure that environmental quality monitoring requirements are established for the project. An Independent Environmental Monitoring Consultant (IEMC) appointed by CPMU shall carry out the monitoring.

- IEMC will be responsible for carrying out environmental sampling, monitoring and marking report during all stages of the Project. Environmental quality monitoring will be reported periodically to PPMU (every 06 months in the construction and in operation phases).
- IEMC will also supply specialized assistance to CPMU and ECO in environmental matters.

6.5.2.4. Environmental Supervision during Construction

During the construction phase, a qualified Construction Supervision Consultant (CSC) reporting to the PPMU shall carry out the environmental supervision. The CSC is responsible for inspecting and supervising all construction activities to ensure that mitigation measures adopted in the ESMP are properly implemented and that the negative environmental impacts of the Project are minimized. The CSC shall engage a sufficient number of Environmental Supervision Engineers with adequate knowledge on environmental protection and construction project management to perform the required duties and to supervise the Contractor's performance. Specifically, ES will:

- Review and assess on behalf of the PPMU whether the construction design meets the requirements of the mitigation and management measures of the ESMP,
- Supervise site environmental management system of contractors including their performance, experience and handling of site environmental issues, and provide corrective instructions;

- Review the ESMP implementation by the contractors, verify and confirm environmental supervision procedures, parameters, monitoring locations, equipment and results;
- Report ESMP implementation status to PPMU and prepare the environmental supervision statement during the construction stage; and
- Approve invoices or payments.

6.5.2.5. Compliance with Legal and Contractual Requirements

The constructions activities shall comply not only with contractual environmental protection and pollution control requirements but also with environmental protection and pollution control laws of the Socialist Republic of Viet Nam.

All the works method statements submitted by the Contractor to the ECO for approval shall also be sent to the ES to see whether sufficient environmental protection and pollution control measures have been included.

The ES shall also review the progress and program of the works to check that relevant environmental laws have not been violated and that any potential for violating the laws can be prevented.

The Contractor shall copy relevant documents to the SEO and the ES. The document shall at least include the updated work progress report, the updated work measure, and the application letters for different license/permits under the environmental protection laws, and all the valid license/permit. The SEO and the ES shall also have access, upon request, to the Site Log-Book.

After reviewing the documents, the SEO or the ES shall advise the ECO and the contractor of any non-compliance with the contractual and legislative requirements on environmental protection and pollution control for them to take follow-up actions. If the SEO or the ES concludes that the status on license/permit application and any environmental protection and pollution control preparation works may not comply with the work measure or may result in potential violation of environmental protection and pollution control requirements, they shall advise the Contractor and the ECO accordingly.

6.5.2.6. Environmental Claims and Penalty System

a) Grievance redress mechanism

Within the Vietnamese legal framework citizen rights to complain are protected. As part of the overall implementation of the subproject, a grievance redress mechanism (GRM) will be developed by ESU of the PPMU which will identify procedures, responsible persons and contact information. It will be readily accessible, handle grievances and resolve them at the lowest level as quickly as possible. The mechanism will provide the framework within which complaints about environmental and safety issues can be handled, grievances can be addressed and disputes can be settled quickly. The GRM will be in place before the subproject construction commences.

During construction, the GRM will be managed by the contractor under the supervision of the CSC. The contractor will inform the communities and communes affected by the contract about the GRM in place to handle complaints and concerns about the subproject. This will be done via the Information Disclosure and Consultation Process under which the contractor will communicate with the affected communities and interested authorities on a regular basis: Meetings will be held at least quarterly, a monthly information brochure will be published,

announcements will be placed in local media, and notices of upcoming planned activities will be posted, and so on.

All complaints and corresponding actions undertaken by the contractor will be recorded in the subproject safeguard monitoring report. Complaints and claims for damages could be lodged as follows:

- Verbally: direct to the CSC and/or the contractor safeguard staff or representative at the subproject office.
- In writing: by hand-delivering or posting a written complaint to the address specified.
- By telephone, fax, e-mail: to the CSC, the contractor safeguard staff or contractor's representative.

On receipt of a complaint, the CSC, contractor safeguard staff or representative will register the complaint in the complaints file and maintain alog of events pertaining to it thereafter, until its resolution. Immediately after receipt, three copies of the complaint will be made. The original will be kept in the file, one copy will be used by the contractor's safeguard staff, one copy will be forwarded to the CSC, and the third copy to the PPMU within 24 hours of the complaint being made.

Information to be recorded in the complaints log will include:

- The date and time of the complaint.
- The name, address and contact details of the complainant.
- A short description of the issue of complaint.
- Actions taken to address the complaint, including persons contacted and findings at each step in the complaint redress process.
- The dates and times when the complainant is contacted during the redress process.
- The final resolution of the complaint.
- The date, time and manner in which the complainant was informed thereof.
- The complainant's signature when a resolution has been obtained.

Small complaints will be dealt with within one week. Within two weeks (and weekly thereafter), a written reply will be delivered to the complainant (by hand, post, fax, e-mail) indicating the procedures taken and progress to date.

The main objective will be to resolve an issue as quickly as possible by the simplest means involving as few people as possible, at the lowest possible level. Only when an issue cannot be resolved at the simplest level and/or within 15 days, will other authorities become involved. Such a situation may arise, for example, when damages are claimed and the amount to be paid cannot be resolved or the cause of the damages determined.

World Bank Grievance Redress Mechanism:Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanism or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Subproject affected communities and individuals may submit their complaints to the WB's independent Inspection Panel which determines whether harms occurred or could occur, as a result of WB non-compliance with its policies and procedures.

Complaints may be submitted at anytime after concerns have been brought directly to the WB's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS), please visit www.worldbank.org/grs. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

b) Penalty System

In the compliance framework, if non-compliance with environmental regulations are discovered by ECO/CSC/ES/IEMC during the site supervision, 2% values of interim payment of the contractor of this month will be held back. The Contractor will be given a grace period (determined by CSC/ES) to repair the violation. If the Contractor performs the repairs within the grace period (confirmed by CSC/ES), no penalty is incurred and keeping money will be pay. However, if the Contractor fails to successfully make the necessary repairs within the grace period, the Contractor will pay the cost for a third party to repair the damages (deduction from keeping the money).

In the case of IEMC/CSC/ES not detected of non-compliance with environmental regulations of the contractor, they will be responsibility payment to repair the violation.

6.5.3. Reporting Arrangements

ESMP monitoring and reporting requirements are summarized in*Table6.8*.

Table6.8:Regular Reporting Requirements

No.	Report Prepared by	Submitted to	Frequency of Reporting
1	Contractor to the Employer	PPMU	Once before construction commences and monthly thereafter
2	Construction Supervision consultant (CSC)	PPMU	Weekly and monthly
4	Community Monitoring	PPMU	When the community has any complaint about the subproject safeguards implementation
5	PPMU	CPMU	Monthly
6	CPMU	WB	Every six-month

6.6. ESTIMATED ESMP COST

The EMP costwill comprise: (a) cost for resettlement and land acquisition; (b) cost for implementation of the mitigation measures by the contractor; (c) cost for supervision by the CSC; (d) cost for the Environmental Management Consultant (EMC) including monitoring of environmental quality; (e) cost for water quality/ecology monitoring during operation for at least 2 years; and (f) supervision and safeguard management costs incurred by PPMU and CPMU. All the costs will be included as the subproject cost as shown in *Table6.9*.

- Cost for the implementation of the mitigation measures during construction will be part of the contract costs while the costs for monitoring by the CSC will be part of the construction supervision contracts.
- Cost for EMC and monitoring of environmental quality during construction is included in the subproject cost (*Table6.9*).

- Costs for PPMU operations related to the EMP are provided for in the subproject management budget of the PPMU.
- Cost for technical assistance for safeguard training and technical services to be provided to mitigate the potential negative impacts during construction and operations of the subprojectcomponents.
- Cost for technical assistance for mitigation of potential negative impacts due to the implementation of the livelihood models especially (a) on poor farmers including undertaking socioeconomic survey, promoting aquaculture products, and implementation of the FFS on aquaculture models in the subproject areas and building farmers networks, and (b) for establishment of a registration system for aquaculture farmings to mitigate potential negative impacts due to possible expansion of the models in the future.

It is estimated that the EMP implementation cost (excluding those to be included in civil works contract and CSC contract and RAP) will be about 7.199.848.640VND over a 4-year period.

Table6.9: Cost for ESMP in the entire subproject

Activity	**Source of fund**	**Total cost (VND)**
(a) Resettlement and land acquisition	Part of subproject cost	
(b) Mitigation measures during the construction phase	Part of contract cost	
(c) Safety monitoring during the construction phase (48months x 5 million VND/months)	Part of subproject cost	240.000.000
(d) PPMU environmental staff	Part of subproject cost	240.000.000
(e) Environmental monitoring in the entire subproject (see in *Table6.5*)	Part of subproject cost	1.479.848.640
(f) Environmental monitoring consultant (EMC)	Part of subproject cost	240.000.000
(g) Technical assistance (national consultant) for safeguard training and development and consultation of the operation plan for subproject including meetings and workshops for 2 years during 2019-2021	Part of subproject cost	1.000.000.000
(h) Technical assistance (national consultant) for (i) planning and undertaking socio-economic survey for the farmers in the pilot sites and nearby areas for 3 years during (2019-2021) to evaluate effectiveness of the pilot models, (ii) development of a registration program on aquaculture farming in the subproject and nearby areas, and (iii) development of FFS application and implementation of a series of	Part of subproject cost	4.000.000.000

Activity	Source of fund	Total cost (VND)
technical workshops, TOT, and development of guidelines and awareness materials, and study visits and building farmer network etc. (to be implemented during 2017-2020)		

CHAPTER 7. PUBLIC CONSULTATION AND DISCLOSURE

7.1. SUMMARY ON THE PROCESS OF ORGANIZING PUBLIC CONSULTATION

7.1.1. Summary of consultation meetings of CPCs and other organizations directly affected by the subproject

After completing the subproject ESIA report, the Subproject Owner sent dispatch with the EIA report to the People's Committees and the Fatherland Front of the communes of Nam Can, Ngoc Hien, U Minh, Phu Tan, and Tran Van Thoi districts, U Minh Ha National Parkand Ca Mau Economic Zone Management Board in the subproject area for consultations and co-ordinate with the CPCs to organize public consultation meetings for people directly affected by the subproject.

All communes, after receiving the dispatch have written comments to the Subproject Owner, which are enclosed in Appendix 4.

7.1.2. Summary of consultation meetings with the community directly affected by the subproject

The Subproject coordinated with the local authorities to conduct consultations with the affected communities, including:

- Those who are affected by the construction of the embankment and reforestation in the ecological shrimp model of Nam Can and Ngoc Hien districts at 8:00 pm on July 18, 2017, at Ngoc Hien District People's Committee. The participants include: affected communities, mass organizations of the communes: Lam Hai (Nam Can district); affected communities, mass organizations of the communes: Vien An Dong, Tan An Tay, Tam Giang (Ngoc Hien district), and the branches and unions and local authorities of Nam Can and Ngoc Hien districts.
- Those who are affected by the construction of thebreakwater, embankment to reduce landslide, recover important protection forests along the coast at 14:00 on 18/7/2017 at the People's Committee of Phu Tan District. The participants include affected communities, mass organizations in Phu Tan commune, Tan Hai commune, Cai Doi Vam town; and thebranches and unions and local authorities of Phu Tan district.
- Those who are affected by the construction of freshwater reservoirs at 8:00 pm on July 19, 2017 at the People's Committee of Khanh An Commune. The participants include: affected communities, mass organizations of Khanh An commune,branches and unions and local authorities U Minh district

- Beneficiaries from livelihood development activities at 14h00 on 19/7/2017 at the People's Committee of Tran Van Thoi district. The participants include beneficial community, mass, organizations of Khanh Binh Tay and Khanh Binh Bac communes,branches and mass organizations and local authorities of Tran Van Thoi district.

The list of participants and minutes of public consultation meetings are attached in Appendix 4. The public consultation photos are in Appendix 5.

The presentation in the public consultations to publicly inform about the subproject to the community and local authorities:

- Dissemination about the subproject, including Locations, components, livelihood activities and livelihood development for people in the subproject area, implementation schedule, implementation budget.
- Introduction of the environmental protection regulations by the Government and the Donor when the subproject is implemented.
- Analysis of impacts caused by subproject activities on the natural environment, social environment, land acquisition impacts, impacts on production and daily life of people, etc.
- Presentation of solutions to overcome and control negative impacts on the environment, society, and production of people....when the structure items of the subproject are implemented.
- Presentation of plans for environmental management, control and protection during the preparation, construction and operation of the subproject works.
- The Investor is committed to complying with the environmental protection regulations when implementing the subproject, adhering to the management and technology solutions as well as the management of the compliance with the mitigation measures mentioned above by the construction contractors.
- People and representatives of departments and sectors discuss and comment to complete the EIA report.
- The Investor answers people’s feedback and commits to implementing the environmental protection measures brought about in the consultations.

7.2. PUBLIC CONSULTANT RESULTS

7.2.1. Opinions of CPCs

- Through the consultations about negative impacts by the Subproject on the natural and socio-economic environment in general, we found that although itaffects people’s lives in the area impacts areinsignificant. If the Subproject is carried out, it will bring great benefits to the production and daily life of people in the area and localities agree and support the Subproject development and expect it to be implemented soon.
- The contents of the EIA report of the Subproject listed in detail environmental and social impacts, solutions and relative mitigation measures in line with local conditions.
- The Subproject Owner must comply with the mitigation measures proposed in the report.
- During the construction phase, the construction unitsmust comply with the stipulated principles and causet least environmental impacts.

7.2.2. Opinions of Ca Mau Economic Zone Management Board

- The Ca Mau Economic Zone Management Board unified the plan of building the reservoir over 102.2ha of public land under the management of the Board.
- The Board is cooperating with enterprises to produce short-timed trees and return to the state when there is a need to use it without compensation, support nor any other expenses.
- The Board will allocate 70ha of resettlement land under their management for disposal of excavated soil from the reservoir construction for ground leveling of this area without any compensation and site clearance.

7.2.3. Opinions of U Minh Ha National Park

The consultant team has worked with U Minh Ha NP (Vo Doi SUF) on the impact of reservoir construction on the NP and on the ability to collect water from the park to the reservoir. The results show that:

- The distance from the reservoir construction area to the national park is about 5km so the impact of the construction to the NP is negligible
- There is a sluice system in the park for water management for the park. In the rainy season, the park will drain the water from the park to the surrounding canals. Water from the inside of the park will be contaminated with Tanin (from melaleuca decay), especially during the first rains, so it will be difficult to use water for water supply.

7.2.4. Opinions of community representatives

- After listening to the presentation from the representative of the subproject owner, the local community agrees and very support for the subproject implementation, they expressed the desire for the subproject to be soon implemented to promote the effectiveness of the subproject in the socio-economic development of the locality.
- When construction, it is necessary to consider the elevation height of the embankment to avoid impacts on people's living and it should be located inside but not close to the river.
- People who lost their land for the embankment construction willing to hand over their land to the Subproject Owner without any compensation for land and buildings on the affected land.
- As the subproject uses public land, environmental and social impacts due to the subproject implementation are negligible.
- Agree with the mitigation measures proposed by the Subproject.
- The water supply of the reservoir is very essential to the locality.
- Acid conversion in the reservoir will affect the living and production of the surrounding people as the soil in the area is very strongly affected byalum.
- Agreed with the proposed models and recommend to develop the breed to bring high efficiency because now people buy breed from other areas with high prices, which is not effective.

7.2.5. Opinions and commitments of Subproject Owner on recommendations and requirements of concerned agencies, organizations, and communities in the consultations

The Subproject Owner accepts all opinions from the communes and local communities and commits to implementing all measures as set out in the report and all responses from the consultations were included in the design and the ESIA report of the Subproject.

7.3. INFORMATION DISCLOSURE

According to the request of the Government and the WB, Ca Mau Project Management Committee will disseminate the draft of this report in Vietnamese version at the CPO office, DARD office, PPC office, DPC office, and subproject communes. The English version of the report will be published on the WB's Infoshop. The official versions of this report will also be disclosed at the locality and the Infoshop.

CONCLUSIONS, RECOMMENDATIONS, AND COMMITMENTS

1. CONCLUSIONS

Climate change is strongly developing, which seriously affects the natural resources, environment and socio-economic development of Ca Mau province. Ca Mau has been facing difficulties and obstacles to sustainable development, namely:

- Lack of fresh water is the main obstacle to the socio-economic development in Ca Mau province. Freshwater supply for daily life and production in Ca Mau province is mainly from underground and rainwater. Overexploitation of groundwater makes it decrease and is the risk of soil subsidence and salinity intrusion into the underground aquifers which are exploited etc.
- The status of coastal erosion/landslide has been becoming serious. Mangrove forest has been declining. As a consequence, livelihoods of coastal people are heavily affected.
- The southern areas of Ca Mau province are newly reclaimed, especially Ngoc Hien and Nam Can districts. Due to the low terrain and influence of the East Sea tides, irrigation works are relatively simple, which are not safe enough for settlers and their production activities.

The solution of the wave breaker that does not directly prevent waves but develops the mangrove belt to reduce the energy of waves when they hit shore is considered a long-term and stable solution. Building the rainwater reservoir for stable water supply for local people is an essential to ensure the livelihood of people in salty areas. Upgrading dike embankment combining with rural transport development contributes to boosting production, helping people take initiative in coping with erratic weather conditions, which are basic solutions and foundation for people's adaptation to climate change and sea level rise. However, any construction works have certain impacts on the natural and social environment. Based on the analysis of environmental impacts by the Subproject, it is possible to draw conclusions about impacts in two aspects as follows.

On the positive side:

- Being active works in adaptation to climate change, sea level rising, thus protecting production, people's living inside the embankment.
- Immediately prevent loss of forest soil due to landslides. In the long run, regenerate mangrove forests which were lost due to erosion over the years.
- The embankment increases the capacity of natural disaster prevention, improvement of the natural environment, ecological environment and biodiversity from the mangrove forests.
- Active of the freshwater source to provide stable water for people in the salty area to reduce the exploitation of groundwater and the brisk of soil subsidence.
- Actively prevent high-tides to protect production in response to sea level rise.

On the negative side:

- When constructing subproject, it acquires 162,95ha of land permanently and 157,39ha of land temporarily.
- Impact on the water environment (domestic wastewater from workers, rainwater washing construction waste into the sea, wash alum ...).

- Impact on the air environment (due to material transfer, dust, exhaust gases of construction vehicles, transportation of materials, odors ... operation of construction equipment causing noise) affects the activities of people in the area.
- Impact on the society (workers from other places have different customs from the local people, an increase of living activities ...) affects the psychology of people; informal information may cause confusion for people.
- Environmental incidents may occur like occupational accidents, fire and explosion, submersible construction equipment, effects of mine/UXO explosion, epidemics and traffic accidents ...
- When operating the wave breaker, subsidence may affect the newly planted forest; Incidents of water supply station affect the quality of domestic water; landslide on the embankment affects the production of people.

With the above impacts, there are mitigation measures (chapter 4) including:

- During the site clearance, minimize impacts of land acquisition, use public soil available to build the works.
- Organize well labor and environmental sanitation to avoid environmental pollution caused by workers and construction machinery.
- Collect and treat solid waste, grease, and wastewater arising during construction and operation phases.
- Implement measures to reduce impacts caused by noise, vibration during the construction phase.
- Implement measures to minimize impacts on the air environment during transportation and gathering materials for the construction process.
- Manage and educate workers in relationships with local people.
- Widely disseminate to the public the subproject impacts on the environment and propose mitigation measures.
- Propagandize and educate to raise awareness of the protection of works to ensure long-term operation and protect the environment.

In addition, the Subproject Owner committed to being responsible for the environment management agencies of the State and local authorities to always carry out commitments and solutions in environmental protection. Minimizing, controlling negative impacts must always be within the environmental and natural regulations.

Besides, environmental monitoring should be undertaken to ensure that the subproject activities do not cause negative impacts on the environment. Monitoring results will be reported periodically to the Ca Mau Department of Natural Resources and Environment.

2. RECOMMENDATIONS

Environmental and Social Impact Assessment report again confirms that the negative environmental impacts are small to moderate, temporary and can be mitigated during the subproject implementation process. It can be fully minimized and overcome by simple technical solutions at a low cost. During the pre-construction, construction and operation phases, concerned parties must comply strictly with the subproject ESMP to ensure sustainable efficiency of the subproject. The impacts on community, environment and sustainable livelihood development for Climate change adaptation of Ca Mau province is mainly positive and long term. Since it is recommended to competent authorities, World Bank

to consider and approve the next steps to implement the subproject on time. It is recommended thatenvironmentalmanagement agenciesmonitor to ensure the construction process complying technological parameters and implement environmental monitoring during subproject construction and operation.

3. COMMITMENTS

The subproject owner commits to strictly implement measures to minimize the environmental impacts as stated in Chapter 4, the environmental and social management plans described in Chapter 5 in accordance with the environmental standards and regulations promulgated by the State; implement community commitments as stated in Section 6.3, Chapter 6 of this EIA report. Comply with the general regulations on environmental protection related to the phases of the subproject as follows:

- Report to the subproject CPCs on the content of the decision approving the EIA report together with the copy of approval decision.
- Public listing in localities of the approved EIA summary report, clearly stating the type and volume of wastes; technology and equipment for waste treatment; the level of treatment according to the characteristics of the waste compared to the standard; other measures for environmental protection.
- Environmental protection during the construction phase: implement the measures to mitigate negative impacts on the environment caused by the subproject and conduct environmental monitoring in accordance with the requirements set out in the approved EIA report as well as other requirements stated in the decision approving the EIA report. During the implementation of the construction activities of the subproject, there are changes and adjustments in the contents and measures of environmental protection have been approved or certified, must be reported in writing to the Ca Mau DONRE and only implement these changes and adjustment after the written approval of the competent authority.
- Be responsible to cooperate and create favorable conditions for the State management agency in charge of environmental protection to supervise and inspect the implementation of environmental protection contents and measures of the subproject; Provide adequate information, relevant data when requested.
- Monitoring and supervision program will be implemented during the construction and operation of the subproject. Funds for environmental monitoring will be prepared by the Subproject Owner;
- During the subproject implementation, if violating international conventions, Vietnamese standards on environment and occurrence of environmental incidents, the subproject owner must take full responsibility before Vietnamese law.
- During the preparation, construction and operation phase, the subproject owner will implement measures to mitigate adverse impacts on the environment as described in Chapter 4.
- Commitment to implement regulations on environmental protection:
  - Cooperate with local authorities, agencies to implement regulations related to environmental protection of the subproject area.
  - Full responsibility before Vietnamese law if violating the Vietnamese regulations and commit to compensate and remedy environmental pollution if environment incidents or risks occur during subproject implementation.

- Restoration of the environment in accordance with the law on environmental protection after closing the subproject.

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APPENDIX

APPENDIX 1: RELATED LEGAL DOCUMENTS

APPENDIX 2: LAYOUTS AND MAPS RELATED TO THE SUBPROJECT

APPENDIX 3: ANALYSIS RESULTS OF EXISTING ENVIRONMENTAL QUALITY

APPENDIX 4: PUBLIC CONSULTATION DOCUMENT

APPENDIX 5: PICTURES RELATED TO THE SUBPROJECT

APPENDIX 6: DREDGED MATERIALS MANAGEMENT PLAN

1. Location of Dredging, Volume and Characteristics of Dredged Materials

In the subproject, only the reservoir generates excavated soil with a volume of 918,780 m^3.

Based on the analysis result of sediment/soil samples in Chapter 2, with the pH values is very low (about 3.0)and heavy metal contents are within the standard of QCVN 43:2012/BTNMT QCVN- National technical regulation on sediment quality and QCVN 03-MT:2015/BTNMT- National technical regulation on allowable limits of heavy metal in soils (agricultural production area).

2. Final Disposal Site

The disposal site of the reservoir item is the resettlement area of Khanh An commune, it is now under management of Ca Mau Economic Zone Management Board. This area is very low and the excavated soil will be used for levelling this area.

Total volume of excavated soil of 918,780m^3 will be blowed to the disposal site by a pipeline with the lengthest distance from the construction site to the disposal area is about 3.0km.

3. Contractor's Dredging Management Plan

The Contractor is required to prepare a Contractor's Dredging Management Plan (CDMP) and submitted to the Environmental Consultant of the Construction Supervision team and the PPMU Environmental Officer for review and approval. The CDMP will include, but not limited to the followings:

- The Scope of Works in the Contract package, construction method and schedule
- Volume and quality of water quality and sediment quality in the dredging area covered by the contract.
- Water users that may be affected by the dredging
- Materials uploading and transportation method: indicate proposed route of the transport from the dredged site to the disposal area, time of operation, type of vehicles/trucks and proposed measures to reduce the leakage of the dredged materials from the transport means.
- Schedule to inform the nearby communities about the subproject, disclosure of name and contact number for possible complaints.
- Potential social and environmental impacts, including the site-specific impacts and risks
- Mitigation measures to address the potential impacts and risks. The mitigation measures should be proposed based on ESIA/ECOP, ESMP, SEMP, the potential impacts and mitigation measures presented in Section 4 and 5 of this Plan and the following requirements:
- Environmental Quality Monitoring plan carried out by the contractor (particularly pH, DO, TSS, BOD, salinity etc. for water and heavy metals including pH, Hg, As, Cd, Cu, Pb, Zn and Cr, Organic Materials and Mineral Oils for sediments and soil
- For soil and sediment: The number of samples taken will follow the following guidelines
- At least one water, soil and sediment sample must be taken for each contract package

Table 1: The number of Sediment samples

Volume of dredged (m^3)	*No of Sediment Samples*
Up to 25,000	3
25,000 to 100,000	4-6
100,000 to 500,000	6-10
500,000 to 2,000,000	10-20
For each 1,000,000 above 2,000,000	Additional 10

- Consultation with affected community about the draft CDMP
- Excavated soil is separated from dredged materials from source. Excavated soils will be reused on-site and off-site as much as possible and transported to the nearest disposal site appraised under ESIA, or identified and approved during detail engineering design or construction phase;
- The mitigation measures are adequate to address the potential social and environmental impacts associated with various steps and activities, areas of influence and receptors of dredging, temporary storage, transportation and final disposal of the dredged materials.
- Field survey are carried out by the Contractor during the preparation of the CDMP in order to identify if there are additional sensitive receptors not identified previously under the subproject and proposed additional site-specific mitigation measures accordingly.
- Contractor's environmental monitoring plan are included
- Commitments to carry out corrective actions when excessive pollution is determined, or when there are complaints about environmental pollution, social impacts from any stake holders.

4. Potential Impacts and Mitigation Measures for Dredging

Impacts and Description	**Mitigation Measures**
AT DREDGING AND TEMPORARY LOADING AREAS	
Odor and air pollution, nuisance Decomposition of organic matters under anaerobic conditions generates strong odor generated gases such as SO_2, H_2S, VOC etc. When the muds are disturbed and excavated, these gases are released much faster into the air. Exposure to odor pollution affect the health of workers, local residents and cause public nuisance	- Inform the community at least one week before dredging is started - Minimize the duration of temporary loading of dredged materials on-site - Temporary loading materials must be transported to the disposal site within 48 hours - Load the materials on-site tidily - Do not load the materials temporarily outside the construction corridor determined for each canal section - Avoid loading the sludge in populated residential areas or near public buildings such as kindergarten. Load the sludge as far from the houses and buildings as far as possible - Cover the temporary sludge loads when loading near sensitive receptors or longer than 48 hours unavoidable

Dust and nuisance - Temporary loading of sludge at the construction site cause nuisance to the public - Dry and wet mud may be dropped along the dredging area and on transportation route causing nuisance to the public and traffic safety risks	- Avoid temporary loading of dredged materials on-site - Dredged materials must be transported to the final disposal sites earliest possible and no later than 48 hours from dredging. - Use truck with water-tight tank to transport wet/damp dredged materials; - All trucks must be covered tightly before leaving construction site to minimize dust and mud dispersion along the road
Traffic Disturbance The placement and operation of dredging equipment and construction plants on the ground, temporary loading of the dredged materials may obstruct or disturb traffic and cause safety risks for the people travelling on the canal-side road, particularly on canal- crossing bridges which are usually very narrow	- Arrange worker to observe and direct excavators driver when traffic is busy
Social Disturbance - Concentration of workers and equipment, construction works, temporary loading of materials and wastes, traffic disturbance, dusts and odour pollution etc. will disturb daily activities and the lives of local residents - Conflicts may also be arisen if workers, waste, materials, equipment etc. are present outside the construction corridor	- Inform the community at least one week before construction is started - Monitor to ensure that physical disturbances are within the construction corridors only - Contractor recruit local labours for simple works, brief them about project environmental and safety requirements before started working - Contractor register the list of workers who come from other localities to the commune at the construction site - Led the water leaked from wet/damp dredged materials going back to the river, not to affect garden or agricultural land - Keep the areas to be disturb minimal - Enforce workers to comply with codes of conducts
Landslide and soil subsiding risks at dredging area - Relative deep excavation or cut and fills on the embankments that createslopes maylead tolandslide and soil subsiding at the slops or excavated areas, particularly in rainy weather - Deep excavation also causes risks to the existing buildings nearby, particularly the weak structures or located too close to the deep excavation area.	- During field survey for the preparation of CDMP, the contractor in coordination with the Environmental Officer of PPMU and the Environmental Consultant of the CES identify weak structures that may be at risk and determine appropriate mitigation measures accordingly - Consider and select appropriate dredging method that allow minimising soil subsiding risks, for example carry out stepped excavation, stabilise slops in parallel to dredging - Apply protective measures such as sheet

	piles at risky locations
Water Quality Degradation - Turbidity in water will be increased when the mud is disturbed; Water leaked from dredged material and surface runoff through disturbed ground also contains high solid contents. Muddy water entering irrigation canals will cause sedimentation. Aquatic life in the canal would also be affected by turbid water.	- If dredging is carried out directly onto the water, dredge at intervals to allow suspended materials to resettle before continuing. - Observe water colour at 20 m upstream and stop dredging when water colour there started to change
Increased Safety risk for the Public	- Place stable barriers along the construction corridor boundary to separate the site with nearby structures - Place warning signs and reflective barriers along the construction area, at dangerous locations and within sensitive receptors - Ensure adequate lighting at
Health and Safety risk to the workers - The health of workers may be affected due to exposure to odour and other contaminants from sludge - Risk of being drown	- Within two weeks before dredging is started, the contractor will coordinate with local authority to identify good swimmers or those who can dive in the locality, and hire at least one of them at each canal construction site deeper than 3 m and there are workers working on or near water surface. - Provide and enforce the workers to use masks. - If and when working in the water, protective cloths, rubber boots, gloves and hats must be wore.
Others	- Other relevant measures specified in ECOP or proposed by the contractors as necessary
MATERIAL LOADING AND TRANSPORTATION	
Dust and nuisance, traffic safety risks - Dust or wet materials may be dropped along the transportation route	- Use water-tight tank boats for transporting wet materials - Cover the materials tightly before leaving the construction site - Do no overload material on the trucks
AT FINAL DISPOSAL SITE	
Landslide and soil subsiding risks at final disposal site Landslide and subsiding risk may happen on slopes created at the final disposal site of dredged materials if the slopes created are too high, steep or unstable	- Level the materials after being disposed off - Slopes of the dumps will not be steeper than 45° - Build/create the embankments to protect slopes - Create and maintain drainage at the foot of each dump higher than 2m
Soil and water quality pollution - The disposal of acid sulfate soil affects the existing soil quality	Apply measures that ensure rainwater onto the acid sulfate materials is not mix with the surface runoff from the surrounding to

– No risks of subsidence and landslide for residential areas around this area – No impacts on river water quality	overflow uncontrolled at the site; rainwater will be infiltrated onto the ground on-site. This can be done by the following mitigation measures: – Build drainage ditches surrounding the designated disposal area – Use impermeable materials to cover the walls surrounding the materials to isolate it with the surrounding – Other measures proposed by the contractors to meet pollution control targets

5. Specific Guidance for Dredging

- Identifying the available land for disposing the dredged materials. The plan should also identify the possible lands to be appropriated for the disposal of dredged materials. 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.
- Preparing for a transportation plan. In case, the dredge disposal area is far away from the dredged sites, the DMP shall set out a transportation plan including: (a) methods of transportation (pipeline, barges, hopper barges) and uploading to the disposal area. If trucks are used, indicate proposed route of the transport from the dredged site to the disposal area, (b) time of operation, (c) type of transportation means and proposed measures to reduce the leakage of the dredged materials from the transport trucks, (d) contractors' responsibilities for cleaning the roads and carry out remedial works if necessary, and (e) a communication plan for the nearby communities including contact number for possible complaints.
- Plan for managing the disposal areas including: (a) plan for reducing the drainage; (b) construction of the perimeter dykes (c) construction of sub-containment area, if applicable; (d) planned thickness of the dredged materials (typically less than 1.5 meters); (e) any measures to protect ground water and soils (e.g., installation of PVC membrane).
- Designing the Draining for Disposal lands. As the dredged materials are in the state of mud at first and soil particles are suspended for 24 to 48 hours. All drainage water from disposal land shall be driven to the drains and discharged back to the river. 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 will be transported to a containing area which is appropriately located and properly design with an adequate size. The dredged spoil will be pumped to the disposal land and then overflow to a settlement pond, where turbidity and total suspended solids are settled. After some time, effluent is returned to the river. A typical design of the dike around each disposal may be as follows: Height: 2m, Footing width: 5 m, and Surface width: 1m. The plan should set out a basic layout.
- Monitoring the Disposed Dredged Materials. A plan for monitoring the dredged materials as well as water quality of effluent would be required. As stated before, an intensive monitoring would be required if the dredged material contains higher content of the heavy metals and other harmful materials than the national thresholds.

- In order to mitigate the issue of turbidity during dredging operation, the DMP shall set out dredging equipment and/or techniques suitable to the particular site. On laying dredging machines on a barge, contractors 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. If the disposal site for dredge materials is located far away from the dredger, a suction dredger should be used to transfer all the mud and soil in water to the disposal sites. The length of dredging sections should be limited less than 1 km and the dredging should be done one by one.
- As for the sections with acid sulfate soil or potential acid sulfate soil, the following measures should be considered: dredging should be carried out in the rainy season when more fresh water could be available for diluting acidic water; treating acidic water in the disposal areas before returning effluent to the canals; and proper locate and design of the disposal area not to affect the nearby agricultural land.
- At the completion of the contract, carry out an assessment on dredged materials, and determine the use of the dredged materials for activities such as: (a) construction (roads and dykes); (b) basis for individual houses; and (c) gardening.

APPENDIX 7: TERMS OF REFERENCE FOR CONSTRUCTION SUPERVISION CONSULTANT (CSC)

1. General

In order to prevent harm and nuisances on local communities, and to minimize the impacts on the environment during the construction of the civil works under the ICRSL project, Environmental Code of Practices (ECOPs) and subproject ESIA have been prepared and should be adhered to the Contractors and his employees.

The Construction Supervision Consultant (CSC)) is to provide professional technical services ("the Services") to help ensure effective implementation of the ECOP and subproject ESMP.

2. Scope of Services

The general services to be provided by the CSC are to inspect, monitor the construction activities to ensure that mitigation measures adopted in the ECOPs/ESMP are properly implemented, and that the negative environmental impacts of the project are minimized.

On behalf of the PPMU, the CSC will conduct the following tasks:

- Conduct regular site inspections;
- Review the status of implementation of environmental protection measures against the EMP and contract documents;
- Review the effectiveness of environmental mitigation measures and project environmental performance;
- As needed, review the environmental acceptability of the construction methodology (both temporary and permanent works), relevant design plans and submissions. Where necessary, the CSC shall seek and recommend the least environmental impact alternative in consultation with the designer, the Contractor(s), and PPMU;
- Verify the investigation results of any non-compliance of the environmental quality performance and the effectiveness of corrective measures; and
- Provide regular feedback audit results to the contractor's Chief Engineer according to the ECOP and site-specific mitigation measures;
- Instruct the Contractor(s) to take remedial actions within a specified timeframe, and carry out additional monitoring, if required, according to the contractual requirements and procedures in the event of non-compliances or complaints;
- Instruct the Contractor(s) to take actions to reduce impacts and follow the required EMP procedures in case of non-compliance / discrepancies identified;
- Instruct the Contractor(s) to stop activities which generate adverse impacts, and/or when the Contractor(s) fails to implement the ESMP requirements / remedial actions.
- For contracts that Site Environmental Management Plan (SEMP) are required, the CSC shall provide the final review and recommend clearance of all Site Environmental plans which may affect the environment. These include, but are not limited to: dredging areas, borrow pits and disposal sites, worker's camp plans. The CSC will review and approve the SEMP presented by the Contractors. Where these plans are found not to comply with the ESMP, ESIA or RAP, the CSC shall work with the PPMU and Contractor to establish suitable measures or remediation.
- Addressing Complaints: Complaints will be received by the Contractor's Site Office from local residents with regard to environmental infractions such as noise, dust, traffic safety,

etc. The Contractor's Chief Engineer or his deputy, and the CSC shall be responsible for processing, addressing or reaching solutions for complaints brought to them. The CSC shall be provided with a copy of these complaints and shall confirm that they are properly addressed by the Contractors in the same manner as incidents identified during site inspections.

- Certification for Monthly Payments: The CSC shall confirm the monthly payments for environmentally related activities implemented by the Contractor.
- Reporting: the CSC shall prepare the following written reports:
  - Bi-weekly report of non-compliance issues
  - Summary monthly report covering key issues and findings from reviewing and supervision activities

At the end of the project the CSC shall prepare a final report summarizing the key findings from their work, the number of infringements, resolutions, etc. as well as advice and guidance for how such assignments should be conducted in the future.

APPENDIX 8: TERMS OF REFERENCE FOR INDEPENDENT ENVIRONMENTAL MONITORING CONSULTANT

1. General

The independent environmental monitoring consultant (IEMC) is to provide professional technical services ("the Services") to monitor the compliance of subproject's activities based on provisions given in the approved environmental and social management plan for the subproject.

2. Scope of service

The major of objective of consultant service is to implement monitoring for social, environmental management activities of the subproject. Of which, the consultant will monitor the compliance of subproject's activities based on provisions given in the approved environmental and social management plan for the subproject.

Monitoring the implementation of environmental and social management plan (ESMP) is to ensure that all civil contractors implement fully the social and environmental mitigation measures identified in the environmental and social impact assessment (ESIA) report for the subproject and ensure that all impacts of subproject on natural environment, social – economic, community are minimized; the environment will be recovered after finishing the subproject. The unavoidable impacts on infrastructures, income and people's daily life will be compensated satisfyingly. Details as follow:

- Task 1: Support PPMU in preparing information dissemination at construction sites, bidding documents and joining negotiation for civil work contracts during subproject implementation:
  - Assist PPMU to prepare necessary contents for dissemination of environmental safeguards (ESs) documents during implementation of subproject;
  - Assist PPMU to incorporate environmental terms into Bidding Documents;
  - Assist PPMU during negotiation of civil work contracts to ensure compliance of environmental safeguard measures during sub-project implementation.
- Task 2: Provide guidance to civil work contractors in preparation of Site Environmental Management Plan (SEMP), review SEMPs prepared by contractors before their submission to PPMU for approval. According to requirements of approved environmental and social management framework (ESMF), civil work contractors must prepare a detailed plan for implementation of environmental terms in the signed contracts, Environmental Codes of Practice (ECOP) and contractor obligations stated in ESMP. EMC shall provide guidance to contractors in preparation of such plans, and review before their submission to PPMU for approval. During its periodical or regular supervision, EMC will evaluate compliance of civil work contractors in Site Environmental Management Plan (SEMP) implementation and recommend necessary remedial actions to PPMU. The monitoring plan will be based on the impacts and mitigation measures identified. The EMC will prepare a checklist to monitor the implementation of the mitigation plan for the construction phase and develop specific recommendations for implementation and control of environmental issues in the operation phase. In addition, the consultant will develop recommendations for environmental monitor and control during operation phase after finishing the project and transferring the subproject works to the subproject operator.
- Task 3: Prepare a form for environmental safeguards compliance monitoring, guide CSC on how to fill in such form which shall be incorporated in reports to PPMU and, upon their

request, be provided to CPO/ CPMU/ independent environmental monitoring consultant (IEMC) managed by CPO/ CPMU. According to ESMF, daily monitoring of safeguard compliance is assigned to CSC therefore EMC should prepare a form for monitoring compliance with ESMP/ECOP, SEMP and guide CSC on how to fill in such form. Information recorded in this manner must be reported to PPMU on a monthly basis and be kept by documentation for independent monitoring by IEMC, internal monitoring by CPO/ CPMU and Supervision Missions by WB.

- Task 4: Support PPMU in preparation of periodical environmental safeguard compliance and monitoring report for submission to CPO/CPMU, WB/CPO. Four (04) times a years, EMC shall conduct periodical monitoring on contractor's compliance with ESMP/ECOP and SEMP to: (i) evaluate compliance of terms on environmental safeguards stated in civil work contracts; (ii) review safeguards compliance monitoring forms filled by CSC; (iii) monitor environmental quality based on necessary samples and parameters stated in ESIA/ESMP and assess patterns of environmental quality during sub-project implementation, environmental impacts of ongoing subproject activities and effectiveness of mitigation measures; (iv) recommend suitable mitigation measures against adverse impacts of subproject activities and necessary revisions of subproject activities to avoid any long-term, negative impacts on the environment.

On such basis, the consultant will assist PPMU in preparation of quarterly reports on safeguards compliance at subproject level and patterns of environmental quality during subproject implementation, which shall be submitted to CPO/ CPMU; assist PPMU in reporting to CPO/ WB during supervision missions by WB.